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Decision quality by the loss cost of Type I and Type II errors

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Abstract

Purpose – The purpose of this paper is to explore the system requirements model. According to the concept of loss costs of Type I and Type II errors, it can define the optimal decision line, and reduce overall loss costs. Moreover, it can decrease the probability of Type I and Type II error by the systems thinking, and it can effectively reduce overall loss costs.

Design/methodology/approach – The paper proposed a system demand model and constructed a decision-making system thinking model as well as a decision-making performance management model using the principle of system demand. Types of decision-making errors were analyzed to set judgments on the error risk and establish a model of improvement evaluation key factors, in order to reduce decision-making error risk and enhance decision quality. It also constructed the improved decision-making to assess the key factors, to reduce the risk of making errors in order to improve the quality of decision-making.

Findings – Optimistic decision-makers (risk takers) tend to make Type II errors, whereas pessimistic decision makers (conservatives) tend to make Type I errors. Financial depressions are the time for optimistic decision makers (risk takers) and boom periods are the time for pessimistic decision makers (conservatives).

Originality/value – The concept of the loss cost of two decision-making errors and related cost function models were proposed. Decision makers could make decisions with a more stable model, taking into consideration false alarms and the cost function of errors in order to determine the position of the decision-making line. It could effectively reduce decision-making error costs and increase the precision of decision-making.

Keywords Decision quality, Decision-making failure costs, Decision-making error risk, Decision-making performance management, Decision making, Performance management

Paper type Conceptual paper

1. Introduction

There is a saying, "Choose what you love, and love what you choose," where "choose what you love" represents the decision-making power, and the power of execution is represented by "love what you choose," which creates happiness. However, without "choosing what you love," the fulfillment will not result in "loving what you choose." Based on the above, decision making is a type of selection ability. It demonstrates the importance of selection and is a key factor in a person's future. Life is sometimes based upon fate, called inborn choice, including parents, children and personal gifts. In addition, life is sometimes a personal choice, called acquired choice, including spouses,

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friends, jobs and all the choices in a person's life that depend on his or her decision-making power. Hence, decision making is a key factor of happiness and success in a person's life. Likewise, decision making is also critical for the survival, growth and continuation of companies.

According to Chen (2007), there are three kinds of important managerial abilities. High-ranking supervisors have decision-making power, and propose innovative ideas and policy management regarding the corporate business model in order to recognize the current position of corporate operations, as well as the policies, goals and direction of future operations. Therefore, high-ranking supervisors' essential abilities are decision-making power, innovation and vision. The managerial abilities of medium and low-level supervisors are execution power (planning, strategy and execution). However, low, medium and high-ranking supervisors should be able to reflect upon themselves (the ability of examination and feedback) to collect executive performance in order to allow high-ranking supervisors to implement and predict performance management. These three managerial abilities must be audited, returned and modified using a high-frequency model as a rolling forecast of production management. Since more recent orders can be more precisely predicted, high-frequency rolling PDCA could lead to a more precise performance value and estimation.

In addition, these managerial abilities should be based on three principles of operation and management: importance management, source flow management and balance management. The principle of decision-making power in importance management is to recognize the key factor of decision making as criterion in order to reduce the failure cost of decision making. The principle of decision-making power in source flow management is to have precise prediction data and interpretation, which significantly reduces the failure cost of decision making; hence the saying "know your enemy and know yourself." The principle of decision-making power in balance management is to listen to the opinions of lower-level employees. However, good advice may sound harsh to the ears. Decision makers must accept different opinions, and the decision-making process should involve both "good advice" and "bad advice." Thus, decision quality will be enhanced, as shown in Figure 1.

A literature review on the application of the artificial neural network industry to business, management and finance referred to Wong *et al.* (1997). These issues can be based on a model using the traditional statistical technique. If the issue is non-linear, a neural network would be more suitable than traditional statistical techniques. On the contrary, when the issue is linear and the level of noise is high, traditional statistical techniques are more appropriate. As for financial investment, there are four types of

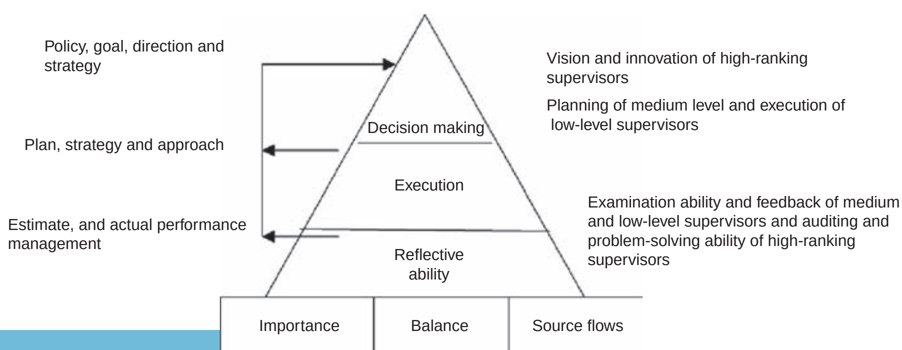

Figure 1.
Three kinds of important managerial abilities

applications: bond rating, which is mostly predicted by the accounting ratio of companies (Dutta and Shekhar, 1988, p. 2) options price estimation, including input variables from the BS model as well as other related variables (Andreou *et al.*, 2006, p. 3) future transaction (Bergerson and Wunsch, 1991, p. 4) currency forecasting, which is applied to predict currency changes as well as other financial variables (Huang *et al.*, 2005). With regard to securities investments, related literature on neural networks in forecasting the stock market can refer to Atsalakis and Valavanls (2009).

The applications are generally divided into four categories: first, forecast of return rate of securities proposed by Olson and Mossmanc (2003) and Cao *et al.* (2005). The forecasts are mostly based on a fundamental analysis of stock investment responsibility analysis. In other words, the long-term return rate of securities are predicted by accounting ratios such as the P/E ratio, stock profit ratio, stock price net value ratio and RoE. Thus, the individual return rate of the next season or year is predicted. Second, the prediction of stock price change as shown by Huang *et al.* (2005), Tsang *et al.* (2007) and Jang *et al.* (1993). The application includes the TAIEX rate of change for the next month or season as predicted by the analyzed variables, and the TAIEX or individual rate of change for the next day or week as predicted by technical analysis. Third, stock price pattern identification is based on a price pattern analysis of technical analysis. For instance, a triangular pattern is recognized from the candle Figure 4. Decision making of stock transactions, as shown by Huang *et al.* (2005), which is mostly based on technical analysis and genetic algorithms to construct stock transaction decision-making systems.

