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A web-based system for analyzing the voices of call center customers in the service industry

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Abstract

We developed a Web-based system for analyzing the voices of call center customers of a life insurance company, so that it would help decision makers understand customer needs better and it would help them make consistent decisions regarding customer support. It used conventional statistical and data mining techniques to identify customer voice patterns. To demonstrate results, we gathered actual customer complaints from the service operation of a target company. Using this data, the system pinpointed problematic areas where complaints happened (one-dimensional analysis), the relationship among problems (two-dimensional analysis), and the root cause of problems (Failure Mode and Effects Analysis).

Keywords: Voice of customer; Call center; Life insurance; Customer relationship management; Data mining

1. Introduction

Until recently, companies focused on selling as many products and services as possible without any regard to those who bought them. The rapid development of information technology and the Internet, however, enables customers to have more choices than before regarding the purchasing of products and services. Emerging electronic commerce has also changed many aspects of existing businesses, business opportunities, and processes. Existing companies are being challenged to reconsider basic business relationships with their customers (Pan & Lee, 2003). This is the starting point of customer relationship management (CRM).

CRM is one of a number of 'customer-centered' strategies and has become a critical success factor in today's business environment. This environment is represented by global competition and the proliferation of customer needs. Companies need to understand their customers and their customer's needs more than ever before. The goal of CRM is to forge closer and deeper relationships with customers, and to be 'willing and able to change company's behavior toward an individual customer'. (Peppers, Rogers, & Dorf, 1999).

At the growth stage of electronic commerce, CRM is divided into three types: Operational, Analytical, and Collaborative CRM (Shahnam, 2000). Among them, collaborative CRM provides various channels to motivate customers regarding their buying needs or activities, while implementing CRM in the multi-channel environment (Dyche, 2001). Its main issue is to provide proper products or services to the customer audience through the right channels (Earl, Frohlich, Hammond, Suarez, & Voss, 2001).

Channels, by definition, connect a company with its customers and deliver its services. These broadly fall into five categories: Direct sales, Telephone, the Web, E-mail, and Partner channels. These categories can be represented as a continuum of forms of customer contact ranging from

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the physical to the virtual (Hopkins & Manasco, 2000). In the near future, channel management will play an important role in the multi-channel environment and in corresponding channel strategy, whereby meeting the rapid changes in customer preferences should be a priority.

As part of such a strategy, companies have built their own call centers to focus on customers through the strength of online channels (Wind & Mahajan, 2002). As time progresses, however, analyzing customers has become a major concern of companies. The first step of customer analysis begins with listening to the voice of customers (VOC) through call centers. In this context, analytical CRM helps companies to extensively analyze the VOC with integrated customer information by using various knowledge discovery techniques.

Successful companies have to pursue customer-centric strategies in order to sustain a competitive advantage. VOC analysis can play an important role in understanding customer requirements in a new product or service development. Moreover, it can provide value to customers and it can leave the customer with a favorable impression. The VOC analysis system can help determine what customers need and predict what they will need in the future. In turn, this can assist in the development of appropriate corporate strategies to meet these needs.

Most of the existing companies, however, tended to consider a VOC analysis system less important. They little settle the received complaints and do not care about analyzing the VOC to find the root cause of problems nor do they promote customer needs. As a result, they often miss opportunities to deal with the complaints in a proactive manner.

This study proposes a new methodology for analyzing the VOC using conventional statistics and data mining techniques, and builds a Web-based system embedding the proposed methodology. To demonstrate some results, we gather the VOC from the service operation of a life insurance company. Through a one-dimensional analysis, we derive patterns of each complaint and discover problematic areas where customer complaints occur. Two-dimensional analysis makes it possible to pinpoint relationships among problems. Failure Mode and Effects Analysis (FMEA) is helpful in finding the source of current problems. If there are significant deviations from standards, derived patterns are used to issue an alert to potential problems that require immediate attention.

The remainder of the paper is organized as follows: In Section 2, we present a literature review on VOC analysis. In Section 3, we develop a methodology to analyze the VOC of a life insurance company and to explain some analysis techniques used to extract complaint patterns. Section 4 describes the results of analyzing the VOC using a prototype system that was built on the Internet. Concluding remarks and the direction of further research are offered in Section 5.

2. Literature review

According to both academic and practitioner's literature, research methodologies used for analyzing and utilizing the VOC vary with application domains. Until now, a great deal of research on VOC analysis deployed the VOC in soliciting and understanding customer requirements in new product development from the conceptual design through to manufacturing. This kind of application uses the VOC as input to Quality Function Deployment (QFD) for formalizing the process of listening to the customer.

Cooper and Kleinschmidt (1994) explained that building the VOC, as a customer-focused and market-oriented new product effort, was the strong driver of on-time and fast-paced product development projects. Tang et al. (2002) used QFD to translate the VOC into product design by analyzing customer requirements through the various stages of product development. Haar et al. (2001) developed an approach to fine-tune the product or service offering through incorporating the VOC into the design of new products or services in a technology-based multinational company. Matzler and Hinterhuber (1998) illuminated a set of methods which ensured a better understanding of customer needs as well as procedures to enhance communication by focusing on the VOC within a product development project. Cooper (1996) claimed that a high quality new product process was a must in successful product development. He placed emphasis on the VOC to increase business' new product performance. Lauglaug (1993) insisted that, through customer experience in new products that were still in the R and D labs, technical-market research was helpful in understanding the mind of the consumer, so that the VOC could be better translated into new products. Cristiano et al. (2000) investigated cross-national differences as well as their implications in using QFD as a tool for bringing the VOC into the product development process.

Several applications, other than new product design and development in manufacturing, also exist. Chen and Bullington (1993) developed strategic plans for departmental research activities through QFD, which listened to the VOC and assigned responsibilities to organization members in order to respond effectively to customer research needs. Hongen and Xianwei (1996) asserted a systematic planning approach for the implementation of TQM during the product design or development process through a QFD technique which analyzed the VOC. Radharamanan and Godoy (1996) used QFD to deploy the VOC in understanding customer requirements and to include them in the continuous improvement of quality in services that are provided by a health care system.

