An Intelligent Cloud-Based Customer Relationship Management System to Determine Flexible Pricing for Customer Retention

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***Abstract*--Due to fierce competition in the market, effective customer relationship management approach is necessary in order to gain competitive advantage. In general, customers can be divided into different categories based on their purchase behavior, historical ordering pattern and frequency of purchase. Customized sales and promotion on specific items can be offered so as to increase sales. However, due to the lack of a flexible pricing strategy, companies can only offer the same sales and marketing strategies to all customers. Valuable customers may be neglected which results in the loss of customer loyalty and even the loss of sales orders. In this paper, an intelligent cloud-based customer relationship management system (ICRMS) is designed to formulating the sales and marketing strategies on flexible pricing in the supply chain. The system integrates cloud technology and the fuzzy logic approach to manage sales and order data on the Internet, and to determine the discount price of products respectively. By conducting a pilot study in an advanced manufacturing technology company, the results show that the service quality can be enhanced while customer satisfaction is increased.**

I. INTRODUCTION

In today's highly competitive business environment, maintaining good customer relationships becomes a key to success in the supply chain [9]. In order to fulfill increasing customer needs and maintain profit, companies not only have to provide high product quality and services, but also build long term relationships with their customers [6][15]. Therefore, companies tends to offer a customized sales strategy to valuable customers so as to gain customer loyalty. It is especially critical for the trading industry which provides manufacturing technology equipment. As an agent which links suppliers and customers, it is known that trading companies do not produce manufacturing technology equipment by themselves and usually cannot provide value-added services to their customers. Instead of ordering goods from trading companies, customers have another option to contact the suppliers directly. In this case, trading companies would have chance to lose the customer due to the lack of customized sales strategy. Hence, customers are recognized as one of the most important assets to trading companies.

In the trading industry which provides manufacturing technology equipment, once a purchase order is received from the customer or dealer, the trading company will then contact its supplier to produce and ship the ordered product to them. The product will then be delivered to its customer or dealer to complete the order. In such practice, there is no value added service provided by the trading company. The only service that the trading company can offer is the after sales service, including training and maintenance. Therefore, customers will be easily lost as they can contact and purchase the product from the supplier directly. In order to retain the customer and fulfill their needs, the trading company usually has to offer different selling prices to various customers. The discount rate changes from time to time, which requires the sales person to calculate the price based on past experience and the existing market environment. However, due to the lack of decision support in such a flexible pricing strategy, companies can only offer the same sales and marketing strategies to each customer. Valuable customers may be neglected which results in the loss of customer loyalty and even the loss of a sales order. Thus, it is crucial to develop a system which can determine flexible pricing strategy in order to retain valuable customers. In this paper, an intelligent cloud-based customer relationship management system (ICRMS) is designed to formulate the sales and marketing strategies on flexible pricing in the supply chain. By integrating the cloud technology and fuzzy logic approach, the sales order can be managed effectively while the discount rate for sales can be determined respectively.

The remainder of this paper is organized as follows. Section II reviews the past literature concerning the concept of customer relationship management in the trading industry, cloud technology, and the fuzzy logic approach for flexible pricing. Section III presents the architecture of the proposed ICRMS. Section IV shows a case study to validate the feasibility of the proposed system. Section V discusses the results and advantages of adopting the ICRMS. Section VI gives the conclusions.

II. LITERATURE REVIEW

In this section, the concept of customer relationship management in the trading industry is first reviewed. The cloud technology and fuzzy logic approach which can be applied for customer retention are then discussed.

A. Concept of Customer Relationship Management in the Trading Industry

Nowadays, the customer has become the most important asset for most companies. Customer relationships have indisputable value for companies, and facilitates the emergence and development of CRM [4]. CRM comes from the concept of the customer-focused business strategy. It is recognized as a business processes that can capture, retain and create value for customers as well as stockholders [18]. Besides, CRM acts as a communication channel to maintain and develop a long-term positive relationship with current and targeted customers of the company [30]. According to

