

A Comparative Study among Policy and Decision Makers through Their Mental Models

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ABSTRACT

Cognitive map analysis has been widely used to understand the structure of decision-makers thought. It has been introduced as a proper tool to map the mental model of a decision-maker. Facilitators as agents who intervene and facilitate change in the mental models can use it to map the mental model of managers and assist them to change it or evaluate its changes over time. This paper introduces a framework of intervention, which has been implemented in three companies in order to change individuals' mental models toward shared mental models. Cognitive maps are used to measure the impact of intervention in different stages. Cognitive maps of three decision-makers, in three companies, have been used as a tool to measure the changes in the thought processes of decision-makers and to measure the rate of sharing among them after each intervention. Analysis and evaluation of the rate of sharing and the contents leads to some guidelines for more effective intervention.

Keywords: Decision making, Intervention, Vision, Mental Model, Cognitive Map, Evaluation, Performance

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1 Introduction

Cognitive map of a person indicates his/her mental models and it is comprised of factors and the relations among them. Specifications of cognitive map, has brought up a great application for it in decision making. In the same manner, the cognitive mapping approach has been introduced as a proper technique, through which it is possible to study that how people make decisions and how they can make better decisions. The mentioned approach, help decision and policy makers to see in what ways their performance can be improved. Therefore, in general, cognitive mapping activity is a way, in which differences in mental models, among the managers, are surfaced, possibilities of systemic investigations are provided and consequently it is a way for achieving the managers to consensus. So the methods, which affect on the mental models of the people, can play an outstanding role in their decision making. In this regard intervention is identified as an important issue.

This paper is based on a research in the field of learning organization according to Senge's theory in his book, titled "The Fifth Discipline" (1990). "The topic of organizational learning has gained a lot of attention" (Kim, Fall93, P.37) and "the rate at which organizations learn, may become the only sustainable source of competitive advantage" (Senge, Fall90, P.7). In this way "Stata" has pointed out that, "the slope of the characteristic half-life curve ... and the slope of the Boston Consultant Group (BCG) experience curve is determined by the rate of organizational learning "(Stata 1989, P. 69). "Learning in this context does not mean acquiring more information, but expanding the ability to produce the results we truly want in life. It is lifelong generative learning. And learning organizations are not possible unless they have people at every level who practice it" (Senge 1990, P. 142). According to the Senge's theory, a traditional organization transfers to a learning organization if it is equipped with at least five disciplines: personal mastery, mental models, shared vision, team learning and systems thinking (Senge 1990). Since the focal point of this paper is on sharing and in learning organization the sharing is ascertained in mental models and vision, therefore, following is a brief description about them.

Mental models: "Mental models are the images, assumptions and stories which we carry in our minds of ourselves" (Senge et al 1994, P. 235) . "Senge describes mental models as deeply held internal images of how the world works which have a powerful influence on what we do because they affect what we see" (Kim 93, P. 52-3). The processes of an organization could be categorised in non-intensive and intensive knowledge. Many of the new organizations, especially future organizations, most of their processes are intensive knowledge. In this regard mental models play an active role because "knowledge intensive processes are often driven and constrained by the mental models of experts acting as direct participants or managers" (Ford & Sterman 1998, P. 309). And also "description of process relationships are often not generally available from traditional data sources, such as company records, but are stored in the mental models of the process experts. Differences in the mental models of team members can constrain and lead to conflict" (Ford & Sterman 1998, P. 310). Mental models are the active storage of memory that contains operational routines for translating operations into know-how and conceptual frameworks that contain the know-why of operations. They directly affect thinking process and provide the context in which to view and interpret new material, and they determine how stored information is relevant to a given situation. "This discipline is focused around developing awareness of the attitudes and perceptions

that influence thought and interaction. By continually reflecting upon, talking about, and reconsidering these internal pictures of the world, people can gain more capability in governing their actions and decisions” (Senge et al 1999, P. 32). “This discipline offers the highest leverage for change and it is probably the most practical of the five disciplines” (Senge et al 1994, P239).¹

Shared Vision: “Shared vision is vital for the learning organization because it provides the focus and energy for learning” (Senge 90, P. 206). “A vision is a picture of the future you seek to create, described in the present tense, as if it were happening now. A statement of our vision shows where we want to go and what we will be like when we get there” (Senge & et al 1994, P. 302). A person intrinsically needs to know what he/she wants to create and where he/she wants to go. Vision contains the answers of the mentioned questions and it has attracted individuals and the managers of organizations so that “vision has become one of the most overused and least understood words in the language, conjuring up different images for different people” (Collins & Porras 1996, P. 66). “Building a vision is not about writing formal statements or establishing stretch goals, although those activities will sometimes be useful. Rather, it is about people discovering who they truly are as an organization so that they can get on with the work of initiating growth and change” (Stone 1996 P.14). “Unfortunately, too many people think that vision is the top leader’s job”(Senge et al 1994, P. 302) whereas it is their responsibility all. Essentially, “at the heart of building shared vision is the task of designing and evolving ongoing processes in which people at every level of the organization, in every role, can speak from the heart about what really matters to them and be heard- by senior management and each other. The quality of this process, especially the amounts of openness and genuine caring, determine the quality and power of the results”(Senge et al 1994, P. 299).²

The focal activity of this research had been based on implementation of an intervention framework and researcher played the role of interventionist to help the senior managers to practice the disciplines of learning organizations.

The purpose of the research was opening a window to performance improvement of an organization via the intervention framework. Three base load power plants (generating company) were chosen as the field of the research. Therefore, in the next pages, the word company(ies) or power plant(s) is referred to the mentioned base load power plants. In studying of this paper, please pay attention to these notes: 1) intervention framework has been implemented at the level of senior managers whereas it has been no any direct relation among the managers in the three power plants. 2) the evaluation of the research has been only concentrated on the three chief executives of the three power plants.

