

Systematic Organizational Conflicts Identification and Resolution Using Perception Mapping and Function Relationship Analysis

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Abstract

This research proposes a set of methods to analyze the relationship between people's perceptions and organizational goals and ultimately to identify and solve complex organizational conflicts using modified TRIZ Perception Mapping, Function Relationship Analysis, Solution Directions, and Business Inventive Principles. Organizational perceptions are usually fuzzy and obscure, making it difficult to detect conflicts in them. However, they may cause friction between colleagues and create significant negative impacts on organizational performance. This research proposes an augmented perception analysis and links organizational perceptions with phenomena and performance indices to form a function relationship diagram which enables a structured unequivocal identification of conflicts within an organization. TRIZ (Theory of Inventive Problem Solving) tools such as Cause Effect and Contradiction Chain Analysis (CECCA), Solution Directives, and Inventive (Business) Principles can then be used to locate root conflicts and resolve complex organizational problems.

Contributions of this research include:

(1) Enhancing Perception Mapping Method. An "Inhibit" relation is added to the existing "Lead to" relation. With the additional relaxation of a one-to-one relationship to multiple-to-multiple relationships and the introduction of organizational phenomena/performance indices into the perception map, this method is able to clearly identify organizational conflicts in a structured way. Objective logical reasoning instead of subject feelings can now be used to identify conflicts in complex perception relationships in organizations.

(2) Enabling us to link individual perceptions to organization performances through Function Relationship Diagram. It helps us identify which perceptions are causing performance problems, thereby allowing us to solve the root cause problems. It also helps us to locate the conflicts between people's perceptions, enabling us to resolve or prevent friction.

(3) Adopting structured application of TRIZ technical tools such as CECCA, Solution Directives, and Business Inventive Principles on solving fuzzy business problems.

Keywords: TRIZ, Perception Map, Conflict identification, Conflict Resolution, Function Relationship Diagram.

1. Introduction

1.1 Background and Motivation

In today's world, most organizations are not embedded with cohesion which meets the expectation of the entrepreneur; rather than the entire benefit of the organization, members of each department usually put much emphasis on the goal and benefit of their own department. Thus, members from different departments have different thoughts, different goals, and diversified interests. The above differences result in internal conflicts to certain degree; hence, the whole performance of the organization is undermined.

This research mainly strengthens the Perception Mapping methodology of Darrell Mann. It probes the

different requests and thoughts of members from different departments from a humanistic viewpoint and investigates whether these differences have influences on performance. This approach distinguishes and manages internal conflicts of the organization on a whole.

1.2 Research Purpose

There are three main purposes of this research:

- (1) To provide a structured method to analyze the relation between different perceptions in an organization and the performance of said organization: In the past, the solutions to management problems are usually determined by the experiences and intuitions of a few strategy personnel instead of a structured and systematic method that measures the relation between

the problem and external effect factor. Therefore, this research proposes a systematic and structured method to analyze that how different perceptions in an organization influence the performance of said organization, then uses the result as a standard to distinguish conflicts within the organization, and finds possible solutions.

- (2) To distinguish different types of conflict in an organization and find out key conflict via (Cause-Effect and Contradiction Chain Analysis ; CECCA):
 - a. The conflict between perception and performance of the organization
 - b. The conflict between perceptions
 - c. The conflict between performances of the organization
- (3) To find out possible solutions to solve the conflict of an organization via systematic tools and methods provided by TRIZ.
 - d. Function Relationship Analysis: Solution Directives
 - e. Engineering contradiction: Contradiction Matrix and Inventive Principles (Business)

Users can find out the trigger solution of solving conflict of organization step by step and convert trigger solution into specific solution based on the type of the problem.

2. Literature

2.1 Perception Mapping

Perception Mapping Method is a method which can identify opportunities and solve problems via analyzing the interrelation between perceptions. Darrell Mann (2007) presents Perception Mapping Method methodology as follows: Throughout interview, the perception of relevant department members can be known; the different perceptions can be linked by “lead to” relationship and become “Perception Mapping.” Users utilize Perception Mapping to distinguish three kinds of chain modes—loop, collector, and conflict chain—and give them different weight. With the weight, the user can rank those perceptions and recognize those perceptions and their importance to the problem. Users then adopt Contradiction Matrix and Inventive Principles to find out the trigger solution of conflict by the distinguished conflict chain and convert the trigger solution into specific solution which deals with the problem.

2.2 Process (in Detail)

The following 8 steps are the detailed progress of Perception Mapping Method:

- (1) Define the problem: Define the questions which needs to be answered related to the specific problem. Because the perception of members in each department is necessary, the questions must be designed in a Q&A mode.
- (2) Inquire and obtain the perception of members of related departments for the specific question and number each perception.
- (3) Find out the affected perception (effect) for each perception (cause) and marked the number of perception (effect) in Lead To column to show the “lead to” relationship between these two perceptions, as in table 1. The “lead to” relationship here means it will happen “Always” rather than “possibly”.
- (4) Compare whether or not the conflict exists between the perceptions in pairs. If the conflict exists, mark the number in Conflict column as in table 1.

Table 1. Perception Mapping Table

N ode	Perception	Lea d To	Conf lict
A	Perception_1	C	
B	Perception_2	D	
C	Perception_3	B	E
D	Perception_4	C	
E	Perception_5	D	C

- (5) Connect all perceptions according to lead to relationship by directional arrow to get a Perception Mapping Diagram.
- (6) Analyze the Perception Mapping Diagram and explore the Conflict chain / Collector point / Loop chain mode between the perceptions.
 - Conflict chain: If the conflict exists in two perceptions, the chain between these two perceptions is a Conflict Chain. Note: a Conflict Chain emphasizes the fact that the conflict exists between two perceptions instead of the direction of the arrow of the Conflict Chain. The Conflict Chain in figure 1 shows that there is conflict between A and B but it doesn’t mean that the conflict exists in perception C. The chain only reveals that there is conflict between A and B and the arrow between A and B is not directional.
 - Collector point: Collector point means that numeral perceptions lead to this perception and this perception is affected by numeral perceptions.
 - Loop: Every perception will finally goes back to the original perception after it moves to next perception according to the direction of the arrow; this chain means Loop. There must be at least one Loop in

Perception Mapping Method; however, the number of node and Loop is not limited.

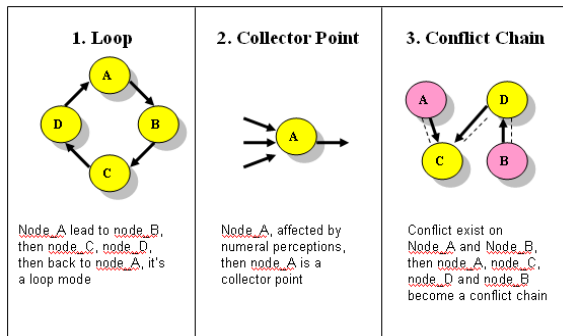


Fig. 1. Loop / collector point / conflict chain modes

(7) Provide different weights for the three chain mode defined in step (6):

- Loops: 4 score, every node in Loop is 4 score.
- Collectors: (n-1) score, n means the number of arrow which connects to the node and Collector is (n-1) score.
- Conflict Chain: 3 score, if there is conflict between two nodes, these two nodes can get 3 score respectively.

(8) To solve the two perceptions of conflict point in Conflict Chain, the corresponding trigger solution can be found via Contradiction Matrix & Inventive Principles; users can find out the corresponding specific solution based on the trigger solution.

