

# A Taxonomy of Customer Relationship Management Analyses for Data Warehousing

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## Abstract

Customer Relationship Management (CRM) is a strategy that supports an organization's decision-making process to retain long-term and profitable relationships with its customers. Effective CRM analyses require a detailed data warehouse model that can support various CRM analyses and deep understanding on CRM-related business questions. In this paper, we present a taxonomy of CRM analysis categories. Our CRM taxonomy includes CRM strategies, CRM category analyses, CRM business questions, their potential uses, and key performance indicators (KPIs) for those analysis types. Our CRM taxonomy can be used in selecting and evaluating a data schema for CRM analyses, CRM vendors, CRM strategies, and KPIs.

**Keywords:** CRM, Customer Relationship Management, CRM Analyses, Taxonomy, Data Warehousing, KPIs, Key Performance Indicators.

## 1 Introduction

Customer Relationship Management (CRM) is a strategy that supports an organization's decision-making process to retain long-term and profitable relationships with its customers. Some define CRM as merely a business strategy (Jackson 2005), while others define it as a data-driven approach to assess customers' current needs and profitability (Fitzgibbon & White 2005). Furthermore, common variations of CRM include: operational CRM (O-CRM); analytical CRM (A-CRM); collaborative CRM (C-CRM); e-Commerce CRM (e-CRM); and mobile CRM (m-CRM) (Pass & Kuijlen 2001). Operational CRM focuses on the business processes; whereas, analytical CRM focuses on applying analytical tools to transactional data. Collaborative CRM focuses on collaboration between the customer and the company. E-Commerce CRM focuses on web-based interactions with customers. Mobile CRM focuses on providing access to CRM applications via handheld devices. Those definitions, however, only represent a partial view of CRM.

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In our earlier work, we defined a more complete definition of CRM as a data-driven strategy that utilizes organizational knowledge and technology in order to enable proactive and profitable long-term relationships with customers (Cunningham et al. 2003, Cunningham et al. 2004). It integrates the use of knowledge management, data warehousing, and data mining technologies to enable organizations to make decisions about, among other things, product offerings, marketing strategies, and customer interactions.

This brings us to the business motivation for using CRM. Interestingly, repeat customers can generate more than twice as much gross income as new customers (Winer 2001). Additionally, acquiring new customers can cost five times more than it costs to retain current customers (Massey et al. 2001). As such companies need to develop and manage their relationships with their customers such that the relationships are long-term and profitable. Therefore, companies are turning to CRM techniques and CRM-supported technologies to differentiate between customers that are valuable (or potentially valuable) from those that are not.

While companies realize that there are benefits of CRM, many have not actually achieved the full benefits of implementing CRM. In fact, recent statistics indicate that between 50% and 80% of CRM initiatives fail due to inappropriate or incomplete CRM processes, poor selection and design of supporting technologies (e.g. data warehouses), and the inability to utilize CRM technologies beyond the basic capacity due to the lack of understanding of business analyses (Gardner 1998, Pass and Kuijlen 2001, Myron & Ganeshram 2002, Panker 2002). Furthermore, analytical capabilities and the types of analyses used have been identified as essential components of CRM (Jackson 2005, Roberts et al. 2005, Alvarez 2006). These results show that a good understanding of various CRM analysis types, including a reference taxonomy on those analyses and business questions, and their impact on data warehouse design decisions could significantly improve the success of CRM processes.

While it is clear that the design of the CRM data warehouse model contributes to the success or failure of CRM, there are no agreed upon standardized rules for how to design a data warehouse to support CRM and how to effectively use CRM technologies. Thus, the ultimate long-term purpose of our study is to systematically examine CRM factors that affect design decisions for CRM data warehouses and to build a taxonomy of CRM

analyses and business questions to help CRM analyzers to effectively use CRM systems.

As stated earlier, understanding the types of analyses is essential to CRM, and it is also the first step in any design methodology. Therefore, the specific goal of this paper is to present a CRM taxonomy that includes CRM analysis categories, CRM business questions, their potential uses, and key performance indicators (KPIs) for those analysis types. The taxonomy could be used to guide CRM initiatives in the CRM planning stage. Furthermore, the taxonomy also would serve as a guideline for companies in the selection and evaluation of CRM data warehouse models, tools, vendors, and related technologies.

The rest of the paper is organized as follows: Section 2 presents the CRM analysis taxonomy, including the specific CRM analysis types and their uses. In Section 3, a discussion of how our CRM taxonomy can be used to select and evaluate a data schema for CRM analyses, CRM vendors, CRM strategies and KPIs. Finally, Section 4 concludes our paper with research contributions and future work.