In this paper evaluation of the interventions’ influence, has been carried out by measure of sharing among the managers through their cognitive maps. Analysis and evaluation of the rate of sharing and the contents of mental models leads to some guidelines for more effective intervention.

¹ For more description and details about mental models, please refer to: (Senge 1990, PP 174-204); (Senge et al 1994, PP235-293); (Kim 1993, PP. 83-120); (Doyle & Ford, 1998, PP. 3-29); (Doyle & Ford, 1999, PP. 411-415); (Lane, 1999, PP. 185-194).

² For more description and details about vision, please refer to: (Senge 1990, PP 205-232); (Senge et al 1994, PP297-347); (Collins & Porras, 1996, PP. 65-77)

In the following sections after a brief review in literature of cognitive map and intervention, the framework of the interventions is described and then intervention influence, through the cognitive maps of the managers, will be evaluated.

2 Cognitive Map

Research on cognition has a long record in human being knowledge but recently “Research on managerial cognition in general, and on cognitive mapping in particular, is receiving a great deal of attention in Europe and US” (Fiol 1992 P.267). “The label cognitive maps has been used for several decades and originates from the ideas of Tolman (1948) who wished to develop an alternative to the stimulus-response mode of man”(Eden 1992,P.261). In general, the cognitive mapping approach has been introduced as a proper technique, through which it is possible to study that how people make decisions and how they can make better decisions. The “approach is to study the cognitive maps used by actual decision makers and policy experts, to see in what ways their performance can be improved” (Axelrod 1976, P.3).

“The cognitive mapping approach, in contrast, uses only one basic type of relationship, namely, the causal relationship. While causation is represented as being either positive or negative (i.e., promoting or retarding effects), and while it can represent evaluative assertions as well as regular causal assertions, the causal relationship is still the basic building block of a cognitive map” (Axelrod 1976, PP. 10-11).

Cognitive map Definition

“What is a map? It is a graphic representation that provides a frame of reference”(Fiol 1992, P.267). According to the map definition cognitive map also should be a representation that provides a frame for cognition. In literature there are some definitions for cognitive map.³ In aggregate, the collection of mentioned definitions could be summed up in the following:

Cognitive map is a graphic illustration of thoughts and beliefs of a person, a group or an organization in a particular policy domain in an actual practice. Cognitive map represents the main agents of cognition and their causal relations with each other. It provides the possibility of comparing and analysing of the thoughts and beliefs in an elapse of time, and facilitates the improvement of decision making and action taking.

Cognitive Map Structure

A cognitive map is comprised of some points and the causal links among the points. “The concepts, a person uses, are represented as points, and the causal links between these concepts are represented as arrows between these points. This gives a pictorial representation of the causal assertions of a person as a graph of points and arrows. This kind of representation of assertions as a graph will be called a cognitive map. The policy

³ For the definitions please refer to: (Axelrod 1976, P. 56) (Axelrod 1976, P. 58) (Fiol, 1992, P.267) (Eden, 1992, P.262) (Eden, 1994, P.264) (Langfield-Smith, 1992, P.1135);

alternatives, all of the various causes and effects, the goals, and the ultimate utility of the decision maker can all be thought of as concept variables, and represented as points in the cognitive map. The real power of this approach appears when a cognitive map is pictured in graph form; it is then relatively easy to see how each of the concepts and causal relationships relate to each other, and to see the overall structure of the whole set of portrayed assertions” (Axelrod 1976, P.5). So “a cognitive map has only two basic elements: concepts and causal beliefs. The concepts are treated as variables, and the causal beliefs are treated as relationships between the variables” (Axelrod 1976, P.58).

The relationships between the variables could be positive or negative. “A positive causal relationship means that changes occur in the same directions, but not necessarily positively” (Axelrod 1976, P. 59). “A word such as augment indicates a positive causal relationship between the cause variable and the effect variable” (Axelrod 1976, P.59). A causal relationship could be negative, that means changes occur in opposite directions. “The word inhibit indicates there is a negative causal relationship between these two concept variables” (Axelrod 1976, P.59).

Drawing the Cognitive Maps

In this research the cognitive maps of the decision-makers (chief executives) in three companies were drawn in each of the phases of the research by the researcher as an interventionist. This was carried out in an open-ended interview between the researcher and a decision-maker. Each interview started with a question “**What are the factors, which have influence on the organizational performance and what is the relationship between the factors and their effects?**” Then the manager begins to describe his views about the question while interventionist draw the map accordingly. Although the interview was open-ended, but experience showed that two hours is enough. The manager will have another one-day opportunity, after interview, to omit/add to the cognitive map if he/she remember more ideas in response to the question.

This paper uses the cognitive map to capture the mental models of the managers with regard organizational performance. This make it possible to trace the changes in one person’s mental models over time, and compare the managers, with each other with respect to the similarity or difference of their mental models. For this purpose, a database has been developed as an instrument.

3 Intervention

Argyris has identified intervention as an important issue in the field of organizational learning (Argyris 1999, P. 19-20). But what is intervention? “To intervene is to enter into an ongoing system of relationship, to come between or among persons, groups, or objects for the purpose of helping them” (Argyris 1970, P.15). A sound intervention needs some requirements, which are called primary tasks. They are valid and useful information, free choice and internal commitment. (Argyris 1970, PP.17-20)

“Valid and useful information is the foundation for effective intervention”(Argyris 1970, P.17). “Without valid information it would be difficult for the client to learn and for

interventionist to help”(Argyris 1970, P.17). Free choice is a necessary process in effective intervention activity (Argyris 1970, P.17). Free choice places: the locus of decision making in the client system, makes it possible for the clients to remain responsible for their destiny and the clients can maintain the autonomy of their system (Argyris 1970, P.19). Internal commitment means that the individual has reached the point where he is acting on the choice because it fulfils his own needs and sense of responsibility, as well as those of the system (Argyris 1970, P.20).