2.3 The Advantages and Disadvantages of the Perception Mapping Method

The advantages of Perception Mapping Method:

(1) The invisible perceptions can be converted into visible logical figure and the relationship between the different perceptions can be clarified.

(2) Communication becomes easier because the perception and attitude can be understood by Perception Mapping Method.

The disadvantages of Perception Mapping Method:

(1) It can only describe the positive relationship between the perceptions of members of different departments, but not the negative one.

(2) It can only subjectively distinguish the conflict and mark that the conflict exists between these two perceptions; however, it cannot distinguish the conflict point directly by figure.

(3) The potential reason of the conflict caused by perceptions cannot be explained without structuring the perception.

2.4 Function Relationship Analysis

Function Relationship Analysis is a problem-solving method. John Terninko (1998) proposes that the “function” is not only a function but also “Anything users want to achieve ...”, probably an event, action ...etc. It disassembles a problem into functions and asserts them into useful/harmful functions and then connects those functions by cause-effect relationship to make a “Function Relationship Diagram (FRD)”. By analyzing those useful and harmful functions, the contradiction problem can be addressed. Next, use “Solution Directives” to find the trigger solution of the contradiction problem and then provide the proposal to improve and solve the problem.

Function Relationship Analysis describes problem through Function and Relationship, and Function and Relationship are illustrated below:

(1) Function: Function can be an action, progress, operation, situation and an execution. It can be presented by a verb or verb phrase. Functions are assorted into two types: useful and harmful; they are distinguished by their form and color. Function is displayed by Box figure and illustrated by words.

a. Useful function: The green rectangle Box is used to represent useful function in system, as figure 2.



Fig 2. Useful function

b. Harmful function: The red rounded rectangle Box is used to represent harmful function in system, as figure 3.



Fig. 3. Harmful Function

c. Contradiction: The yellow rectangle is used to represent the function which is both useful and harmful, as figure 4.

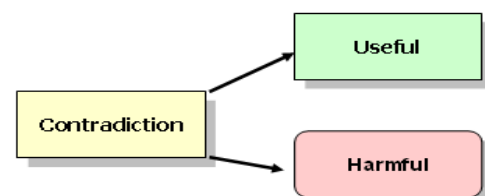


Fig. 4. Contradiction Function.

2.5 Relationship:

Relationship is used to connect two function boxes and illustrate the relativity between them; it can be assorted into “lead to” and “inhibit”, as in figure 5.

(1) Lead to Relationship means that when function of origin point of the arrow increases (decreases), the function of arrow point increases (decreases) simultaneously; it is an obverse relationship. Lead to can be classified into useful Lead to or harmful Lead to; if the function of arrow point is connected with a useful function, it is a useful Lead to; if the function of arrow point is connected with a harmful function, it is a harmful Lead to.

(2) Inhibit Relationship is represented by an arrow with a vertical. It means that when function of origin point of the arrow increases (decreases), the function of arrow point decreases (increases) simultaneously; it is a reverse relationship. Inhibit can be classified into useful Inhibit or harmful Inhibit. If the function of arrow point is connected with a useful function, it means that a useful function is inhibited; it is a harmful Inhibit. If the function of arrow point is connected with a harmful function, it means that a harmful function is inhibited; it is a useful Inhibit.

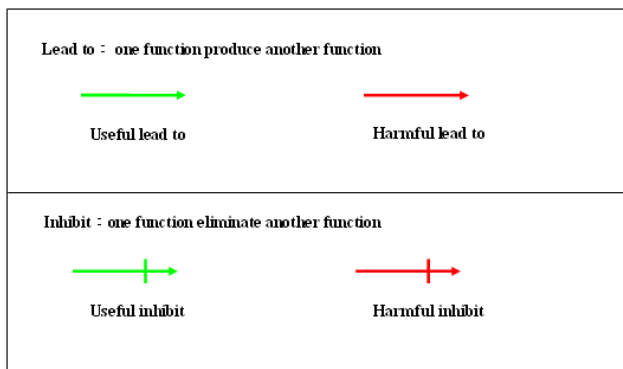


Fig. 5. Lead to / inhibit useful vs harmful relationship symbol.

(3) Function and Relationship Type Permutations:

The following 8 types of situation are produced by permuting and combining Function and Relationship (as in figure 6). Relationship can be classified into two types: Lead to and Inhibit.

There are two types of useful Lead to in Lead to Relationship: (1) Useful function creates useful function. (2) Harmful function creates useful function, but the harmful function here is a contradiction function because a harmful function creates a useful function. There are two types of harmful Lead to: (1) Useful function creates harmful function but the useful function here is a contradiction function because a useful function creates a harmful function. (2) Harmful function creates harmful function.

There are two types of useful Inhibit in Inhibit Relationship: (1) Useful function inhibits harmful function. (2) Harmful function inhibits harmful function; the former harmful function is a contradiction function because

harmful function creates useful function: Inhibit harmful function. (2) Useful function Inhibits useful function; the former useful function is a contradiction function because useful function inhibits another useful function. (2) Harmful function inhibits useful function.

Throughout the above 8 combination, whether there is contradiction or not in the Function Relationship Figure can be clearly defined.

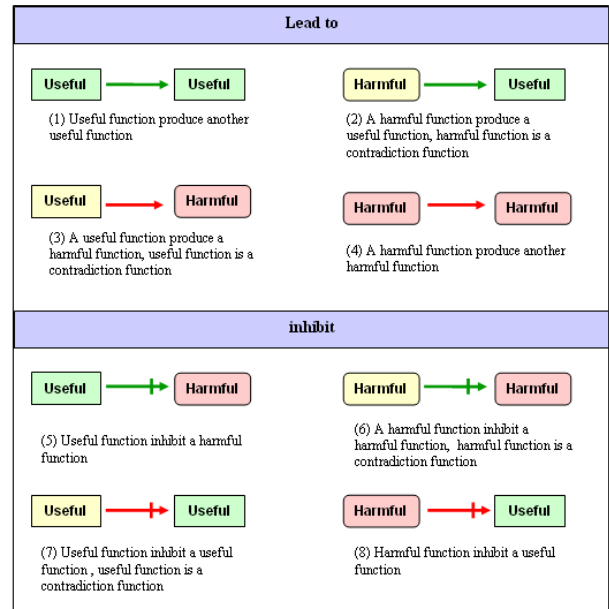


Fig. 6. Lead to / inhibit useful vs harmful relationship permute

(4) Solution Directives:

The useful function/ harmful function/contradiction function in system can be distinguished via Function Relationship Diagram; the different Solution Directives module is provided for useful function/ harmful function/contradiction function respectively. The Solution Directives is provided for users systematically; thus, users can find out the specific solution corresponding to the problem. The instruction of solution of useful function/ harmful function/contradiction function will be illustrated respectively below.

a. Guidelines for Useful Functions:

The improvement plan should be presented for the useful function in the system according to the following methods: (a) Provide useful result. (b) Do not provide any harmful result. (c) Any other function should not provide useful function previously. (d) Do not be affected by harmful function. (Refer to figure 7)