Ngai et al. [26], CRM can be divided into four dimensions, which are customer identification, customer attraction, customer retention and customer development. Customer identification involves targeting the potential and profitable population who are most likely to become customers, or the group of existing customers that will bring additional profit to the company [24]. Customer attraction is the second phase where organizations invest effort and resources into attracting the target customers, which concentrates on allocating resources for its marketing strategies so as to maximize the effectiveness in direct marketing that motivates customers to place orders through different channels [28]. Regarding customer retention, it requires effort in meeting customers' expectation and increasing customer satisfaction based on a customized marketing approach, which is a critical step in building long term relationships with customers [14]. The last stage, customer development, is the consistent expansion of transaction intensity, value, and customer profitability. To manage the customer relationship effectively, efforts have been made to develop company websites or apps to promote and sell products through the Internet, over the last decade. However, the use of IT and mobile devices have become popular, and becomes a big challenge in managing the huge amount of data being collected. To tackle the problem of the large amount of data volume, high complexity data forms and high speed result generation, cloud computing services have been introduced as an emerging direction for efficient data storage and analysis.

B. Cloud Computing Services

With the mature development of the Internet in recent years, the concept of cloud computing is emerging in many business areas, such as enterprise resources planning, warehouse management and CRM [19][32]. From the customer perspective, an enterprise can adopt cloud computing services to attract and retain customers by improving products and services while enhancing customer experience [5]. According to Armbrust et al. [3] and Zhang et al. [34], cloud computing refers to the applications delivered as services over the Internet for enabling convenient on-demand network access with minimum management effort and investment in both hardware and software. From a business perspective, cloud computing can lower the barrier to IT adoption and make it easier to scale services by the analytical ability to manage big data [25]. The function of data-as-service in cloud computing allows enterprises to visualize both structured and unstructured data, anytime and anywhere. However, without a proper data analytical process, the data collected is hardly understood by users. Hence, text mining in cloud computing has been applied to convert the vast amount of data into useful information that is understandable for decision making [11][12]. Amalarethinam and Beena [1] proposed a customer facilitated cost-based scheduling model such that customer can enjoy an economic cost when they pay for cloud computing services. Considering the financial affordability of small and medium businesses, a cost-effective materials management and tracking system, based on a cloud-computing service, was developed by Ko et al. [17] to improve the supply chain visibility in inventory tracking. Rajaval and Thangarathanam [29] designed a behavioural learning system to manage the unpredictable random behaviour in a trading market with consideration of the probabilistic rules in negotiation. Although it is found that cloud computing services can facilitate big data analysis in an economic and efficient way, the focus on how to analyze customer behaviour and purchase patterns for CRM on the Internet is relatively limited.

C. Artificial Intelligence in CRM

Fuzzy logic is one of the artificial intelligence (AI) techniques that can be applied in various research domains, such as performance measurement [13], supplier selection [2][10], CRM [16][21] and warehouse management [27]. It is suitable to manage attributes under uncertainty and for values that cannot be differentiated strictly [23]. It presents a mathematical model to depict the meaning of unclear concepts and linguistic variables that are imprecise, vague, fuzzy and with no clear underlying measurement [20]. According to Chen and Pham [7], a fuzzy logic controller system comprises three main processes; (i) fuzzification, (ii) rule-based reasoning and (iii) defuzzification. According to Lin [22], fuzzy application in measuring service quality is needed due to the presence of fuzziness in subjective human judgment. Shah [31] considered fuzzy logic based classification of customers which can reduce the complexity of customer data and extract valuable hidden information. Further, Zandi and Tavana [33] adopted fuzzy logic approach to evaluate and select the best agile e-CRM framework in the manufacturing industry. Chougle et al. [8] presented a fuzzy logic approach to assess service quality and reliability at each customer level in the automotive industry so that overall customer satisfaction can be measured. With the ability to manage attributes under uncertainty or with vague values, it is found that applying fuzzy logic approach in managing customer relationships is promising.

In summary, the reviews of the above indicate that effective customer relationship management can assist companies to attract new customers and retain valuable customers by providing customized services. However, the existing CRM approach can only collect customers buying behaviour, and the way to analyze data for resources allocation is neglected. Therefore, cloud technology and the fuzzy logic approach are considered to extract and detect the hidden customers' data in order to deploy relative marketing strategies to target, attract and maintain long term profitable relationships with customers.