“Focusing on the three primary tasks also helps an interventionist prevent himself from falling into the trap of being associated ahead of time with certain types of managerial styles”(Argyris 1970, P.24). “Adherence to the three primary tasks, therefore, allows the interventionist to be better able to make some contributions to his field (Argyris 1970, P.31). “Effective intervention helps the client system learn not only how to solve a particular set of problems but how to operate more competently”(Argyris 1970, P.21). “It is important that the decision not be prejudged by the interventionist, and according to this framework, the client should be helped to make the decision. The interventionist can help the client by assisting him in obtaining valid and useful information”(Argyris 1970, P.22).

According to the above, the interventionist role is very sensitive and requires precise attention and it is more likely possible to deviate from right direction. In brief it is possible to integrate all of the interventionist activity in keyword of “**help**”. In an organizational learning model, the keyword “help” is translated that, help the client system to learn how to learn from every thing, every person every organization and from every event and experiment.

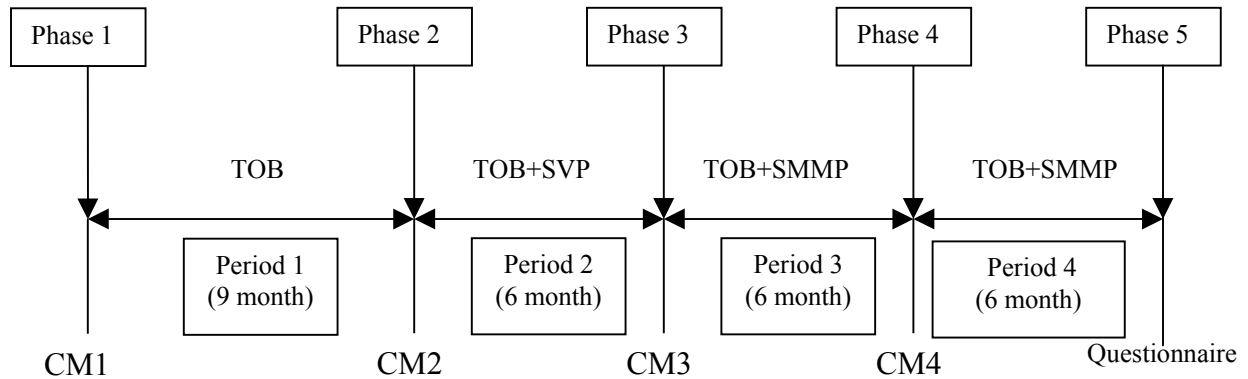
4 Intervention Plan

The research was arranged in four phases and three periods. In each phase the cognitive map of each manager was drawn and in each period, some interventions were implemented. The objectives of the three intervention periods were as follows:

First period: Preparing the groundwork foundations in managers’ thought. In this regard, basic theories of the research, based on literature, were taught. It was called transfer of basic theories(TOB). Second period: Developing shared vision of managers from the company. In this regard, transfer of basic theories was continued and a shared vision process was implemented. Third and fourth period: Changing the managers’ mental models so that the managers, collectively, could start a movement to meet the shared vision. Transfer of basic theories (TOB), from first and second periods, was continued and shared mental model process was implemented.

In each phase, the managers’ cognitive maps, in respect to the company performance, was drawn by the researcher. Consequently, four cognitive maps(CM) were drawn, from CM1 up to CM4 for each manager. By recording cognitive maps in consequent phases, it is possible to trace the change of mental models as time passes, and makes it possible to

trace and evaluate the interventions' influence on the managers. Figure 1 shows the layout of the research.



Layout of the Research

Fig 1

CM: Cognitive Map,
 SMMP: Shared Mental Models Process,
 SVP: Shared Vision Process,
 TOB: Transfer of Basic theories.

The Details of the Interventions

The purpose of the interventions, in each period, was:

Period1: To prepare the ground works and background

Period2: To develop the managers' shared vision

Period3: To develop managers' shared mental models.

Preparing Groundwork and Background

Transfer of basic theories to the managers, was the backbone of this period and includes the following theories and models.

- ◆ Management functions based on literature
 - Holding management functions workshop as a practice
 - Investigation of obstacles and facilitators in respect to implementation of the management functions.
 - Presentation of, at least, one of the relevant subjects in management functions, by each of the managers.
- ◆ System dynamics methodology
 - Causal Linear thinking and causal cyclic thinking
 - The necessity of substituting causal cyclic thinking for causal linear thinking.
 - Team practice in system dynamics thinking and methodology
 - Team practice in the methodology of system dynamics was carried out in two types of activities: (1) drawing the causal diagram of the different working fields of the company and (2) story telling in events of the company. Story

telling leads to causal diagram of the story and determination of the related archetype.

- For each working field in the company, a team was formed. A team was comprised of managers whose duties were related to each other. In the research, the team was considered as an infrastructure and was used in different activities during the periods of the research.
- ◆ Theory of Organisational Learning
 - Five disciplines: *personal mastery, shared mental models, shared vision, team learning and systems thinking*
 - Presentation of, at least, one of the five disciplines by each of the managers

Developing Managers' Shared Vision

Developing the shared vision of the managers from company consisted of the following processes.

- ◆ Boosting the individual visions in different personal affairs generally, and boosting the individual vision from the company specifically.
- ◆ Developing the vision of each team from the company.
- ◆ Developing the shared vision of all the managers from the company.

