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BUILDING A LEARNING ORGANIZATION BY USING SYSTEMS THINKING AND SYSTEM DYNAMICS

by

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LIST OF ABBREVIATIONS

LO	Learning Organization
OL	Organizational Learning
OD	Organizational Development
MFS	Management Flight Simulator
MIT	Massachusetts Institute of Technology
CLD	Casual Loop Diagram
BOT	Behavior Over Time
R	Reinforcing
B	Balancing

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ABSTRACT

Together with developing and changing world, the environment where organizations live in is getting more complex. Organizations need transformation and knowledge to cope with all these developments and to continue their existence. Under this situation, learning and being a learning organization is getting important to realize this transformation and to get information and even to produce information. Furthermore, the concepts of systems thinking and system dynamics play an important role to build a learning organization.

In this study, the basic concepts of learning organizations, the discipline of systems thinking as a new way of thinking, system dynamics as a graphical language for building a model of a system in a computer environment are examined. In computerized environment, a learning laboratory which is based on a case, is built. It is illustrated that how managers develop strategies, and learn from these strategies at the learning laboratory by system dynamics model.

At the end of this study, it is understood that the discipline of systems thinking and system dynamics play an important role to lead the managers to build a learning organization. Also, it is understood that learning laboratories are one of the important tools for learning organizations. Managers find an opportunity to inquiry their ideas, and learn from each other in a discussion environment by develop strategies at the learning laboratory. In this respect, the learning laboratories helps managers as an effective tool, and managers can simulate the real world by using learning laboratories.

ÖZET

Gelişen ve değişen dünya ile birlikte, organizasyonların içinde yaşadığı ortam gittikçe karmaşıklaşmaktadır. Bütün bu gelişmelerle baş edebilmek ve varlıklarını sürdürebilmek için, organizasyonlar dönüşüme ve bilgiye gereksinim duymaktadır. Bu durumda, öğrenme ve öğrenen bir organizasyon olma, bu dönüşümü gerçekleştirmek ve bilgiyi elde etmek ve hatta üretmek açısından önem kazanmaktadır. Ayrıca, sistem düşüncesi ve sistem dinamikleri kavramları öğrenen bir organizasyon kurmada önemli rol oynarlar.

Bu çalışmada, öğrenen organizasyonlarla ilgili temel kavramlar, yeni bir düşünce tarzı olan sistem düşüncesi disiplini ve bir sistemin modellenmesi için bilgisayar ortamında grafiksel bir dil yaratan sistem dinamikleri incelenmiştir. Bilgisayar ortamında, örnek olaya dayalı bir öğrenme laboratuarı yaratılmıştır. Bu laboratuarda yöneticilerin nasıl stratejiler geliştirip, bu stratejilerden öğrenebildiği sistem dinamikleri modeli ile gösterilmiştir.

Bu çalışmanın sonucunda, sistem düşüncesi disiplini ve sistem dinamiklerinin, yöneticilere öğrenen organizasyon kurma konusunda yol göstermede önemli bir rol oynadığı anlaşılmıştır. Ayrıca, öğrenen bir organizasyonun kullandığı önemli araçlardan birinin öğrenme laboratuarları olduğu anlaşılmıştır. Yöneticiler öğrenme laboratuarında strateji geliştirerek, kendi düşüncelerini sorgulama, tartışma ortamında birbirlerinden öğrenme imkanı bulmaktadır. Bu bakımdan, öğrenme laboratuarları etkili bir araç olarak yöneticilere yardımcı olmaktadır ve yöneticiler; öğrenme laboratuarlarını kullanarak, gerçek dünyayı simule edebilmektedir.

1. INTRODUCTION

In today's world, corporate environment turbulent and complex, unpredictable future, technology driven, everything is connected to everything else. This creates dynamic and complex managerial environment for managers. Under these circumstances, organizations become more dynamic and complicated too. Also, everything changes so quickly like technology, competitive environment, products, etc. The only one thing remains constant, this is change by itself. In such an environment, to be a powerful and competitive organization, the only way is to adapt to change and to manage the change. Therefore, organizations must understand and transform themselves to the changing and complicated environment immediately and continuously to survive and gain competitive advantage.

Under these conditions, organizations need knowledge which is a very important asset to transform. It is stated that "our age is such a period of transformation. ...knowledge is the primary resource for individuals and for the economy overall" (Drucker, 1992). "The term "transformation" implies that there is a greater emphasis on the process by which "the organization develops itself rather than being changed by outside intervention" (West, 1994). The idea that emphasizes and supports the above ideas that "The world is changing quickly. In order to survive and grow, organizations must learn and adopt faster and faster or wedded out in the economic evolutionary process" (Schein, 1993).

To change and transform, producing knowledge, being competitive, and being innovative are necessary. "Every organization must devote itself to creating the new" (Drucker, 1992). This is the main task or function of the organizations in today's environment.

In brief, organizations must learn faster and adapt to the rapid change in the environment to obtain and sustain a competitive advantage. So that, organizations need to transform themselves into a learning organization where individuals and teams continuously engage in new learning processes.

1.1 Definition of the Problem

Individuals, teams, and organizations need knowledge to sustain their existence in a competitive environment. This knowledge should be used to create a value for all stakeholders of the organization. On the other hand, sustainable value is created from developing not only tangible assets like raw materials and equipment, but also intangible assets, such as the skills and knowledge of the workforce, the organization environment that encourages innovation, the information technology that supports the workforce and links the company to its customers and suppliers, problem solving, decision making, and sustainable competitiveness.

Under these circumstances, the problem is to how an organization adopt itself to change and sustain its competitiveness. In order to succeed, knowledge is an important asset to create a value. The problem is to explore the concepts, tools, methodologies, and managerial paradigms to find the ways about how managers share their knowledge from each other to learn and reach a big picture of the problems or issues on their hands in order to create a value.

1.2 Goals of the Study

In this study, there are several goals. One of the aim of this study is to discover the new organizational structure to sustain competitiveness. This structure gives an opportunity to individuals, teams and organizations to create a value by producing and using knowledge

Secondly, this structure requires to employ some disciplines. Especially, one of the disciplines is the key discipline. So that, this study is aimed to offer a discipline to explore how managers can see the big picture. In other words, to discover this discipline which helps managers to see everything as a whole and connected, in stead of seeing separately.

Also, another goal of this study is to discover a methodology to implement these disciplines into managerial practice. Managers can understand the dynamics of their issue or problem by applying this methodology.

Finally, the learning environment can be designed by using this methodology. In fact, this learning environment is called as a management tool for organizations to produce knowledge and create a value. These learning environments help managers to solve problems, develop strategies, and make decisions. Also, these environments allow managers to make many simulations by using computers. But, managers are experienced by these simulations like real life experiences.

1.3 Scope of the Study

The main scope of this study is to examine the new management paradigm which introduces fundamental changes in the structure of the organization. This paradigm is like a revolution which takes place in management. This revolution is caused by changes in environment, technology, and also increase in competition. So that, organizations need a shift in the management paradigm from stability to change. The new paradigm in management offers disciplines, methodologies, and tools to change the structure of the organization fundamentally. Under this condition, systems thinking and system dynamics are critical components of such organizations, and also, to build them. Simply, such organizations are called as learning organizations. Briefly, the scope of this study is to examine how to build a learning organization by using systems thinking and system dynamics.