III. METHODOLOGY

In this paper, an intelligent cloud-based customer relationship management system (ICRMS) is designed to

formulate the sales and marketing strategies on flexible pricing in the supply chain. Fig. 1 shows the system architecture of ICRMS, which consists of two tiers. The front-end tier collects various types of data through internet enabled devices such as PC and mobile devices, and, enterprise social media such as websites and apps. Examples of the data include supplier information, customer information, product information, sales and promotion data, etc. The back-end tier consists of two modules which are (i) cloud-based information services module, and, (ii) flexible pricing strategy module.

A. Cloud-based Information Services Module

Lots of data is being collected and stored in the cloud-based services platform every day, such as web data, customer actions, supplier data, product and sales data. These data can be viewed using online analytical processing (OLAP) techniques for real time reporting. Generally, the data are in the form of text data in the web, semi-structure data such as XML, as well as unstructured data such as figures, tables and the semantic web. In the era of big data, the data collected are always large in volume and complex in form. Therefore, data extraction and pre-processing is an important step to convert the collected data or documents to a structured form which can improve the performance in text mining. Firstly, all the figures and tables collected from the data source are removed. Then, stop words removal is applied to reduce the noisy information, as many words are not informative and thus irrelevant for data representation. These set, of words rarely contribute useful information even though they may appear frequently, for example, a, an, the, of, to, with, etc. The text processing accuracy will be increased after removal of the stop words. Word stemming is then performed to reduce words to their root forms. Several words are syntactic variants of each other since they share a common word stem. For example, a data record may contain several occurrences of words like measure, measures and measuring. They are generally derived from the word "measure". Different words share the same word stem and should be represented with its stem, instead of the actual word. As a result the redundancy and dimension of the document can be greatly reduced. After the text mining process, text information containing customer searching behavior are passed to the decision maker for designing sales and pricing strategy to the target customers. The company can then contact their target customers for promotion according to the keywords obtained.