2. Concept of decision making

2.1 Step of decision making

According to Chen (2007), before decision making occurs, the expected quality cannot usually be defined, and the expected quality defined is not based on a person's approval. Therefore, cognition quality after decision making does not necessarily refer to a person's approval. During decision-making situations, the definition could be based on the perspective of Taguchi quality, which includes three stages: system design, parameter design and tolerance design. As for system design, the matching of supply and demand should meet the four "its" suggested by Master Sheng Yen: "face it, accept it, deal with it, and leave it." The first three "its" are consistent with management. "Leave it" means to ignore the outcome, which must be recognized and adjusted with a positive life philosophy. In other words, an individual must prepare for the worst condition, but make the best effort. Adjustment means to reduce expectations and avoid greed, hatred and obsession. Quality management also includes nine processes: discover problems, admit problems, face problems, recognize the main causes of problems, propose solutions, propose preventions, propose related measures in the implementation, fulfill implementation, confirm feedback of performance after implementation and standardize the solution after accomplishing the performance. However, when performance does not meet the standard, the problems must be redefined and improved upon, which is the principle to ensure decision quality.

2.2 System demand management

Corporate operational strategy can be divided into the first, second and third strategies. The first strategy is patent advantage, the second strategy is quality advantage and the third strategy is cost advantage. Based on the above, decision making can be divided into a routine decision-making model of daily management and an exceptional decision-making model of improvement management, policy management and innovative management, as shown in Figure 2.

2.3 Types of decision making
Based on the decision-making importance and quantity, the 80/20 principle and the classification of decision making above, the two types of decision making are routine and non-routine decision making. The quantity of routine decision making in ordinary companies is 80 percent; however, the importance of failure and success is 20 percent. Routine decision making is based on rich databases and there are few random factors, therefore the forecasting model is more simple and precise. After decision making, the failure costs of type I and type II errors will be lower. On the other hand, the quantity of non-routine decision making is about 20 percent, and the importance of success and failure is about 80 percent. Non-routine decision making lacks a rich database, and there can be no previous cases. Due to more random factors, the forecasting model is more complicated and imprecise, and a forecast and decision-making model cannot be suggested immediately. Therefore, after decision making, the failure costs of type I and type II errors will be higher, and could negatively affect the survival of the companies or systems, as shown in Figure 3.

3 Decision quality of process of decision-making system

3.1 The process of a decision-making system
During system thinking, decision quality factors can be divided into closed and open systems. Closed systems include input, process and output (IPO). In Deming's PDCA cycle, only plan, do and check (PDC) is mentioned, without action (A). Thus, the system cannot fulfill the expectations of management, and there will be higher failure costs of type I and type II errors. Closed systems can be divided into black-box operations and white-box operations. Black-box operations only focus on input and output instead of the process. Closed systems and white-box operations (input, process, output and

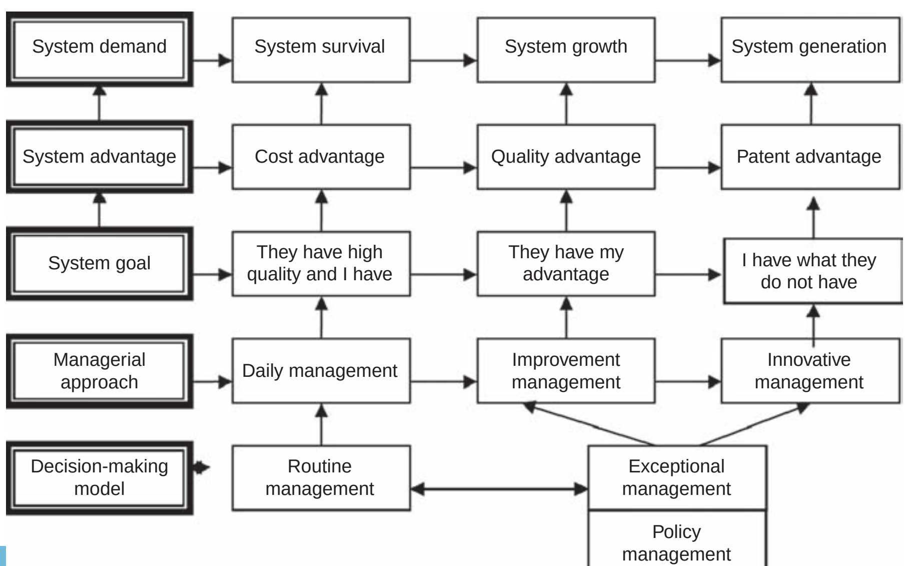

Figure 2.
Relation of the decision-making model for system demand management

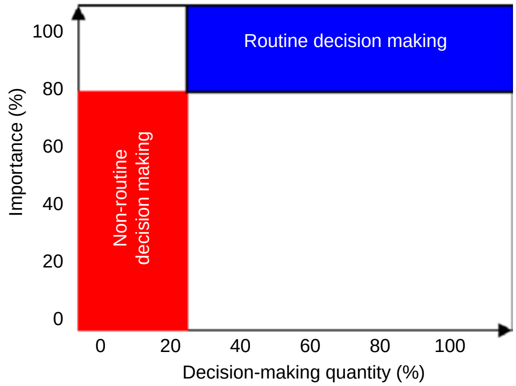

Figure 3.
Types of decision making

feedback, or IPOF) meet Deming's PDCA cycle. The system reveals managerial precision and reduces type I and type II failure costs. It also increases the business costs of decision making. When expanding individual systems into the overall system, using supply chain model as an example, it can be defined as SIPOCF (supplier, input, process, output, customer and feedback). Decision-making models of different kinds of system thinking influence decision quality and decision-making costs.