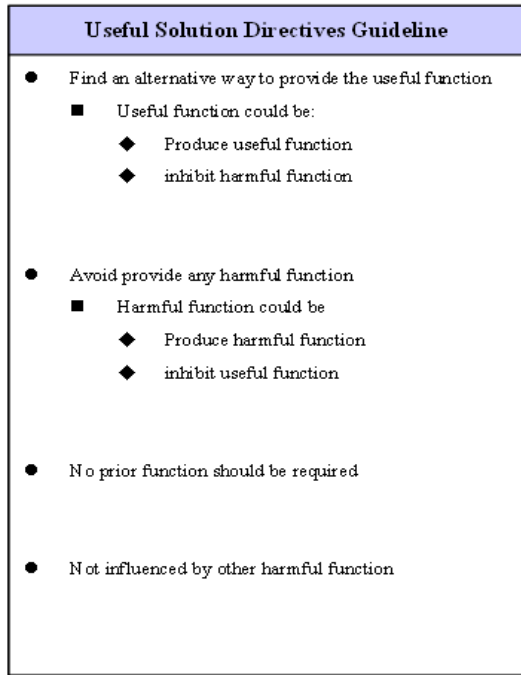


Fig. 7. Useful Solution Directives Guideline.

b. Guidelines for Contradiction Functions:

The improvement plan should be presented for the contradiction function in the system according to the following methods: (a) Useful function should exist; if useful function produces useful result, the useful function relationship should exist. (b) If useful function produces harmful result, the useful function relationship should not exist and should be eliminated. (Refer to figure 8)

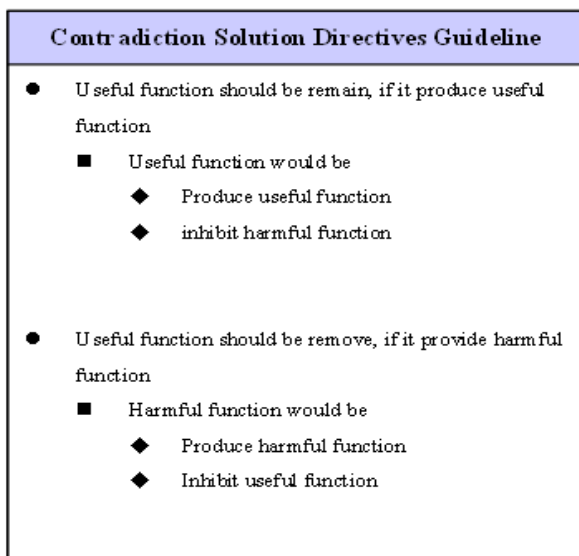


Fig. 8. Contradiction Solution Directives Guideline.

c. Guidelines for Harmful Functions

The improvement plan should be presented for the harmful function in the system according to the following methods: find out an alternative way to eliminate, reduce or prevent other harmful conditions before providing

harmful function. (Refer to figure 9)

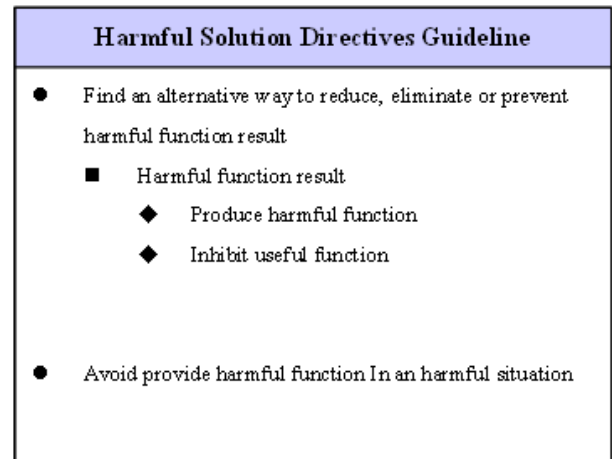


Fig. 9. Harmful Solution Directives Guideline.

(5) Function Relationship Analysis: Advantages and Disadvantages

The advantage of Function Relationship Analysis is that it converts engineering problem into functions and it can utilize useful/harmful function to help users to find out the key problem. Moreover, it provides corresponding instruction of solution and systematical method to find out the trigger solution.

The disadvantage of Function Relationship Analysis is that it is usually applied to analyze the engineering problem rather than complicated management problem. Hence, this research intends to apply Function Relationship Analysis to management problem. Use perception/phenomenon/performance of human to replace the original function elements, then describe the relationship of perception/phenomenon/performance by relationship, and analyze the conflict which is produced by different perception of human for the organization performance. Then adopt the Solution Directives provided by Function Relationship Analysis to find out the solution for conflict.

3. Research Method

This research mainly intensifies the Perception Mapping Method of Darrell Mann. With this structured method, the perception appeal structure of members of different organizations and how the appeal activities establish interactive relationship with performance can be explored. Then connect the relationship between perception appeal structure and performance to find out (1) the conflict between perception and performance, (2) the conflict between perception and perception, (3) the conflict between performance and performance. Then utilize the tool Cause-effect and Contradiction Chain Analysis provided by TRIZ to find out key conflict and

adopt (1) Function Relationship Analysis: Solution Instruction, (2) Engineering Contradiction: Contradiction Matrix & Inventive (Business) Principles to find out the trigger solution. Thus, users can find out the specific solution of solving organization conflict via trigger solution based on the problem.

3.1. Preliminary Definitions:

Perception, phenomenon, and performance are defined respectively as follows.

Perception: It means “appeal and opinion toward things”. The perception of human decides his/her ways of solution. Different people have different appeal/opinions; their ways of doing things are different either.

Phenomenon: It means “a series of events or a situation of facts produced to achieve the goal which is set by perception”. Whereas Perception is an internal thought which is hard to be observed, phenomenon is an external event or a situation of fact which is visible. Therefore, people’s perception can be understood by observing the external phenomenon, such as interactive relationship.

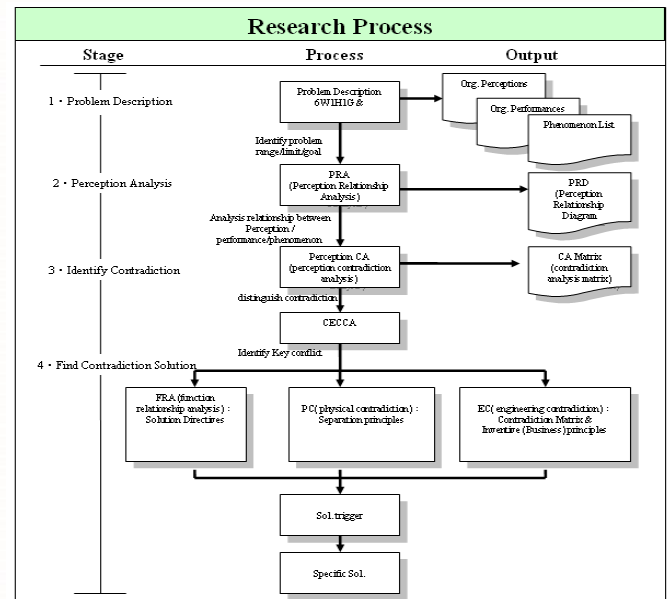
Organization Performance: It means “the result of members in organization striving to achieve the expected goal from the organization. It will be measured and evaluated as the criterion of reward and punishment”. For an enterprise, the most important thing is to pursue the highest organization performance, achieve the intended operating goal, and enhance competitiveness of the enterprise. Most of the activities of an enterprise are created for its core managerial task: improving performance. By providing methods of improving, reasons that affect organization performance can be located to improve performance successfully. This research investigates how perception affects organization performance by combining perception and performance, then find out the reason of abating performance, and provide solutions to improve organization performance.