There are many applications incorporating Web technology and artificial intelligence into simple QFD. Huang and Mak (2002) proposed a Web-based QFD system which offered remote and simultaneous access on the Internet and supported more efficient methods in order to listen to the VOC. Chen, Khoo, & Yan (2002) developed a prototype

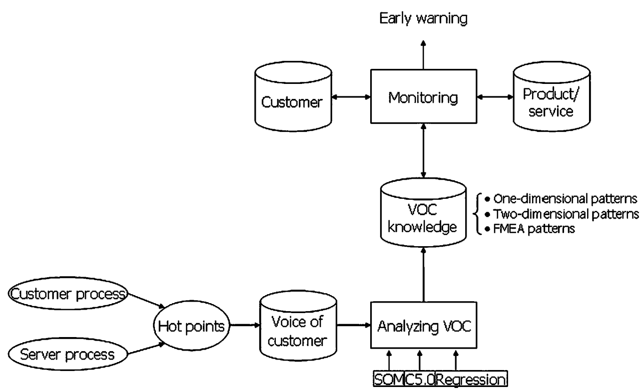

Fig. 1. Overall procedure for VOC analysis.

system which systematically solicited customer requirements from the VOC and analyzed customer orientation with neural networks in the development of new wood golf clubs. Myint (2003) provided a methodology for the development of intelligent QFD applications in the personal computer assembly environment. He described the needs of the VOC in developing intelligent QFD in product creation and expansion. Xie (1998) proposed a hybrid system incorporating the QFD, analytic hierarchy process, and fuzzy set theory for the decoding, prioritizing, and inferring of qualitative, vague, or imprecise VOC. Yan, Chen, and Khoo (2001) realized a prototype system which combined the laddering technique and the radial basis function neural network for customer requirements acquisition from the VOC. This was done in terms of a multicultural factor evaluation for a refrigerator design.

3. Framework of analysis

Fig. 1 provides a basic understanding of the structure of the proposed system and summarizes the VOC system functions that are necessary for an effective VOC analysis.

The VOC system identifies the customer and server processes in a specific service company, including the aforementioned life insurance company, and gathers the VOC at the hot points where the two processes cross each other. It then performs three types of analysis—one-dimensional analysis, two-dimensional analysis, and FMEA—along with a VOC database. The system utilizes a statistical technique (regression analysis) and machine learning techniques (self-organizing map and C5.0) to extract knowledge of customer needs. Domain experts verify the extracted knowledge in advance of storing them in a VOC knowledge base, which also incorporates other knowledge provided by the domain experts.

The VOC system continuously looks at changes in the knowledge base, customer database, and product or service database, and detects the matching patterns, so that it generates a recommended course of actions including the possibility of an early warning.

3.1. Understanding customer and server processes

The service operation conducted by a life insurance company is generally divided into nine phases: *Access*, *Registration*, *Diagnosis*, *Exploration*, *Segmentation*, *Maintenance*, *Payment (Loan)*, *Return to Community*, and *Post-sale maintenance*. Fig. 2 classifies these nine phases into customer process, server process, and hot points, respectively.

A potential customer chooses a life insurance company in the Access phase. In the Registration phase, the selected company explains life insurance policies and clauses to the customer and receives a written subscription from him or her. The applicant (potential customer) undergoes a medical examination in the Diagnosis phase. The insurance company screens him or her to determine if he or she is

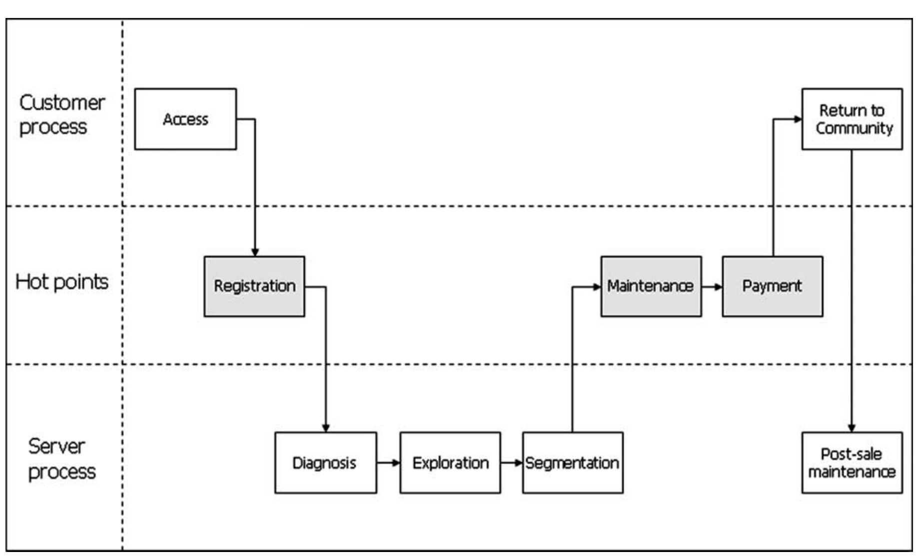

Fig. 2. Customer process, server process, and hot points in a life insurance company.

a suitable candidate for coverage. The Exploration phase seeks other cross-selling opportunities-selling new policies-by considering the insured's characteristics. The Segmentation phase is helpful in dividing the insured into numerous segments and focusing on target customers. The insured pays a premium in the Maintenance phase. The insured might receive an insured amount or a contract loan in the Payment (Loan) phase. In the Return to Community phase, the insurance expires, and the insured receives insurance and the relationship with the company is completed at the end of this phase. The insurance company solicits the ex-insured for another new subscription in the Post-sale Maintenance phase.

Most of the VOC happen at the hot points where a customer and an insurance company meet. Registration, Maintenance, and Payment (Loan) phases are typical hot points.

3.2. The voice of the customer

Voice of customers is about listening to customers. There is no one monolithic voice of the customer. Customer voices are diverse and possibly including the following: *Advice*, *praise/suggestion*, *complaints*, and *claims*. Some customers can advise the company on a summary or details of consultations about insurance goods or services. Other people praise the company or suggest opportunities for improving the services provided. VOC encompasses various specific complaints from customers. These complaints often develop into legal claims, which may result in administrative correction orders from company superiors.

Gathering VOC is to serve customers by resolving their complaints and identifying their needs. In addition, it aims to prevent similar types of complaints from occurring again. To do so, we should systematically organize the VOC and carefully investigate the subject matter. The mass of interview notes, documents, market research, and customer data needs to be distilled into a handful of statements that express key customer issues. 5W1H is a useful tool to assist this effort and serves as a basis for organizing the customer complaints into the following: WHO, WHEN, WHERE, WHAT, WHY, and HOW. We can easily identify WHO, WHEN, WHERE, and WHAT from the VOC. Describing WHY and HOW, however, is not that simple.