Therefore, when selecting decision-making models, it is necessary to consider type I and type II error costs and the decision-making cost of managerial efficiency related to the precision of decision making. Managerial efficiency aims to acquire high-management benefits with low management costs. The management risk coefficient (probability and seriousness, or cost degree) is also an important decision-making criterion. The decision-making formation model includes the definition of questions, changes and trend analysis (simple answers, Q and A or development), solutions and measures, yes/no or case study multiple-choice questions (one answer from multiple choices or multiple answers from multiple choices), paradigm transfers, paradigm modification transfers and innovation transfers.

3.2 Bullet control and missile control

Regarding forecasting models of the supply chain for convenience stores and traditional stores in the circulation industry, the supply to traditional stores occurs about once every one to three months. Therefore, the gap between forecasting and real demand is high. On the contrary, the supply to convenience stores occurs one to three times every day. Therefore, the gap between forecasting and real demand is relatively low. An increase of feedback or supply frequency enhances the supply cost of the unit. Thus, chain operations and centralized logistics systems are necessary in order to reduce the cost.

This study proposed two models: bullet control and missile control. Bullet control decision making has a PDCA cycle with a single frequency, and cannot be immediately modified in the manufacturing process. Thus, the probability of errors is high. Missile control decision making has a multi-frequency PDCA cycle and can be immediately modified in the manufacturing process. Thus, the probability of errors is low. In traditional retailers with a bullet (rocket launcher) management model, since the frequency of low delivery batches is high and there are few PDCA cycles, type I shortage costs and type II error scrap costs increase. In convenience stores with missile control, since delivery frequency is high and delivery batches are diverse and in small quantity, the stores can increase their economic scale with a chain model. Hence, inventory is low, and type I shortage costs and type II error scrap costs are also reduced.

3.3 Decision quality

Decision quality is determined by immediate rich information, including complete data from the past, precise forecasting models, critical forecasting parameters and random factors, as well as a rational decision-making evaluation. In addition, another key factor of decision quality is the distance from the forecasting point and the current time point. The closer they are, the more precise the forecasting value will be. On the contrary, the more distant they are, the less precise the forecasting value will be. Therefore, immediate feedback and feedback frequency in the decision-making process are key factors of decision quality that influence the precision of the prediction. Upon such a principle, there are many related managerial measures. For instance, a rolling production schedule enhances the precision of scheduling forecasts by increasing feedback frequency.

Finally, six key principles of decision quality are listed below are: immediate and rich information, including complete data from the past; a precise forecasting model; key forecasting parameters and random factors; the distance between the forecasting point and current time point, where the closer they are, the more precise the forecasting value is; an immediate and multi-frequency feedback rate in a decision-making process missile control model; and overall system thinking and rational decision-making evaluations, as shown in Figure 4.

4. Decision-making performance management and decision-making effort patterns

4.1 Decision quality

The performance parameters of decision quality can be defined by the performance management model of value, quality and quantity. A Performance management model is defined as value = quality × quantity. In a managerial pattern, there is a water

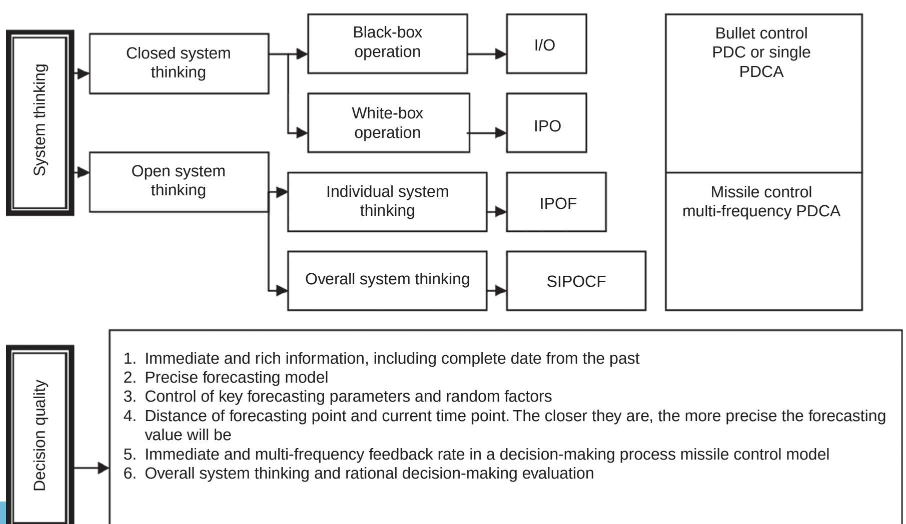

Figure 4.
System thinking model and decision quality relations

tower theory of cash flow control. The formula is shown below:

$$\text{Flow}\ (\text{cm}^3/\text{day})\ (\text{value}) = \text{flow}\ (\text{cm/sec})\ (\text{quality}) \times \text{diameter}\ (\text{cm}^2) \times \text{time}\ (\text{sec/day})\ (\text{quantity})$$

Regarding cash flow, in order to have a high accounts receivable turnover rate (value) of corporate fund input, a short payoff period and a low bad debt rate, the daily batch (quality) and price of each batch (quantity) must be high. The requirements of accounts receivable is a long period and a low rate. The formula is shown below:

$$\text{Payable flow}\ (\text{value}) = \text{flow frequency}\ (\text{times/year})\ (\text{quality}) \times \text{batch}\ (\text{NTD/times})\ (\text{quantity})$$

The concept can be applied to convenience stores in order to enhance the performance management of business volume. The relation formula is shown below:

$$\text{Business volume}\ (\text{NTD/day})\ (\text{value}) = \text{unit price of customer}\ (\text{person/day})\ (\text{quality}) \times \text{number of customers}\ (\text{NTD/person})\ (\text{quantity})$$

As long as the performances of the unit price of the customer and the number of customers are controlled, business volume will increase, and the profits can be calculated by the contribution rate. The contribution rate can be measured by "good profits" and "easily sold" to increase profits. The relation formula is shown below:

$$\text{Profits}\ (\Pi)\ (\text{NTD/day})\ (\text{value}) = \text{good profits}\ (\text{P} - \text{AC})\ (\text{NTD/piece})\ (\text{quality}) \times \text{easily sold}\ (\text{Q})\ (\text{piece/day})\ (\text{quantity})$$