## 2 A Taxonomy of CRM Analyses

An examination of the different types of CRM analyses is an important step. This section discusses (1) the types of analyses that are relevant to CRM as well as (2) how those analyses are used by business users in the form of business questions. Often, understanding the business use of the data analyses provides additional insights into how the data should be structured, including the identification of additional attributes that should be included in the model.

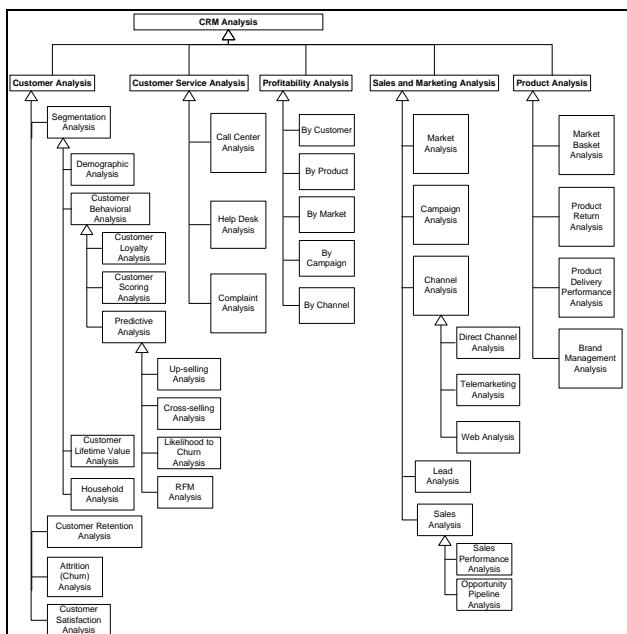


Figure 1: A Taxonomy of CRM Analysis Types

### 2.1 CRM Analysis Types

This section describes the classification of various CRM analysis types. The taxonomy of CRM analysis types we present is summarized in Figure 1 in the form of a UML class diagram. It should be noted that each subclass in

Figure 1 has specific types of attributes and implications on data warehouse design as well as on governances for maintaining the data. The specific implications of each analysis subclass will be discussed in a subsequent paper.

#### 2.1.1 Customer Analysis Category

The Customer Analysis category is a very important part of CRM analysis because it provides insight into an organization's customer base. That insight can be achieved by *customer segmentation analysis*, *customer retention analysis*, *customer attrition analysis*, and *customer satisfaction analysis*. *Customer segmentation analysis* allows a company to group similar customers into groups based upon characteristics that are common to the members of that group.

There are different types of customer segmentation analysis: *demographic analysis*, *customer behavioral analysis*, *customer lifetime value analysis* and *household analysis*. *Demographic analysis* pertains to analyzing inherent characteristics of a customer such as age, gender, income, and geography. *Customer behavioral analysis* enables a company to study a customer's buying propensities. In other words, customer behavioral analysis is used to determine which products and/or services a customer buys or is likely to buy. *Customer lifetime value analysis* is used to analyze a customer's historical value and future value to the company. The analysis of the relationships that exist between customers (i.e., lines of potential customer influence) is known as *household analysis*. It is important to understand and manage extended households, because a company's decision to treat a member of one segment potentially could have a negative impact on a related customer. *Customer retention analysis* tracks and analyzes the number of customers that a company is able to keep from one time frame to another (i.e. customer loyalty). *Customer attrition (or churn) analysis* allows a company to determine the number of customers lost over a period of time and provides insight into why customers leave. Its goal is to reduce the number of turnover of profitable customers by allowing a company to identify and take appropriate actions to retain customers that are likely to leave. *Customer satisfaction analysis* allows a company to gain insights into how a customer perceives the organization by analyzing customer survey responses about the company and its products and services (i.e. measures how satisfied the customer is). The results allow a company to understand the key drivers for customer satisfaction and loyalty.

#### 2.1.2 Profitability Analysis Category

Profitability is defined as revenues minus the sum of all costs. Profitability analysis, however, is very broad and can be thought of as a generalized class of CRM analysis type. The profitability analyses that are relevant to CRM include *customer profitability*, *product profitability*, *market profitability*, *channel profitability*, and *campaign profitability*. *Customer profitability analysis* is the ability to determine the profitability (or margin) of each customer; whereas, *product profitability analysis* is the

ability to determine the profitability of each product or service that the business provides.