To express properly customer complaints in terms of WHY and HOW, we use the seven types of *failure mode errors*: Information validation omission, Process validation omission, Reception omission, Transmission omission, Information feedback omission, Process improvement omission, and Process exception (Born, 1994). They are designed to analyze the customer and server processes and the ways in which they fail to produce desired results. Each of them occurs mainly due to a lack in either procedure or information. A lack of procedure means that an error (i.e. a complaint) happens because of defects in the prevention system. Even if appropriate procedures exist to prevent errors, a complaint can happen due to a lack of information.

3.3. Methodology for analyzing VOC

3.3.1. One-dimensional analysis

A one-dimensional analysis tries to observe how the VOC occurs, attempts to find out the occurrence patterns of types of customer complaints in the hot points, and to discern problematic areas. The VOC system carries out two kinds of one-dimensional analysis: One uses detailed transaction-level complaints and the other uses lightly summarized complaints. Analyzing one-dimensional patterns with complaint details observes the frequency of each complaint. The other one-dimensional analysis, however, uses lightly summarized data, such as RFM (*recency*, *frequency*, and *monetary*) values, to extract additional patterns of types of complaints. Recency describes how long it has been since a life insurance company receives a complaint. As recency increases, the importance of the complaint decreases. Frequency is how many times a complaint is received. Monetary value calculates the cost of solving a complaint.

The patterns resulting from one-dimensional analysis can be divided into four categories: *Chronic*, *New*, *Cyclical*, and *One-time*. The chronic pattern indicates that the same types of complaints always occur over a period of time. A new pattern is observed when a complaint only happens at a specific point in time within an analysis period, but, after that point, it is newly recorded. A complaint, which has a cyclical pattern typically has up and down cycles (i.e. a repeat in the number of increases and decreases). A one-time complaint occurs only once and cannot be described as a chronic, new, or cyclical pattern. Note that the four types of patterns are not mutually exclusive and the occurrence pattern of each type of complaint can be changed in accordance with the various time windows in an analysis period.

Each of the patterns can be identified by data visualization and regression analysis based on the relationship between time and occurrence frequency during an analysis period. (Note: Regression models can be linear or nonlinear) The detailed methods are described as follows:

- *Chronic pattern*: If the estimated y-intercept is above zero and the estimated slope of the regression line approximately approaches zero in a linear regression, the complaint is said to be of a chronic pattern.
- *New pattern*: In this case, there exists a time interval that shows a zero frequency and the other interval shows a linear (or nonlinear) relationship between time and occurrence frequency.
- *Cyclical pattern*: Split an analysis period into two time intervals and apply regression analysis to each of the time intervals. If one interval shows a positive (negative) relationship and the other a negative (positive) relationship between time and frequency, a cyclical pattern exists.

3.3.2. Two-dimensional analysis

One-dimensional analysis finds problematic areas at hot points by discerning the patterns of complaints at each area. If several complaints exist at several areas and they are closely related to each other, a one-dimensional analysis is unable to properly determine the relationships among them. Two-dimensional analysis is an alternative, which is necessary to determine their relationship.

To perform a two-dimensional analysis, the VOC system uses a SOM, which is a neural clustering method, which divides the complaints into numerous groups. A SOM, also called a Kohonen network, provides unsupervised clustering. It tries to uncover patterns within the set of input fields and clusters the data set into distinct groups without a target field. Records within a group or cluster tend to be similar, and records in different groups are dissimilar (Han & Kamber, 2001).

The SOM algorithm uses competitive learning. When an input pattern is imposed on the neural network, the algorithm uses Eq. (1) and selects the output node with the smallest Euclidean distance between the presented input pattern vector ($\hat{X}$) and its weight vector ($\hat{W}_j$).

$$\max_j(\hat{X}^t \hat{W}_j) \tag{1}$$

Only this winning neuron generates an output signal from the output layer; all other neurons in the layer have an output signal of zero. Since learning involves weight vector adjustment, only the neurons in the winning neuron's neighborhood can acquire this particular input pattern. They do this by adjusting their weights closer to the input vector according to Eq. (2).

$$w_j(n+1) = \begin{cases} w_j(n) + \eta(n)[x(n) - w_j(n)], & j \in N(n) \\ w_j(n), & \text{otherwise} \end{cases} \tag{2}$$

where η is a learning rate and N is a neighborhood function.

The neighborhood's size initially includes all units in the output layer. As learning proceeds, however, it progressively shrinks to a predefined limit, and fewer neurons adjust their weights closer to the input vector. Lateral inhibition of weight vectors, that are distant from a particular input pattern, might also occur.

After segmenting complaints into numerous clusters, the VOC system uses a decision-tree induction technique, such as C5.0, to capture discriminant descriptors (i.e. the most distinctive attributes) for each cluster. A decision-tree induction technique utilizes a supervised learning method that constructs decision trees from a set of training examples. It finds features of a newly presented object and assigns it to one of the predefined classes. It generates production rules that can classify unseen cases, which have not been included in the training examples. It represents them with nested if–then statements that people can read and understand easily.

A decision tree is a directed graph showing the various possible sequences of tests, answers, and classifications. The algorithms for building decision trees include ID3, CHAID, C4.5/5.0, CART, IC, and SLIQ (Kim, Lee, Shaw, Chang, & Nelson, 2001). The C5.0 algorithm adopts a top-down induction strategy that searches only part of the search space. It uses an information theoretical approach, which minimizes the expected number of tests needed to classify an object. It selects the attribute, which provides the highest information gain ratio as a criterion for evaluating proposed splits and classification functions. Refer to the Eq. (3).

$$\mathrm{GainRatio}(X) = \frac{\mathrm{Gain}(X)}{\mathrm{SplitInfo}(X)} \tag{3}$$

where

$$\mathrm{SplitInfo}(X) = -\sum_{i=1}^{n} \frac{|T_i|}{|T|} \log_2 \frac{|T_i|}{|T|},$$

$$\mathrm{Gain}(X) = \mathrm{Info}(T) - \mathrm{Info}_X(T),$$

Gain(X) measures the information that is gained by partitioning T in accordance with the test X.

The C5.0 has a special method for improving its accuracy rate called boosting. It works by building multiple models in a sequence. The first model is built in the usual way. Then, a second tree is built such a way that it focuses on the records that were misclassified by the first tree. A third tree is built to focus on the second tree's errors, and so on. Finally, cases are classified by their application to the whole set of trees using a weighted voting procedure which combines the separate predictions into one overall prediction (Han & Kamber, 2001).