Companies tend to neglect output value and over emphasize creating plenty of business volume, value and profit. However, the correlation between business volume and profit rate is not necessarily positive, and there can be a negative correlation. Since the profit ability of products depends on the price, average cost and sales of products, the formula is shown as:

$$\pi = \text{TR} - \text{TC} = (\text{P} \times \text{Q}) - (\text{AC} \times \text{Q}) = \text{Q}\,(\text{P} - \text{AC})$$

where π is the product profits, TR the total profit, TC the total cost, P the price, Q the sales and AC the average cost. According to the formula above, in order to have high-profit ability, there must be an increase of sales, increase of prices and a reduction of the average cost. It could be defined as the larger the difference between the product price and average cost, the more the average profit will be. Therefore, it is called good profits P–AC. Furthermore, when sales are higher, it is called easily sold Q. Good profits P–AC and easily sold Q influence the profit ability of products. As for the application of value, quality and quantity in logistics delivery management, the formula is shown below:

$$\text{Delivery}\ (\text{quantity/day})\ (\text{value}) = \text{delivery frequency}\ (\text{times/day})\ (\text{quality}) \times \text{delivery batch}\ (\text{quantity/times})\ (\text{quantity})$$

The above is reorganized, as shown in Figure 5.

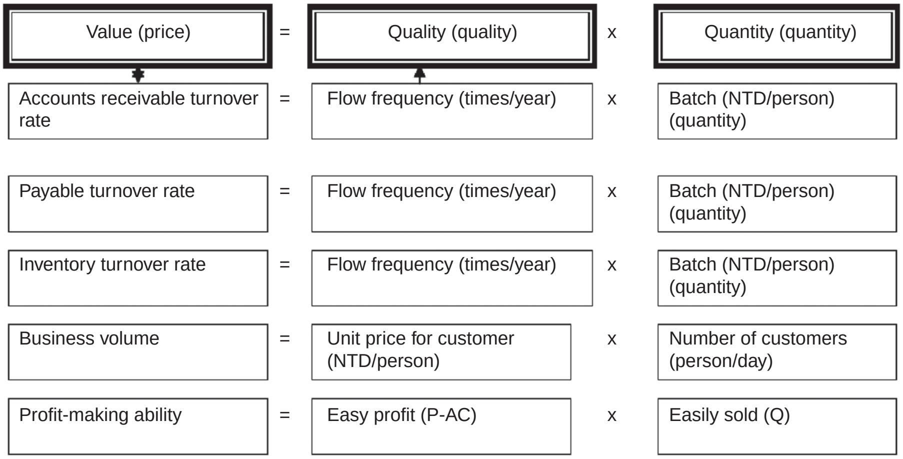

Figure 5.
Decision-making performance management model of value, quality and quantity

4.2 Decision-making error pattern

Cost can be divided into decision-making business costs and failure costs. Ordinary error sources refer to "a man can but does not do, and does what he should not do, and it is overly done." Time, quality, quantity and overly done are defined below. Time means the loss cost of being too late or too early; quality means an overly done quality or poor quality; quantity means too much quantity (supply more than demand) or too little quantity (supply is less than demand). Optimization means the balance between the optimized supply and demand. An optimized balance in nature creates an optimized benefit.

Therefore, the optimized benefit of decision making is an optimization of people, things, time, locations, objects, quality, quantity and price. In terms of human resources, it means to place the most suitable people in the most proper positions to do the most appropriate tasks. From the perspective of marketing, it means to sell the most suitable goods (objects) and services (things) to the most proper customers (people) using the optimized quality, quantity and price, and deliver them to the most proper places (location) according to the most appropriate time (time) demanded by the customers. Types of decision-making errors are shown in Figure 6.

4.3 Evaluation of the loss cost of decision making

In order to construct the optimized decision-making model, this study proposed an overall system thinking model and constructed type I (over) and type II (less) loss cost evaluations using risk management and positive, negative and combination type I and type II errors. Decision-making control was established using Statistics Process Control (SPC). Using a product test as an example, the correct decision making was for good products to be accepted and bad products refused. However, when good products were refused, it would be a type I error (producer risk α risk), and when bad products were accepted it would be type II error (consumer risk; β risk), as shown in Table I. Using the risk coefficient (manufacturing capacity) and probability, decision-making analysis of type I and type II errors of the product test could be constructed. In this analysis, it was difficult to determine the decision-making line, since it was related to type I and type II loss costs, which were also related to probability, as shown in Figure 7.

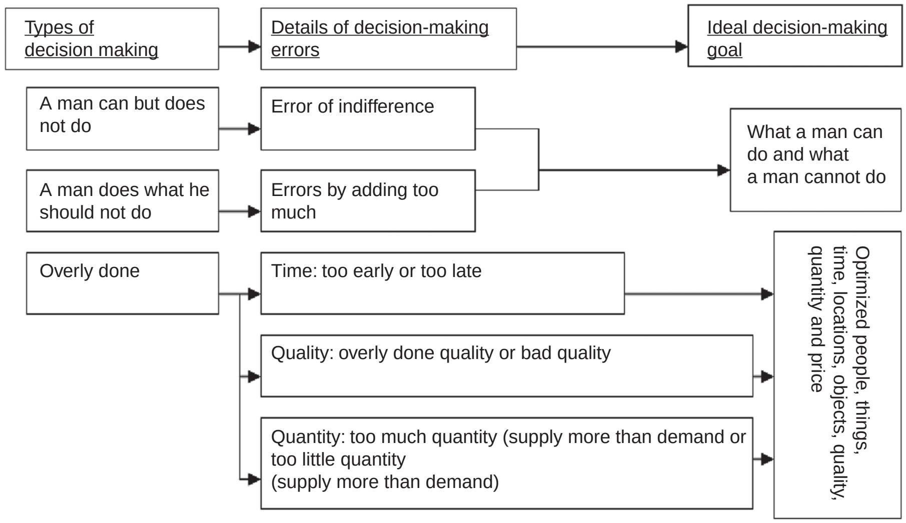

Figure 6.
Types of decision-making errors

Table I.
Type I and type II errors of product test

State decision-making	Good	Bad
Accept	Correct	Type II error Consumer risk β risk
Refuse	Type I error producer risk α risk	Refuse

The decision-making loss cost is determined by the four factors of before-predication, middle-seriousness, probability and after-control. Forecasting will indicate middle-seriousness and probability, which will easily recognize, prevent and reduce the seriousness, probability, and after-control, as shown in Figure 8.