The last two processes relied on the discipline of team learning (TL) with concentration on dialogue.

Shared vision of the managers was comprised of two parts: the general statement and dimensions. The general statement describes the desired view of all the managers for the future horizon (five years). Since the general statement does not clearly lead to actions, it therefore needs a section to spread and translate it in the different fields of the company.

The dimensions of the vision are clear translations of the vision statement in different fields of the company. There are different dimensions, including: technical; financial and economic; human resources; customer satisfaction; systems and management; and environmental and so on. The clearer each dimension of the statement is, the more it is used in executing the vision. It is not necessary that all mentioned dimensions are selected; it is up to the managers' preferences.

Developing Shared Mental Models

According to the literature, a person's behaviour is rooted in his/her mental models. If the managers would like to lead the company toward their shared vision, they need to change their mental models to what their shared vision implies. The mentioned change occurs from a cycle containing surfacing, testing and improving. Operation of the cycle is called mental models management. In this research mental models management was carried out by means of two interrelated activities:

- ◆ Working in dimensions of shared vision
- ◆ Working on assumptions of the managers in relation to the dimensions of the shared vision.

Working in Dimensions of Shared Vision

This activity started by assigning a manager as responsible for each dimension. He/she has taken the following steps to prepare and provide the issues, which were to be shared then among the managers. The steps were:

1. Determination of the dimension index/indices
2. Definition of the index/indices from the literature's point of view.
3. Data gathering of the functional elements of index/indices formula for the last few years
4. Calculation of the index/indices and drawing the related curves.
5. Forecasting the index/indices curves for next five years according to present trends.
6. Drawing the indices curves for next five years according to what has been determined in the shared vision of the managers.

Note: Steps number 5 and 6 indicate the “**gap**” between the current trend and the path, which comes up from the shared vision.

7. Gap analysis
8. Determination of drivers and related actions to fill the gap.
9. Presentation of the outcomes of above steps to the managers.
10. Continuation of dialogue and discussion among the managers about the mentioned outcomes to achieve to the relative accepted sharing among the managers.

Working on Assumptions of the Managers

Working on assumptions of the managers was carried out as follows:

- 1) Preparing the primary list of the managers' assumptions in respect to their shared vision and its dimensions, by the researcher, regarding to the following:
 - Using preliminary notes which have been made by the researcher accordingly for this purpose
 - Remembering the behaviour of the managers in reaction of different situations and events
- 2) Presenting the primary list to the managers for their approval or possibly modification.
- 3) Holding dialogue sessions of the managers on the list of the assumptions (the outcome of step 2) and preparing new list of the managers' assumptions with respect to the shared vision and its dimensions.

Steps 2 and 3 were repeated every six months. In each repetition the list from the previous time, would be the input of the session.

Additional Period for process of shared mental models

Above descriptions about different activities in processes of shared vision and shared mental models, clearly indicated that process of shared mental models takes more time in comparison with shared vision process. The mentioned fact showed itself during the research implementation and the researcher experimentally found that it is needed to add another period for process of shared mental models. Therefore the research was continued for fourth period in continuation of activities of the third period.

Differences of actions taken in three companies

There were some differences in the actions, which has been taken in three companies. They were as below:

- In power plant 3 there was no phase one and period one, and consequently the intervention of transfer of basic theories (TOB) in this power plant was not as strong as the other two power plants.
- Form point of view of ISO; power plant 3 was awarded ISO-9002 only in a small section of the company, before the research was started. Power plant 1 was seriously engaged in the process of ISO 9002 award during the periods 2 and 3, and power plant 2 was not involved in ISO award during the research project.

Timetable of the research

Table 1 shows the timetable of the research. It should be noted that obtaining approval of the research from the power plant managers took about two months. Therefore, real time for start point of the research would be 22 July 1998.

Timetable of the Research

Periods	From	To	Duration
1	22 Sep. 1998	20 Jun. 1999	9 Month
2	21 Jun. 1999	20 Dec. 1999	6 Month
3	21 Dec. 1999	20 Jun. 2000	6 Month
4	21 Jun. 2000	20 Dec. 2000	6 Month

Table 1

5 Results and Analysis

To facilitate the evaluation of cognitive maps of the managers, they have been accumulated in a database. By means of the database the required tables were prepared and evaluated.

5.1 Evaluations of the Cognitive Maps

The purpose of this evaluation is to find a rational relationship between the interventions and the changes in the mental models of the decision-makers. Interventions were implemented in accordance with the action plan. Please bear in mind the followings.

- ◆ Various kinds of interventions applied to each company in four periods as indicated in the layout of the research (Fig. 1).
- ◆ There were differences of intervention according to what has been mentioned in fourth section of this paper.
- ◆ The interventions have been implemented at the level of senior managers of the three companies in separate whereas; there were not any direct relations between them.

- ◆ This paper confined itself only on the chief executives of the three companies and the evaluation has been carried out on their cognitive maps.

Evaluation of Number of Factors (NOF)

NOF Indicates the number of factors that have been used, by a person, in his/her cognitive map. In the following table MID stands for manager identification and indicates to the chief executive in each of the three companies. PPID stands for power plant identification and it is pointed out to the related company.