3.3.3. Failure mode and effects analysis

Failure mode and effects analysis allows us to find the sources of current problems. It is a series of systematic activities intended to recognize and evaluate the potential failure modes of an insurance good or service and their effects, and to identify actions, which could eliminate or reduce the chance of the potential failure modes occurring. We use four potential failure modes in this study: *Prior*, *posterior*, *process*, and *exception failure modes*.

- *Prior failure mode*: This failure has never happened before, but it happens now. It occurs mostly in new insurance goods or services, since new goods or services can be provided to customers without considering anticipated problems and preparing solutions.
- *Posterior failure mode*: It indicates that there are no remedies in place that are able to deal with certain problems which already happened. Although the same types of complaints already occurred several times in the past, procedures are not ready to resolve the problems. The existence of a posterior failure mode shows that even the revealed requirements of customers are not satisfied.

Table 1
Typical customer complaints in a life insurance company

Hot point	Activity	Typical complaint
Registration	Insurance solicitation	Lack of explanation of guarantee, insurance goods, or premium surrendered
	Quality guarantee	No delivery of stipulation, or no execution of autograph or basic services
	Written subscription	Lack of explanation for subscription, contractor's false notification, or contracts without consent
	Subscription cancellation	Dissatisfaction with unreliable guidance or transaction delay
Maintain	Electronic fund transfer	Defects in registration for automatic transfer or withdrawal after loan redemption
	Visiting collection	No collection of premium in a timely manner or embezzlement of premium
	Giro	No delivery of receipt. Request for reissuing receipt. Verification of deposit
	Maintenance, modification	Delay in updating address or policy clause, or in notification of modification
Payment (Loan)	Insurance expired, Receipt of payment	Lack of explanation for amount, period, and procedures involved
	Policy cancellation	Lack of explanation for amount and procedure
	Loan application, Receipt of loan	Discontent with lending procedure or loan criteria. Poor response for request of information
	Principal, interest pay-back	Discontent with principal and interest, request for transaction history, or overdue management
	Due, Overdue, Loan again	Poor notification of procedures and poor response for request of documents

- *Process failure mode*: Customer complaints occur when the problem solving process is too complicated. It is necessary to make the process easy in favor of the customer.
- *Exception failure mode*: Customer complaints occur at unexpected problematic areas.

4. Applying the VOC analysis system to a life insurance company

For the first step toward the VOC analysis, we gather the VOC including customer complaints at intersecting points of the customer and server processes, and determine the error-prone process and typical types of complaints through analysis of the VOC. Table 1 presents typical hot points along with the related types of complaints.

4.1. VOC analysis system

The VOC system performs three types of analysis: one-dimensional analysis, two-dimensional analysis, and FMEA. In reality, because it is difficult to perform all three types of analysis across all areas, it is better to limit the analysis to problematic areas. Therefore, one-dimensional and two-dimensional analyses are good starting points in the preparation of FMEA, since they provide information on problematic areas and their interaction.

Table 2 describes details of one-dimensional and two-dimensional analyses.

4.2. One-dimensional analysis using complaint details

The VOC system computes the occurrence frequency of each complaint from complaint details and identifies patterns to pinpoint problematic areas.

Fig. 3 shows the daily frequency of customer complaints which were collected at the Western Head Office between Jan 1, 2002 and Mar 31, 2002. The target type of complaint was set to *loan application*. The number of complaints fluctuated periodically during the analysis period. When judging from visual appearance, the complaints in the western district are likely to have this cyclical pattern.

Table 2
Detailed contents of one- and two-dimensional analysis

Type of analysis	Category	Description
One-dimensional	Insurance good, Complaint, Policy writing agent	To identify individual patterns and RFM patterns for insurance good/complaint/policy writing agent's point of view
	Occurrence point of complaint	To classify patterns according to the elapsed time after registration
	Customers' characteristics	To analyze customer information, including occupation, contract type, and previous complaints (if any)
Two-dimensional	The present	To discover interactions between problem factors through analyzing problematic areas now
	The present versus the past	To compare the present situation with that of the same period of previous years

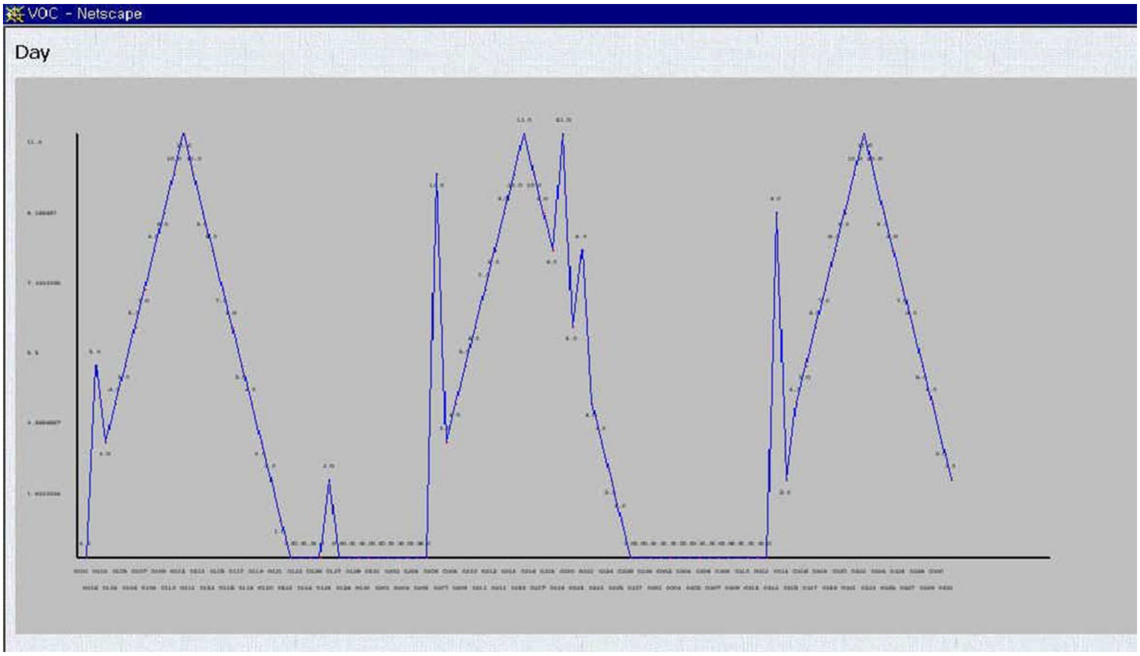

Fig. 3. One-dimensional customer complaint analysis for the Western Head Office.

