System Dynamics Modelling in CRM: Window Fashions Gallery

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Abstract: *The core research issue on which this study focuses is customer relationship management (CRM) in a designated window fashions firm. A system dynamics-based CRM model is developed to help evaluate the effectiveness of CRM in the firm and examine factors affecting customer satisfaction. Different relationships and linkages between the firm, its employees, and its customers are identified to establish feedback loops that analyze the system over time. The analysis of the CRM model shows that employee satisfaction is the key leverage point affecting customer satisfaction, number of customers, and sales volume of the firm. Product attractiveness and service quality also play an important role in influencing the level of customer satisfaction. On the other hand, advertising and employee training have only minor effects on customer satisfaction.*

Keywords: *Customer Relationship Management, System Dynamics, Customer Satisfaction*

1. Introduction

Maintaining long-term customer relationships is imperative because committed relationships can deliver greater value than that provided by the firm's core product (Zineldin, 2006). Customer relationship management (CRM) plays an important role in maintaining long-term relationships and generally refers to the management of relationships with customers over their lifetime. The increasing emphasis on CRM has led to a concern over how relationships among parties should be defined. CRM is no longer a strategy that only leading-edge enterprises use to gain a competitive advantage; it is now considered to be a necessity for business survival. CRM helps companies to understand their customers' needs, especially their relationship needs, and enables them to do so in a manner superior to that of their competitors. Companies must build strong foundations to reinforce their customer relationships. Moreover, they need to understand the market structure and develop long-term customer relationships, factors that are more important than low prices, advertising, promotions, or even advanced technology (Zineldin, 2006).

The increasing globalization of business and the customer-oriented marketing strategies adopted in recent years have led to increased levels of competition among companies. To compete with others, the powerful tool of CRM should be used (Chu, 2007). Recent practical applications of CRM include a model for predicting customer value (Chan et al., 2010), a CRM system to solve adverse selection problem for martketers (Cao and Gruca, 2005), an e-CRM framework to manage customer relationshops in electronic commerce (Romano and

Fjermestad, 2003), and a knowledge-enabled CRM to support business decisions (Ranjit and Vijayan, 2003). Evidence shows that CRM is not only used when doing business with customers, but is also aimed at retaining customers and prolonging business flows to generate profits. Maintaining customer loyalty is not easy in the customer-oriented and open marketplace of today, but is a goal to which every firm aspires.

The core research issue addressed in this study focuses on the CRM practices of a designated window fashions firm—Hunter Douglas Window Fashions Gallery—which is the leading manufacturer of custom window coverings worldwide. Hunter Douglas Window Fashions Gallery ("HDWFG") is a dealer authorized by Hunter Douglas to sell its custom-made window treatments and coverings in Hong Kong. It provides a wide variety of top–quality, innovative window coverings to meet the specific needs of homeowners. As a retailer, HDWFG faces the challenge of offering customers high-quality services and products and shorter delivery times while remaining cost-effective. This firm appreciates the need to investigate core factors that increase customer purchases, customer satisfaction, and customer loyalty so that resources can be focused to these factors, thereby maximizing firm profits.

2. Literature Review

2.1. Customer Relationship Management

CRM is one-to-one marketing activity in which an appropriate marketing strategy is adopted for each individual customer. The purpose of CRM is to develop a good understanding of each customer and foster greater

customer loyalty. In this sense, it is different from traditional marketing approaches that rely on frequent contact with a large number of customers. Bryan (2002) pointed out that adopting CRM is imperative to maintain relationships with suppliers and customers. Francis (2004) suggested that CRM is the core business strategy that integrates internal processes and functions with external networks to generate value that benefits customers, and represents an important way for firms to stay competitive in the market. Furthermore, the extensive use of CRM can have a substantial influence on gaining loyal and satisfied customers by improving their business while reducing acquisition costs and achieving acknowledgment of their brand, all of which translate into better financial performance (Gefen and Ridings 2002). Bryan (2002) expanded on the positive effects of CRM, a strategy often touted as a means of improving customer satisfaction and therefore of enhancing long-term customer loyalty.

2.2. Relationships among Parameters

Employee satisfaction (ES) is a crucial element of customer satisfaction (CS). A prior study (Berry, 1981) pointed out that if firms intend to satisfy their customers' needs, they must first satisfy their employees' needs. Further evidence in support of this view was provided by Adsit *et al*. (1996), who concluded that employee attitudes were one of the variables affecting CS in general. Furthermore, Reicheld (1996) adduced hard data quantifying the direct and quantifiable links between CS and ES. Therefore, to satisfy customers, firms must first focus on their employees (Coleman, 1990).