3.2. Research Process:

The study process is divided into four phases: (1) Problem Description, (2) Perception Analysis, (3) Conflict Identification, and (4) Conflict Solution as shown in Figure 10.

Fig. 10. Research Process

Description: the main purpose is to confirm the range of the problem. Users can use 5W1H1G question method to define problem, limit and goal. The “Organization Performance Form”, “Organization Perception Appeal Form” and “Phenomenon Observation Form” can be used to record the perception, phenomenon and performance of



members of related departments.

Phase 1: Problem Description. The main purpose in phase 1 is to confirm the range/limit/goal of the problem; a problem well put is a problem half solved. Thus, this phase is essentially important because it lays a solid foundation for the following phases.

Phase 2: Perception Analysis. Phase 2 gives an overview of how Perception Relationship Analysis (PRA) makes use of diagram tool to connect perception, phenomenon, and performance to accomplish Perception Relationship Diagram (PRD). PRD can be used for the next phase to distinguish conflict.

Phase 3: Contradiction Identification. It mainly analyzes how many times inhibit relationship happens from perception to performance via Perception Relationship Diagram to decide whether perception produces useful or harmful effect. Useful/harmful effect is used to find out (1) conflict between perception and performance, (2) conflict between perception and perception, and (3) conflict between performance and performance. Cause-effect and Contradiction Chain Analysis is used to find out the key conflict. Conflict solution is expected to be located in the next phase.

Phase 4: Conflict solution. After finding out the trigger solution by TRIZ tool, users can convert trigger solution into specific solution. In this case, the following TRIZ tools are adopted: (1) Function Relationship Analysis: Solution Directives (2) Engineering contradiction: Contradiction Matrix and Inventive (Business) Principles.

The four phases are illustrated below:

(1) Problem Description: Phase 1 is Problem Description. The main purpose in this phase is to confirm the range of the problem. Users can use 5W1H1G question method to define the problem, limit and goal. The following

“Organization Performance Form” (Table 2), “Organization Perception Appeal Form” (Table 3) and “Phenomenon Observation Form” (Table 4) can be used to record the perception, phenomenon and performance of members of related departments.

Table 2. Org Performance Form

Question : what performance could be measure or evaluate the issue and list by each unit concerned ?	
Dept.	Performance Factor
Unit_1	performance_1
Unit_1	performance_2
Unit_1, Unit_2	performance_3
Unit_2	performance_4
Unit_2	performance_5
Unit_3	performance_6

Table 3. Org Perception Appeal Form

Question : what perceptions could solve or improve the issue ? please list them.		
Dept.	perception	Desc
Unit_1	Perception_1	
Unit_1	Perception_2	
Unit_2	Perception_3	
Unit_2	Perception_4	
Unit_3	Perception_5	

Table 4. Phenomenon Observation Form

Question : What phenomenon/ event/ situation will be accrued when perception perform ? Please list them.		
Dept.	phenomenon	Desc.
Unit_1	phenomenon_1	
Unit_1	phenomenon_2	
Unit_2	phenomenon_3	
Unit_2	phenomenon_4	
Unit_3	phenomenon_5	
Unit_3	phenomenon_6	

(2) Perception Relationship Analysis: After finishing describing the problem, the purpose of phase 2 is to introduce how Perception Relationship Analysis method use diagram tool to combine perception, phenomenon and performance to complete Perception Relationship Diagram. Two diagram tools are used in Perception Relationship Analysis method: Element and Relationship. Perception Relationship Analysis method is to connect each element by relationship and form a Perception Relationship Diagram. Element, Relationship and Perception Relationship Diagram are illustrated below:

Element:

It can be classified into three types: Perception, Phenomenon, and Performance. Perception Relationship Analysis is used to clarify the relationship among these three types of elements. Element can also be assorted into “Useful Element” and “Harmful Element”. Useful element refers to like-event for the department; harmful element, dislike-event.

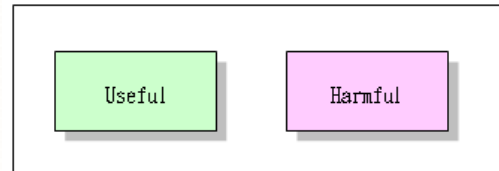


Fig. 11. Useful vs Harmful Element

▪ **Relationship:**

Relationship is used to describe the interaction between two elements. There are two types of description: lead to description and inhibit description; they are shown as an arrow. The original point represents the affected element (cause) whereas the end point represents the affected element (effect).

Lead to relationship means that element of cause and effect is cyclical; that is, they increase and decrease simultaneously. Inhibit relationship means that element of cause and effect is countercyclical; that is, one element increases (decreases) when the other decreases (increases).

Lead to relationship is assorted into two types: “useful lead to” and “harmful lead to”. “Useful lead to” leads to events which the organization wants, displayed in green; “harmful lead to” leads to events which the organization does not want, displayed in red.

Inhibit relationship is assorted into two types: “useful inhibit” and “harmful inhibit”. “Useful inhibit” inhibits events which the organization does not want, displayed in green; “harmful inhibit” inhibits events which the organization wants, displayed in red.

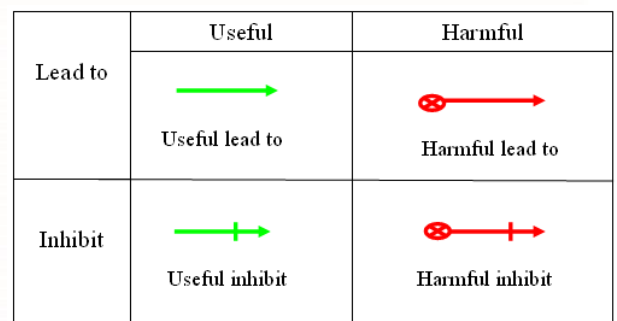


Fig. 12. Lead to/ Inhibit Useful vs Harmful Symbol

Perception Relationship Diagram

The Perception Relationship Diagram is used to illustrate the relationship diagram which is constructed by perception and performance; it uses relationship to connect

the structure of perception, phenomenon and performance (as shown in figure 14). Through observing the interactive relationship between perception and performance, the gradually perception-changing events illustrate: (1) how perception of humans affects organization performance, and (2) whether the interactive relationship between perceptions of humans in different departments enhances or weakens organization performance.

Therefore, perception of humans becomes a series of invisible phenomenon rather than just exists in the imagination phase. In addition, it can be connected to organization performance; the rise/fall of performance can help users observe: (1) which perception is useful to some performance or (2) which perception causes some side effect to other performance to weaken the performance.

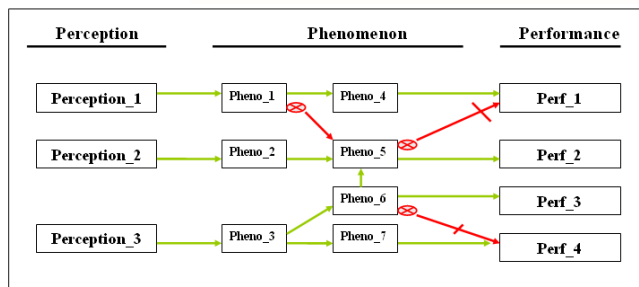


Fig. 13. Perception Relationship Diagram

An example: How to Increase Operating Revenue of a Fixed Network Company is shown in the Perception Performance Diagram in Figure 14. It shows how Perception A (Increase customer volume to increase market share be the target) pursues (1) **Customer volume increase** to facilitate (2) **Sales volume increase** and achieves the goal of (P1) **Increase Operating revenue**. Yet, (1) **Customer volume increase** also precipitates (3) **Increase in Service Demands** and (4) **Increase in Maintenance Levels**, suppressing the effect and performance of (P2) **Total Quality improve**. Due to a lack in increase of salesmen numbers, a demand for increase in service in this case will result in a decrease in quality of service.