This study includes six main parts. The first part comprises introduction. The second part contains the literature review about the concept of the learning organization. The third part includes systems thinking. The fourth part is about system dynamics. The fifth part comprises the learning laboratories that are examined as an effective systems thinking tool and as system dynamics model to solve problems and develop strategies with a case study. And, the sixth part includes conclusions and suggestions.

The first part includes the definition of the problem, goals of the study, scope of the study, and methodology of study. In this part, it is stated that learning organizations are necessary to gain competitive advantage, and to survive.

In the second part, the concept of the learning organization is examined. The main subjects are the definition of the learning organizations, comparison learning organizations with traditional organizations, the characteristics of the learning organizations, reasons for building a learning organization, benefits of them, organizational learning, comparison learning organization with organizational learning, the role of leader according to learning organizations, conditions to build a learning organization, and the five learning disciplines and systemic perspective.

The third part is about the subject of systems thinking. In this part, the subjects to cover are understanding the system and systemic perspective, definition of systems thinking, principles of systems thinking, laws of systems thinking, reasons for using a systems thinking approach, comparison systems thinking with traditional analysis approaches, systems thinking as a language, and tools of systems thinking.

The fourth part contains the subjects of system dynamics. In this part, the main subjects are the definition of system dynamics, the relation between systems thinking and system dynamics, the relation of system's behavior and system's structure, system dynamics models, and sources of information and system dynamics models.

The fifth part includes the learning laboratories, and methodology of system dynamics models to build a learning laboratory. The learning laboratories are examined as a systems thinking tool to help managers or management teams to solve their problems and develop strategies both long term and short term. The case study is introduced to show how the learning laboratories are built and used.

The sixth part comprise conclusion of this study. Several conclusions are indicated briefly. Also, suggestions are introduced for further investigation.

1.4 Methodology of the Study

In this study, descriptive study about the learning organizations are examined with given subjects in Scope of the Study. In order to obtain necessary information literature review, internet survey, and building a learning laboratory with a case study are used.

1.4.1 Literature review

Many articles, books, and magazines are examined to obtain information about the learning organizations, systems thinking, system dynamics, and learning laboratories. Articles, books, and magazines give idea and show the path to understand how to build a learning organization by using systems thinking and system dynamics.

1.4.2 Internet survey

Also, necessary information is obtained by visiting some university, society, and community sites. Especially, MIT system dynamics site have been visited to obtain information about system dynamics.

1.4.3 Building a learning laboratory with a case study

In computerized environment, a learning laboratory is built with a case study. An adapted case study in a real management team is introduced and this case study is used to build a learning laboratory by using computer. Managers can develop strategies and apply them by using this learning laboratory.

2. LEARNING ORGANIZATIONS

2.1 Definition of the Learning Organization

Academicians made a lot of definitions of learning organization. Garvin (1993) defines learning organization as "...an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights". Senge (1996) defines learning organizations shortly as "organizations that continually expand their ability to shape their future".

Senge (1990) describes learning organization in the fifth discipline book as "Learning organizations are organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together."

Dodgson (1993) defines learning organization as "...firms that purposefully construct structures and strategies so as to enhance and maximize organizational learning." Drucker (1988) points out the importance of knowledge and defines learning organizations as knowledge-based organizations. He states "The typical business will be knowledge-based, an organization composed largely of specialists who direct and discipline their own performance through organized feedback from colleagues, customers, and headquartes".

According to Malhotra (1996) learning organization is an "...organization with an ingrained philosophy for anticipating, reacting and responding to change, complexity and uncertainty." Sugarman (1996b) describes learning organization as "...one which has the capacity for continually improving its effectiveness as its members find new and better ways to organize their efforts in pursuit of goals that are important to them. So it is essential that the individual aspirations of the members are linked to the goals of their teams which should be integrated into the larger corporate goals". Ayas and et al., (1996) define a learning organization as "...the 'product' of the acknowledgement of people and their capabilities as organizational competence".

Briefly, a learning organization 1) is an organization where its members can create, acquire, and transfer knowledge and change their behavior according to new knowledge, 2) continually expands its ability to shape its future by creating learning opportunities for its members, 3) is an organization where people can produce the results they really desire, 4) is an organization where new and expansive patterns of thinking are nurtured, 5) is an organization where its members can increase their capacity by getting feedback other members and customers, 6) constructs structures and strategies to enhance organizational learning 7) is an organization where its members are continually learn how to learn collectively, 8) is an organization where individual aspirations of the members are linked to the goals of their organization that makes them integrated into larger collective goals.

2.2 Learning Organization vs. Traditional Organization

Learning organizations differ from traditional or classical organizations. It is stated that the difference between them as follows: "Learning organizations will require profound shifts in the nature of managerial work. The dogma of the traditional hierarchical organization was planning, managing and controlling. The 'dogma' of the learning organization of the future will be vision, values, and mental models" (Senge and Sterman, 1992). It can be observed that the managerial works in the learning organizations are totally different from the traditional organizations.

"Learning organizations are both more generative and more adaptive than traditional organizations. Because of their commitment, openness, and ability to deal with complexity, people find security not in stability but in the dynamic equilibrium between holding on and letting go--holding on and letting go of beliefs, assumptions, and certainties" (Kofman and Senge, 1993). Therefore, the learning organizations are more capable than the traditional organizations.

Boyett and Boyett (2000) prepared a table based upon the work of Edgar Schein comparing the culture of a learning organization to that of the traditional organization as cultures that enhance and inhibit learning. This can be summarized in Table 2.1.

Table 2.1 Cultures that enhance and inhibit learning

Adapted from (Boyett and Boyett, 2000)

A Culture that Enhances Learning	A Culture that Inhibits Learning
Leaders balance the interests of all stakeholders---customers, employees, etc.	Task issues take precedence over relationship issues.
Leaders and managers believe that people can and will learn, and value learning and change.	A key theme of the culture is designing humans out of the systems rather into them.
People hold the shared belief that they have the capacity to change their environment and that ultimately they make their own fate.	People in the organization are reactive rather than proactive. They change only in response to outside forces that are seen as threats.
The organization makes time for learning.	The organization is preoccupied with short-term coping and adapting.
People in the organization have a shared belief that economic, political, and socio-cultural events are interconnected.	Work roles and tasks are compartmentalized and separated from family and self-development.
Managers and employees have a shared commitment to open and extensive communication.	Managers are presumed to have a "divine right" to information and prerogatives.
People share the belief that trust, teamwork, coordination and cooperation are critical for success.	Individual competition is perceived as the natural state and the proper route to power and status.
Leaders acknowledge their own vulnerability and uncertainty. The leader acts as a teacher and steward of change rather than a charismatic decision maker.	Leaders and followers assume that leaders are supposed to be in control, decisive, certain, and dominant. Leaders are not allowed to acknowledge their vulnerability.

"...it is important to note that a true learning organization is never constructed, but it is always being constructed. That is, there is no end to the process of learning that goes along with building a learning organization; once an organization stops learning or feels that it has reached an endpoint (of organizational restructuring) then it is no longer a learning organization. Learning is a life long process and the construction of a learning organization depends upon the establishment of feedback loops and recursive learning processes that become fundamental to the very structure of the organization and thus never allow the organization to stop changing" (Guthrie, 1996). Briefly, it can be said that the learning organizations are more dynamic than the traditional organizations. Because, people in the learning organizations continuously learn as a never ending process.