One way to verify the cyclical pattern is to perform regression analysis to create trend lines, along with the frequency of complaints. As a result, if a positive correlation between time and frequency changes into a negative correlation (or, from negative to positive), the complaint follows a cyclical pattern. After separating the given period between Jan 1, 2002 and Jan 31, 2002 into two intervals, the system performs a regression analysis

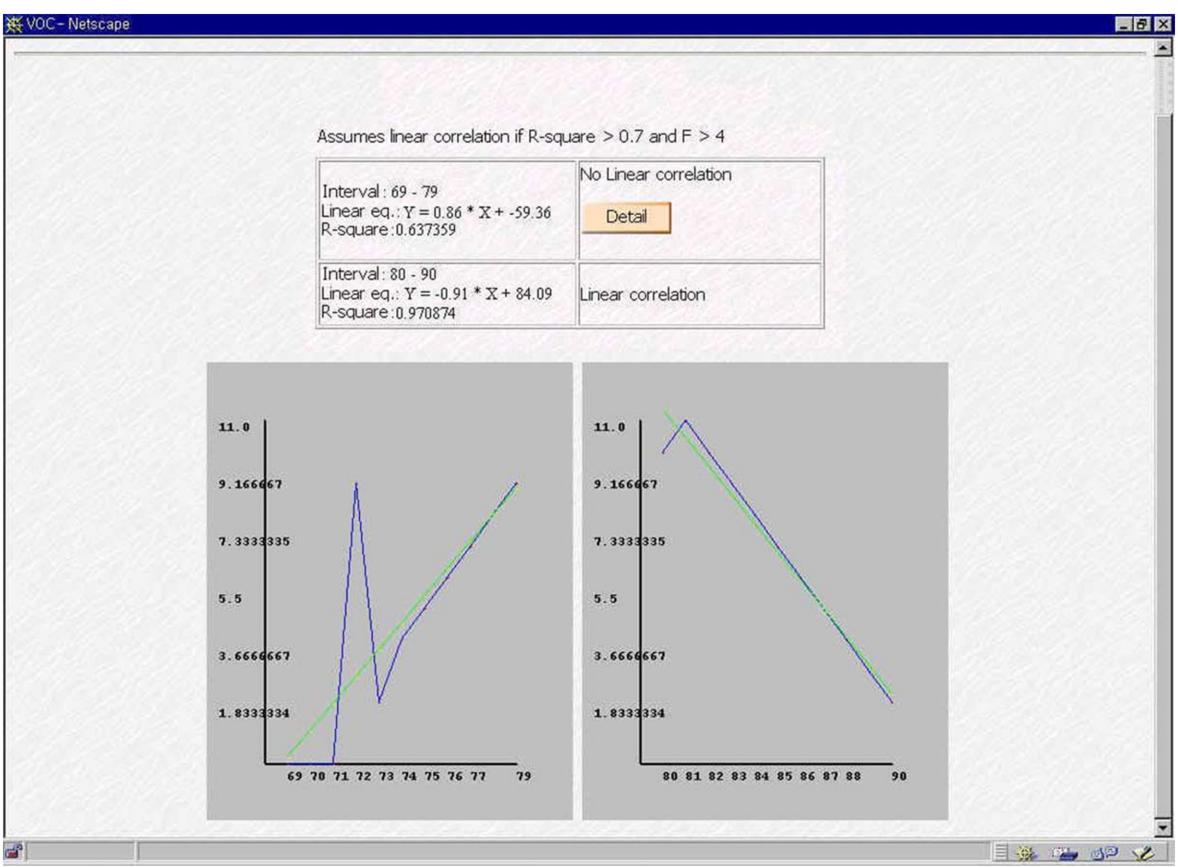

Fig. 4. Detailed analysis for the *cyclical* pattern of a complaint *loan application.*

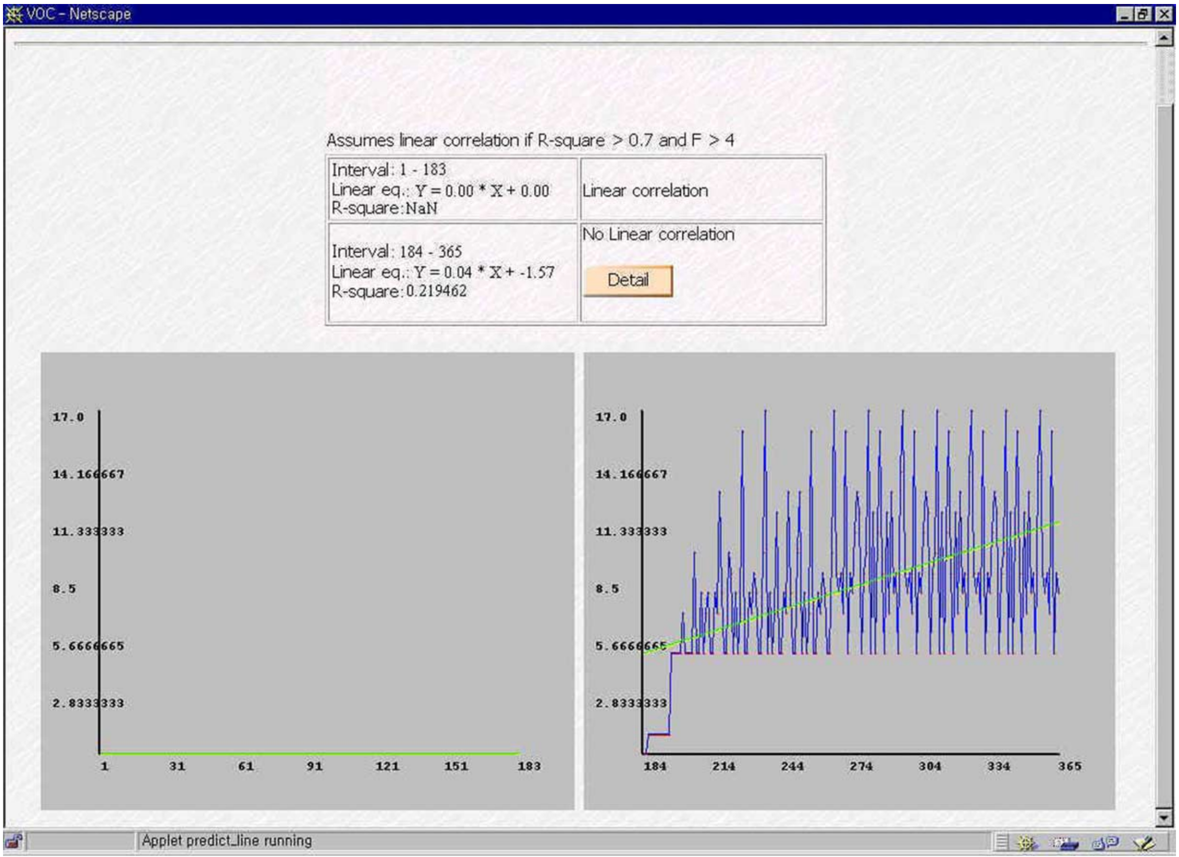

Fig. 5. Detailed analysis for the *new* pattern in the Metropolitan Head Office.

for each interval, respectively. Fig. 4 shows that the slope of the trend line between the time and frequency changes from positive to negative.