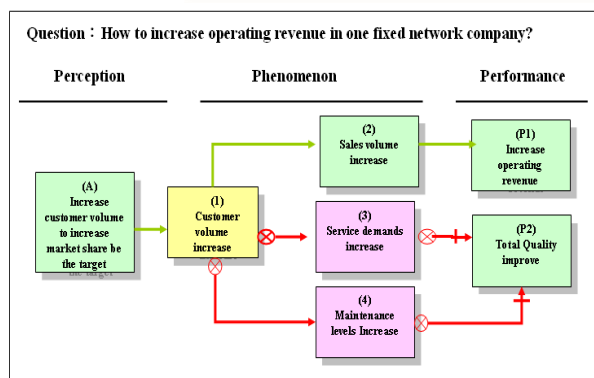


Fig. 14. Perception Relationship Diagram

3.3. Perception Contradiction Analysis

The perception, not the phenomenon, is the control factor. To find all the reasons behind organization influence and provide improvement methods to achieve the purpose of improving organizational performance, observation of the contradiction between perception and performance is necessary in order to determine the inefficiencies of said perception. The performance of the organization will be improved by improving the structure of the perception.

Contradiction Types

The contradictions between perception and performance can be classified into four kinds: (1) Contradiction From Perception to Performance, (2) Contradiction Between Different Perceptions, (3) Contradiction within Performance(s), and (4) Physical Contradiction Within Perception.

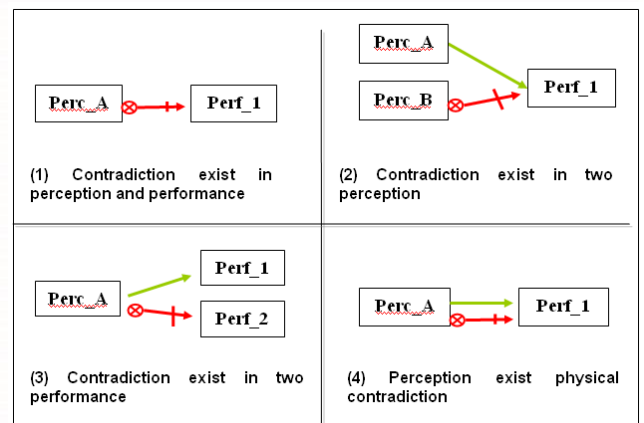


Fig. 15. Contradiction Type

Contradiction Analysis Matrix

Contradiction types can be determined through the Contradiction analysis matrix. First, one must use the Perception Relationship Diagram and observe the trajectory of Perception to Performance. If there is an odd number of inhibition, mark with a minus (-) sign. If there is an even number (including zero) of inhibition, then mark with a plus (+) sign. Through observation of all inhibitory relationships arising from each perception of achieving performance, one can complete a Contradiction analysis matrix. This is demonstrated in Figure 16.

performance Perception	(P1)	(P2)	(P3)	(P4)
A	-		+	
B	-		+	
C	+		-	
D		+	-	-
E		+	-	
F			-	+
G	-/+		-	+

Fig. 16. Contradiction Analysis Matrix

Through the Contradiction Analysis Matrix, we can determine four types of contradictions:

- **Conflict between Perception and Performance:** From the viewpoint of the Perception, if a “+” is present, it signifies the lack of conflict between the perception and said performance. If a “-” is present, it signifies the presence of conflict. If there is no “+” or “-” present, then there is no relationship between the perception and performance.
- **Conflict between Perception and Perception:** From the viewpoint of the Performance, one “+” and one “-” between two Perceptions represents the presence of a conflict between the two.
 - Observing from Performance P1, the “-” and “+” signs between Perceptions A and C show the conflict between each other.
- **Conflict between Performance and Performance:** From the viewpoint of the Perception, a “+” sign and a “-” sign between two Performances illustrates the presence of a conflict between the two.
 - Observing from Perception F, the “-” between it and Performance 3 (P3) and the “+” between it and Performance 4 (P4) demonstrates the conflict between these two Performances.
- **Physical Conflict within Perception:** From the viewpoint of the Perception, if a “+” and “-” appear in relation to the same Performance, it signifies that there is a physical contradiction within the Perception’s approach to the Performance.
 - Observing from Perception G, its “+” and “-” in relation to Performance 1 (P1) shows that Perception A would create a physical conflict on Performance 1.

In an organization, it is not easy to notice the conflicts between human perceptions and organizational performances. But through the “Contradiction Analysis matrix,” one can, in a structured and systematic method, help user recognize “Contradiction between Perception

and Performance,” “Contradiction between Perception and Perception,” “Contradiction between Performance and Performance,” and “Physical Contradiction within Perception.”

■ Cause-Effect and Contradiction Chain Analysis

Use of the Contradiction matrix can locate the many potential conflicts between perceptions and performances, but not all conflicts need to be focused on. Rather, it is more effective to locate the key conflict(s) and focus on resolving that conflict to solve the grand problem. To further streamline this process, this research puts the conflicts determined by the Contradiction Analysis matrix in a Cause-Effect and Contradiction Chain Analysis to locate key conflict(s) and design corresponding counter-strategies. As Ill. 18 illustrates, “(1) Target Disadvantage” refers to the weakened performance factor. Using the Perception Relationship Diagram, one works backwards from the impaired performance to track any unfavorable factors. Once unfavorable factors have been found, one then continues working backwards to trace the perception(s) that produce these unfavorable factors; such perceptions are the major unfavorable factors behind the respective weakened performance. (2) If postulating backward from these key unfavorable perceptions creates a positive effect, then these perceptions are termed “key conflicts.” If not, then they are termed “target disadvantage.” (3) Through Darrell Mann contradiction matrix and inventive (business) principles, one can determine specific parameter for all the elements of the cause-effect and contradiction chain. (4) One can resolve the conflict by improving and worsening parameters to address the corresponding inventive principles.

Cause-Effect & Contradiction Chain Analysis

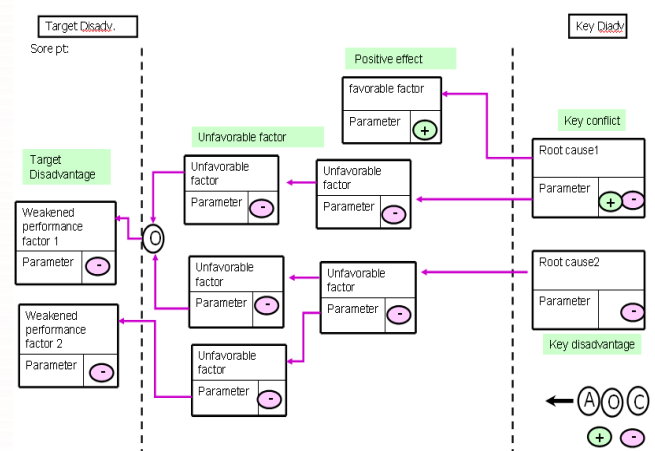


Fig. 17. Cause Effect and Contradiction Chain Analysis

■ Searching for Conflict Resolutions

The Cause-Effect and Contradiction Chain

Analysis enables discovery of the key conflict(s) of a problem. Using the tools offered by TRIZ—(1) Function Relationship Analysis: Solution Directives (2) Engineering contradiction: Contradiction Matrix and Inventive (Business) Principles—one can determine the trigger solutions and corresponding specific solutions to the key conflicts as shown in Figure 18.