To summarize, it can be observed that the learning organizations are fundamentally different from the traditional organizations in many ways. Firstly, the managerial works in the learning organizations are different from the traditional organizations. Secondly, Learning organizations are both more generative and more adaptive than traditional organizations. Therefore, the learning organizations are more capable than the traditional organizations. Thirdly, the learning organizations are more dynamic than the traditional organizations. Because, the learning organizations offer an environment to people to learn continuously as a never ending process.

Finally, the culture of organization is important. Because, the culture may enhance or inhibit learning. When the culture enhances learning, the organization has unique properties. People in this organization can learn continuously and have the capacity to change their competitive environment. They can see all relations between events as interconnected. The communication among them improves extensively. The collectivity and teamwork take place to deal with problems and issues. Leaders and managers act as a teacher.

2.3 Characteristics of Learning Organizations

After emphasizing the differences between the learning organizations and traditional organizations, the characteristics of the learning organizations can be stated as follows:

1) They provide continuous learning opportunities.
2) They use learning to reach their goals.
3) They link individual performance with organizational performance.
4) They foster inquiry and dialogue, making it safe for people to share openly and take risks.
5) They embrace creative tension as a source of energy and renewal.
6) They are continuously aware of and interact with their environment (Kerka, 1995).

In addition to these characteristics, the following characteristics can be added. These are as follows:

1) Individuals should be encouraged to contribute to the organization in a democratic way with innovation fostered in a climate of trust and safety.
2) Learning opportunities may occur by feedback and exchange of information by questioning, reflecting and reformulating values and premisses in terms of how they affect the organization's goals and objectives.
3) Internal exchanges with departments are seen as customer-supplier relationships with effective and collaborative negotiation.
4) Enabling structures such as roles and careers are designed to facilitate growth with the ability to respond to change.
5) Boundary workers are seen as environmental scanners who develop an awareness and a positive interaction externally.
6) Inter-company learning is encouraged with collaboration and joint ventures pursued within a learning climate of continuous improvement.

7) Difference is not only tolerated but also is regarded as essential to promote learning and creativity.

8) Self-development opportunities are freely available for all employees, with the exploration of needs being central to appraisal and career planning (West, 1994).

The list of the characteristics of the learning organizations can continue. The important thing that the learning organizations require fundamental shifts in every task, field, or area in organizations. These fundamental shifts bring competitive advantage to the organization to grow and survive. In stead of following changes, the organization can and will generate changes. In fact, these shifts offer structural changes for better communication, relationships, and learning.

So far, it is understood that the learning organizations are necessary. Now, it is time to list the reasons for building a learning organization to support the necessity. Briefly, the reasons for building a learning organization can be listed as follows:

1) Because we want superior performance.

2) To improve quality.

3) For customers.

4) For competitive advantage.

5) For energized, committed work force.

6) To manage change.

7) For the truth.

8) Because the times demand it.

9) Because we recognize our interdependence.

10) Because we want it (Senge, 1994).

As it can be seen that the concept of the learning organizations offers main advantages to the organization. Briefly, it can be said that this is the power of the learning organizations.

After listing the reasons for building the learning organizations, the benefits of the learning organizations can be examined. These are listed as:

1) Ensuring the long-term success of the organization;
2) Making incremental improvements a reality;
3) Ensuring that successes and best practices are transferred and emulated;
4) Increasing creativity, innovation and adaptability;
5) Attracting people who want to succeed and learn and retaining them;
6) Ensuring that people are equipped to meet the current and future needs of the organization (Teare and Dealtry, 1998).

Finally, it can be said that characteristics, necessities, and benefits of the learning organizations shape the concept of the learning organization. These are all to give an idea about the learning organizations. They support the definitions of the learning organizations. It can be observed that all of these should be thought collectively. Because, definitions and characteristics complete each other as a whole. Also, this provide better and deeper understanding to people about the concept.

2.4 Organizational Learning

Another subject that is related with the concept of the learning organizations is organizational learning. The first important thing is the definition of the organizational learning. Scholars defined organizational learning by emphasizing its different features. Fiol and Lyles (1985) state "Organizational learning means the process of improving actions through better knowledge and understanding". Argyris (1977) defines organizational learning as a process and says "Organizational learning is a process of detecting and correcting error".

Dodgson's (1993) idea about the definition of organizational learning is, "it can be described as the ways firms build, supplement and organize knowledge and routines around their activities and within their cultures, and adapt and develop organizational efficiency by improving the use of the broad skills of their workforces".

"An entity learns if, through its processing of information, the range of its potential behaviors is changed... The information processing can involve acquiring, distributing or interpreting information. When the entity is an organization, these processes are frequently interpersonal or social, but they are occasionally more mechanical, and they can often be usefully viewed as logistical processes" (Huber, 1991).

De Geus (1988) defines organizational learning as an institutional learning. He states "institutional learning, which is the process whereby management teams change their shared mental models of their company, their markets, and their competitors".

"Organizational learning is the ability of an organization to gain insight and understanding from experience. It involves experimentation, observation, analysis, and a willingness to examine both successes and failures" (McGill and et al., 1992).

"The concept of OL steers us to focus on the organizational processes for reviewing the suggestions of individuals, encouraging them, enhancing them, combining them to create new ideas, promoting them, generalizing them, adopting them, storing them, remembering them, and so forth" (Sugarman, 1996a).

To summarize, organizational learning 1) is a process that people should be added to improve their knowledge and understanding, 2) is a process that organizations should be added to become a learning organization, 3) helps people to increase organizational efficiency and innovation, 4) is a process that uses information as a tool to build a learning organization, 5) is a process whereby people change their shared mental models, their markets, and competitors, 6) helps people to become more aware of their ability by increasing it.

2.4.1 Goals of organizational learning

Learning is necessary for organizations to improve their productivity, competitiveness, and creativity in complex and uncertain environments. When uncertainties become the greater, the need for learning become the greater. Organizational learning helps us to improve our adaptability and efficiency during times of change. Also, it helps to give quicker and effective responses to a complex and dynamic environment. In addition, learning creates an environment in an organization for sharing information, communicating, understanding, and making effective decisions on strategic issues.

2.4.2 Types of organizational learning

Academicians divide the organizational learning into various types and levels. Senge (1990) states adaptive and generative learning. Argyris and Schon (1978) point out three levels which are single-loop, double-loop, and deutero-learning or triple-loop learning. Fiol and Lyles (1985) mention from lower and higher level learning.

Senge (1990) points out that generative learning is important to be a learning organization. He states "a 'learning organization' -- an organization that is continually expanding its capacity to create its future. For such an organization, it is not enough merely to survive. 'Survival learning' [adaptive learning] is necessary. But for a learning organization, 'adaptive learning' must be joined by 'generative learning,' learning that enhances our capacity to create."

Argyris and Schon (1978) divide organizational learning into three that are single-loop, double-loop, and deutero learning. They define single-loop learning as "organizational learning involves the detection and correction of error. When the error detected and corrected permits the organization to carry on its present policies or achieve its present objectives, then that error-detection-and-correction process is single-loop learning." Larsen and et al., (1996) define single-loop learning as "Single loop learning is linear. It is trying to find a better way to do a process. It is comparable to continuous quality improvement." By this, this idea emphasizes the Total Quality Management.

According to Argyris and Schon (1978), "double-loop learning occurs when error is detected and corrected in ways that involve the modification of an organization's underlying norms, policies and objectives." Larsen and et al (1996) state "Double loop learning goes a step further and asks why we are doing the process in the first place. Should we be doing something else?"