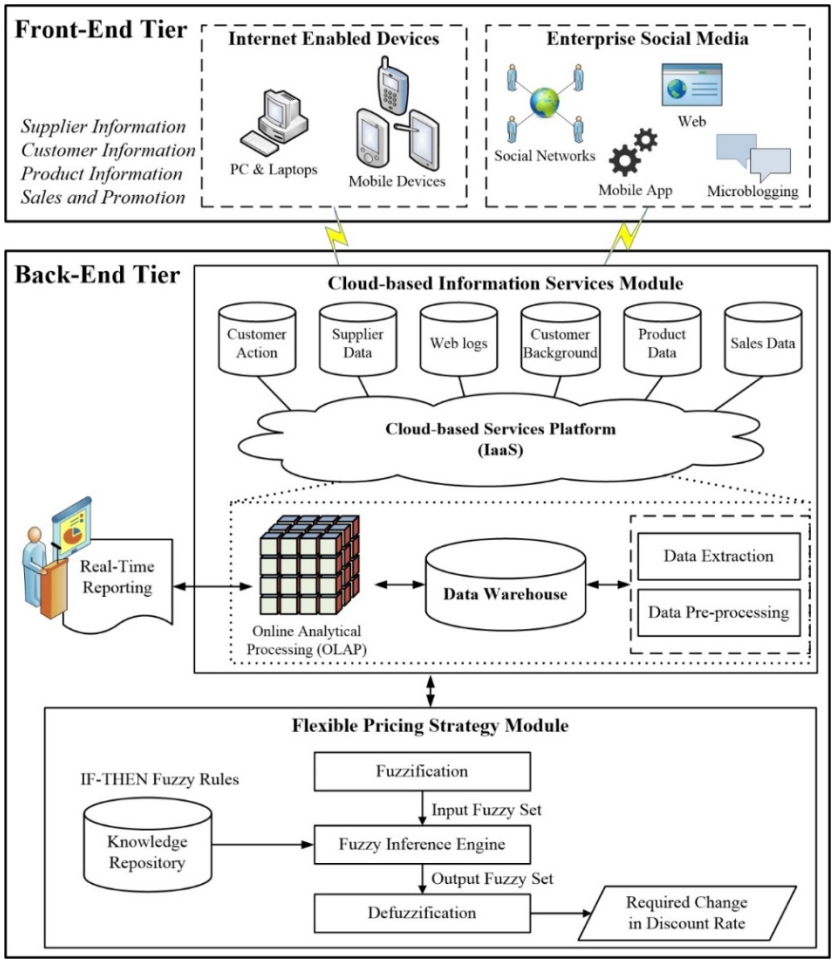

Fig. 1. System architecture of ICRMS

B. Flexible Pricing Strategy Module

In order to keep customers and get orders, a trading company usually provides different levels of discount to their potential customers. In this module, one of the common artificial intelligence techniques, fuzzy logic, is applied to determine the discount rate that should be offered to the customers. There are three main components in this module: (i) fuzzification, (ii) fuzzy inference engine, and, (iii) defuzzification. Firstly, domain expert i.e. sales managers are required to identify both input and output variables for determining the discount rate. The crisp values of the input and output variables are converted into fuzzy sets through fuzzification so that the concepts of fuzzy set theory can be applied. Fuzzification is the process of converting the input data set into fuzzy sets by determining the universe of discourse and membership functions of the variables. The universe of discourse is divided into several regions which belong to different predicates. For example, the universe of discourse of order volume may include *very low, low, normal, high and very high*. The predicates have special shapes and styles, such as triangle and trapezoid, to represent their membership functions. Then, domain experts are asked to determine the linguistic terms for describing each parameter and then describe each linguistics term by means of membership functions. Once the input fuzzy sets are defined, they are sent to the fuzzy inference engine. The fuzzy inference engine is connected with the knowledge repository which stores the fuzzy rules in the form of IF-THEN structure. The input fuzzy sets are matched and aggregated with the fuzzy rules in the knowledge repository to generate the output. The final step is the defuzzification setting. The output solution has to process a reverse process to obtain crisp values. Based on the output crisp value, the company is able to decide on the discount rate for their customers. Through the fuzzy logic process, a flexible pricing strategy with discount rate can be formulated to attract customers in ordering.

IV. CASE STUDY

In order to validate the feasibility of the proposed system, the ICRMS was applied to a quality manufacturing technology and solutions provider in Hong Kong.

A. Company Background

ABC (Holdings) Ltd. was founded in 1967, and is listed on the main board of the Hong Kong Stock Exchange in 2003. ABC is a leading importer and distributor of many world-famous brands of advanced equipment and tools, serving all segments of the manufacturing industry, from heavy manufacturing to customer electronics. ABC's products and services also cater for every stage of the manufacturing process, from product design to production and quality control. ABC's vision is to help improve both the quality and productivity of the manufacturing industry, and thus enhance everybody's standard of living and quality of life.

B. Problems Faced by the Company

As long as manufacturing exists, there will always be business opportunities for ABC. As a trading company which focuses on supplying various manufacturing tools and equipment to its customers worldwide, ABC would like to further increase sales as well as customer satisfaction. However, to further expand their business, ABC is now facing some challenges. Currently, ABC lacks a systematic approach to achieve their two business objectives. They do not have a standard model to build long term relationships with their customers. Thus, it is difficult for them to retain their valued customers. On the other hand, they found that there is a lack of channels for them to attract new, and potentially new, customers. Although past sales records are available, ABC did not make use of the available data for analysis and find out hidden relationships. As a result, ABC is unable to define appropriate sales strategies to attract new customers.

C. Implementation of ICRMS in the Company

The ICRMS was implemented in the case company for building long term relationships with customers. There are four implementation stages: (i) to collect and extract relevant data by cloud technology, (ii) to determine input and output variables for flexible pricing, (iii) to determine fuzzy sets and membership functions of the variables, and, (iv) to determine appropriate discount rate to target group of variables.

1) Collect and extract relevant data by cloud technology

To adopt the ICRMS, relevant data including product specification and promotion details from the suppliers and customers are collected. Through the company website, mobile app and other social networks, customers can easily view and search for interesting products, any time. All the data such as customer login ID, date and time on site, page views, price range, products and keywords searched on site are collected and stored in the cloud-based services platform. The use of a cloud-based platform can lower the hardware requirement in the local company while the data collected can be viewed online, everywhere. Since the data collected are large in volume and complex in form, data pre-processing is performed to convert the data into a structured form for analysis. Fig. 2 shows the data pre-processing steps in the cloud-based information services module. Firstly, the source code in the form of HyperText Markup Language (HTML) is extracted from the web data. Then, all HTML tags such as <html>, <body> and <title> are removed as no specific meaning is presented by the tags. Afterwards, a data record with only plain text is obtained. To reduce the noisy data and redundancy of information, the process of stop words removal and words stemming are also performed so that the data record, in plain text with keywords, is shown. By viewing the data record with keywords, the company can obtain the searching behavior of their customers, such as the types of products that are interested in, the number of searches, and, the time on site. By so doing, the company can contact the customers and actively promote the products to them.