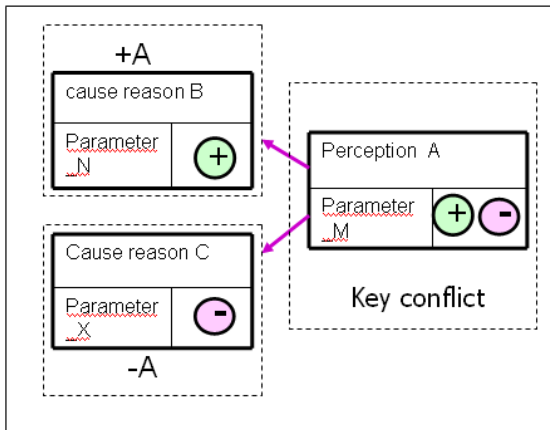


Fig. 18. Solution Directives

◆ Solution Directives Guide: Trigger Solutions

The solution guide enables the user, in an interrogative manner, to analyze solutions to the key conflicts and infer trigger solutions to the key conflicts. The method works as follows:

◇ Solution Guide 1: Fully satisfy “Positive Effect (+A)” and eradicate negative effects.

➔ Raise positive effects to the state of largest scale, and eliminate the production of negative effects.

◇ Solution Guide 2: Fully eliminate “Negative Impact (-A)” and maintain positive effect.

➔ Prevent the occurrence of negative effect and achieve the gains of a positive effect.

◇ Solution Guide 3: Eradicate A and provide positive effect methods.

➔ Remove A, locate other methods that offer positive effects, and thus prevent the occurrence of the negative effect.

◇ Solution Guide 4: Make the negative effect insignificant, obtuse, or directly remove it.

➔ The negative phenomenon is irrelevant to A element, so switch to eradicating all components and units that observe such phenomenon.

Specific Solution: User locates trigger solution through the problem-solving index, and targets problem requirements to find suitable solutions.

▪ Engineering Contradiction: Contradiction Matrix and Inventive (Business) Principles

In 2002, Darrell Mann stated that the business contradiction matrix involves using improved and worsened parameters to locate conflict points, and then utilizing corresponding inventive principles to achieve possible and tangible solutions.

◇ Use improved and worsened parameters to locate inventive principles in the contradiction matrix, and determine trigger solutions from the inventive principles.

◇ Specific Solutions: Find solutions to problems through their corresponding trigger solutions.

3.4. Case Study

Based on the backgrounds of an individual case [7], a fixed network company has, at countless times, set up its strategic objectives to increase operating revenue, business scale, and engineering units, with an emphasis on each department’s methodology to achieve these goals. In order to meet the company’s strategic objectives, the marketing department has proposed increasing clientele and sales figures to achieve the goal of increasing revenue. The engineering unit has, on the other hand, proposed elevating internet and service quality as a means of increasing clientele and, thus, sales.

Table 5. Org Performance Form

Question : How to raise marketing income and record the related performance factor.	
Dept.	Performance Factor
Engineering dept	Total quality improve
Sales dept	Increase operating revenue
Engineering, Sales dept	Increase employees satisfaction
Engineering dept	Increase productivity
Sales, Engineering dept	Improve quick response

(1) Problem Description

Use an interrogative manner to obtain relevant perceptions, phenomena, and performances from each department. Questions may be formatted in the 5WH1G questioning style.

a. Set up required questions: How to increase sales revenue?

b. Record the performances of the relevant units, as Table 5 shows:

c. Record the perceptions from each relevant unit, as depicted in Table 6.

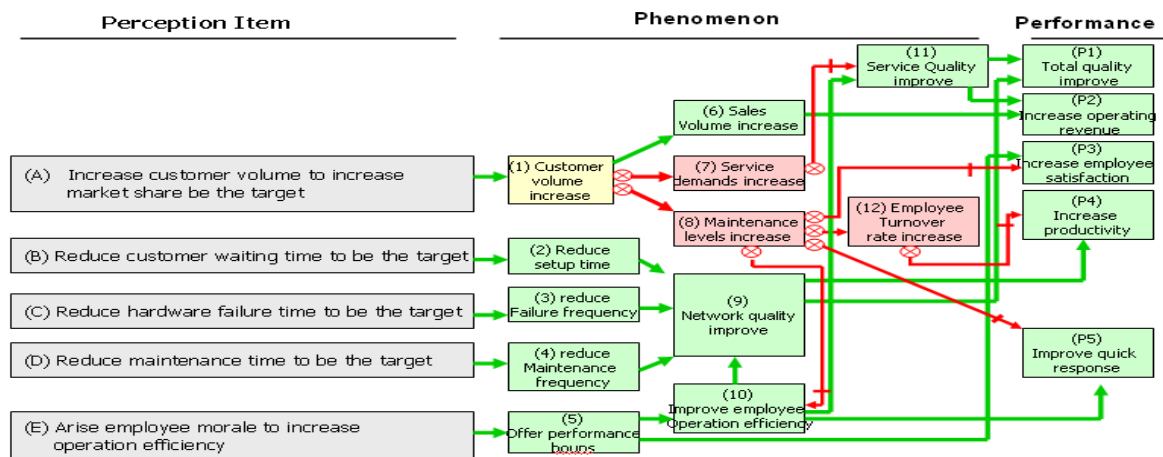
Table 6. Org Perception Appeal form

Question : How to raise marketing income and record the perceptions of the relevant units		
Dept.	perception	Desc.
Sales dept	Increase customer volume to increase market share be the target	Increase customer volume to increase operating revenue
Engineering dept	Reduce the customer waiting time to be the target	Increase quality satisfaction
Engineering dept	Reduce hardware failure time to be the target	Increase quality satisfaction
Engineering dept	Reduce maintenance time to be the target	Increase quality satisfaction
Engineering sales dept	Arise employee morale to increase operation efficiency	To encourage employee then increase service efficiency

d. Record observed and heard phenomena from the interviews, as shown in Table 7.

Table 7. Phenomenon Observation Form

Question : What phenomenon/event/situation will be accrued by those perception perform ? Please list them.		
Dept.	phenomenon	Desc.
Sales dept	Increase customer volume	Perception (A) Increase customer volume to enlarge market share
Sales dept	Increase sales volume	Increase customer volume will increase sales volume
Sales dept	Operating revenue increase	Increase sales volume will increase operating revenue
Engineering dept	Reduce setup time	Perception (B) Reduce customer waiting time will reduce setup time
Engineering dept	Reduce failure frequency	Perception (C) Reduce hardware failure time will reduce failure frequency
Engineering dept	Reduce maintenance frequency	Perception (D) Reduce maintenance time will reduce maintenance frequency
Engineering dept	Increase network quality level	Reduce setup time/failure frequency/maintenance frequency to increase network quality level
Engineering dept	Increase productivity	Increase network quality level will increase productivity
Engineering sales dept	Offer performance bonus	Perception (E) Arise employee morale and efficiency by offer performance bonus
Engineering sales dept	Improve employee operation efficiency	Offer performance bonus s improve employee operation efficiency
Engineering sales dept	Service quality improve	Improve employee operation efficiency will improve service quality level
Engineering sales dept	Service demands increase	Increase customer volume will increase the service demands
Engineering sales dept	Maintenance levels increase	Increase customer volume will increase the maintenance request
Engineering sales dept	Employee turnover rate increase	Maintenance and service demands increase, make employee busy and turnover rate will be increased

case 1 : Fixed Network co. increase operating revenue — FRD

Fig. 19. Fixed Network co. increase operating revenue — FRD

(2) Perception Relationship Analysis

Use the Phenomena Observation Form, Perception Appear Form, and Performance Form to help establish the relationships among and between the elements, and determine if said relations are suppressive or facilitating. The chart also establishes whether the facilitating or suppressive relationships are beneficial or harmful, as Figure 19 shows.