Also, Argyris and Schon (1978) mention from deutero learning. They states "when an organization engages in deutero-learning its members learn about previous contexts for learning. They reflect on and inquire into previous episodes of organizational learning, or failure to learn. They discover what they did that facilitated or inhibited learning, they invent new strategies for learning, they produce these strategies, and they evaluate and generalize what they have produced." Larsen and et al (1996) define deutero learning as "Learning about learning. Understanding why we make the choices we do. What predisposes us to act in certain ways?"

Argyris (1977) gives a good example to understand single-loop and double-loop very deeply. "Single loop learning can be compared with a thermostat that learns when it is too hot or too cold and then turns the heat on or off. The thermostat is able to perform this task because it can receive information (the temperature of the room) and therefore take corrective action. If the thermostat could question itself about whether it should be set at 68 degrees, it would be capable not only of detecting error but of questioning the underlying policies and goals as well as its own program. That is a second and more comprehensive inquiry; hence it might be called double loop learning."

Fiol and Lyles (1985) state organizational learning as lower-level and higher-level learning instead of single-loop and double-loop learning. They define these types of learning as follows:

Lower-level learning: Focused learning that may be mere repetition of past behaviors – usually short term, surface, temporary, but with associations being formed. Captures only a certain element – adjustments in part of what the organization does. Single-loop. Routine level.

Higher-level learning: The development of complex rules and associations regarding new actions. Development of an understanding of causation. Learning that affects the entire organization. Double-loop learning. Central norms, frames of reference, and assumptions changed.

Schein (1994) states the difference between adaptive and generative learning as: "...we have to make the distinction between "adaptive learning and coping," on the one hand and what Peter Senge calls "generative learning," what Argyris and Schon call "double loop learning," .... Adaptive learning is usually fairly straightforward. We identify a problem or a gap between where we are and where we want to be, and set about to solve the problem and close the gap. Generative learning comes into play when we discover that the identification of the problem or gap is itself contingent on learning new ways of perceiving and thinking about our problems."

Also, Drew and Smith (1995) relate organizational learning to organizational change as follows: "A distinction has been drawn between learning related to superficial change, where the context remains essentially invariant (single-loop, type-1 or adaptive learning), and learning related to change where the context is transformed (double-loop, type-2 or generative learning). Proactive transformational change is usually related to the latter."

To summarize, the types of organizational learning are shown in Table 2.2 that helps to take a brief look. Generally, they can be classified into main three group with their intellectual. Argyris and Schon (1978) divide organizational learning into three which are single-loop, double-loop, and deutero learning. Fiol and Lyles (19859 classify organizational learning as lower-level and higher-level learning. Finally, Senge (1990) divides organizational learning into two which are adaptive and generative learning.

Table 2.2 Types of organizational learning

	Organizational learning types
Agyris and Schon (1978)	Single-loop Double-loop Deutero
Fiol and Lyles (1985)	Lower-level High-level
Senge (1990)	Adaptive Generative

2.5 Learning Organization vs. Organizational Learning

The definitions of the learning organization and the organizational learning can show the difference between them. The difference is structure and process. The concept of learning organization is related to structure. However, the concept of organizational learning is related to a process. This should be obvious. Because, the process of learning can reshape the organization structure, and organization becomes a learning organization.

The distinction between the two concepts can be brought up the learning organization short definition which is as "an organization that excels at advanced, systematic collective learning", whereas "organizational learning" refers to methods of collective learning" (Leitch and et al., 1996).

2.6 The Role of Leader

To be a learning organization, leaders play an important role. "The leader's role is not to create a mono-culture, but to share and develop leadership in others so there is true interdependent diversity in the organization. Leaders must be able to access the entire body of knowledge carried within the people of their organizations. Their job is to pay attention to the gifts of all workers and encourage workers to share with each other" (Kaipa, 1996).

"One of the tasks of the leader is to share the vision with the followers. Without a vision, an organization has no sense of direction, and therefore a road map in which to chart progress" (Terziovski and et al., 2000).

"Senge (1990) argues that the leader's role in the Learning Organization is that of a designer, teacher, and steward who can build shared vision and challenge prevailing mental models. He/she is responsible for building organizations where people are continually expanding their capabilities to shape their future -- that is, leaders are responsible for learning" (Malhotra, 1996).

To conclude, leaders 1) must encourage all other organization members to carry and share knowledge, 2) must build a shared vision and challenge other's prevailing mental models as a teacher or coach, 3) must build a learning organization.

2.7 Building a Learning Organization

Building a learning organization is a difficult job and requires some necessities. Some of them as follows:

1) Developing a learning organization requires a major commitment of time, energy, and resources.
2) To become a learning organization, employees must communicate in every direction, and everyone must be interested in what they are learning.
3) A learning organization will emerge when the members become genuinely excited about the process of learning, because learning begets learning.
4) Creating and nurturing a learning environment requires a dramatic shift in the organization's pattern of decision making.
5) The reason for creating and nurturing a learning organization is not to create an inner-focused university of people who enjoy learning with each other, but rather to keep the organization vital by having it learn how to better serve its markets and the customers that constitute those markets (Pfeiffer and et al., 1993).

"Building learning organizations requires that leaders develop employees who see their organization as a system, who can develop their own personal mastery, and who learn how to experiment and collaboratively reframe problems" (McGill et al., 1992).

Information is necessary to build a learning organization. "A critical component of such organisations is a system which continually makes all necessary information available to workers and encourages the sharing of information and ideas. Management strategies must aim at ensuring the availability of information to employees, including the conceptual frameworks to enable them to use that information for organisational ends" (Swain, 1999).

"Building learning organizations, we are discovering, requires basic shifts in how we think and interact. The changes go beyond individual corporate cultures, or even the culture of Western management; they penetrate to the bedrock assumptions and habits of our culture as a whole. We are also discovering that moving forward is an exercise in personal commitment and community building... Without commitment, the hard work required will never be done. People will just keep asking for "examples of learning organizations" rather than seeking what they can do to build such organizations. They will keep believing that the purpose of learning is the survival of an organization rather than its generativeness. And the larger meaning of this work will elude them. Without communities of people genuinely committed, there is no real chance of going forward" (Kofman and Senge, 1993).

Senge et al., (1994) state five disciplines for building a learning learning organization. These are personal mastery, mental models, shared vision, team learning, and systems thinking. He explains them in this way:

Personal mastery – learning to expand our personal capacity to create the results we most desire, and creating an organizational environment which encourages all its members to develop themselves toward the goals and purposes they choose.

Mental models – reflecting upon, continually clarifying, and improving our internal pictures of the world, and seeing how they shape our actions and decisions.

Shared vision – building a sense of commitment in a group, by developing shared images of the future we seek to create, and the principles and guiding practices by which we hope to get there.

Team learning – transforming conversational and collective thinking skills, so that groups of people can reliably develop intelligence and ability greater than the sum of individual members' talents.

Systems thinking – a way of thinking about, and a language for describing and understanding, the forces and interrelationships that shape the behavior or systems. This discipline helps us see how to change systems more effectively, and act more in tune with the larger processes of the natural and economic world.