Table of NOF

Power Plant	MID	Number of Factors (NOF)			
		Phase1	Phase2	Phase3	Phase4
1	1	28	25	24	20
2	16	16	14	26	16
3	25	-	17	29	17

Table 2

- ◆ In the above table, in MID 1, there is an outstanding trend of decrease in NOF from phase1 down to phase4 although the difference between phases 2&3 is not meaningful. It will be dealt with later on.
- ◆ There is a decrease from phase1 to phase2. It indicates that intervention of transfer of basic theories (TOB) has played an effective role and has been efficient.
- ◆ The managers of power plants 2&3 have an upward mutation in magnitude of NOF in phase3 in comparison with phase2 while there is no meaningful difference in power plant 1 in the same phases. It is remarkable that the intervention in power plants 2&3 were the same and different in comparison with power plant1. In power plant1, the interventions were what has been carried out in power plants 2&3 plus process of ISO award. This indicates that building shared vision played a scattering role in the managers' mental models while process of ISO award has played a preventive role in scattering of the mental models.
- ◆ All of three power plants have a decrease in phase4 in comparison with phase3. It indicates that the intervention, process of shared mental models, has played a controlling role in scattering of mental models and it has played the role of convergence. among the managers.
- ◆ Managers of power plants 2&3 have an upward mutation in phase 3 in comparison with phase 2 and have a downward mutation in phase 4 in comparison with phase 3, while there is no mutation in power plant 1 in the same phases. It means that, in power plant 1, scattering was controlled from the beginning and consequently there is no upward mutation in magnitude of NOF. By regarding to the result of previous item, this behaviour indicates that process of ISO-Award is of the same nature as the process of shared mental models.
- ◆ In an aggregate view to periods 2&3, it is observed that, the processes of shared vision and shared mental models play different roles in the mental models. The process of shared vision prepares the condition to enhance the imaginative

activities of thought, idealism orientation, whereas the process of shared mental models tends toward the reality of the situation, reality orientation.

Deductions of Table “NOF ” Evaluation

1. Intervention framework has played an active role in managers’ mental models toward convergence.
2. Interventions played the role of rationalising in thinking of the decision-makers.
3. Process of shared vision plays scattering role in the mental models.
4. Process of shared mental model plays a preventive role in scattering of mental models and plays the role of converging.
5. Process of ISO-Award is of the same nature as the process of shared mental models and plays an active role in convergence of the mental models.
6. Process of shared vision without process of shared mental models could be risky.
7. The essence of shared vision process is “idealism” and the essence of shared mental models process is “pragmatism”.

Evaluation of Number of Relations (NOR)

NOR stands for number of relations in a cognitive map. In the following table MID stands for manager identification and indicates to the chief executive in each of the three companies.

Table of NOR

Power Plant	MID	Number of Relations (NOR)			
		Phase1	Phase2	Phase3	Phase4
1	1	35	24	27	29
2	16	17	13	29	20
3	25	-	16	32	30

Table 3

- ◆ In the above table there is a decrease in NOR between phase1 and phase2. It indicates that intervention of transfer of basic theories (TOB) has played an effective role and has been efficient.
- ◆ For all three managers there is an increase in magnitude of NOR in phase3 in comparison with phase2. This trend indicates that intervention of shared vision process has played a scattering role in the manager mental models. Notify that there is an upward mutation in NOR of managers 16 & 25 while there is a soft increase in manager 1. It is remarkable that the interventions in power plant 2&3 were the same (i.e. shared vision process) and different in comparison with power plant1. In power plant1, the interventions were what has been carried out in power plants 2&3 plus process of ISO award. This indicates that building shared vision played a scattering role in the managers’ thought while process of ISO award has played a preventive role in scattering of the mental models.
- ◆ Changes in NOR in phases 3&4 show a slow down in slope of the increase of NOR, in manager1 while there is a decrease mutation in manager16 and a soft

decrease in manager 25. The mentioned trends indicate that shared mental model process has played a controlling role in scattering of mental models.

- ◆ Different trends in above-mentioned items draw a rational relationship in comparison with the different interventions in three power plants. In power plant 1, shared vision process has been implemented simultaneously with ISO award process while in two other one has not. It means that in power plant 1, a controlling process has been implemented from the beginning and it has controlled the above-mentioned scattering. But the difference of trends in power plant 2&3 is referred to the different of interventions, in periods one and two. Since lack of transfer of basic theories, power plant 3 has not have a foundation as strong as power plant 2 consequently upward mutation in manager 16, in phase 3, has been controlled strongly by shared mental model process while, in power plant 3 it has been controlled not as strongly as Power Plant 2. Totally the mentioned analysis indicates that:
 - Transfer of basic theories has plays an effective role in build up a basis in individual mental models, in another word it is known as an efficient practice in personal mastery discipline,
 - ISO award process is the same nature of shared mental model process,
 - Shared vision process causes scattering in mental models while shared mental model process controls the scattering. Therefore they are complementary of each other, in other words the process of shared vision prepares the condition to enhance the imaginative activities of thought, idealism orientation, whereas the process of shared mental models tends toward the reality of the situation, reality orientation.

Deductions of Table “NOR ” Evaluation

1. Interventions, one by one and totally, have played an effective role in managers' mental models.
2. Transfer of basic theories has played an effective role in build up a basis for individual mental models, and it is known as an efficient practice in discipline of personal mastery.
3. Process of shared vision (SV) plays scattering role in the mental models
4. Process of shared mental model plays a preventive role in scattering of the mental models and it plays an active role in converging of the mental models.
5. Process of ISO-Award is of the same nature as the process of shared mental models and plays an active role in convergence of the mental models.
6. Process of shared vision without process of shared mental models could be risky
7. The essence of shared vision process is “idealism” and the essence of shared mental models process is “pragmatism” therefore they are complementary of each other.
8. Implementation of shared vision process and shared mental models, simultaneously, makes synergy.
9. ISO award process could be known as one of the standards in discipline of mental models.

Evaluation of P

P indicates the number of factors in the cognitive maps of all the people, in this case, the three managers of the companies, in a phase. It is reminded that, according to the action plan of the research, in phase1, there are the cognitive maps of two managers

(MID=1 & 16) and in the other phases there are the cognitive maps of three managers MID= 1,16 & 25).