(3) Perception Contradiction Analysis

The Perception Relationship Diagram calculates all the individual occurrences of inhibit relations on the trajectory from perception to performance, and fills in the corresponding contradiction Analysis matrix as depicted in Table.

Table 8. Contradiction Analysis Matrix

Perf Perf	(P1)	(P2)	(P3)	(P4)	(P5)
A	-	+/-	-	-	-
B	+			+	
C	+			+	
D	+			+	
E	+		+		+

a. Through the contradiction analysis matrix, the following four types of conflicts can be analyzed:

- Conflict Type 1: Conflict arising between perception and performance

Using coordinates to depict the conflict:
(A,P1) (A,P2) (A,P3) (A,P4) (A,P5)

- Conflict Type 2: Conflict between Perception and Perception:

Using coordinates to illustrate the conflict:

(A,B) (A,C) (A,D) conflict with Performance P1

(A,E) conflicts with Performance P3

(A,B) (A,C) (A,D) conflict with Performance P4

(A,E) (D,G) conflict with Performance P5

- Conflict Type 3: Conflict between performance and performance

The conflict depicted as coordinates:

(P1,P2) conflicts with Perception A

(P2,P3) conflicts with Perception A

(P2,P4) conflict with Perception A

(P2,P5) conflict with perception A

- Conflict Type 4: Physical contradiction Inherent in Perception

(A,P2) conflicts with Perception A

b. Cause-Effect and Contradiction Chain Analysis

Use of the contradiction analysis matrix carries out all contradiction in a problem to be determined; using the cause-effect and contradiction chain analysis can help locate key disadvantage. Identification of target disadvantage allows for step-by-step inference of the key disadvantage. "Target disadvantage" in this case refers to weakened performance factors. Use the contradiction analysis matrix to identify the target disadvantage factor, from the viewpoint of the performance factor, and if a "-" is present, it shows the performance is one of the "target disadvantage" factors. Follow the CECCA method and put the weakened performance into the target disadvantage. After that, search all unfavorable factors step-by-step as demonstrated in Figure 20.

Cause-Effect & Contradiction Chain Analysis

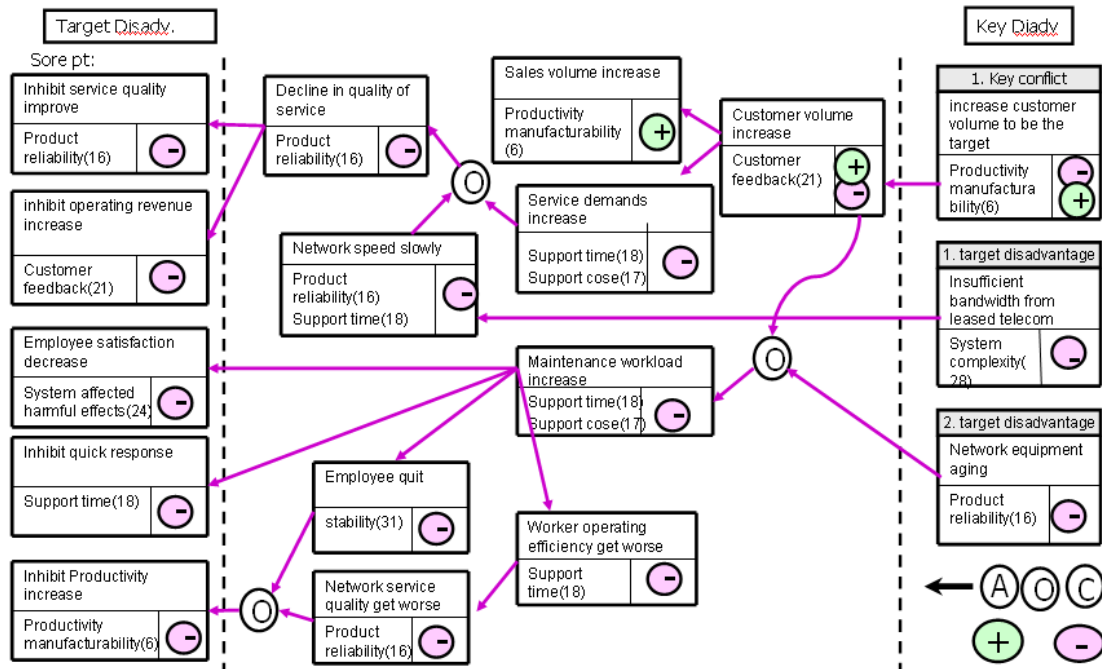


Fig. 20. Cause effect and contradiction chain Analysis

The reason for “inhibit service quality improve” is “Decline in Quality of Service,” while “Decline in Quality of Service” is a result of “Service demand increase.” “Service demand increase” is a direct product of “customer volume increase,” and “customer volume increase” is a resulting phenomenon of the perception “increase customer volume to increase market share to the target.”

This trajectory shows that the key disadvantage factor causing “inhibit service quality improve” is “increase customer volume to increase market share to the target.” Yet, consideration of whether the key disadvantage factor might also provide positive, favorable factors is also necessary, so as to prevent the eradication of favorable factors in the removal of the key unfavorable factor. If a favorable factor is present along with the key disadvantage factor, then the key disadvantage factor is the locus of the key conflict.

The Cause-effect and Contradiction Analysis thus helps identify one conflict and two disadvantage factors. In this case, the key conflict is the perception “increase customer volume to increase market share to the target,” while the disadvantage factors are “insufficient bandwidth from leased telecom” and “Network equipment aging.”

(4) Locating Conflict Solutions

- **Disadvantage Factor 1: Insufficient bandwidth from leased telecommunications network inhibit service quality improve**

Specific Solution: Switch to leased fiber-optic network to improve overall network speed, thus reducing occurrences of dissatisfaction over slow internet speeds.

- **Disadvantage Factor 2: Network equipment aging causes increase in maintenance work**

Specific Solution: Replace new and high-stability equipment to lower maintenance workload.

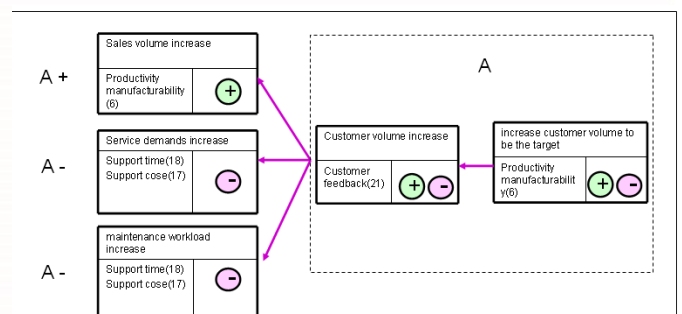


Fig. 21. Key Conflict diagram

- **Solution Index for Key Conflict Point 1: Solution Directives**

(1) Solution Guide1: Fully meets “Positive Effect (+A)”, and eradicate negative effect

Solution Trigger: How to fully meet goal of sales volume increase without increasing service Demands

Specific Solution: Simplify the user interface and decrease the level of service needs in spite of an increase in customer numbers. The improvement in quality is not affected.