Fig. 5 shows a detailed analysis for a type of complaint which was received at the Metropolitan Head Office between Jan 1, 2002 and Dec 31, 2002. The target type of complaint was set to *maintenance and modification*. When judging from visual appearance, the complaint never happened before July and occurred again after July. The complaint in the metropolitan district is likely to have this new pattern.

The new complaint shows different correlations at two time intervals within the analysis period: One interval has no frequency at all and the other has a positive linear (or, non-linear) correlation. It is necessary to investigate the cause of occurrence and to prevent the complaint from becoming serious.

Fig. 6 explains that the pattern of complaint, *insurance expired*, in the eastern region is different from that of the new or cyclical complaint. Since the Eastern Head Office received the complaint similarly in number over time (i.e. the estimated y-intercept was above zero and the estimated slope of the regression line approached zero), the complaint appears to be a chronic occurrence at that district.

A detailed analysis also shows that the complaint has a positive linear relationship with time, irrespective of the analysis period including day, week, month, quarter, or year. This fact proves that the complaint becomes chronic, since appropriate action for solving the problem was not taken. If action were taken, then the remedy was insufficient.

4.3. One-dimensional analysis using lightly summarized complaints (RFM)

Fig. 7 depicts the results of one-dimensional RFM analysis for each head office selected arbitrarily; they include the Western Head Office, Metropolitan Head Office, Eastern Head Office, and a local head office. For this analysis, the analysis period was between Jan. 1, 2002 and Apr. 30, 2002.

Fig. 7(a) shows the average recency values of each head office during the analysis period. By definition, as a complaint's recency increases, the consequence decreases because it occurred a long time ago. The local head office (the rightmost bar) in Fig. 7(a) has the greatest recency value during the period. This indicates that the head office has received few complaints lately, as compared with the others. The Metropolitan and Eastern Head Offices (the 2nd and 3rd bars from the left) have received, on the average,

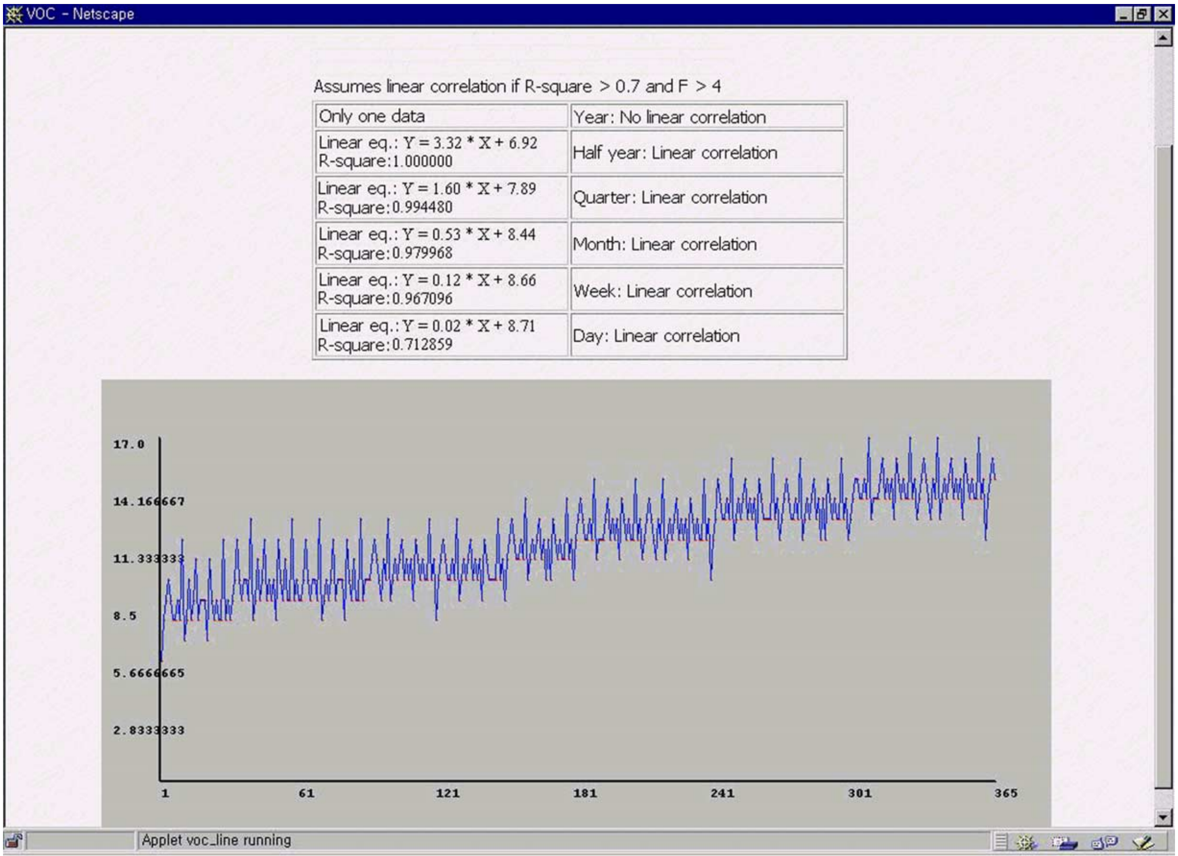

Fig. 6. Detailed analysis for an *insurance expired* complaint in the Eastern Head Office.