The efficiency of employees in completing orders in business-to-customer transactions is critical to CS (Nelson, 1970). Further confirmation of this concept was provided by Lee and Whang (2001), who suggested that the ability to fulfill and deliver orders on time was a key step on the road to success. An empirical study (Heim and Sinha, 2001) also concluded that variables underlying order completion efficiency (OCE) had a positive impact on CS. Therefore, a higher OCE rate leads to higher CS and hence to a higher customer retention rate. OCE is often related to order lead time (OLT), another measure considered in this study.

Kristin and Carol (2002) stated that interaction and communication between employees and customers are prime factors in the provision of quality services. Moreover, Bowen and Schneider (1988) also suggested that increased interaction between employees and customers provides opportunities for employees to understand their customers such that fast response times, connections, and empathy can then be developed. This shows that different forms of customer interaction (CI) are critical factors in defining service quality (SQ).

Apart from ES, SQ is also one of the important factors affecting CS. In a study (Cronin and Taylor, 1992) examining the interaction of SQ and CS, the results showed that while SQ had a significant effect on CS, SQ did not have a significant influence on CS. The importance of CS and its direct relationship with SQ and profitability have long been exhorted by researchers in many fields and industries (Brewton, 1990 ; Edwards, 1992), and there is growing evidence that investment in SQ improvement pays off in enhanced CS and customer retention (Francis, 2004).

Advertising (AD) is another factor that helps to build and maintain brand awareness and recognition, and in turn generates CS (Francis, 2004). This concept was further confirmed by Rucci *et al*. (1998), who showed that creating positive word-of-mouth, and therefore AD, are critical to maintaining a customer base and CS.

Prior investigations have demonstrated that product attractiveness (PA) is also related to CS. Chen and Chuang (2008) concluded that the aesthetic qualities of products are critical factors in achieving higher CS. Bottani and Rizzi (2008) also stated that the relationship between product criteria and CS has mostly been assumed to be linear. Therefore, it is highly likely that the higher the level of PA, the higher the degree of CS.

A previous study (Yi, 1990) pointed out that customer acquisitions are directly influenced by CS. Customers who are satisfied are more likely to return next time and sometimes recommend the service organization to others through positive word-of-mouth (Rucci *et al*., 1998), thereby helping the firm to gain new customers. Customer acquisition is defined as gaining new customers for the firm (Francis, 2004). Attracting more new customers to the firm increases the firm's customer base. Initial purchases refer to first-time purchases of products in which customers are usually satisfied before making their purchase; initial purchases are normally prompted by a successful customer acquisition strategy. Potential customers will become new customers and seek to purchase the firm's products, when efforts to acquire customers are successful. Once a customer has made the initial purchase, the number of purchases will increase.

Eric (2006) stated that CS is generally the measure of greatest concern to firms, reflecting an emphasis driven by the belief among firms that CS leads directly to customer loyalty (CL). Customers who are satisfied are more likely to return for future business and sometimes recommend the service organization to others through word-of-mouth (Rucci *et al*., 1998), thereby leading to the formation of CL.

CL is also related to revenue. According to Reicheld (1996), profits per customer increase with customer longevity. The longer they stay with the firm, the more willing they will be to pay premium prices, make referrals, demand less hand holding, and spend more

money. CL is emphasized because loyal relationships are hard for competitors to understand, copy, or displace, which helps to retain customers. Given that it costs significantly more to acquire a new customer than it does to retain a relationship with an existing customer, CL is believed to be beneficial to firm productivity and profits (Reicheld, 1996).

3. Causal Loop Diagram Development

Causal loop diagrams are used to record mental models representing interrelation and feedback processes in a system. Although studies in the existing CRM literature have introduced various relationships among parameters such as ES, SQ, CS, and CL, each study has examined only a few parameters and hence has not given an overview of CRM as a whole. Table 1 compares parameters investigated in prior studies with those examined in this paper. As Table 1 shows, the CRM model employed here covers all of the parameters observed in previous studies and includes several unique parameters such as OCE and OLT. These unique parameters are added to the model to reflect the nature of the business conducted by the window fashions gallery and provide a comprehensive picture of its CRM practices. The corresponding causal loop diagram for the CRM model adopted in a window fashions gallery is exhibited in Fig. 1.