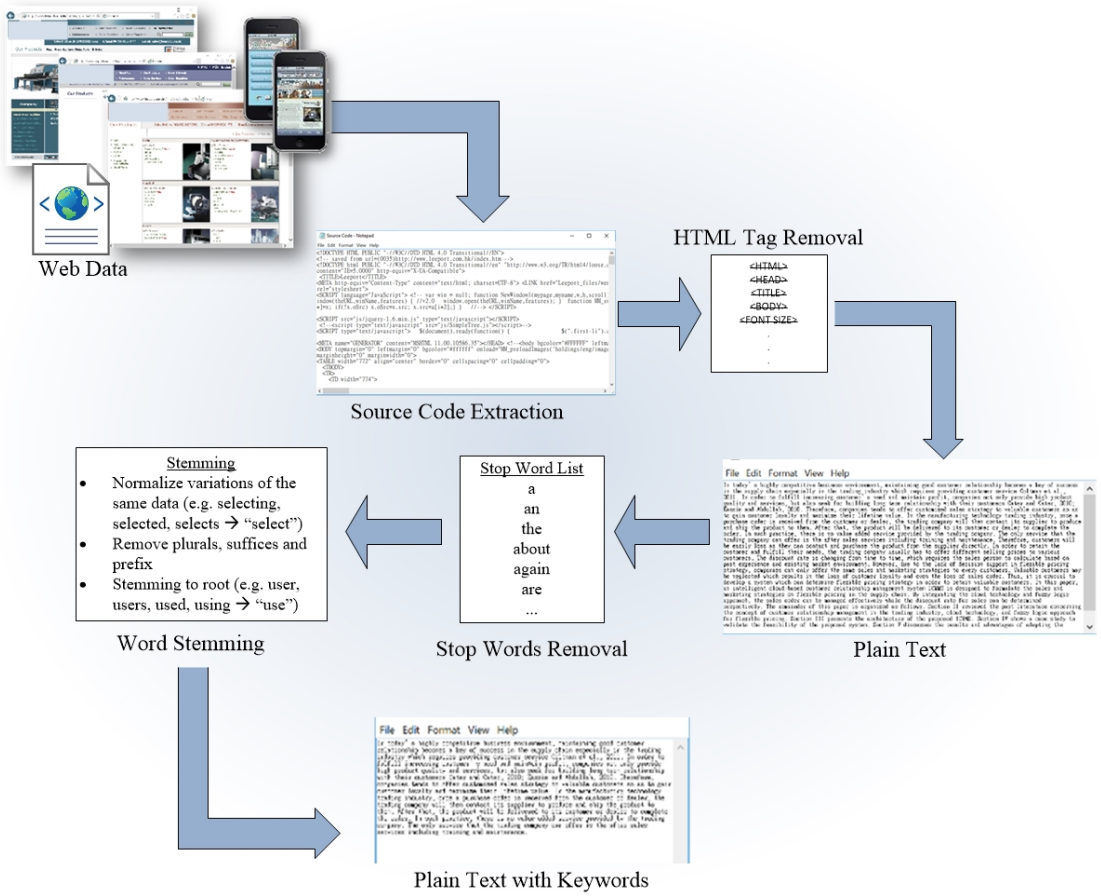

Fig. 2. Data pre-processing in the cloud-based information services module

2) Determine input and output variables

If the customers are interested in buying the products, the company will contact them directly to confirm the sales order. However, customers may sometime argue whether a lower selling price can be offered. Such decision has to be made by the company representative so that a certain profit can still be maintained. After investigating the key decision making criteria, it is found that the discount rating is determined based on five major criteria: (i) customer rating, (ii) order volume, (iii) change in supplier price, (iv) change in exchange rate, and, (v) change in forecasted demand. The trading company classifies its customers into different grades such that valued customers would have a higher rating and could enjoy more benefits. This rating is defined based on the past sales record of the customers such as order frequency, sales volume and contributed profit margin. In addition, discount is usually given if a large quantity order is placed. The supplier price and exchange rate would change frequently due to dynamic changes in the business market, materials and production cost. Lastly, the seasonal change in demand is also taken into consideration. If it is forecast that the demand of product will decrease in the coming months, the trading company would provide a higher discount to attract its customers to place purchase orders for increasing sales. Fig. 3 shows the input and output variables for determining the sales discount. As the five key decision making criteria affect the discount rate that should be given, they become the input parameters in the module, while the output parameter is defined as the required change in discount rate.