This study set the asymmetric loss function to test α and β errors below:

Yij = to test the distance between α and β errors and goals (0 error);
$i = 1,2,\ldots,$ and 37 (real value); $j = 1,2,\ldots,$ and 37 (forecasting value);
$n = 1,2$ (1 is the optimized forecasting model and 2 is the original forecasting model); and
$\Delta_\alpha = \alpha$ distance between control limit and goal value; $\Delta_\beta = \beta$ distance between control limit and goal value.

A_1 = loss cost of producer risk under α control limit; A_2 = loss cost of consumer risk under β control limit:

$$L(y) = \begin{cases} A_1, y < UCL \\ k_1(y-m)^2, if \quad UCL \leq y \leq m \\ A_2, y > LCL \\ k_2(y-m)^2, if \quad m \leq y \leq LCL \end{cases}$$

$$k_1 = \frac{A_1}{\Delta_1^2}, k_2 = \frac{A_2}{\Delta_2^2}, TC = \text{total cost}$$

$$TC_n = \sum_{i,j=0,1}^{i>j} k_1(y_{ij}-m)^2 + \sum_{i,j=0,1}^{i<j} k_2(y_{ij}-m)^2$$

the nth approach:

$$\alpha \text{ risk loss expectation value} = \alpha \text{ risk loss cost rate} \times \alpha \text{ risk probability}$$
$$\beta \text{ risk loss expectation value} = \beta \text{ risk loss cost rate} \times \beta \text{ risk probability}$$
$$\text{Total loss expectation value} = \alpha \text{ risk loss expectation value} + \beta \text{ risk loss expectation value}$$

Based on the above, the formula is constructed below:

$$L(x_\alpha) \times P(x_\alpha) = L_\alpha$$
$$L(x_\beta) \times P(x_\beta) = L_\beta \text{ total loss cost is } L_T = L_\alpha + L_\beta$$

5. Methodology – neural network method

In terms of decision making, it often uses traditional statistical techniques to establish a pattern in inventory management, production management, quality management, financial management, R&D management, customer relationship management, supply chain management. However, if the nature of the problem is non-linear, the neural network has better performance than the traditional statistical techniques (Ho *et al.*, 2010). On the contrary, if the problem is approximately linear, and the noise is large, the neural network has poor performance than the traditional statistical techniques

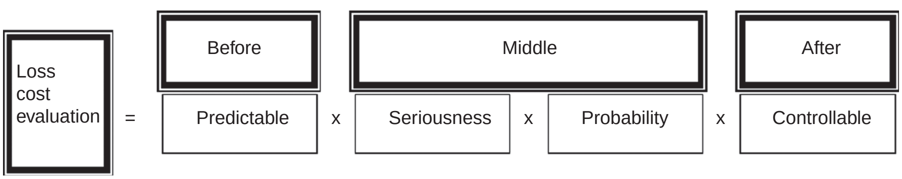

Figure 7.
Loss cost evaluation factors

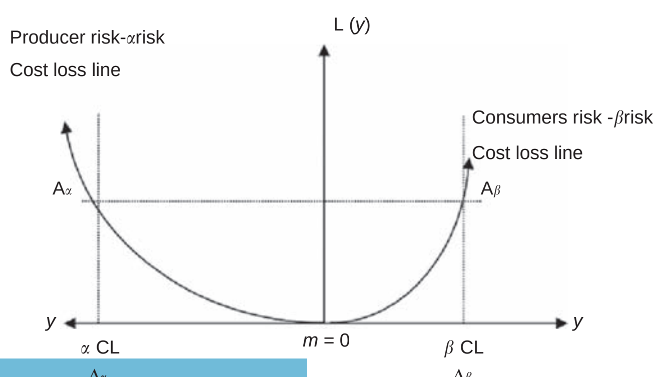

Figure 8.
Test of asymmetric loss function α and β error

(Hahn *et al.*, 2009). Overall, the problems of nature of decision-making model are non-linear, therefore neural networks is suitable to analyze the decision-making problems.

6. Case study

6.1 Study of loss cost of quality control case

This study applied a type I and type II error and loss cost of quality management test to decision-making analysis, and then introduced related incidents (the broken Houfeng Bridge, toxic milk powder, typhoon forecasting) to elaborate related parameters and the loss cost of decision quality. First, using the concept of quality management, this study constructed a type I and type II errors of product test (Table I) and established decision-making analysis (Figure 9) using a control figure, as well as type I and type II loss costs and decision-making timing. Additionally, using type I and type II loss costs, decision-making analysis was conducted. Subsequently, using type I and type II loss costs, a decision-making control figure was established, as shown in Figure 10.

6.2 Study of the loss cost of Houfeng Bridge

Typhoon Sinlaku caused the tragedy of the broken Houfeng Bridge (two people dead and four people missing). Thus, it was the correct decision making to not sound an alarm in safety and to sound an alarm in danger. When the alarm sounded in safety, it would be a Type I error (producer risk; α risk) and when it did not alarm in danger, it would be a type II error (consumer risk; β risk), as shown in Table II. In this case, the decision-making parameters were imprecise, as they only treated the river surface reaching the red line as the decision-making criterion to block the bridge. It did not

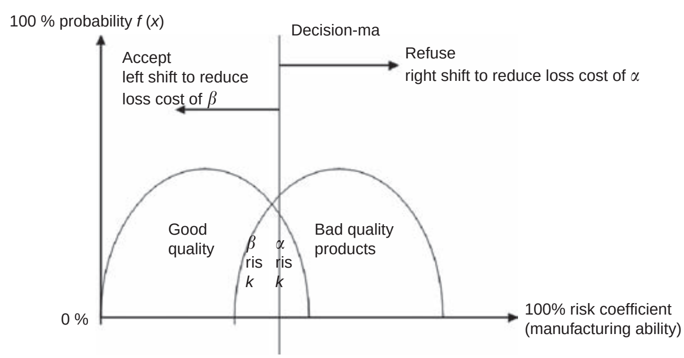

Figure 9.
Analysis of decision making of type I and type II errors in product test