4. Methodology

Stock and flow diagrams are used to capture the stock and flow structures of systems. The stock and flow model
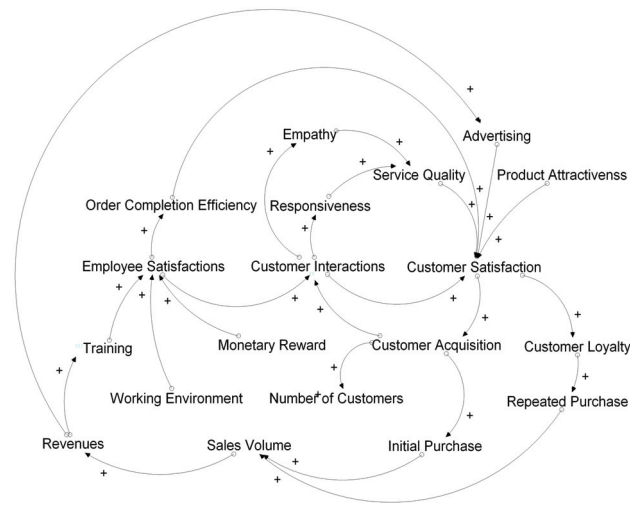

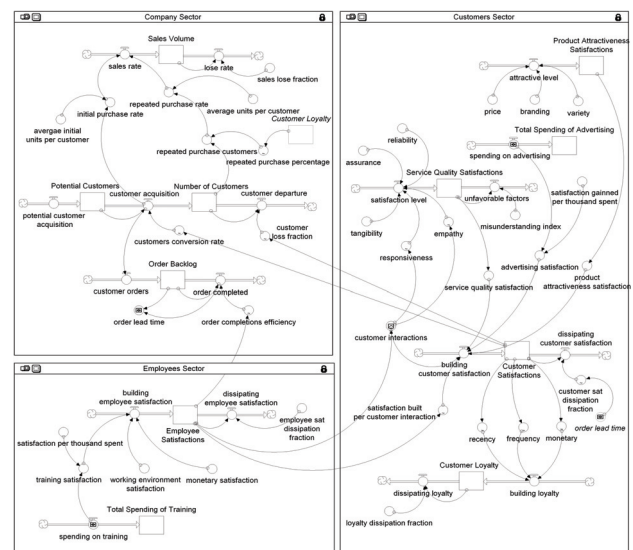Fig. 1. Causal loop diagram for the proposed CRM model

Fig. 2. System dynamics-based CRM model

presented on Fig. 2 is based on the causal loop diagram in Fig. 1, where the variables selected are translated into stocks according to their corresponding relationships and relevance to systems. A high-level map of the system that conceptualizes it as a three-sector model including firm employees, customers, and the firm itself is developed and shown in Fig. 2. The analysis is carried out on monthly basis and the length of the simulation run is 13 months, with the simulation interval being set at a default value of 0.25. The initial data are obtained from a survey in which ES is based on three factors—working environment, training, and monetary rewards—while CS

Parameters \ Authors	The CRM model	Steven and Thomas (1994)	Chen and Chuang (2008)	Yiannis and Denton (1997)	Rucci et al. (1998)	Anderson and Narus (1998)	Reinartz and Kumar (2003)
ES	✓			✓			
OCE	✓						
OLT	✓						
SQ	✓	✓		✓			
AD	✓						
PA	✓		✓	✓			
CS	✓	✓	✓	✓	✓	✓	
CL	✓			✓		✓	✓
No. of Customers	✓						
Initial Purchase	✓	✓					
Repeated Purchase	✓					✓	✓
Sales Volume	✓						✓

Table 1. Parameters studied in the prior literature and in the proposed CRM model

is based on four factors—CI, SQ, AD, and PA. A five-point Likert scale is used in which five represents "strongly agree" and one represents "strongly disagree". Because ES and CS are defined as stocks rather than variables in this model, to make them compatible with the model, the survey scales of 1, 2, 3, 4, and 5 are modified to the satisfaction levels of 0, 25, 50, 75, and 100, respectively. The total training spend refers to the total spend on employee training as recorded in the firm report for the previous year. SQ is based on five core components—tangibility, assurance, responsiveness, reliability, and empathy (Parasuraman *et al.*, 1988)—while PA is assessed according to three dimensions—product variety, branding, and price—with both measures based on a seven-point Likert scale.