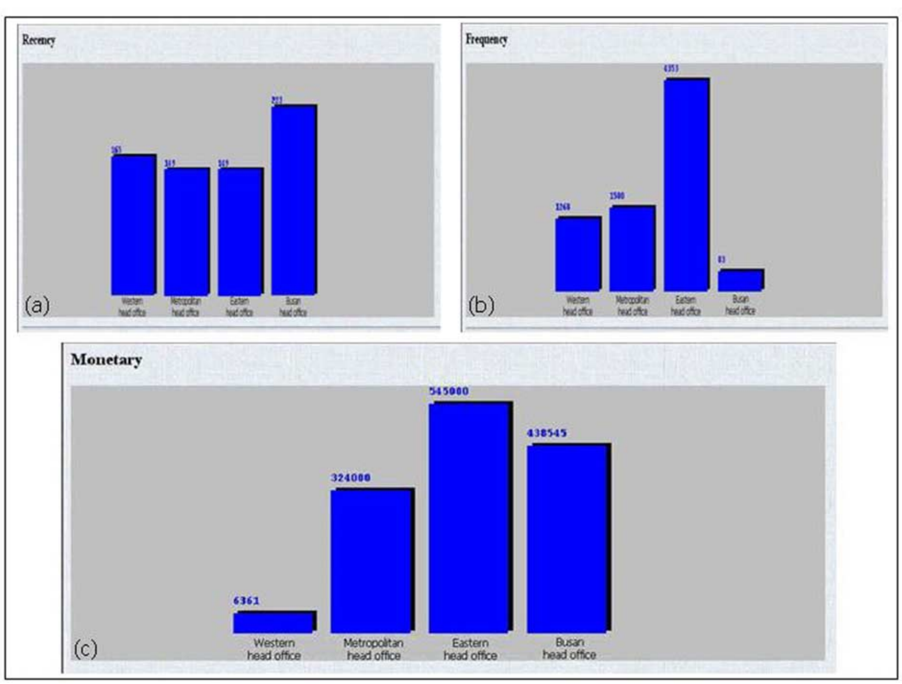

Fig. 7. One-dimensional RFM analysis for each head office.

more complaints lately than the others. Both of them need special attention.

Fig. 7(b) shows that the local head office has the lowest average frequency. When thinking about the results of recency analysis, the Eastern Head Office had many complaints until recently. This means that the region suffers some problems in customer service operation.

Fig. 7(c) exhibits the average monetary values necessary for resolving customer complaints that occur at each head office. When considering all three figures, the eastern district is quite likely to have a serious problem with service operation, based on high values in frequency, monetary, and a low value in recency. Since the local head office has low frequency values but relatively high monetary values, the internal process for solving complaints proves to be less efficient in this area. In the Western Head Office, the average cost for solving an individual complaint is very low in comparison with the average frequency in that area. It seems probable that customer complaints in the western region are not as serious as other regions.

4.4. Two-dimensional analysis

Fig. 8 depicts the results of a two-dimensional analysis when the measure of *similarity degree* was set to 0.8. The measure is one of the execution options in training SOM. It determines the extent of records within a group (or cluster) that tends to be similar with each other. The bigger the measure, the more similar the records of a group are. As the measure becomes smaller, the records increase in number but become more different. The default value of this measure is 0.9.

The execution results of SOM appear in the middle of the figure and assume the form of a 3×3 matrix. In training SOM, output units are restricted to ten or less due to managerial convenience. Generally a SOM ends up with a few output units that summarize many observations, and several units that do not really correspond to any of the observations. The strong units represent probable clusters and they have the same color (other than white) in the matrix. In this case, the VOC analysis system derived two dominant clusters.

At the bottom of the figure, a detailed explanation of SOM follows: The first row explains that as a result of executing SOM, two clusters come out and one is bigger than the other. The number of complaints in each cluster determines the size of the cluster. The second and third rows show the characteristics of each cluster. A decision-tree induction technique, C5.0, tests which attribute is the most discriminant for each cluster. To do so, C5.0 needs a definition of attributes and classes, and a training set that consists of pre-classified examples, each described by one or more attributes (the frequency of each type of complaints) and exactly one known class (cluster).

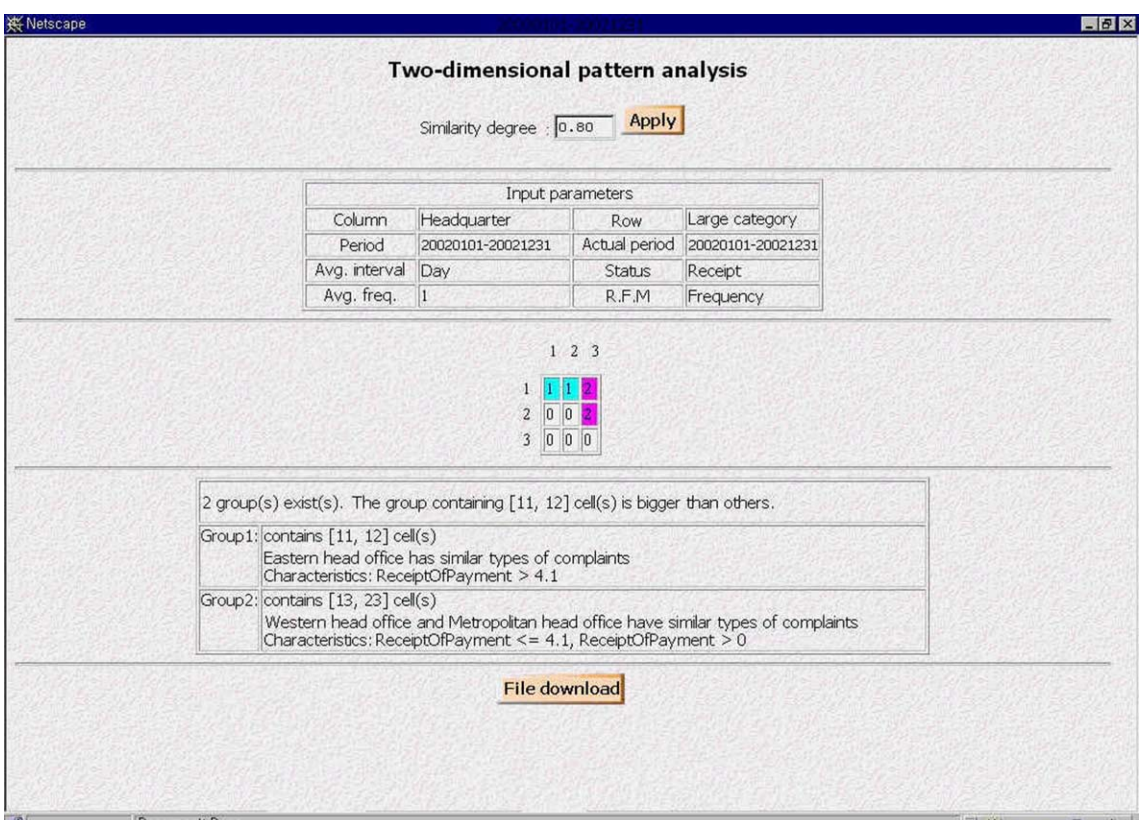

Fig. 8. Two-dimensional analysis of complaints using SOM and C5.0.