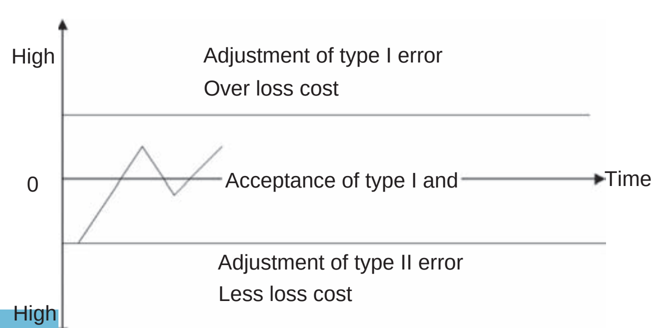

Figure 10.
Control of decision making

consider the flow and scouring power of the water, and thus the bridge pier was destroyed by a rush of water. In the decision-making process, the control limit of the bridge pier was not considered. Through the immediate decision making (yes/no), six people's lives were taken away, indicating the importance of precisely predicting the loss costs of type I and type II errors in order to make the best decision making with the lowest loss cost. Regarding modifications of the loss cost, this study revised SOP using real economic income. It was necessary to consider the price index at the time so that the evaluation values of different times could be based on the same level. The formula to evaluate real income is shown below:

$$\text{Real income} = \text{nominal income}/\text{price index}$$

However, when setting SOP, it is also necessary to consider the parameters at the time, so that the evaluation values of different times will be based on the same level. The formula of the real standard evaluation is shown below:

$$\text{Real standard} = \text{nominal standard}/\text{situation parameters}$$

For the nominal standard, the decision making implies α risk and β risk. However, α risk and β risk could be conversed to be different percentages of the risk loss cost. Thus, the formula is below:

$$\text{Nominal standard} = \text{real standard} \times \text{situation parameters} \times \text{loss cost rate}\ (\alpha\ \text{risk}, \beta\ \text{risk})$$

For instance, yellow-line standard = red-line standard × situation parameters (water flow, flow speed, life of bridge pier without flood prevention and degree of destruction) × loss cost rate (α risk and β risk). Thus, the decision-making line should be based on the loss cost of life and property caused by type I and type II errors. It is also closely related to probability, as shown in Figure 9. Finally, it determines the control limits of type I and the type I and type II loss costs and decision-making time, and constructs the decision-making control. When the loss cost and probability of the accident increases, it must shift the decision-making line in Figure 11 to the left, compress the lower control limit (β control limit-error) and loosen the upper control limit (α control limit -warning), as shown in Figure 12.

6.3 Study on the loss cost of the financial tsunami

Using the financial tsunami incident as an example, the correct decision making was a refusal of financial products with bad credit (high profit and risk) and an acceptance of financial products with stable credit (stable profit and low risk). However, once

State decision-making	Safe	Dangerous
Without alarm	Correct	Type II error Error risk β risk
With alarm	Type I error False alarm risk α risk	Correct

Table II. Type I and type II errors of the Houfeng Bridge incident

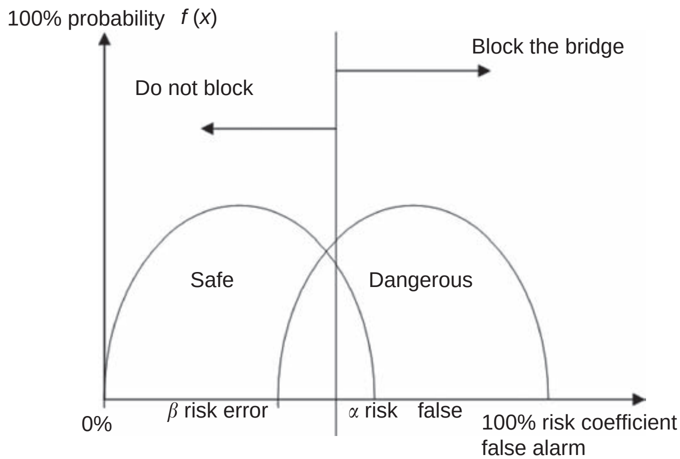

Figure 11. Analysis of decision quality

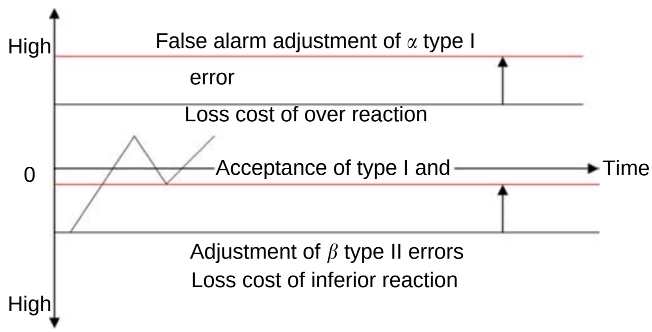

Figure 12. Control of decision making

financial products with stable credit were refused, it would be a type I error (producer risk; α risk), and when financial products with bad credit (high profit and risk) were accepted it would be a type II error (consumer risk; β risk). Likewise, regarding credit loan cases in the banks, the correct decision making was to refuse clients with bad credit and accept clients with stable credit. However, when clients with stable credit were refused, it would be a type I error (producer risk; α risk) and when clients with bad credit were accepted it would be a type II error (consumer risk; β risk), as shown in Table III. After the financial tsunami, the decision-making line related to loans was strictly judged and shifted to the left. Hence, α risk type I errors increased and business declined. It reduced the probability of type II errors and reduced the loss cost of bad debt. A shift of the decision-making line should be upon the total cost of type I and type II errors. The formula is shown below:

$$\begin{aligned}\text{Total cost} &= (\text{Type I error probability} \times \text{Type I loss cost rate})\\ &\quad + (\text{Type II error probability} \times \text{Type II loss cost rate})\end{aligned}$$

In order to increase decision quality, key statistic physical factors and dynamic situational factors related to bad debt rate should also be recognized, other than the total cost of loss (Nanni and Lumini, 2009). Thus, Figure 13 was modified to define the probability distribution of bad debt and payoff, as shown in Figure 14. It would easily determine the decision-making line and significantly reduce type I and type II error risk, further reducing the total cost.