To ensure the dimensional consistency of the stock and flow diagram, the components are converted into relative satisfaction values. A case in point in SQ is survey result 5.25 for tangibility satisfaction with a value of about 70. Given that the CRM model measures tangibility satisfaction on a monthly basis, the input value for tangibility satisfaction will be about 6 (e.g. 70/12). The other components of SQ and PA are calculated according to the same method. Because both forms of satisfaction are measured on a transactional basis in this model, the initial stock value of SQ can be set to zero. However, it is assumed that even a new customer will still have a low level of satisfaction contributing to SQ and PA. Thus, the initial stock value of SQ is set to 5 instead of zero. The behavioral loyalty approach is adopted in defining and measuring the CL value.

Francis (2004) stated that many direct marketing companies measure behavioral loyalty using variables like recency of purchase (R), frequency of purchase (F), and monetary value of purchase (M), where CL=(FxM)/R. Forty sets of customer records are randomly selected from the records of the window fashions gallery. The sample period is set to two years and the mean values are taken given that the three indexes count equally towards CL. A potential customer is defined as one who is interested in purchasing blinds from the window fashions gallery, the initial stock value of which is estimated by counting the total number of visitors in its retail shops and the potential number of customers currently within the shopping mall. Number of customers refers to the total number of customers in the window fashions gallery, while order backlog is the total number of pending or uncompleted orders in the window fashions gallery. Sales volume is equal to the total number of product units sold in the window fashions gallery and is calculated as the sum of initial purchase units and repeated purchase units within the firm. Most of the initial stock values are extracted from firm records.

5. Results and Findings

5.1. Simulation Results

Once the model is developed, all the growth factors and behavioral graphical relationships such as the customer conversion rate and the customer loss fraction are neutralized by setting the growth factors to zero and all the values in the graphical input relationships to one. The purpose of doing so is to examine the behavior of the model in equilibrium so that the inflow values are equal to the outflow values in the initial stage. After setting the model to equilibrium, the next run of the model includes relaxing the assumptions of zero growth factors and constant graphical input relationships. Relative values are input into the model and a simulation is run. The simulation confirms that an increase in ES leads to an increase in SQ and a decrease in OLT; increases in SQ, PA, and AD lead to an increase in CS; an increase in CS leads to an increase in CL; an increase in CL leads to an increase in repeated purchase customers; an increase in CS leads to an increase in CA; and an increase in the sales rate leads to an increase in sales volume.

5.2. Sensitivity Analysis and Policy Analysis

Sensitivity analysis is usually used to test model behavior and establish the variables that have a significant effect on model behavior or performance measures (Kambiz and Robert, 2000). In this section, three parameters—ES, SQ, and PA—are selected to perform the sensitivity analysis examining the relative influences of different variables on CS, number of customers, and sales volume. Tables 2, 3, and 4 show the sensitivity analysis results for ES, SQ, and PA on CS, number of customers, and sales volume, respectively, in which the satisfaction level is varied from 0 to 100 with a step change of 25 levels. The results reported in Table 2 show that increasing ES from 25 to 50 leads to a greater percentage change in CS, for which the increase is about 74%. The percentage increases in CS then level off at about 8% as CI and OCE near their maximum values due to the limited ability and capacity of employees. The results suggest that it may be enough to keep ES at a level of 75 or slightly higher, as further increases in ES appear to be uneconomic given that they lead to percentage increases in CS of only about 8%, which in turn contribute to only small increases in the number of customers. Table 2 shows relatively large percentage increases in number of customers (about 7%) and sales volume (about 5%) when ES is increased from 25 to 50. Subsequent changes in these measures follow the trend in CS in that when ES is increased from 75 to 100, the percentage changes in number of customers and sales volume become minor at only 0.7% and 0.6%, respectively. These results also confirm that keeping the ES level at about 75 or slightly higher is good enough, although the firm still wants to expand its customer base

ES	CS	% Change	No. of Customers	% Change	Sales Volume	% Change
0	29.21	N/A	2531.93	N/A	10684.15	N/A
25	38.97	+33.41%	2548.15	+0.64%	10728.50	+0.42%
50	67.91	+74.26%	2718.57	+6.69%	11251.71	+4.88%
75	80.96	+19.21%	2781.51	+2.32%	11433.84	+1.62%
100	87.63	+8.24%	2801.15	+0.71%	11497.96	+0.56%