"The first four disciplines contain many methods similar to what has been done in organizational development. The fifth one (systems thinking) involves learning to see the big picture, to understand how the consequences of our actions often loop around to affect us in unsuspected ways, and to use this analysis of system dynamics to find points of leverage that allow one to free the organization from vicious cycles that thwart its effectiveness. In the hands of experts, this discipline could find powerful answers, but typically these recommendations were not followed. Upon reflection, it became clear that unless the managers of the system themselves went through the analysis and struggle to understand the system, they would not be convinced of its efficacy and would not fight to see it applied" (Sugarman, 1996b).

"Senge's philosophy according to Dumaine (1994), is built on the following tenets: that managers should put aside their old ways of thinking (mental models); learn to be open with others (personal mastery); understand how their company really works (systems thinking); form a plan everyone can agree on (shared vision); and then work together to achieve that vision (team learning)" (Terziovski and et al., 2000).

According to Senge, practicing these disciplines requires lifelong and never-ending process for individuals and teams in organizations. He called systems thinking as the fifth discipline. Because, it ties other four disciplines. Also, systems thinking has a lot of tools to build a learning organization. In addition,. systems thinking requires systemic approach. Therefore, systemic approach and systems thinking are valuable.

Buckler (1998) agrees with Senge. He states "Without developing a deep understanding of the learning process, it is unlikely that managers will be capable of the change in behaviour which will be necessary to design and implement a systemic approach to learning within their organisation. Without a systemic approach to learning it is unlikely that full benefits of the learning organisation will be realised." It can be summarized in Figure 2.1 what Buckler (1998) says.

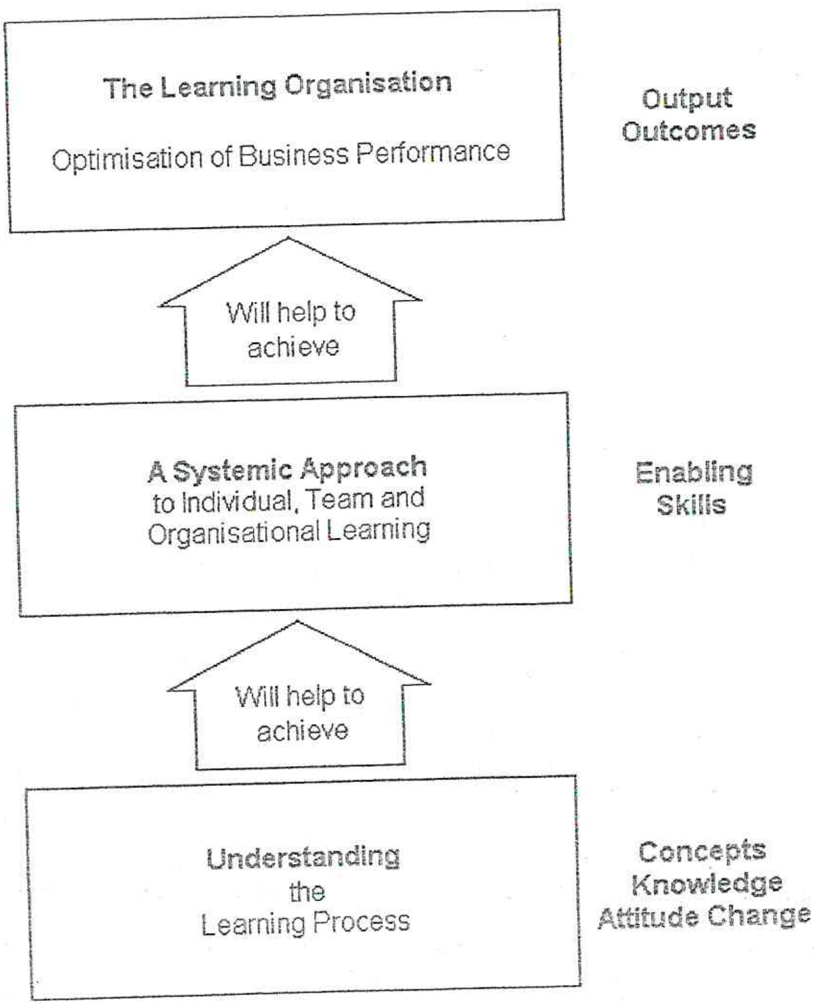

Figure 2.1 Moving an organization towards the learning organization concept (Buckler, 1998)

In this study, Senge's five disciplines philosophy is used to build a learning organization. Therefore, the discipline of systems thinking plays an important role as the fifth discipline. Systems thinking integrates the other four disciplines, offers a language, tools, supports systemic perspective, has a good relation with system dynamics. Finally, it is the key discipline to build a learning organization because of its features.

2.8 The Five Disciplines and Systemic Perspective

To understand the disciplines, they should be examined with systemic perspective or approach. The five disciplines are necessary to build a learning organization. In fact, these disciplines show the path to organizations to be a learning organization. Each of them has tools, but these tools are not included in this study. Mainly, the tools of systems thinking are examined especially learning laboratories. Also, the discipline of systems thinking introduces systemic perspective.

Systems thinking: At the heart of systems thinking is an awareness of the interconnectedness and varying levels of interdependency of people in teams, of teams in organizations, and organizations in the larger environment. To take a systems perspective also means to function individually and as part of a workteam to optimize the organization as a whole even if that means that one's workteam subsystem is suboptimized.

Personal mastery: In learning organizations the personal and professional development of individual are viewed as crucial to the organization's success. Personal mastery means charting a course of development that leads to a special level of proficiency through life-long learning. This learning is not only in the areas related to the product or service of the organization but includes such areas as enhancing interpersonal competence, personal awareness, emotional maturity, and an enlarging understanding of the ethical/moral dimensions of organizational life. This kind of personal mastery leads people to make a unique contribution because of their deepening understanding of and commitment to their personal vision expressed in concert with others pursuing personal mastery. Personal mastery must be pursued from a systems perspective if it is to be useful to the individual, the team, and the organization.

Mental models: Responses of people to new situations are influenced by their ingrained assumptions and generalizations about how things work in organizations. These mental models enable them to rapidly size up new situations and take action and can be found at the individual, team, and organizational level. The problem is that sometimes these mental models are limiting or even dysfunctional and prevent adaptation that would strengthen the person, team, or organization. In the learning organization mental models are freely shared, rigorously scrutinized, and revised as necessary at the personal, team, and organizational levels. If an organization is to become a learning organization it must overcome the fear or anxiety that prevents its members from challenging established ways of thinking and doing. Some organizations may also have to overcome a "bias for action" that can prevent a more self-reflective appraisal. The mental models that survive scrutiny and prove most useful will be those that view the individual, the team, the organization, and its environment from a systems perspective.

Shared vision: Goals, values, and missions will have the most impact on behavior in an organization if they are widely shared and owned by persons throughout the organization. This larger shared picture of the future emerges from the partial visions of individuals and teams. A shared vision produces a much higher level of sustained commitment than is possible when the vision is imposed from above. Systems thinking is necessary in order for shared vision to translate into coordinated action involving all of the individuals and teams in an organization. Also, it should be not forgotten that systems perspective is necessary in order to use systems thinking appropriately.

Team learning: Teams exist in all organizations. They may be called departments, units, divisions, committees, etc. Often a person functions on several teams. Each of these teams will have its own dynamic processes. Team learning has to do with improving the processes in a team to improve its effectiveness. Of particular interest is the phenomenon of defensive routines (activities that help a team avoid knowing) that can undermine learning by preventing a team from accurate appraisal of its processes and the consequences of those processes on the work of the team. When effective processes are in place the team can engage in its primary task of providing a product/service. Team learning requires a systems perspective so that persons see themselves as interdependent with other team members and their team as interdependent with other teams that make up the larger organization.