The formula of the modified situation, parameters and loss cost rate related to the above decision making is shown below:

$$\begin{aligned}\text{Compressed loan standard} &= \text{normal loan standard}\\ &\times \text{situation parameters(trend of bankruptcy; depression)}\\ &\times \text{loss cost rate } (\alpha \text{ risk}, \beta \text{ risk})\end{aligned}$$

Table III. Type I and type II errors of financial loan risk

State decision-making	Pay off	Bad debt
Agree Loan	Correct	Type II error Bad debt loss risk β risk
Disagree Loan	Type I error Risk of declining business α risk	Correct

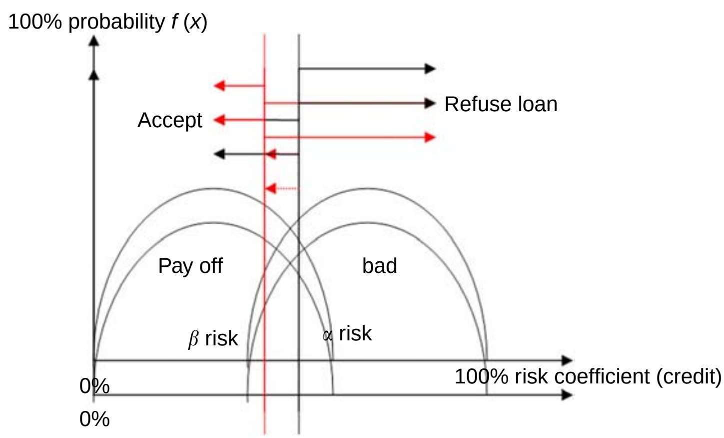

Figure 13. Judgment of the error risk of the financial tsunami

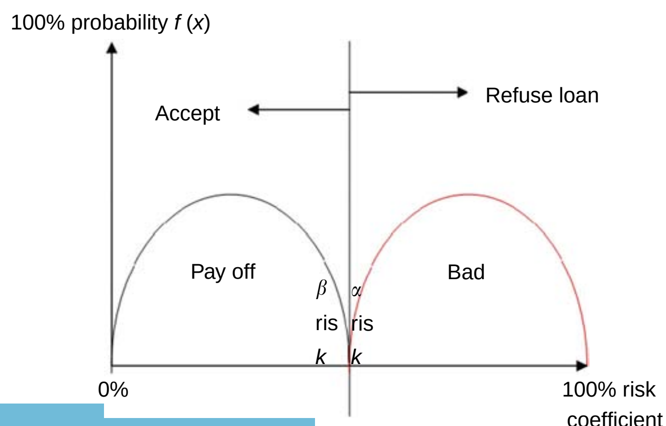

Figure 14. Error risk judgment of improvement evaluation key factors

6.4 Study on the loss cost of inventory decision making

Using loss caused by inventory decision making as an example, excess components are created due to excess types of products. In addition to wrong forecasting of market demand and underestimation of rivals' advantages, ASUS encountered financial difficulties (from profit to loss). The correct decision making was to have products needed by customers in inventory and to not have any inventory of products with no demand. However, when there was no inventory for products needed by customers, it would be a type I error (order or work stoppage and waiting for materials; α risk), and when there was inventory for products that were not needed by customers, it would be a type II error (loss of idle materials scrap; β risk), as shown in Table IV. Currently in the net book industry, companies promote the low unit price and refined quality of small net books.

As a result, it is necessary to refine the product specifications and simplify component requirements in order to reduce the cost. The notebook industry of the past, with its high profits, no longer exists. Nowadays, it is a product requirement for low profit and optimized demand. Thus, decision makers must treat consumer demand and pressure from rivals as the decision-making parameters in order to construct product and inventory decision making with the optimized situational demand. Finally, the control limits of type I, the type I and type II loss cost and the decision-making time were determined, and the decision-making control figures were established. After the incident, with media exposure, the decision-making line in Figure 15 was shifted to the left, the lower control line (β control limit) was compressed and the upper control line (α control limit) was loosened.

Table IV.
Type I and type II errors of inventory decision-making incident

Demand supply	Needed by customers	Not needed by customers
With inventory	Correct	Type II error β risk Loss of idle materials or scrap
Without inventory	Type I error α risk Loss of order or work stoppage and waiting for materials	Correct

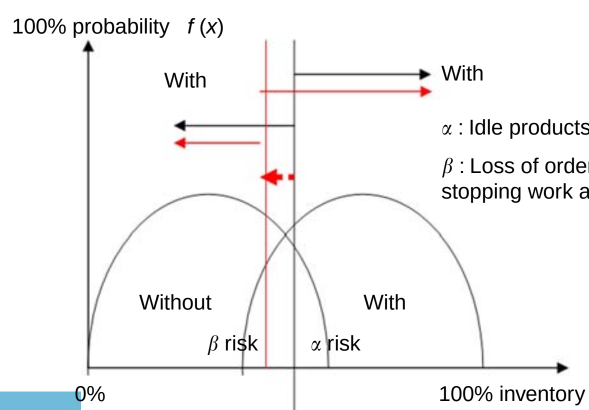

Figure 15.
Analysis of inventory decision quality

The formula of the modified situation, parameter and loss cost rate related to the above decision making is shown below:

$$\text{Compressed inventory standard} = \text{normal loan standard} \times \text{situation parameters} \\ (\text{market demand, competition and business}) \\ \times \text{loss cost rate } (\alpha \text{ risk}, \beta \text{ risk})$$

7. Discussion

This study proposed a system demand model and constructed a decision-making system thinking model as well as a decision-making performance management model using the principle of system demand. Types of decision-making errors were analyzed to set judgments on the error risk and establish a model of improvement evaluation key factors, in order to reduce decision-making error risk and enhance decision quality. This study also finds that optimistic decision makers (risk takers) tend to make type II errors, whereas pessimistic decision makers (conservatives) tend to make type I errors. Financial depressions are the time for optimistic decision makers (risk takers) and boom periods are the time for pessimistic decision makers (conservatives). However, it is not easy to predict a depression or boom period, and the failure cost of decision making will not be zero. However, good decision makers try to approach the truth (Tetenova, 2012).