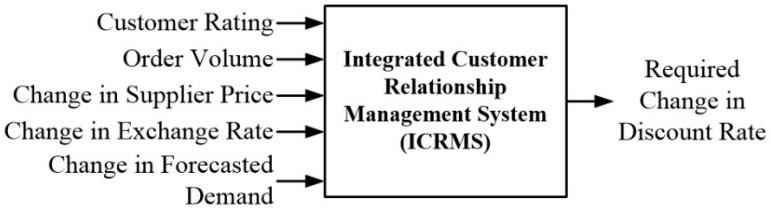

Fig. 3. Input and output variables for determining sales discount

3) Determine fuzzy sets and membership functions of the variables

After determining the input and output variables, the fuzzy sets and membership function of each variables are defined. Fuzzy logic is applied because the values of the five decision variables are vague and cannot be described with a single linguistic term such as either "low" or "very low. Take order volume as an example, the order volume of 2,500 can be classified as normal and high. There are no clear-out boundaries for the industrial practitioners to associate the values to one linguistic term. Without applying fuzzy logic, the sales manager is unable to clearly describe the order volume of 2,500 in linguistic term. A fuzzy set has an ability to classify elements into a continuous set using the concept of degree of membership. Domain experts are asked to determine the linguistic terms for describing each decision variables and then describe each linguistics term by means of membership functions. For the input variables, the fuzzy set of customer rating is defined as {***L, N, RH, H***} where ***L*** is Low, ***N*** is Normal, ***RH*** is Relatively High, ***H*** is High. The fuzzy set of order volume is defined as {***VL, L, N, H, VH***} where ***VL*** is Very Low, ***L*** is Low, ***N*** is Normal, ***H*** is High, ***VH*** is Very High. For the change in supplier price, change in exchange rate and change in forecasted demand, the fuzzy sets are defined as {***SiD, SlD, NC, SlI, SiI***} where ***SiD*** is significantly decreased, ***SlD*** is slightly decreased, ***NC*** is no change, ***SlI*** is slightly increased and ***SiI*** is significantly increased. For the output variable, the fuzzy sets of required change in discount rate is defined as {***SuD, SiD, SlD, NC, SlI, SiI, SuI***}, where ***SuD*** is substantially decreased, ***SiD*** is significantly decrease, ***SlD*** is slightly decreased, ***NC*** is no change, ***SlI*** is slightly increased, ***SiI*** is significantly increased and ***SuI*** is substantially increased. Fig. 4 shows the membership functions of the input and output variables. The Matlab fuzzy toolbox is then used to build the flexible pricing strategy module for generating the discount rate.