Customer profitability analysis allows a company to identify not only *who* its customers are but also which ones provide the greatest margins to the company's bottom-line. *Market profitability analysis* deals with analyzing profits by geographical locations such as by sold-to locations, ship-to locations, regions, and branches that are within a company's organization structure. *Channel profitability analysis*, on the other hand, deals with the profitability of the different means of delivery of products and services. *Campaign analysis* pertains to analyzing the profitability and successfulness of each campaign program, where *successful* could be measured by campaign responsiveness.

### 2.1.3 Sales and Marketing Analysis Category

*Sales and marketing analysis* allows an organization to analyze its sales of products and services through all sales activities as well as the effectiveness of its marketing and campaign efforts. Specific types of sales and marketing analysis include *market analysis*, *campaign analysis*, *channel analysis*, and *sales analysis*. *Market analysis* allows a company to determine appropriate market segments, including understanding customer behaviors in specific markets, profitability in those markets, as well as campaign effectiveness in those markets. *Campaign analysis* analyzes the impact of different campaign programs on sales, including which customers respond to which campaigns. *Channel analysis* is used to study the different means in which a customer interacts with the company (e.g. direct, web, telemarketing). *Sales analysis* is used to examine the overall performance of sales of products and services.

### 2.1.4 Product Analysis Category

*Product analysis* allows a company to analyze its product portfolio. Specific types of product analysis includes: *market basket analysis*, *product return analysis*, *product delivery performance analysis*, and *brand management*. *Market basket analysis*, also known as affinity grouping, involves identifying which products commonly sell together. *Product return analysis* allows an organization to investigate the number of product returned as well as to provide insight as to why products are being returned. *Product delivery performance analysis*, also known as order fulfillment analysis, deals examines a company's ability to deliver product and services on time. *Brand management analysis* allows a company to manage its product portfolio. It is important, however, to analyze the products and services from the customer's perspective, which means including in the analysis all brands that influence the customer's decision to buy. This is different from the traditional approach to brand management, which involves arranging the company-owned brands in a single hierarchy along organizational lines (Lederer and Hill 2001).

## 2.2 Business Uses of CRM Analysis Types

CRM analysis categories must be associated with their business uses as well as *Key Performance Indicators* (KPIs). KPIs are used to measure a company's performance and can help organizations to identify internal areas for process improvements and ultimately influence customer satisfaction and possibly customer retention. KPIs were identified from both experience and literature (Boon et al. 2002, Kellen 2002, Rust et al. 2004). Due to space limitations, Table 1 shows an excerpt of the summary of potential uses for a sample of the different types of CRM analyses and places them in the context of the CRM taxonomy. Table 1 also includes sample KPIs as well as sample business questions in the context of the CRM taxonomy excerpt. The full summary of the CRM taxonomy will be published in a subsequent paper.

## 3 Discussion

In this section, we discuss how our CRM taxonomy can be used to select and evaluate a data schema for CRM analyses, CRM vendors, CRM strategies and KPIs. We also discuss several queries that correspond to some sample business questions in the CRM taxonomy.

### 3.1 The Role of the CRM Taxonomy in Designing Data Warehouses

Both a top-down and a bottom-up approach should be used with the CRM taxonomy to derive an appropriate data warehouse model as follows. The top-down approach would require that for each CRM business process, the relevant types of CRM analysis categories are identified. Then the Goal Metric Question (GQM) paradigm would be used to identify the relevant business goals, business questions, and metrics. For each business question, additional attributes needed to answer the question as well as additional attributes that may influence the metrics would also be identified. The bottom-up approach would require the identification of measures needed to compute each KPI. For each measure, the functional dependencies (FDs) would be determined. Those measures that have the same FDs should belong to the same fact schema, thus there would be a formal way of identifying relevant fact tables. Similarly, for each dimension, the dimension hierarchies would be developed by determining the FDs between dimension attributes. For those dimension attributes that have a FD, they should be represented as a hierarchy from the granular to the broader level.

