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A Mixed Bi-level Model to Correspond Service Recovery Chain

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ABSTRACT

In the competitive environment, minimizing time space between service failure perception and service recovery with lowest cost is one of fast responsiveness company's requirements. In this article, modeling service failure response time is considered. It was not only service recovery chain profit optimization carefully planned but also satisfaction of consumers who disturbed by a service failure was considered profoundly. Inconsistency between optimization of service recovery chain's total benefit and existing firm's local benefit was modeled by bi-level programming approach. The core recovery firm or department plays leader character and in lower level there are firms or departments as followers that make local decisions in service recovery chain. In this article, a heuristic algorithm was developed to solve the model.

Keywords: Bi-level Programming, Service Recovery, Service Chain
JEL Classifications: C6, L2

1. INTRODUCTION

Service failures are customer displeasure expressions in relation to a service organization. These service failures can point out a shortcoming, subjective and incorrect activities in servicing. As soon as such faults or failures came to mind, it is necessary that effects of such failures were minimized and customer satisfaction and hope should renovate. In a competitive setting, organizations have to build up service recovery chains to response customer's service failure demands. These organizations have to diminish operational costs and on the other hand, recover customer services repetitively to keep competitiveness. For that reason, proper service recovery is one of needed factors in service profit chain which prevent customers switching.

A service recovery chain is a set of facilities, suppliers, customers and services. In a service recovery chain, the flow of services between a supplier and a customer passes throughout several stratums, and each stratum may consist of many facilities. Any alter in each stratum can have an effect on the overall performance of service recovery chain. Service recovery chain response time optimizing is one of main service recovery chain targets.

Recovery logistic involves plans and efficient implementation and control of goods in service recovery chain process. On the other hand, with increasing uncertainty in trade and industry settings, it is conspicuous to facilitate organization operations integration, they should challenge for more operations cooperation, response time reduction, cost minimization, competitive advantage enhancement and global profit of service recovery chain optimization. This research develop a bi-level programming approach to model service recovery response time assignment and the related profit based negotiation means were besides argued in detail.

The primary research approach is focused on failure in receipt of service. This approach attempts describe customer reactions regarding these failures in the course of attribution theory. Based on attribution theory, consumer attributions from service failures classify their reactions about those failures. In many cases, service users probably blame service providers. Service failure perceived causes by customers, are characteristics that cause customer protest or satisfaction and other customer behaviors concerning the organization. Thus, understanding customer attributions from service failures assist organizations in making optimum recovery decisions (Zhu et al., 2004).

The second research approach is focused on recovery influences on customer satisfaction. In this approach, perceived justice from recovery behaviors has been posed and by customer recovered satisfactions' modeling assists managers in understanding how these recoveries are able to have an effect on customer satisfaction (Zhu et al., 2004).

A research is done on the subject of service recovery influences on service consumer's assessment during service delivery. Findings of aforementioned research gave an idea about those consumers who are silent concerning happened service failures are named as noiseless murderers of organizations (Hocutt et al., 2006).

According to a research about relationship between a bank customer satisfaction and different service recovery strategies in the United States, customer satisfaction rate severely controlled by implemented service recovery strategy types (Duffy et al., 2004). In another research about efficient service recovery strategies, it is made obvious that customers prefer receiving service recoveries which consistent with service failure nature. For instance, customers who obtain a monetary service recovery after facing with a monetary service failure have upper satisfaction level and repurchase intentions (Huang and Lin, 2010). Results of another research stated consistent with highly service recovery undertaking, satisfaction level, positive word-of-mouth, and purchase intentions are influenced remarkably. According to aforesaid research, it appears weak service recoveries weaken dissatisfaction about service failure. Results of aforesaid research do not support service recovery paradox and said that organizations may not make prospective benefit from upper a proper level service recovery (Maxham, 2001).

Designing a service recovery by considering financial aspects is a basic concern in a competitive market (Tsai et al., 2011). Financial aspects are one more approach of efficient service recovery management studies. For instance, data from foremost service companies such as xerox and Federal Express specify that the expenditures of recovering from poor service can comprise to the extent that 30% of sales revenue, and that characteristically approximately 70% of the recovery effort are misdirected as a result of mislaid or exceeding customer service requirements during the recovery (Carr, 1992). Even with the detrimental financial outcomes of suboptimal recovery decisions, and regardless of orders for financial responsibility in making service investment decisions, academic study which it's meeting point be on the financial aspects of service recovery is almost nonexistent (Bialas and Karwan, 1984). A mathematical model of service failure and recovery strategies is one of abovementioned studies which propose a conceptual framework for designing optimal service recovery strategies after taking into account the trade-offs between the two potentially conflicting, but equally important, goals. Based on this model, they derived most advantageous recovery strategies and demonstrated them throughout mathematical cases. In addition, their model can also help recognize the most susceptible customers and take suitable corrective actions (Zhu et al., 2004).

In another study, the efficiency of recovery strategies for various service failures in the restaurant industry was determined. Efficiency was determined by the customers' motivation to revisit the restaurant. The major findings propose that recovery strategies that contain service contact with customers were dominant over strategies which contain pecuniary compensation (Silber et al., 2009).