Teams are vital because they are the fundamental learning unit in organizations. Therefore, unless teams can learn, the organization cannot learn. When teams can learn, organizations have a chance to be a learning organization. This is the main reason why the tools of systems thinking are used by teams especially management teams.

Team learning is one of the five disciplines. When the concept of team learning is examined, the concept of team building comes to people's mind. Senge and et al., (1994) differs team learning from team building as follows:

"Because of the long-standing experience which many organizations have with group dynamics and team building, many teams believe that they have been practicing a version of this discipline for years. However, unlike team building, team learning is not a discipline of improving team members' skills, not even communications skills. For many years, we have used the concept of alignment as distinct from agreement, to capture the essence of team learning. Alignment means "functioning as a whole." Building alignment (you never "get there") is about enhancing a team's capacity to think and act in new synergistic ways, with full coordination and a sense of unity, because team members know each other's hearts and minds. As alignment develops, people don't have to overlook or hide their disagreements; indeed, they develop the capacity to use their disagreements to make their collective understanding richer."

Team learning as a discipline transforms mental models into capabilities. Then people in a team become more collective. Also, their shared understanding increases. At this point, the discipline of systems thinking and its tools help team members to solve problems and issues, and develop strategies.

3. SYSTEMS THINKING

3.1 Exploring and Understanding Systems

To understand systems thinking, the starting point should be the concept of the system. There are some questions to answer. These are definition of a system, characteristics of a system, and finally, event-pattern-structure-shared vision pyramid to understand systems perspective very deeply and to discover the highest leverage to solve problems or deal with issues.

3.1.1 Definition of a system

"A system is a group of interacting, interrelated, or interdependent components that form a complex and unified whole. A system's components can be physical objects that you can touch, such as the various parts that make up a car. The components can also be intangible, such as processes; relationships; company policies; information flows; interpersonal interactions; and internal states of mind such feelings, values, and beliefs (Anderson and Johnson, 1997). Another definition is "'System', stated that the only things that need to be common to all systems are identifiable entities and identifiable connections between them" (Mason, 1997).

"Draper L. Kauffman, Jr. describes a system as "a collection of parts which interact with each other to function as a whole." By "a whole" he means that a system cannot be split into separate parts and still be useful. Similarly, you can't add one system to another and make a bigger system; you'll simply have two systems" (Gyford, 1999).

Similar definition of system is as "very simply, a system is a collection of parts (or subsystems) integrated to accomplish an overall goal (a system of people is an organization). Systems have input, processes, outputs and outcomes, with ongoing feedback among these various parts. If one part of the system is removed, the nature of the system is changed" (McNamara, 1999).

To understand what a system is, maybe it is required a good example. This example may be about human body. "...within it, your circulatory system delivers oxygen, nutrients, hormones, and antibodies produced by other systems and carries waste to the excretory system. The circulatory system is made up of the hearth, veins, and arteries, blood, and a host of supporting elements. All of these components interact to carry out their purpose within the larger system – your entire body" (Anderson and Johnson, 1997).

In conclusion, definitions which are above similar. Briefly, it can be stated that a system is made up several components that interact each other with feedback processes and function as a whole.

3.1.2 Characteristics of systems

For better understanding what a system is, looking its characteristics can be useful. The characteristics of systems can be listed as:

1) Systems consist of (definable) elements - just as a mathematical set consists of certain, distinguishable elements.

2) Between these elements there exist (mostly functional) interrelations. A system is more than a mere accumulation of elements; there has to be also a certain structure of relations among these elements.

3) Every system has a boundary to the surrounding "environment", which is more or less permeable. This boundary might be material (like the skin of a human body) or immaterial (like the membership to a certain social group). System borders are important for several reasons:

a) Borders ensure (and even may determine) the identity of the system.
b) The relations between a system and its environment take place mainly at the borders. It is at the borders, where it is determined, what can enter or leave a system (input and output).

4) Systems often have a dynamic behavior over time. This behavior is often related to the aim of the system. Biological systems (living beings) are determined to ensure their self-preservation (essentially via homeostasis); production systems are made for a certain output; transport systems are designed for a certain throughput etc.

5) On a closer perspective, individual system elements might be considered as whole sub-systems or a system might be a single element of a larger system. A motor might be a sub-system of a car, which is again an element of a more complex transport system. Thus whole hierarchies of systems may emerge (Ossimitz, 1997).

Another characteristics of systems can be listed as follows:

1) A system's parts must all be present for the system to carry out its purpose optimally.
2) A system's parts must be arranged in a specific way for the system to carry out its purpose.
3) Systems have specific purposes within larger systems.
4) Systems maintain their stability through fluctuations and adjustments.
5) Systems have feedback (Anderson and Johnson, 1997).

As can be observed from all definitions and characteristics, systems are made up several or many components or subsystems. These components or subsystems interact each other with feedback relations, they function as a whole. Systems have their own environment with their boundaries. Sometimes, systems interacts continuously, this causes a dynamic behavior over time. This behavior is related with the purpose of the system.

3.1.3 Levels of understanding the world

After defining the systems with their characteristics, it is time to understand the world according to systemic perspective. There are four levels of understanding the world. These are events, patterns of events, systemic structures, and shared vision.

According to systemic perspective, understanding the structure of a system is very important. Because, "systems are built on structures that leave evidence of their presence, like fingerprints or tire marks, even if you can't see them... structure is the overall way in which the system components are interrelated – the organization of a system. Because structure is defined by the interrelationships of a system's parts, and not the parts themselves, structure is invisible... system structure that gives rise to – that explains – all the events and trends that we see happening in the world around us" (Anderson and Johnson, 1997).

Therefore, people should focus on systemic structure. "The internal structure of the system is often more important than external events in generating the problem" (Kirkwood, 1998). The levels of understanding the world can be understood by examining the events-patterns-structure-shared vision pyramid.

3.1.3.1 Events

People encounter events exactly everyday like eating dinner, making a phone call, a machine breaks down. So that, they have a tendency to focus on events rather than considering their causes or considering patterns that behind them. "Focusing on events is like wearing blinders: you can only react to each new event rather than anticipate and shape them. What's more, solutions designed at the event level tend to be short lived. Most important, they do nothing to alter the fundamental structure that caused that event" (Anderson and Johnson, 1997).

"If we focus on events, the best we can ever do is to predict an event before it happens so that we can react optimally. But we cannot learn to create" (Senge, 1990). Therefore, if people and managers focus on events, generative learning cannot be built in an organization.

Events are the tip of the pyramid as shown in Figure 3.1. It is clear that the leverage point is the lowest level to understand the world.

Figure 3.1 The tip of the pyramid (Anderson and Johnson, 1997)

3.1.3.2 Patterns

The next level of understanding is patterns of events or (patterns of behaviors). "Whereas events are like a snapshot, a picture of a single moment in time, patterns let us understand reality at a deeper level. Patterns are trends, or changes in events over time" (Anderson and Johnson, 1997). "Patterns of events are the things accumulated memories of events" (Kim, 1994b). At the patterns level, the pyramid is bigger, the level of understanding is deeper, and the leverage point of understanding is higher as shown in Figure 3.2.