When judging from the frequency of complaints, the Western and Metropolitan Head Offices have similar types of complaints, but they definitely differ from the eastern region. This difference comes from the attribute *Receipt of Payment*, which is classified by C5.0 as the most discriminant descriptor.

4.5. Failure mode and effects analysis

Fig. 9(a) shows the frequency of complaints that result from the posterior failure mode and the lack of necessary complaint-preventing procedures at the Western Head Office. A detailed analysis shows that the occurrence pattern of this type of complaint, regarding the loan application, falls into cyclical. Periodicity at the western region is due to poor management of posterior failure mode complaints. It is imperative to prepare proper procedures for solving cyclical complaints and to train employees continually for addressing these problems.

Fig. 9(b) and (c) shows that a complaint, such as maintenance and modification, occurs newly in the metropolitan area. In this area, this type of complaint generally arises from a prior failure mode and a lack in both the complaint-preventing procedures and information. Since most of the prior failure modes reside in new insurance services when developing new services, one method to avoid this kind of complaint is to prepare solutions in advance which can prevent possible problems by using concurrent engineering techniques or sufficient SERV-QUAL procedures.

Fig. 9(d) shows that a complaint, such as the expiration of insurance, has a chronic problem in the eastern area. This type of complaint is fundamentally attributed to a process failure mode and a lack of procedures. One way to reduce the number of complaints is to simplify complicated procedures and introduce a one-stop service system for customers where they can benefit from efficient services.

5. Conclusion and further research

Since analyzing the VOC makes it possible for companies to identify in advance customer needs and to actively cope with forthcoming opportunities, it recently attracts public attention from the CRM perspective. Many companies try to identify their needs with those of customers through analyzing the VOC. The Web-based system described here offers several characteristics:

- Most companies, until now, have adopted the VOC as input to QFD to solicit and understand customer requirements qualitatively in new product design and development. The proposed system for analyzing the VOC, however, contributes to improving the processing and utilization of the VOC. It derives the problems of service operation in a life insurance company via

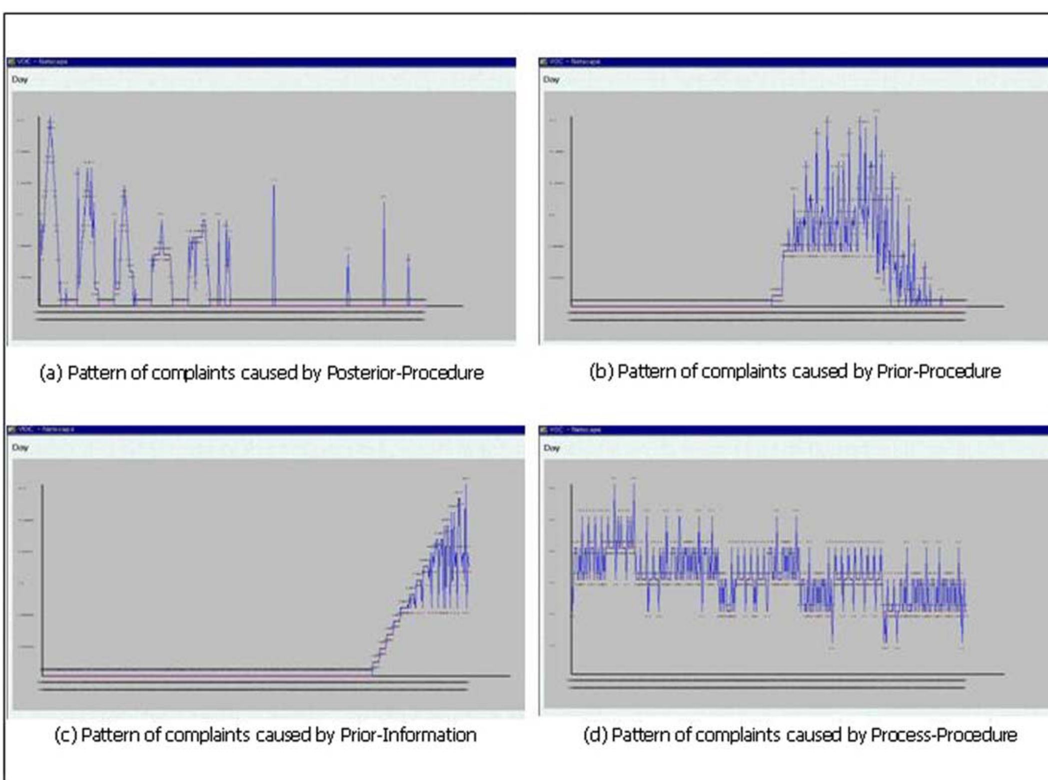

Fig. 9. Several patterns of complaints revealed by FMEA.

the VOC and attempts to find out the root cause of the problems. The system can handle customer complaints at hot points as well as prevent those complaints from occurring again.
- Since the proposed prototype system uses both conventional statistical techniques and data mining techniques, it improves the degree of confidence in the VOC analysis. The system obtains satisfactory results in identifying the types of complaints, such as new, cyclical, and chronic patterns. In addition, it finds out the problematic areas (one-dimensional analysis), interactions among problematic areas (two-dimensional analysis), and the root cause of the problems (FMEA), quantitatively.
- The prototype system can provide early warnings and a course of action through integrating the product or service database, customer database, and knowledge base. Moreover, derived patterns in the knowledge base can be used to identify target customers, help acquire new customers, develop new insurance goods or services, and perform loyalty management.

Future research can extend the work of this study in several ways. First, combining the prototype system with intelligent agent technology can make it possible to automate early warnings without user intervention through deriving VOC patterns and locating problems autonomously.

Second, developing an index tracking system is one way to improve the functionality of the prototype system. An index number can put together the abnormality of a product, service, or process immediately. By monitoring changes in the index number, we can identify changes in the VOC and customer requirements.

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