By reviewing the extant literature, the main research problem is summed as following. Customers need special services during a particular service delivery period. Also, customers' desirable service quality regarding accountability and service quality level will request an exceptional response. Therefore, lessening service delivery period and maximizing service consistency in the direction of customer needs are a number of customers' expectations. In addition, a service provider provides a service level including service occasion and quality to gain maximized profitability. In detail, following service failure happening, optimal decisions toward obtaining correct recovery strategies will be a bi-level programming sandwiched between service provider and service distributer. A decision maker in each level controls numerous decision variables serially.

2. RESEARCH PROBLEM

Most mathematical models on the subject of present problem involve just one decision maker and one objective function which are used in centralized programming problems. In this article, for producing a result in service recovery actual problem we make use of bi-level mathematical programming developed for decentralized decision making. In particular, consider a case where there are two decision makers; one of the decision makers first makes a decision, and then the other who knows the decision of the opponent makes a decision. Such a situation is formulated as a bi-level programming problem. The decision maker who first makes a decision is called the leader, and the other decision maker the follower. Each decision maker challenges to optimize his or her objective function with no view to another objective function. Each decision maker knows the objective function of the opponent as well as the objective function of self and the constraints. The leader first determines a decision and after that the follower specifies a decision so as to optimize the objective function of the follower with complete information of the leader. In proportion to this rule, the leader also makes a decision so as to optimize the objective function of self.

A bi-level linear programming problem is formulated as:

$$\max_{x} F(x, y) = c_1 x + d_1 x$$

$$\max_{y} f(x, y) = c_2 x + d_2 y$$

Subject to:

$$A_1 x + A_2 y \le b \quad (1)$$

$$x, y \ge 0$$

Where, c_i, $i = 1, 2$ are n_1-dimensional row coefficient vector, d_i, $i = 1, 2$ are n_1-dimensional row coefficient vector, A is an $m \times n_1$

coefficient matrix, B is an m × n_2 coefficient matrix, b is an m-dimensional column constant vector. In the two-level linear programming problem (1), F(x,y) and f(x,y) represent the objective functions of the leader and the follower, respectively, and x and y represent the decision variables of the leader and the follower, respectively (Sakawa and Nishizaki, 2009).

A successful service recovery fulfillment may pass across plentiful facilities or firms offered in service recovery chain to respond the final customer demands. Therefore, service recovery response time is sum of sub response time of any firms or facilities subsist in service recovery chain. A given firm or a specified facility sub response time is sum of its service or production time and logistic time in the service recovery chain.

Computational methods for obtaining solutions to bi-level linear programming problems are classified approximately into three categories: The vertex enumeration approach (Bialas and Karwan, 1984), the Kuhn-Tucker approach (Bard and Falk, 1982), penalty function approach (White and Anandalingam, 1993) and the heuristic approaches.

3. METHODOLOGY

The bi-level programming model is made up of two sub-models SLP and MLP, where SLP is called superior level programming and MLP is called minor level programming. If the service delivery time required by customers (i.e., service recovery chain response time) has been determined, the superior level sub model can be eased to a time allocation problem in the integrated procure-service system. It optimizes the service recovery chain's global profit and supplies the finest assignment of response-time to each firm or facility constrained by its service or production capability. The SLP sub model is characterized as follow.

$$\max F = \sum_{i=0}^{n} F_i\left(x^{(i)}, y_1^{(i)}, y_2^{(i)}\right) \tag{2}$$

s.to:

$$a^{(i)} \le x^{(i)} \le b^{(i)},\ i = 0,1,\ldots \tag{3}$$

$$a \le \sum_{i=0}^{n} x^{(i)} \le b, i = 0,1,\ldots \tag{4}$$

$$x^{(i)} \quad \{0,1,2\ldots\},\ i = 0,1,\ldots \tag{5}$$

Where, F is the service recovery chain's global profit, $F_i(x^{(i)}, y_1^{(i)}, y_2^{(i)})$ is the i^{th} firm's local profit (i = 0, 1,…). $x^{(i)}$ is the i^{th} firm's sub-response time and the superior level decision variable which value is a nonnegative integer. $[a^{(i)}, b^{(i)}]$ is the interval where allocate the i^{th} firm's response-time. $\sum_{i=0}^{n} x^{(i)}$ is the recovery chain response-time. [a, b] is the time interval that a customer requires. $y_1^{(i)}$ and $y_2^{(i)}$ are the i^{th} firm's production or service time and logistics time respectively and the minor level decision variables which value are a nonnegative integer.

The SLP sub model is an integer programming problem. When the expressions of $y_1^{(i)}$ and $y_2^{(i)}$are given, $x^{(i)}$ could be solved through the integer simulated annealing approach.