Table 2. Percentage changes in parameters by varying ES

SQ	CS	% Change	No. of Customers	% Change	Sales Volume	% Change
0	76.78	N/A	2760.63	N/A	11368.17	N/A
25	81.18	+5.73%	2781.73	+0.76%	11434.62	+0.58%
50	85.57	+5.41%	2802.58	+0.75%	11502.60	+0.59%
75	89.97	+5.14%	2822.06	+0.70%	11567.11	+0.56%
100	94.36	+4.88%	2841.70	+0.70%	11630.72	+0.55%

Table 3. Percentage changes in parameters by varying SQ

PA	CS	% Change	No. of Customers	% Change	Sales Volume	% Change
0	76.26	N/A	2758.75	N/A	11362.34	N/A
25	82.11	+7.67%	2784.58	+0.94%	11444.29	+0.72%
50	87.97	+7.14%	2809.23	+0.89%	11525.02	+0.71%
75	93.83	+6.66%	2832.65	+0.83%	11603.99	+0.69%
100	99.69	+6.25%	2859.25	+0.94%	11700.87	+0.83%

Table 4. Percentage changes in parameters by varying PA

Spending on AD	CS	% Change	No. of Customers	% Change	Sales Volume	% Change
0	70.63	N/A	2737.58	N/A	11302.74	N/A
2.5	74.15	+4.98%	2750.28	+0.65%	11337.27	+0.31%
5	77.66	+4.73%	2764.69	+0.52%	11380.57	+0.38%
7.5	81.18	+4.53%	2780.39	+0.57%	11430.66	+0.44%
10	84.69	+4.32%	2795.74	+0.55%	11480.67	+0.43%

Table 5. Percentage changes in parameters by varying spending on AD ($K/ month)

Spending on Training	CS	% Change	No. of Customers	% Change	Sales Volume	% Change
0	76.01	N/A	2759.16	N/A	11363.19	N/A
2.5	79.49	+4.58%	2771.07	+0.43%	11401.12	+0.33%
5	81.95	+3.09%	2780.10	+0.33%	11430.88	+0.26%
7.5	83.18	+1.50%	2785.88	+0.21%	11449.62	+0.16%
10	83.79	+0.73%	2789.29	+0.12%	11460.57	+0.10%

Table 6. Percentage changes in parameters by varying spending on training ($K/ month)

OLT	CS	% Change	CL	% Change	No. of Customers	% Change	Sales Volume	% Change
2	76.83	N/A	20.59	N/A	2767.82	N/A	11380.57	N/A
1.5	78.75	+2.50%	21.40	+3.93%	2770.41	+0.09%	11398.23	+0.16%
1	82.34	+4.56%	22.76	+6.36%	2785.40	+0.54%	11446.89	+0.43%

Table 7. Percentage changes in parameters by varying OLT (month)

and achieve even higher sales volumes. Given that SQ is one of the major factors affecting CS, changes in SQ contribute directly to CS. Table 3 shows that the average percentage increase in CS is about 5% and that there is little variation in the percentage changes when SQ is increased from 0 to 100. Although both the number of customers and the sales volume show similar upward trends, their percentage increases (the average percentage changes in number of customers and sales volume are about 0.70% and 0.60%, respectively) are lower than those in CS. As PA is one of the significant parameters affecting CS, changes in PA directly influence CS. Table 4 shows that the average percentage increase in CS, number of customers, and sales volume is about 7%, 0.90%, and 0.70%, respectively, and that these percentages are quite stable over different levels. The growth in number of customers and sales volume is slightly higher when the PA level is increased from 75 to 100. These results emphasize the importance of making further improvements to PA, as customers may consider this a major factor in their level of satisfaction.

Tables 5 and 6 show the corresponding values for the sensitivity analysis of AD spending, CS training, number of customers, and sales volume, respectively, by varying AD spending from $0K/month to $10K/month with a step increase of $2.5K. Table 5 shows that the percentage increases for all parameters are steady. The average percentage increase in CS is about 5%, while those of number of customers and sales volume are 0.60% and 0.40%, respectively, implying that the percentage changes in the parameters are nearly proportional to the increase of AD spending. Table 6 shows that the percentage changes in CS, number of customers, and sales volume are not proportional to the increase in spending on training as they decrease as further step increases are made. A fixed increase in spending on training will result in a lower percentage increase in the three parameters.