### 3.2 Using the CRM Taxonomy to Evaluate Data Schema for CRM Analyses

In order to objectively quantify the completeness and suitability of a CRM data warehouse model, we proposed two new metrics (Cunningham et al. 2004): *CRM success ratio* and *CRM suitability ratio*. The *CRM success ratio* ( $r_{success}$ ) is defined as the ratio of queries that successfully executed to the total number of CRM queries. A query is executed successfully if the results that are returned are meaningful to the analyst. The CRM success ratio can be

used to measure the completeness of CRM data warehouse models. The range of values for  $r_{success}$  is between 0 and 1. The larger the value of  $r_{success}$ , the more complete the model. The following equation defines the CRM success ratio:  $r_{success} = Q_p / Q_n$ , where  $Q_p$  is the total number of queries that successfully executed against the model, and  $Q_n$  is the total number of CRM queries. The *CRM suitability ratio* ( $r_{suitability}$ ) is defined as the ratio

of the sum of the individual suitability scores to the sum of the number of applicable analyses. The following equation defines the CRM suitability ratio:  $r_{suitability} = \sum_{i=1}^N (w_i C_i) / N$ , where  $N$  is the total number of applicable analysis criteria,  $C$  is the individual score for each analysis capability, and  $w$  is the weight assigned to each analysis capability

#	Decision Class	Analysis Category Type	Business Question	Potential Use(s)	KPI
1	S	Customer Profitability Analysis	Which customers are most profitable based upon gross margin and revenue?	Classify customers	gross margin, revenue
2	S	Customer Profitability Analysis	What are the customers' sales and margin trends?	Classify customers	gross margin, revenue
3	S & T	Customer Analysis	What are the costs per customer?	Insights into what it really costs to do business with each individual customer; Can be used as the basis for segmenting customers in order to subsequently apply the appropriate strategy	Total revenue/total costs
4	S & T	Market Profitability Analysis	Which products in which markets are most profitable?	Setting performance goals, allocate marketing resources	gross margin/ products/ market
5	S & T	Product Profitability Analysis	Which products are the most profitable?	Managing product cost constraints, identify products to potentially eliminate from product line	gross margin/ product
6	S & T	Product Profitability Analysis	What is the lifetime value of each product?	Managing product cost constraints, identify products to potentially eliminate from product line	gross margin/ product

**Table 1: Excerpt of a Taxonomy of CRM Analyses (S=Strategic and T=Tactical)**

Our CRM taxonomy in conjunction with the CRM suitability ratio ( $r_{suitability}$ ) can be used to help an organization to determine the suitability of a data schema based upon the contextual priorities of the decision makers (i.e., based upon the company-specific CRM needs). The organization can use the CRM taxonomy to identify all of the CRM business questions ( $N$ ) from each of the CRM analysis category types that are relevant to it. Once a company has made that determination, then it can assign weights to each CRM business question ( $w_i$ ) within the CRM analysis category types in order to reflect the level of importance that each business question has to the organization. The company can then evaluate whether or not the specific CRM data warehouse schema that is being evaluated can analyze each of the business questions within each of the CRM analysis category type that the organization selected. The closer the CRM suitability ratio ( $r_{suitability}$ ) value is to 1, then the more

suitable the CRM data warehouse schema is for that particular company.

Our CRM taxonomy in conjunction with the CRM success ratio ( $r_{success}$ ) can be used to help an organization to determine the completeness of the data schema for CRM analyses. This is important since the company's business and analytical needs are likely to change over time; and the CRM data warehouse needs to be able to handle anticipated analytical needs (i.e. what is suitable today may not be suitable tomorrow). For example, a company can compute the CRM success ratio for each CRM analysis category type identified in the CRM taxonomy by dividing the total number of business questions within that category that the CRM data schema can answer by the total number of business questions within that CRM analysis category type. The result will be a measure of the completeness of the data schema to answer questions that are relevant to the specific CRM analysis category. Furthermore, the measure of

completeness for each CRM analysis category type can be summed to provide an overall measure of completeness for the CRM data schema.

### 3.3 Using the CRM Taxonomy to Evaluate Analytical CRM Vendors

The CRM taxonomy can be used to select and evaluate analytical CRM vendors. This can be accomplished by first eliminating vendors whose product cannot handle CRM analysis category types (or subtypes) that are important to the organization. Of the vendors that were not eliminated, the CRM suitability ratio ( $r_{suitability}$ ) and the CRM success ratio ( $r_{success}$ ) can be computed. The vendors whose product objectively scored the highest can be further considered by the organization

### 3.4 Using the CRM Taxonomy to Identify CRM Strategies and KPIs

Our CRM taxonomy can be used to help an organization identify appropriate strategies and KPIs. A company can review the CRM taxonomy to select the potential uses that it deems appropriate. Furthermore, the CRM taxonomy will allow the company to identify the CRM business questions to ask as well as the KPIs to measure in order to monitor and adjust their CRM programs.