The minor level sub model centers on service or production time and logistics time distribution problem in each firm or facility subsist in service recovery chain. The objective function is formulated to maximize its profit, while ensuring the sum of production time and logistics time don't rise above the response time allocated. The MLP sub model is characterized as follow.

$$\max F(x,y) = \sum_{i=0}^{n} F_i\left(x^{(i)}, y_1^{(i)}, y_2^{(i)}\right) \tag{6}$$

$$= q_i I_i\left(x^{(i)}, y_1^{(i)}, y_2^{(i)}\right) q_i \left[P_i\left(x^{(i)}, y_1^{(i)}, y_2^{(i)}\right) - f_i\left(x^{(i)}, y_1^{(i)}, y_2^{(i)}\right)\right],$$
$$i = 0,1,\ldots$$

s.to:

$$C_1^{(i)} \le y_1^{(i)} \le D_1^{(i)}, i = 0,1,\ldots \tag{7}$$

$$C_2^{(i)} \le y_2^{(i)} \le D_2^{(i)}, i = 0,1,\ldots \tag{8}$$

$$y_1^{(i)} + y_2^{(i)} \le x^{(i)} \tag{9}$$

$$y_1^{(i)} \in \{0,1,2\ldots\}, i = 0,1,\ldots \tag{10}$$

$$y_2^{(i)} \in \{0,1,2\ldots\}, i = 0,1,\ldots \tag{11}$$

Where, q_i is the service failure order batch by customers. q_i can be treated as a constant after customer recovery order. $I_i(x^{(i)}, y_1^{(i)}, y_2^{(i)})$ is the recovery unit batch profit function. $P_i(x^{(i)}, y_1^{(i)}, y_2^{(i)})$ is the recovery unit batch price function. $f_i(x^{(i)}, y_1^{(i)}, y_2^{(i)})$ is the recovery unit batch cost function.

For the reason that recovery unit batch price and cost are related to response time, production or service time and logistics time, recovery unit batch price function $P_i(\cdot)$ and recovery unit batch cost function $f_i(\cdot)$ can be formulated by variables $x^{(i)}$, $y_1^{(i)}$ and $y_2^{(i)}$, and their expression can be attain by regression analysis. $[C_1^{(i)}, D_1^{(i)}]$ and $[C_2^{(i)}, D_2^{(i)}]$ are the intervals where assign the ith firm's production or service time and logistics time respectively. Equation 6 is the minor level objective function. Equations 7 and 8 are the restriction functions for production or service time and logistics time. Equation 9 is the restriction function ensuring the sum of production or service time and logistics time don't surpass the response-time. Equations 10 and 11 are nonnegative integer constraint quantity for production or service time and logistics time, respectively. The correlation between recovery unit batch price function, $P_i(\cdot)$ and $x^{(i)}$, $y_1^{(i)}$, $y_2^{(i)}$ and also the correlation between recovery unit batch cost function $f_i(\cdot)$ and $x^{(i)}$, $y_1^{(i)}$, $y_2^{(i)}$ are explored in the subsequent section.

3.1. Mixed Algorithm

Consistent with sub-models SLP, MLP and Equations 12, 13, we can discern that the model is a nonlinear integer bi-level programming. SLP could be solved throughout a simulated annealing approach, and MLP could be solved through a scatter searching approach. The decision variable $x^{(i)}$ verified by SLP can be treated as a constant during solving MLP.

The mixed algorithm starts with initialization of the upper-level decision variable $x_0^{(i)}$. Substitute $x_0^{(i)}$ into MLP. After that, resolve MLP by scatter searching approach and SLP by simulated annealing approach. We can attain global optimum of the bi-level programming through iterating the steps aforesaid.

We utilized Matlab 7.1 to program the mixed algorithm and then attain the global optimum exposed as follows.

$$F^* = 738, x^{(1)} = 28, x^{(2)} = 33$$

$$F_0^* = 181, y_1^{(0)} = 12, y_2^{(0)} = 4$$

$$F_1^* = 133, y_1^{(1)} = 24, y_2^{(1)} = 4$$

$$F_2^* = 422, y_1^{(2)} = 27, y_2^{(2)} = 6$$

4. DISCUSSION AND CONCLUSION

In service recovery throughout, each firm or facility possibly pays fully attention to itself limited benefit and ignores global profit of service recovery chain. This issue, may damage service recovery global profit. In support of efficient service recovery operation management and for solving abovementioned matter, a coordinated service recovery planning mechanism is proposed based on information and facilities existed in service recovery chain.

First, finished service firm/facility that is considered as the core firm, indicates profit domain of each firm or facility existed in service recovery chain. After that, each firm or facility existed in service recovery chain, optimizes its local benefit within allowance domain indicated through the core firm or facility and feedbacks it to the core firm or facility. Then, the core firm or facility make an optimized global decision derived from presented firms or facilities local decisions. Finally, an optimized collaborated decision applies within existing firms or facilities, in which the core firm named leader negotiates with other firms or facilities within chain, named followers, interactively.

As a result, incorporated service recovery chain operation management is the bi-level decision mechanism, considering the core firm as a leader who is the planning, controlling, and matching core in the entire service recovery chain and each firm or facility as followers who possess relative autonomous decision allowed by contract.

We discovered that the bi-level programming model developed here can harmonize effectively the service recovery chain plan via allocating response time among the firms or facilities and assigning production or service time and logistics time reasonably to each firm or facility, and is an effectual decision-making support implement for the service recovery chain response-time plan.

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