Table of "P"

PhID	1	2	3	4
P	41	46	57	33

Table 4

- ◆ Regarding to the above reminding, indeed, the magnitude of P in phase2 is not higher than phase1 and it indicates that the basic theories have played an efficient role in convergence of the mental models.
- ◆ There is an increase in magnitude of P in phase 3 in comparison with phase2 that indicates shared vision process has played a scattering role in the mental model of the people.
- ◆ There is an outstanding decrease in magnitude of P in phase 4 in comparison with phase3 that indicates shared mental models process has played an efficient role to control the scattering, raised up from shared vision process.
- ◆ Above ups and downs of the magnitude of P indicates that shared vision process and shared mental models process are complementary and shared vision process without shared mental model process could be risky

Deductions of Table of " P " Evaluation

1. Interventions have played an effective role in managers' mental models.
2. Process of shared vision plays scattering role in the mental models
3. Process of shared mental model plays a preventive role in scattering of the mental models and it plays an active role in converging of the mental models.
4. Process of shared vision without process of shared mental models could be risky
5. Shared vision process and shared mental models process is complementary of each other.
6. The designed framework of intervention, as an efficient framework to change the mental models of the people, is approved.

Evaluation of P_{ab}

P_{ab} indicates the number of factors in the maps of two person who have been called a and b in a phase.

Table of P_{ab}

MID1-MID2	P _{ab}			
	Phase1	Phase2	Phase3	Phase4
1-16	41	35	42	27
1-25	-	38	41	28
16-25	-	27	45	25

Table 5

- ◆ In the above table there is a decrease in P_{ab} between phase1 and phase2. It indicates that intervention of transfer of basic theories (TOB) has played an effective role in mental models and it has been efficient.
- ◆ In all lines of the table there is an increase in magnitude of P_{ab} in phase3 in comparison with phase2. This trend indicates that intervention of shared vision process has played a scattering role in the mental models.
- ◆ In all lines of the table, there is a decrease in magnitude of P_{ab} in phase4 in comparison with phase3. This trend indicates that intervention of shared mental model process has controlled the scattering of mental models, raised from shared vision process in previous period. Therefore these two processes, shared vision process and shared mental model process, are complementary of each other and shared vision process without shared mental model process could be risky.
- ◆ Changes of P_{ab} in lines of one and two are, by many degrees, quieter in comparison with line three. By reminding the quiet changes of number of factors (NOF) in the cognitive maps of manager 1 in comparison with the high changes of two other managers (refer to the table 2), a comparison between this trend and that one, indicates the controlling role of ISO award process over the scattering, raised from shared vision process. This matter indicates the essence of ISO award process is the same nature of shared mental model process.
- ◆ Above-mentioned trends in the above table draw the efficiency of the interventions on the mental models and approve the framework of the intervention as an efficient framework to change the mental models of the people.

Deductions of Table “ P_{ab} ” Evaluation

1. Interventions have played an effective role in managers’ mental models.
2. Process of shared vision plays scattering role in the mental models
3. Process of shared mental models play a preventive role in scattering of the mental models and it plays an active role in converging of the mental models.
4. Process of ISO-Award is of the same nature as the process of shared mental models and plays an active role to control the scattering in the mental models.
5. Process of shared vision without process of shared mental models could be risky
6. Shared vision process and shared mental models process are complementary of each other.
7. ISO award process could be known as one of the standards in discipline of mental models.
8. The designed framework of intervention is approved as an efficient framework to change the mental models of the people.

Evaluation of Number of Common Factors (NOCF)

NOCF stands for number of common factors, among the cognitive maps of the people, in a phase. Following is the NOCF table for MID= 1,16 & 25. This table indicates the role of intervention framework, in establishment of sharing, among the mental models of the people. It is reminded that, according to the action plan of the research, in phase1 there is the cognitive maps of two managers (MID=1 & 16) and in the other phases there are the cognitive maps of three managers (MID= 1,16 & 25).

Table of "NOCF"

Phases (PhID)	NOCF	P	NOCF/P
1	3	41	7.3 %
2	2	46	4.3 %
3	8	57	14 %
4	6	33	18.2 %

Table 6

- ◆ Regarding to the above reminding, decrease in NOCF/P percent in phase2 in comparison with phase1 is meaningless.
- ◆ There is a clear ascending in sharing among the mental models of three managers in phases of 2,3&4. This trends indicates that both of the processes, shared vision and shared mental models, have been played an outstanding role in convergence of the mental models that has been led to higher sharing among the managers
- ◆ The trend of mentioned ascending in previous item denotes approving of efficiency in intervention framework of the research, generally.

Evaluation of Number of Common Factors, 2 by 2

This table, which is shown below, contains number of common factors (NOCF) between the people, two by two. This table indicates the efficiency of intervention framework in establishment of shared mental models among the people two by two in details and in general. Once again it is reminded that, according to the action plan of the research, in phase1 there is the cognitive maps of two managers (MID=1 & 16) and in the other phases there are the cognitive maps of three managers MID= 1,16 & 25).