### 3.5 Analyzing CRM Business Questions

We now discuss a few of the business questions from our CRM taxonomy that were analyzed using Figure 2, which shows the starter model that we presented in an earlier paper (Cunningham et al. 2004). The SQL statement in Figure 3 is used to identify the most profitable customers based upon total revenue and gross margin. By excluding the time dimension, the customer profitability SQL statement identifies the customer's historical lifetime value to the company. This is an important analysis that, in conjunction with the customer's future value and the customer service interaction costs, is used to classify customers in one of the four CRM quadrants (Table 1), which subsequently can be used to determine the appropriate strategy for managing the customer.

The SQL statement in Figure 4 is used to determine the margins for each product and subsequently identifies products that potentially may be eliminated from the company's product line. The ability to be able to determine the lifetime value of each product (irrespective of market) merely by modifying the SQL statement in Figure 4 to exclude the product code further illustrates the flexibility and robustness of the proposed CRM model

## 4 Conclusions

In this paper, we have presented a detailed taxonomy of CRM analyses together with how it can be used to select and evaluate CRM data warehouse schema, vendors, CRM strategies and KPIs. Our taxonomy can serve as a guideline for companies in the selection and evaluation of

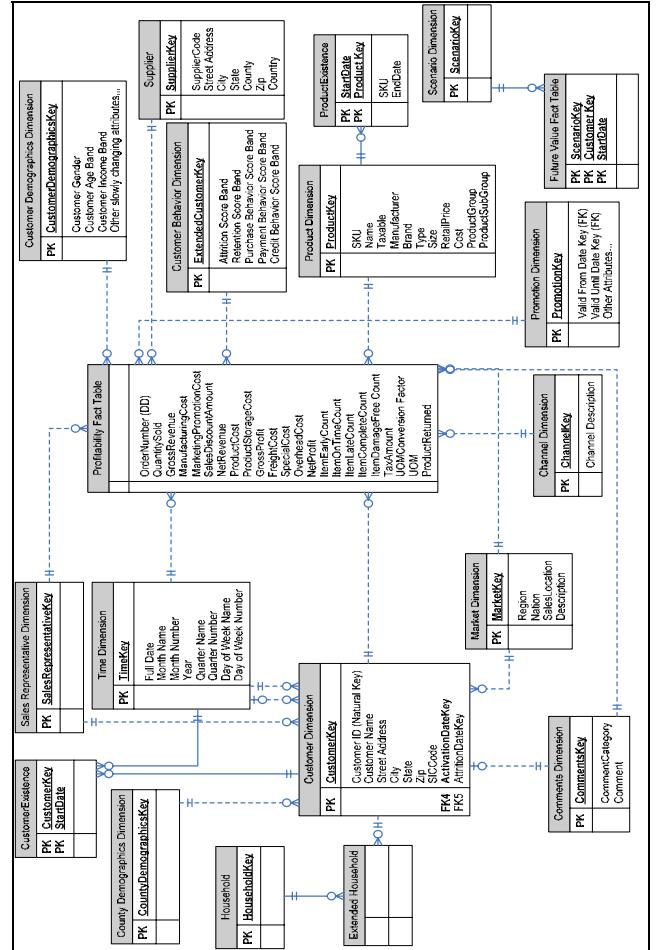


Figure 2: A CRM Data Warehouse Model

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SELECT b.CustomerKey, b.CustomerName, Sum(a.GrossRevenue) AS TotalRevenue, Sum(a.GrossProfit) AS TotalGrossProfit,
TotalGrossProfit/TotalRevenue AS GrossMargin
FROM tblProfitabilityFactTable a, tblCustomer b
WHERE b.CustomerKey=a.CustomerKey
GROUP BY b.CustomerKey, b.CustomerName
ORDER BY Sum(a.GrossRevenue) DESC;
    
```

Figure 3: Customer Profitability Analysis Query - Which customers are most profitable based upon gross margin and revenue?