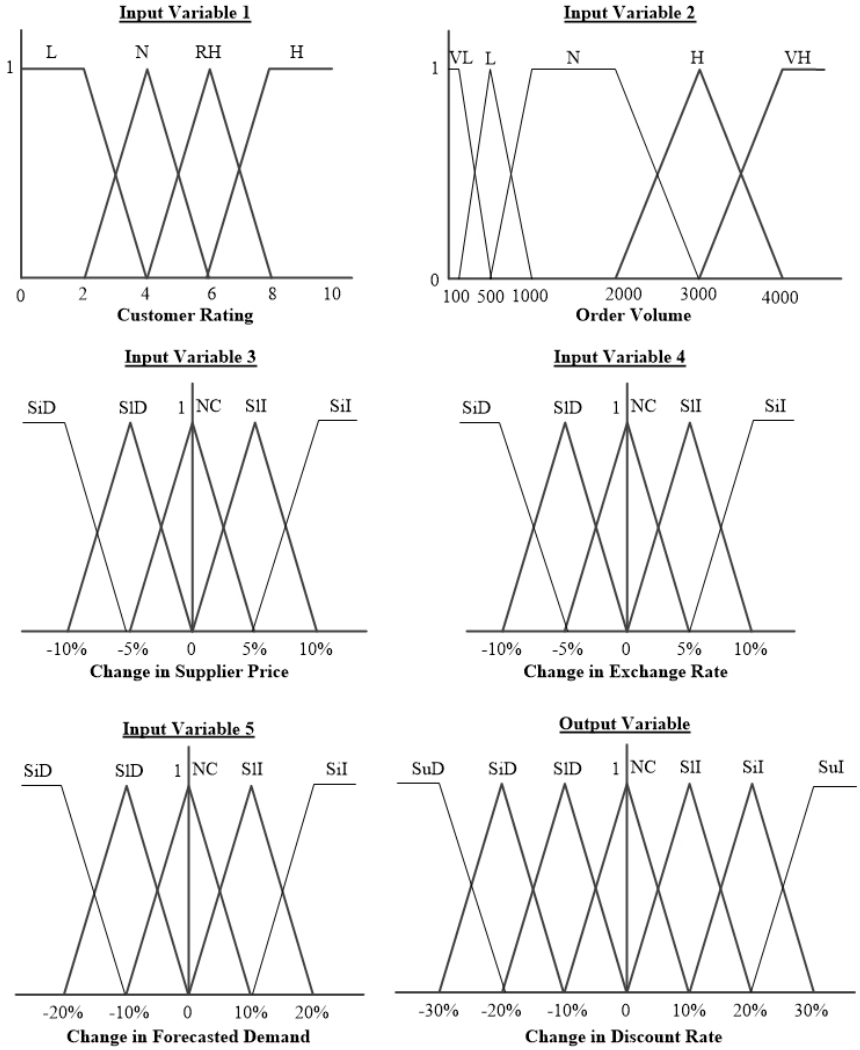

Fig. 4. Membership functions of input and output parameters

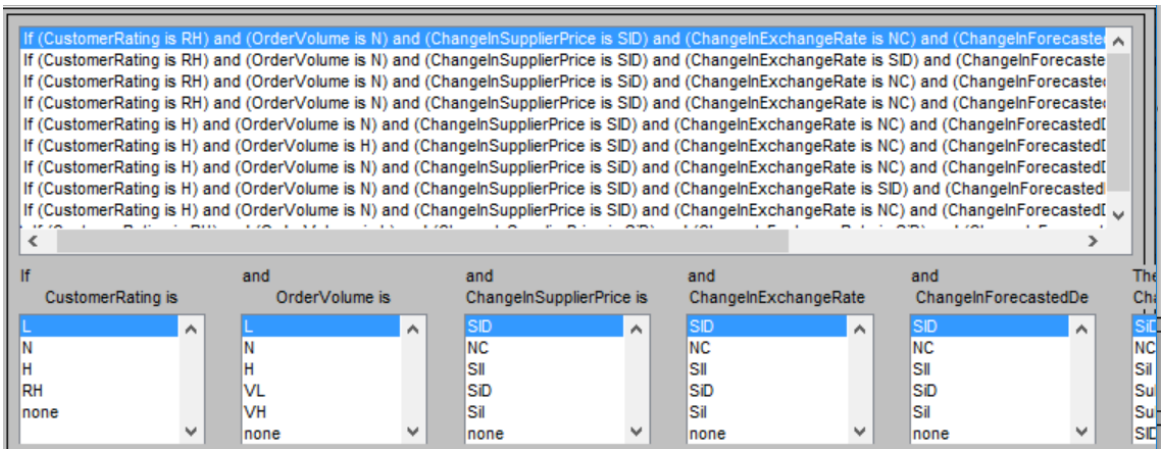

Fig. 5. Rule editor of ICRMS

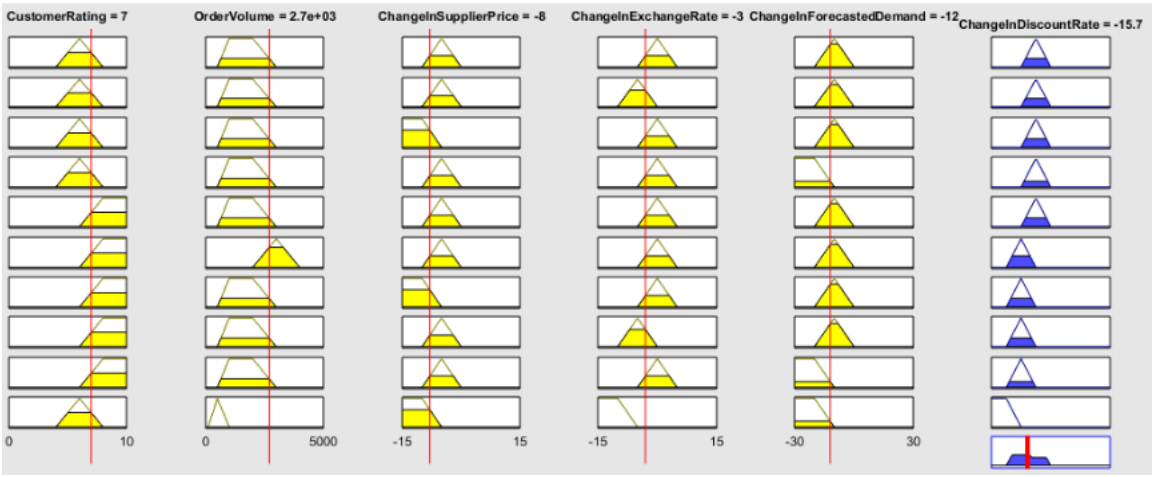

Fig. 6. Result of change in discount rate in ICRMS

4) Determine appropriate discount rate to target group of variables

After defining the fuzzy sets and membership functions of the input and output variables, the fuzzy rules also need to be defined in the knowledge repository such that successful rules can be fired to obtain the solution, as shown in Fig. 5. In order to demonstrate how the ICRMS works, an illustrative example is presented as follows. Suppose there is a new potential purchase order, the customer rating is 7, order volume is 2700, change in supplier price is -8%, change in exchange rate is -4% and change in forecasted demand is -13%. Given the input crisp values of the input variables, the resultant membership values of the input fuzzy sets are then calculated. Successfully fired rules are extracted for calculating the crisp values of the output parameters to determine the consequent fuzzy region of each output fuzzy set. Fig. 6 shows the result of change in discount rate such that a discount of 15% is suggested to this customer.

V. RESULTS AND DISCUSSION

Through the adoption of ICRMS, ABC (Holdings) Ltd. can collect and analyze the searching behavior of customers so that appropriate discount rates can be offered to attract customers. After the pilot run in the case study, it is found that (i) the successful ordering rate is increased while (ii) the service satisfaction of existing customers is also enhanced.

1) Increase in successful ordering rate

With the help of the cloud-based information services module, the trading company can understand the searching behavior of their existing customers who login to the company website or app through computers or mobile devices. Instead of contacting the existing customers regularly and promote a wide variety of products to them, the sales person in the trading company can now contact the customers actively and promote the targeted products to them. By so doing, the successful ordering rate was increased from 26% to 42% per month.