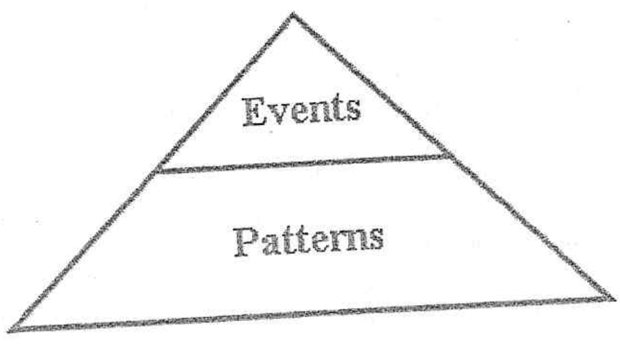

Figure 3.2 Moving from events to patterns (Anderson and Johnson, 1997)

"If we begin to see the world as pattern of behavior over time, we can anticipate problems and accommodate them. At this level, we are still responding to events, but in a more proactive manner" (Kim, 1994a). The advantage of thinking at the pattern level can be explained in this way: "Detecting a pattern helps you put the most recent event in the context of other, similar events. The spotlight is then taken off the specific event, and you can focus on exploring how the series of events are related and begin thinking about what caused them. In the end, to anticipate events and ultimately change a pattern, you need to shift your thinking one more time: to the level of structure" (Anderson and Johnson, 1997).

3.1.3.3 Structure

Understanding this level gives the opportunity to understand the structure of the system. This level determines the behavior of the system. "Structure is the network of relationships of things, not the things themselves; that's why it's harder to see... structure is about relationships between things, so a structural observation must include a causal connection, not just naming the factors, forces, or elements of the system... focus on seeing structures, seeing causal connections, seeing relationships that would start to explain what's happening" (Karash, 1996). "Systemic structure can be viewed as "event generators" because they are responsible for producing the events" (Kim, 1994b).

"Whenever we ask questions like, "Why is this pattern happening?" or "What's causing these events?" we are probing at structure. Thinking at the structural level means thinking in terms of casual connections. It is the structural level that holds the key to lasting, high-leverage change… Here's where the real power of structural-level thinking comes in: Actions taken at this level are creative, because they help you to shape a different future, the future that you want… Our ability to influence the future increases as we move from event-level to pattern-level to structural-level thinking" (Anderson and Johnson, 1997).

Figure 3.3 shows moving from pattern of behavior level to system structure level. As can be seen that the pyramid is bigger, the level of understanding is deeper, and the leverage point is higher than both events and patterns.

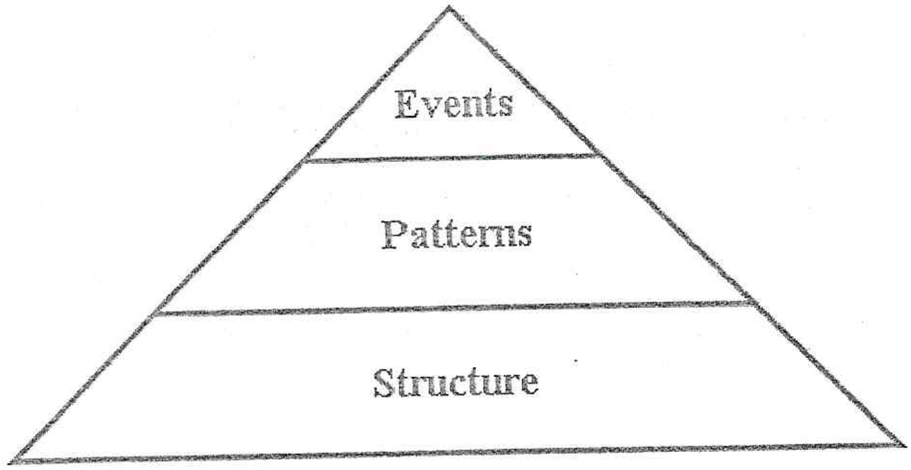

Figure 3.3 Moving from patterns to structure (Anderson and Johnson, 1997)

Systems thinking seeks for the higher leverage as a discipline and help people to understand the casual connections and relations. Therefore, this third level of understanding very important.

"To start to consider system structure, you first generalize from the specific events associated with your problem to considering patterns of behavior that characterize the situation. Usually this requires that you investigate how one or more variables of interest change over time. (In business setting, variables of interest might be such things cost, sales, revenue, profit, market share, and so forth.) That is, what patterns of behavior do these variables display. The systems approach gains much of its power as a problem solving method from the fact that similar patterns of behavior show up in a variety of different situations, and the underlying system structures that cause these characteristic patterns are known. Thus, once you have identified a pattern of behavior that is a problem, you can look for the system structure that is know to cause that pattern. By finding and modifying this system structure, you have the possibility of permanently eliminating the problem pattern of behavior" (Kirkwood, 1998).

3.1.3.4 Shared vision

The shared vision level tries to find an answer to a question that is where do the systemic structures come from? They are usually a reflection of a shared vision of what is valued or desired. "Shared vision can be viewed as systemic structure generators, because they are the guiding force behind the creation or change of all kinds of structures" (Kim, 1994b).

The level of understanding pyramid is completed with the shared vision as shown in Figure 3.4. At this level, the pyramid is biggest, the level of understanding is the deepest, and the leverage point is the highest.

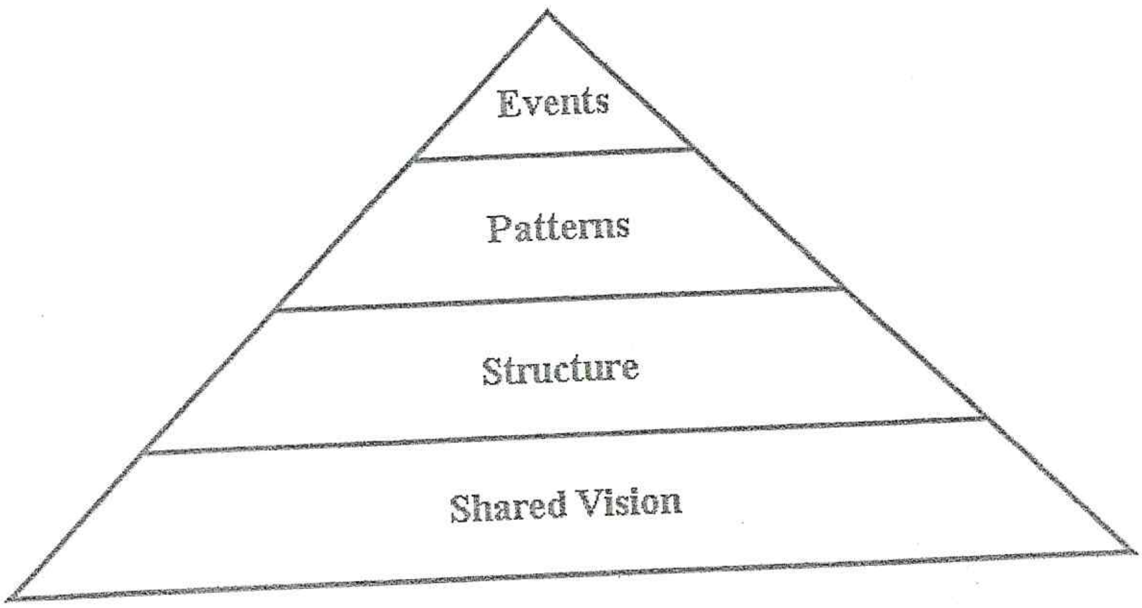

Figure 3.4 The complete pyramid

To conclude, there are four levels of understanding. These are shown in Table 3.1 with their properties. Levels of understanding can be used to find the highest leverage point. When people and managers move from the events level to shared vision level, they continually expand their capabilities to shape their future, and to see the big picture.