Solution Trigger: How to fully meet goal of sales volume increase without increasing maintenance work

Specific Solution: Increase internet reliability to lower maintenance workload; quality standards will thus not decrease in spite of rise in customer numbers.

(2) Solution Guide 2: Fully eliminate “Negative Impact (-A)” and maintain positive effect

Solution Trigger: How to eliminate “Service demands increase” and keep providing “Sales volume increase”

Specific Solution: Train employee to be the multi-ability-worker to serve more customers and maintenance jobs and meet company goal of revenue growth.

(3) Solution Guide 3: Eradicate A, and provide positive effect methods

Solution Trigger: How to remove the demand on marketers to raise clientele numbers and provide an alternate method for increasing sales figures.

Specific Solution: Provide high-quality and high-speed fixed-line services, and customers will, through word of mouth, bring in more customers and meet company goal of revenue growth; additionally, install automated voice query services to provide additional means of service through internet and telephone network (not limited to the amount of configurations of service staff) to influence service quality.

(4) Solution Guide 4: Make the negative effect insignificant, obtuse, or directly remove it.

Solution Trigger: How to make the phenomenon of service demand increase unimportant, non-sensitive, or directly remove said phenomenon.

Specific Solution: Increase staff number to facilitate and maintain rising demand for service and maintenance workload without causing decrease in service quality.

Solution Trigger: How to make the phenomenon of increase in maintenance workload unimportant, non-sensitive, or directly remove said phenomenon

Specific Trigger: Utilize fully automated service, thus rendering increasing for service and maintenance workload irrelevant.

▪ **Engineering Contradiction: Contradiction Matrix and Inventive (Business) Principles**

Table 9 Contradiction Matrix

Worsen / Improve	Productivity manufacturability(6)
Support time(18)	5,6,10,12
Support cose(17)	13,10,17,2

Inventive Principle 5: Merging

Specific Solution: Combine service categories and provide customer service through the call center in maintaining consistency in service quality.

Inventive Principle 6: Universality

Specific Solution: Train relevant staff to be multi-ability-worker and assist other staff members so as to slow down increase in service demand and unfinished business proceedings.

Inventive Principle 12: Remove Tension

Specific Solution: Automate service needs, and eradicate tension from increased rates of service.

Inventive Principle 2: Take Out/Suspension

Specific Solution: Establish voice inquiry service system and leave all easily-resolved service demands/questions to it, so as to lower service load on staff members.

◆ **Physical Contradiction: The Physical Contradiction Between Perception A and Performance P2**

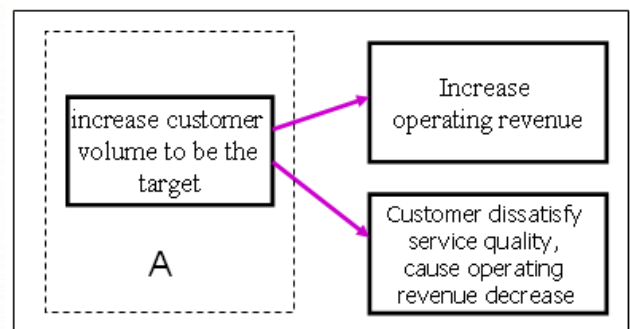


Fig. 22. Physical Contradiction

⊕ Time Separation: When (+A) is required, (-A) is required

Solution Trigger: When +A (the goal to push marketers to raise clientele figures) is necessary, -A (the goal to push marketers to decrease clientele figures) is necessary.

Specific Solution: Increasing clientele figures (+A) is

imperative when fixed-line usage is infrequent, using new marketing methods to attract more customers and increase sales revenues. When fixed-line usage is high and frequent, lowering customer numbers (-A) is needed, setting higher fee rate to limit customer usage.

5. Conclusion and Proposals

5.1. Conclusion

This research mainly set out to: (1) Provide a method for analyzing human perceptions by transforming an initially-unseen perspective into a visible phenomenon, then combining the perspective with the performance to observe and evaluate whether the effect of the perspective on the performance is conducive or negative; (2) Analyze the relationships between different perceptions to find any potential underlying contradictions, using the methods provided throughout this research. Through the structured method provided here, seemingly-unrelated perceptions can be expanded together into a series of related phenomena, depicting contradictions that might exist between each other through the links between those phenomena.

The main contributions of this research are:

(1) Strengthening the original Perception Mapping Method, furthering its methodology and application. While original perception mapping can only describe “lead to” relationships between positive effects of different perceptions, the methodology of this research utilizes both “lead to” and “inhibit” relationships to describe positive and negative correlations between perceptions. A description of perception relationships through both negative and positive factors illustrates contradictions between the perceptions more clearly.

(2) By using the combination of perceptions and performances with the “Perception Relationship Diagram,” unfavorable factors of the performances can be located and thus improved so as to meet the goal of raising organizational performance.

(3) Expanding the application range of Function Relationship Analysis (FRA): Traditionally, Function Relationship Analysis and Solution Index were mainly applied to engineering-related problems. Few research papers have observed the relevancy of FRA to solve management problems. This research combines Function Relationship Analysis with Perception Mapping to analyze and solve management-related problems.

(4) Traditional Perception Mapping required subjective judgment regarding identification of contradictions; this research proposes a logical inference method based on odd-number and even-number suppression to determine the relationships with no

standing contradictions.

(5) Via Cause-Effect and Contradiction Chain to the Perception Relationship Diagram, utilizing the Contradiction Analysis Matrix and Cause-Effect and Contradiction Chain Analysis can assist in further recognizing technical and physical contradictions. Conflicts in management can thus be resolved through Business Inventive Principles and the Principle of Separation.

5.2. Suggestions and Directions for Future Research

(1) While discussing the relationships between perceptions, phenomena, and performances, this research solely described the interactions, no degree of the interactions is discussed. If System Dynamic is applied to the relationships to quantify the degrees of influence between perceptions and performances through simulations, the relative sizes of influence between perceptions and performances can be discerned, allowing the user to concentrate resources on resolving major problems. (Huang, 2005)

(2) Combine the Theory of Constraints with this research to locate core issues and target whether an organization’s strategic direction meets required evaluation and execution. The Theory of Constraints poses that a system’s constraints usually only exist amongst a handful of links, yet core problems are in actuality those in which constraint factors pose major influence on an entire organizational system’s production and performance. By undergoing a set of structured thought processing to infer the causality of the issue and using the graph theory of arborescence to organize that inference, one can unravel the core of the problem. Through a three-stage implementation of strategic thinking, one targets:

a. What to change: Note underlying reasons of the problem using a Current Reality Tree depicting the current status

b. What to change: Many bottleneck problems cannot be remedied immediately with the use of Evaporating Cloud (i.e. Conflict Resolution Diagram) and Future Tree as a result of preexisting paradoxes and contradictions in their requirements. The Conflict Resolution Diagram merely points out the existence of contradictions. Future Trees, on the other hand, are used to test whether desired programs/methods can contribute to the final desired result of the organization.

c. How to change: Using Prerequisite Trees and Transition Trees, confirming all necessary elements of the program, and breaking down details of the actual implementation. (Wang, Yen 2008)

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