Table of Common Factors, 2 by 2

Phases (PhID)	MID: 1 & 16			MID: 1 & 25			MID: 16 & 25		
	NOCF	P_{ab}	$\frac{NOCF}{P_{ab}}$	NOCF	P_{ab}	$\frac{NOCF}{P_{ab}}$	NOCF	P_{ab}	$\frac{NOCF}{P_{ab}}$
1	3	41	7.3 %	-	-	-	-	-	-
2	4	35	11.4 %	4	38	10.5 %	4	27	14.8 %
3	8	42	19 %	12	41	29.3 %	10	45	22.2 %
4	9	27	33.3 %	9	28	32.1 %	8	25	32 %

Table 7

- ◆ In a glance there is a continuous growth in index of NOCF/ P_{ab} for three managers in three separate different companies. This trend indicates the high efficiency of the intervention framework in sharing of mental models of the people.
- ◆ In previous sections of evaluation of the cognitive maps it was concluded that the processes of shared vision and shared mental models play different roles in the mental models. The process of shared vision prepares the condition to enhance the imaginative activities of thought or scattering in the mental models, whereas the process of shared mental models tends toward the reality of the situation, or converging in the mental models. But here it is shown that both of the two processes played an outstanding role in sharing of mental models among the people. In other words in both cases: scattering and converging in the mental models, the processes of shared vision and shared mental models play similar role that is sharing. This result is reconfirmation to what was already mentioned that the processes of shared vision and shared mental models are complementary of each other, and both of them play an outstanding role in sharing of mental models.

Deductions of Table “ Common Factors, 2 by 2 ”

1. The intervention framework has played an outstanding role in sharing of mental models of the people.
2. Each of the processes of shared vision and shared mental models plays an outstanding role in sharing of mental models of the people.

Evaluation of Common Relations, 2 by 2

This table, which is shown on next page, contains number of common relations between the people, two by two. Here common relation means common in factor 1 (FID1) and factor 2 (FID2) with the direct relation between them (effect of FID1 on FID2 is not considered because the managers are from different companies with different conditions). In the table, index of NOCR/NOR has been chosen as the measure of sharing in mental models and indicates the efficiency of intervention framework in establishment of shared mental models among the people two by two. Once again it is reminded that, according to the action plan of the research, in phase1 there is the cognitive maps only for two managers: MID=1 & 16 whereas in the other phases there are the cognitive maps of all three managers: MID= 1,16 & 25.

- ◆ In a glance to the column of NOCR/NOR, there is no any meaningful change between phases 1&2 in MID: 1-16 whereas there is a harmony of ups and downs from phase 2 to 3 and from phase3 to 4 for all three managers two by two.
- ◆ Outstanding increase in the index in phase 3 to phase 2 indicates that share vision process has played an outstanding role in establishment of sharing in mental models of the managers
- ◆ Outstanding decrease in the index in phase 4 to phase 3 indicates that share mental models process has not played a suitable role in sharing the mental models. As it was mentioned in section 4 of this paper, the researcher, experimentally found that shared mental model process takes more time to shared vision process. In fact in one period, share mental models process has not yet been completed. This

conclusion confirms requirement of more time for share mental models process in comparison with share vision process.

Table of Common Relation, 2 by 2

PhID	MID: 1-16					MID: 1-25					MID: 16-25				
	NOR 1	NOR 16	NOR	NOCR	$\frac{\text{NOCR}}{\text{NOR}}$	NOR 1	NOR 25	NOR	NOCR	$\frac{\text{NOCR}}{\text{NOR}}$	NOR 16	NOR 25	NOR	NOCR	$\frac{\text{NOCR}}{\text{NOR}}$
1	35	17	51	1	2 %	35	-	-	-	-	17	-	-	-	-
2	24	13	37	0	0 %	24	16	37	3	8%	13	16	27	2	7.4 %
3	27	29	48	8	17 %	27	32	48	11	22.9%	29	32	50	11	22 %
4	29	20	44	5	11.4 %	29	30	50	9	18%	20	30	44	6	13.6 %

Table 8

Deductions of Table “ Common Relations, 2 by 2 ”

1. Share vision process has played an outstanding role in establishment of sharing in mental models.
2. Share mental models process in comparison with share vision process takes more time and it should be considered in design of intervention framework.

Evaluation of Common Relations

The following table, contains number of relations (NOR) and number of common relations (NOCR), between three managers, in three companies, in a phase. Here common relation means common in factor 1 (FID1) and factor 2 (FID2) with the direct relation between them (effect of FID1 on FID2 is not considered because the managers are from different companies with different conditions). In the aforesaid table, the index of NOCR/NOR has been chosen as the measure of sharing in mental models and it is an indicator for efficiency of intervention framework, in establishment of shared mental models, among the people. Once again it is reminded that, according to the action plan of the research, in phase1 there is the cognitive maps only for two managers: MID: 1 & 16 whereas in the other phases there are the cognitive maps of all three managers MID: 1,16 & 25.

Table of Common Relations

PhID	NOR	NOCR	$\frac{\text{NOCR}}{\text{NOR}}$
1	51	1	2 %
2	48	0	0 %
3	65	7	10.8 %
4	63	4	6.3 %

Table 9

- ◆ Regarding to the above reminding, decrease in NOCR/NOR percent in phase2 in comparison with phase1 is meaningless.
- ◆ There is an ups and downs from phase 2 to 3 and from phase3 to 4. Outstanding increase in the index in phase 3 to phase 2 indicates that share vision process has played an outstanding role in establishment of sharing in mental models of the managers
- ◆ A decrease in the index in phase 4 to phase 3 indicates that share mental models process has not played a suitable role in sharing the mental models. As it was mentioned in section 4 of this paper, the researcher, experimentally found that shared mental model process takes more time in comparison with shared vision process. In fact in one period, share mental models process has not yet been completed. This conclusion confirms requirement of more time for shared mental models process in comparison with share vision process.

Deductions of Table of Common Relations

1. Share vision process has played an outstanding role in establishment of sharing in mental models.
2. Share mental models process in comparison with share vision process takes more time and it should be considered in design of intervention framework.

6 Summary and Conclusions

This research has been carried out in the field of organizational learning, based on Senge's theory in his book the Fifth Discipline (Senge 1990) and it has been based on intervention by the researcher as a facilitator or an interventionist according to the theory of intervention, introduced by Chris Argyris in his book (Argyris, 1970). The research was implemented on senior managers in three companies. At the level of an organization, it provided a framework for intervention. The framework is included four phases and three periods.