```

SELECT c.Year, b.MarketKey, b.LocationCode, b.Location, b.Description,
b.CompetitorName, d.ProductCode, d.Name, Sum(a.GrossRevenue) AS TotalRevenue, Sum(a.GrossProfit) AS TotalGrossProfit, TotalGrossProfit/
TotalRevenue AS GrossMargin
FROM tblProfitabilityFactTable a, tblMarket b, tblTimeDimension c,
tblProductDimension d
WHERE b.MarketKey=a.MarketKey And a.TimeKey=c.TimeKey And a.ProductKey=d.ProductKey

GROUP BY c.Year, b.MarketKey, b.LocationCode, b.Location,
b.Description, b.CompetitorName, d.ProductKey, d.ProductCode, d.Name,
b.MarketKey

ORDER BY Sum(a.GrossRevenue) DESC;
    
```

Figure 4: Product Profitability Analysis Query - Which products in which markets are most profitable?

CRM data warehouses and related technologies. In addition to the design of the CRM data warehouse model, the selection of appropriate customer strategies and appropriate KPIs also contributes to the success or failure of CRM. To that point, our contributions include the creation of a taxonomy that can be used to select CRM strategies and KPIs. The taxonomy can also be used to

evaluate the capabilities of CRM data warehouse schemas as well as when evaluating vendors. Finally, we plan to: (1) extend the CRM taxonomy to include specific data warehouse design considerations for each of the CRM analysis categories; (2) refine the specific design methodology that incorporates the use of the CRM taxonomy; and (3) relate the specific CRM data warehouse design methodology to a broader data warehouse design approach.

## 5 References

- Alvarez, J. G., Raeside, R., & Jones, W. B. (2006). The importance of analysis and planning in customer relationship marketing: Verification of the need for customer intelligence and modelling. *Journal of Database Marketing & Customer Strategy Management*, **13**(3), 222-230.
- Boon, O., Corbitt, B., & Parker, C. (2002, December 2-3). Conceptualising the requirements of CRM from an organizational perspective: A review of the literature. In *Proceedings of 7th Australian Workshop on Requirements Engineering* (AWRE2002), Melbourne, Australia.
- Cunningham, C., Song, I-Y., Jung, J. T., & Chen, P. (2003, May 18-21). Design and research implications of customer relationship management on data warehousing and CRM decisions. In proc. of 2003 *Information Resources Management Association International Conference* (IRMA 2003) (pp. 82-85), Philadelphia, Pennsylvania, USA.
- Cunningham, C., Song, I-Y., & Chen, P. (2004). Data Warehouse Design to Support Customer Relationship Management Analyses. In K. Davis & M. Ronthaler (Eds.), *Proceedings of the 7<sup>th</sup> ACM International Workshop on Data Warehousing and OLAP* (DOLAP 2004) (pp. 14 – 22), Washington, DC, USA. ACM Press.
- Fitzgibbon, C. & White, L. (2005). The role of attitudinal loyalty in the development of customer relationship management strategy within service firms. *Journal of Financial Services Marketing*, **9**(3), 214-230.
- Gardner, S.R. (1998). Building the Data Warehouse. *Communications of the ACM*, **41**(9), 52-60.
- Jackson, T. W. (2005). CRM: From ‘art to science’. *Journal of Database Marketing & Customer Strategy Management*, **13**(1), 76-92.
- Kellen, V. (2002, March). CRM measurement frameworks. Available: <http://www.kellen.net/crmmeas.htm>
- Lederer, C. & Hill S. (2001). See Your Brands Through Your Customer’s Eyes. *Harvard Business Review on Customer Relationship Management*, pp. 151-173.
- Massey, A. P., Montoya-Weiss, M. M., & Holcom, K. (2001). Re-engineering the customer relationship: Leveraging knowledge assets at IBM. *Decision Support Systems*, **32**(2), 155-170.
- Myron, D., & Ganeshram, R. (2002, July). The truth about CRM success & failure. *CRM Magazine*. Available: <http://www.destinationcrm.com/articles/default.asp?ArticleID=2370>
- Panker, J. (2002, June). Are reports of CRM failure greatly exaggerated? *SearchCRM.com*. Available: [http://searchcrm.techtarget.com/originalContent/0,289142,sid11\\_gci834332,00.html](http://searchcrm.techtarget.com/originalContent/0,289142,sid11_gci834332,00.html)
- Pass, L. & Kuijlen, T. (2001). Towards a general definition of customer relationship management. *Journal of Database Marketing*, **9**(1), 51-60.
- Roberts, M. L., Liu, R. R. & Hazard, K. (2005). Strategy, technology and organisational alignment: Key components of CRM success. *Journal of Database Marketing & Customer Strategy Management*, **12**(4), 315-326.
- Rust, R. T., Lemon, K. N., & Zeithaml, V. A. (2004). Return on marketing: Using customer equity to focus marketing strategy. *Journal of Marketing*, **68**(1), 109-139.
- Winer, R. S. (2001). A framework for customer relationship management. *California Management Review*, **43**(4), 89-108