As another form of analysis, policy analysis involves performing a planned range of policy experiments with a model and varying the policy parameters. In this study,

policy analysis is performed against OLT to examine the behavior of the model. The reference OLT is set to 2 months, the average number from the CRM model. For policy experiment 1, OLT is compulsorily set to 1.5 months regardless of the OCE and order backlog values. Table 7 shows the behavior of the model in policy experiment 1. It can be seen that the values for all of the attributes increase, the most obvious growth being seen in CS, which increases by about 2 levels. For policy experiment 2, OLT is set to 1 month only. Table 7 reports that all of the attribute values increase to a greater extent if OLT is set at one than they do if OLT is set at a higher level. This demonstrates that a further decrease in OLT can result in a further decrease in the proportion of customer dissipation and hence in a further increase in CS. This in turn affects the values of customer acquisition and CL, which themselves influence the number of customers and sales volume.

The sensitivity analysis described in this study demonstrates the key role played by employee satisfaction (ES) in firm performance. The results suggest that ES should normally be maintained at a level of at least 50, but that it is better to improve ES to a level of 75 to achieve the greatest improvement in different aspects of firm performance such as CS and sales volume. Given that training satisfaction, working environment satisfaction, and monetary satisfaction are the major components contributing to ES, it is suggested that resources be focused on these three areas. Percentage changes in CS, number of customers, and sales volume drop significantly as further improvements are made to the ES level. The sensitivity analysis for PA reveals that percentage changes in the number of customers and sales volume are higher when the PA level is increased from 75 to 100. Therefore, when the ES level is about 75, it is recommended that resources be refocused to improve PA, as further increases in the PA level to 100 will lead to comparatively large increases in the number of customers (0.2%) and sales volume (0.3%). To increase PA, the firm should focus on product variety, branding, and price. It is difficult to improve these three variables in the firm examined as they are centrally determined by the Hunter Douglas Group. Apart from the ES and PA parameters, step increases in other parameters such as SQ and spending on AD still exhibit stable growth in different aspects of firm performance, with SQ having a relatively strong influence on CS. Although spending on training is the least sensitive parameter among those tested, the results do not suggest that training is unimportant, as employees still require knowledge to improve customer service. Regular training remains a crucial aspect of maintaining ES, especially when new products are introduced to the market.

According to the policy analysis, shortening OLT from 2 months to 1.5 months is an effective way of improving CS, CL, number of customers, and sales volume. Reducing OLT from 2 months (average OLT) to 1.5 months is still possible, as OCE can be increased by improving ES. However, reducing OLT from 1.5 months to 1 month becomes difficult due to the minimum manufacturing period of 3 weeks. As a result, workflow improvements including ordering process enhancements may be one way in which OLT can be reduced further. However, additional investment in training and increased effort may be needed. In sum, the window fashions gallery should focus on different aspects of management that contribute to CS in different time periods and situations according to its ability to do so. This will allow it to define the best strategies for maximizing business growth.

7. Limitations and Conclusions

The system dynamics CRM model proposed helps to evaluate the effectiveness of the firm's CRM practices and to examine factors affecting CS, CL, number of customers, and sales volume. With respect to the sensitivity analysis and policy analysis results, it is suggested that keeping the ES level at about 75 or slightly higher is adequate, as further improvements in ES will not have the expected performance results. The firm should then shift its focus to other aspects of management that can lead to a greater increase in CS. The sensitivity results suggest that the firm should raise its PA level to 100. However, improving PA is difficult for the firm examined here as PA is controlled at the group level. In view of this, it is a good idea for the firm to shift its focus to increasing SQ and AD, factors that are much easier to control because they are within the firm's management scope. In summary, the window fashions gallery should focus on different aspects in different time periods and situations to define the best strategies for maximizing business growth.

By using the proposed CRM model as a pilot scheme, the marketing director of the case company, Hunter Douglas Window Fashions Gallery, said, "it helps us to greatly improve our customer services and rapidly respond to customer needs. Making our customers happier, we really retain more customers and gain more profit during the scheme". This confirms that the proposed model is effective and significant.

However, the simulation graphs presented here are only indications of patterns rather than actual numeric relationships and may not reflect reality. Besides, the proposed CRM model is based solely on relationships to which the firm is a party, such as relationships between the firm and its employees and customers. Other external factors may be neglected. Further research could be done to address these problems accordingly.

8. Acknowledgment

9. References

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