Researcher as an interventionist made several interventions in the three periods. In the first period the intervention included introduction to the basic theories of management principles, system dynamics, and organizational learning. In the second period the intervention included facilitating the formation of shared vision process and in the third period, the intervention included facilitating the formation of shared mental model process. In the second and third periods of the intervention, the discipline of dialogue has been emphasised on.

In this research sharing among the managers' mental models was chosen as the measure to evaluate the effectiveness of the interventions and in this regard cognitive map is used as a tool, by which the effectiveness of interventions on mental models, can be traced and evaluated.

In each phase, the researcher drew the managers' cognitive maps, in respect to policies to improve performance. Cognitive maps were conveyer of effectiveness of interventions, so by recording of cognitive maps, in consequent phases, it became possible to trace the evolution of managers' mental models and evaluate the effectiveness of interventions.

Although the intervention framework was implemented on all senior managers in three companies but this paper has been concentrated on the evolution of mental models of three chief executives of three companies.

Regarding to the analysis and evaluation of the results, the followings are the major outcomes that have been derived:

1. Generally, implementation of a scientific management model, in an organization is very efficient in aligning of the mental models and it is a basic action to increase sharing among the individuals.
2. Intervention framework totally and each of the interventions, in each of the periods have played an effective role in managers' mental models toward convergence.
3. Transfer of basic theories, that is management functions, system dynamics methodology and organizational learning, have played an effective role in build up a basis for individual mental models and it is known as an efficient practice in discipline of personal mastery.
4. Interventions played the role of rationalising in thinking of the decision-makers.
5. The shared vision process, in essence, is "idealism" and shared mental model process, in essence, is "pragmatism".
6. Process of shared vision, by itself; leads to scattering of the mental models whereas process of shared mental models leads to convergence of mental models and controls the scattering raised from shared vision process.
7. In an organization, process of shared vision without process of shared mental models could be risky.
8. As a result of previous two items processes of shared vision and shared mental models are complementary of each other and it is strongly implied simultaneously implementation of them.
9. ISO award process is the same nature as the process of shared mental models and it plays an outstanding role in sharing of mental models among the people.
10. ISO award process is introduced as an standard in discipline of mental models in learning organisations
11. Shared mental models process in comparison with shared vision process takes more time and it should be considered in design of intervention framework.

REFERENCES

- Argyris Chris (1970), *Intervention theory and Method: A Behavioural Science View*, Addison- Wesley.
- Argyris Chris (1999), "On Organizational Learning", Blackwell Publishers Ltd
- Axelrod Robert (1976), "Structure of Decision: The Cognitive Maps of Political Elites ", Princeton University Press Princeton New Jersey
- Collins James C. and Porras Jerry I. (1996), "Building Your Company's Vision", *Harvard Business Review*, Sep.-Oct., PP. 65-77
- Doyle James K., Ford David N. (1998), "Mental Models Concepts for System Dynamics Research", *System Dynamics Review*, Vol. 14, No. 1, PP. 3-20,
- Doyle James K., Ford David N. (1999), "Mental Models Concepts revisited: Some Clarification and a Reply to Lane", *System Dynamics Review*, Vol. 15, No. 4, PP. 411-415
- Eden C. (1992), " On the nature of Cognitive maps ", *Journal of management studies*, Vol. 29, No. 3. PP. 261 - 265
- Eden C. (1994), " Cognitive mapping and problem structuring for system dynamics model building ", *system Dynamics Review*, Vol. 10, Nos. 2-3, PP. 257-276
- Foil. C.M. & Huff A. S. (1992), " Maps for Managers: Where are we? Where do we go from here? ", *Journal of management studies*, Vol. 29, No. 3, PP. 267-285
- Ford David N. and Sterman John D. (1998), "Expert Knowledge Elicitation to Improve Formal and Mental Models", *System Dynamics Review*, Vol. 14, No. 4, PP. 309-340
- Kim Daniel H. (1993), "A Framework and Methodology for Linking Individual and Organizational Learning: Application in TQM and Product Development", Ph.D. dissertation, Sloan School of Management, MIT, Cambridge, MA
- Kim Daniel H. (Fall 1993), "The Link Between Individual and Organizational Learning," *Sloan Management Review* ", Vol. 35, No 1, PP. 37-50.
- Lane David C. (1999), "Friendly Amendment: A Commentary on Doyle and Ford's Proposed Re-definition of Mental Model", *System Dynamics Review*, Vol. 15, No. 2, PP. 185-194
- Langfield-Smith K. & Wirth A. (1992), " Measuring differences between Cognitive Maps," *Journal of operational Research society*. Vol. 43, No 12, PP. 1135-1150
- Senge Peter M. (1990), " The fifth Discipline: The Art and Practice of the Learning Organization ", Published By Doubleday, USA
- Senge Peter M. (Fall 1990), "The Leader's New Work: Building Learning Organizations" *Sloan Management Review*, Vol. 32, No. 1
- Senge P. M., Kleiner. A., Roberts C., Ross R. B., and Smith B. J. (1994), " The fifth Discipline Fieldbook: strategies and tools for Building a Learning Organization ", Published by Doubleday, New York, USA.
- Senge P. M., Kleiner. A., Roberts C., Ross R., Roth G. and Smith B. (1999), " The Dance of Change: The Challenges to Sustaining Momentum in Learning Organization", Published by Doubleday, New York, USA.
- Stata Ray (1989) "Organizational Learning, The Key To Management Innovation", *Sloan Management Review*, spring 1989, pp.63-74
- Stone Nan (1996), "The Value of Vision", *Harvard Business Review*, Sep.-Oct., P14