2) Increase in customer satisfaction

To keep monitoring the service performance, customer feedback was collected after the completion of each order. According to the feedback after the adoption of ICRMS, it was found that the new approach not only increases the successful ordering rate, but also enhances customer satisfaction. Flexible pricing strategies with different discount rates can now be formulated by ICRMS, with consideration of both internal and external factors, including customer rating, order volume, change in supplier price, change in exchange rate, and change in forecasted demand. As a result, valued customers can enjoy a customized promotion price which encourages them to place orders with the ABC Company in the long run. Thus, customer satisfaction is enhanced.

VI. CONCLUSIONS

Since value-added service on tool replenishment is usually not provided in the trading industry for providing manufacturing technology equipment, maintaining good customer relationships is important so that customers will continue to place sales order with the trading company. In order to retain the customer and build long term relationships with them, customized sales and marketing strategies should be provided to different types of customer. In order to fulfill customer needs, a flexible pricing strategy should be adopted such that valued customers would enjoy special discounts when ordering. Therefore, in this paper, an integrated customer relationship management system (ICRMS) is designed for enhancing customer satisfaction. By integrating cloudy technology and the fuzzy logic approach, the trading company can analyze the searching behavior of customers and promote products that are of interest to the customer at attractive prices. To conclude, the developed model can provide a clear road map to explore potential business opportunities in the trading industry, enabling trading companies to retain customers by building long term relationships.

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