This paper developed the concept of the loss cost of two decision-making errors and constructed the best decision-making model. Moreover, this model could be a great forecasting tool and increase the accuracy. In term of implementation suggested the missile control decision making has a multi-frequency PDCA cycle and can be immediately modified in the manufacturing process. Thus, the probability of errors is low.

The neural network model can effectively analyze the database to figure out the probability of type I and type II errors, and then offers the optimal decision-making model in light of circumstances. The method can be used by multi-frequency PDCA (plan, do, check, action, PDCA) of the fool-proof surveillance mechanism to predict and control data (Sokovic *et al.*, 2010). Moreover, to analyze decision maker's psychological and behavioral aspects through management practices and improve the quality of decision making.

Finally, the hazed analyze critical control point (HACCP) of the decision-making process and implementation, it can find out the effects of key hazed points in decision making which causes type I and type II errors. Furthermore, it can improve quality of decision making and reduce the loss cost.

8. Conclusion

All kinds of systems are based on survival, growth and continuation. As Confucius stated, food and sex are basic human desires. Human beings and all things on earth pursue individual survival and growth through food and have generations of species through sex. Therefore, systems must survive through daily management, acquire growth though improvement management and have continuation through innovative management. During a recent war between Israel and Palestine, several rocket missiles launched by Palestine resulted in the deaths of three people. However, missile attacks from Israel caused the deaths of over 300 people. Based on the analysis of the number of deaths, there was a difference of 100 times. Immediate feedback and modifications enhanced the precision of system performance and reduced the failure cost of type I and type II errors. Base on this, this study also proposed two models: bullet control and missile control.

The concept of the loss cost of two decision-making errors and related cost function models were proposed. Also, the probability distribution of two decision-making errors was constructed upon key indices (Bornmann and Daniel, 2009). Thus, decision makers could make decisions with a more stable model, taking into consideration false alarms and the cost function of errors in order to determine the position of the decision-making line. It could effectively reduce decision-making error costs and increase the precision of decision making. Finally, in the future study, the concept of the loss cost of two decision-making errors could be applied to many fields, such as production and marketing system, inventory preparation, supply chain management, economic management, supply and demand balance system.

9. Managerial implications

Our research examines the decision quality by type I and II errors. Before the strike of Typhoon Morakot in 2009, the government announced water restrictions, which caused stocks to fall. However, the government immediately modified the announcement that water availability could still last for more than two months. Decision making and reporting should be cautious. Weather reports announced that Typhoon Morakot was a medium typhoon and would only strike central and northern Taiwan; however, the typhoon seriously damaged southern Taiwan. The Central Weather Bureau focussed on measuring the wind velocity of the typhoon eye at the front and emphasized the wind as a key factor of disaster. CNN described the typhoon as a super typhoon that would cause serious damage according to overall measurements of the clouds. The Central Weather Bureau generalized types of typhoons (weak, medium, and super typhoon) by wind velocity and the size of the typhoon. During Typhoon Kalmaegi in 2008, weather forecast focussed on wind velocity and the size of the typhoon, wrongly forecasting the square measure of the cloud at the back of the typhoon and underestimating the rainfall, which caused serious damage in central Taiwan. However, the Central Weather Bureau still has not changed its current criteria for weather judgment. Thus, different interpretations and views on weather satellite images have resulted in different forecast decision making, which involved different risk probabilities of errors and false alarms. The analysis is shown in Figure 16.

Using the decision making of weather forecasts as an example since the weather forecasts for Typhoon Kalmaegi underestimated the amount of rainfall, central Taiwan was seriously damaged. During Typhoon Sinlaku and Typhoon Jangmi, weather

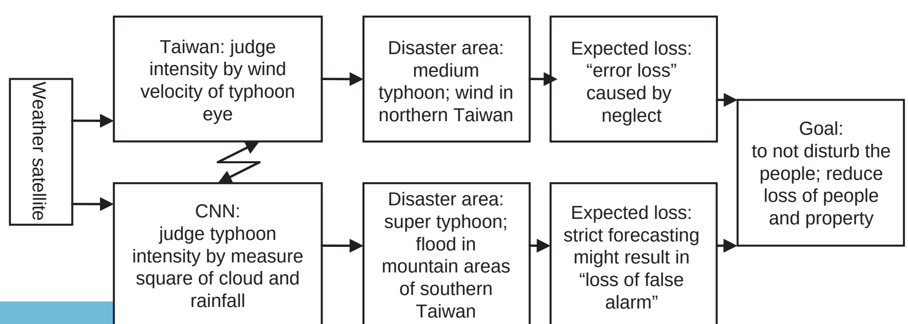

Figure 16.
Conflict of information interpretation

forecasts predicted the power and scale using an overestimated model. The above incidents indicated errors and false alarms. When real rainfall met the forecast, the probability of errors would be low. When rainfall was predicted to be high but real rainfall was low, there would be a false alarm. Likewise, when rainfall was predicted to be low but real rainfall was high, there would be an error. False alarm errors increase public tension and the loss cost is low. However, failure errors cause public loss of life and property, which is a much higher loss cost. Typhoon Morakot caused the deaths of more than 700 people. Therefore, most decision makers would try to avoid failure risk, which will increase the false alarm risk.

Likewise, in the planning of many special projects, the finishing time of the projects is increased and the finish cost tends to be neglected (Wu, 2009). Regarding the repulsive effect among the decision-making performances, it is necessary to consider the system demand, the system endurance of loss cost caused by errors and false alarms, and related situational factors. With different decision-making perspectives, there are different errors and false alarm risk probabilities. This study judged typhoon intensity by the wind velocity of the typhoon eye and established a decision quality analysis figure according to the decision making of the weather forecast. The measured square of the typhoon cloud and rainfall would determine the intensity. The decision quality analysis figure would then be drawn by the decision making of the weather forecast.

Finally, In order to reduce the loss cost of decision-making errors, the position of the decision-making line needs to be determined using false warning and cost functions. In addition, different performance indices should be considered and decision-making views and principles should be changed, as well as reducing errors and the probability of false alarms. Hence, good decision making must first be based on key decision-making measures. The probability of errors and the false alarm risk would then be reduced. False alarms and error cost functions are considered to determine the position of the decision-making line. Thus, it would effectively increase decision quality and reduce decision-making error costs.

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