Table 3.1 Levels of understanding (Kim, 1994b)

Level of Understanding	*Action Mode*	*Time Orientation*	*Leverage Point*	*Typical Questions*
Shared Vision	Generative	Future ↑	Higher ↑	"What are stated or unstated visions that generate the structure?"
Systemic Structure	Creative			"What structures are in place that are causing these patterns?"
Patterns of Events	Adaptive		↓	"What kinds of trends of patterns of events seem to be recurring?"
Events	Reactive	Present	Lower	"What's the fastest way to react to this event NOW?"

3.2 Definition of Systems Thinking

Scholars have proposed a lot of definitions about what systems thinking is. Stuter (1998) defines systems thinking as "Systems thinking sees everything as wholistic, with all parts interconnected, interdependent." Also, Stuter emphasizes the importance of systemic perspective according to systems thinking by this definition. Cooper (1998) argues with Stuter and defines systems thinking by keeping systemic perspective and organization in mind. "Systems thinking viewed an organization and its respective environment as a complex whole of interrelating, interdependent parts" (Cooper, 1998).

"The subject of systems thinking is also suggestive of anything interdisciplinary to encourage the recognition of interconnectedness" (Berryman, 1995). Fuenmayor (1997) sees systems thinking as a way to manage learning process, and he says "Systems thinking is the way of conducting a process of learning about our limitations and hidden assumptions." This definition conveys other meanings. For instance, systems thinking helps people and managers to bring mental models to the surface. Mental models are tacit and invisible. As one of the Senge's discipline, mental models help people and managers to bring all tacit knowledge to the surface with minimum defensiveness. Doing this creates an environment to organizational learning.

Therefore, Senge (1990) expresses that systems thinking is the fifth discipline because it is the conceptual cornerstone that underlies all of the five learning disciplines. Dunphy and et al., (1997) argue with Senge and express "Systems thinking that Senge refers to as "the fifth discipline" and which he sees as the one that integrates the other four. Therefore Senge's favoured approach is to teach systems thinking."

All of these definitions say that systems thinking sees everything as a whole like seeing the big picture, and all parts that form this whole are interrelated and interconnected. Also, it is the most important discipline that integrates and ties the other four. So that, it is called the fifth discipline.

3.3 Principles of Systems Thinking

Systems thinking has some principles as a discipline. Understanding these principles give the opportunity for better comprehending what systems thinking is. These principles can be listed as follows: (Anderson and Johnson, 1997)

Thinking of the "big picture": As you know, whatever problem you're involved in right now is part of a larger system. To discover the source of a problem, you have to widen your focus to include that bigger system. With this wider perspective, you're more likely to find a more effective solution.

Balancing short-term and long term perspectives: The point is not that the long-term view is "better" than the short-term view... Whether you're focusing on the long term or the short term, the key is to be aware of all the potential impacts of whichever strategy you choose.

Recognizing the dynamic, complex, and interdependent nature of systems: When you look at the world systemically, it becomes clear that everything is dynamic, complex, and interdependent. Put another way: Things change all the time, life is messy, and everything is connected... The main point is that we need to be aware of all the system's relationships – both within it and external to it.

Taking into account both measurable nonmeasurable factors: Some organizations value quantitative (measurable) over qualitative (nonmeasurable) data. Others are just the opposite. Systems thinking encourages the use of both kinds of data, from measurable information such as sales figures and costs to harder-to-quantify information like morale and customer attitudes. Neither kind of data is better; both are important.

Remembering that we are all part of the systems in which we function, and that we each influence those systems even as we are being influenced by them: We usually contribute to our own problems. When we look at the big picture, over the long term, we often find that we've played some role in the problems facing us.

Also, there are some laws of systems thinking. These laws play a supplementary role, they are completed the principles of systems thinking. The laws of systems thinking are as follows: (Senge, 1990)

Many of today's problems are the result of yesterday's 'solutions'; Solutions which merely shift the problem from one part of the system to another often go unnoticed because the people who fixed the first problem are usually, particularly in complex systems, different from those who inherit the new one.

Systems resist change; In systems terminology this is called compensating feedback and is typical of many government interventions.

Faster is slower; All natural systems, such as ecosystems, have intrinsically optimal rates of growth. This rate is always less than the fastest possible rate. When growth accelerates the system seeks to compensate by slowing down.

Cause and effect are not closely related in space and time; This is one of the fundamental differences between the reality of complex systems and our own ways of thinking.

Small changes can produce big results; The main incentive for systems thinking is to find where these small changes should take place. This is called the principle of Leverage.

All of these definitions, principles, and laws form systems thinking show that the reason why the discipline of systems thinking is called as the fifth discipline. Studying and better reflection of these principles and laws cause better results on systems thinking approach.

3.4 Reason for Using Systems Thinking Approach

So far, the concept of the system and the discipline of systems thinking are defined. To go further, the reason for using systems thinking approach should be examined. This examination shows the powerful and beneficial points of systems thinking as a discipline or as an approach.

"Most organizations are complex and becoming increasingly more so. Most of the problems of today's organizations do not exist in isolation; they interrelate to each other. Detailed analysis of any specific educational problem or issue in isolation will only take you so far. You must look beyond individual issues towards a broader perspective, where an individual issue is seen as part of a coherent whole. Studying something in isolation from the environment in which it exists will also limit your understanding. You must look at the interrelationships amongst problems to make sure any proposed "fix" for the problem does not adversely affect other related issues. You can't solve any of these problems on your own because one perspective per problem is not enough to wholly understand it; you must apply many different perspectives. Keeping these points in mind, systems thinking can be used as restructuring tool to create a more effective organizations because it encourages personal mastery, shared vision, accurate mental models, and team learning" (Bixler and et al., 1996).

Another important point of systems thinking is that it is a better way to deal with most difficult problems. "So many important problems that plague us today are complex, involve multiple actors, and are at least partly the result of past actions that were taken to alleviate them. Dealing with such problems is notoriously difficult and the results of conventional solutions are often poor enough to create discouragement about the prospects of ever effectively addressing them. One of the key benefits of systems thinking is its ability to deal effectively with just these types of problems and to raise our thinking to the level at which we create the results we want as individuals and organizations even in those difficult situations marked by complexity, great numbers of interactions, and the absence or ineffectiveness of immediately apparent solutions" (Aronson, 1996).

To conclude, systems thinking is used by organizations and especially managers to understand the world, and to see the big picture in a better way. Systems thinking is also better to solve most difficult problems. Furthermore, systems thinking is powerful as a tool and as an approach. Also, it is the fifth discipline to build a learning organization.

3.5 The Difference Between Traditional Analysis and Systems Thinking Approach

Systems thinking is better as a discipline, as a tool, and as an approach. It is an approach, because it helps people to make analysis, to make decisions, and to solve problems. Under this condition, the difference between traditional analysis and systems thinking approach should be examined to understand the power of systems thinking as an approach.

"The approach of systems thinking is fundamentally different from that of traditional forms of analysis. Traditional analysis focuses on the separating the individual pieces of what is being studied; in fact, the word "analysis" actually comes from the root meaning "to break into constituent parts." Systems thinking, in contrast, focuses on how the thing being studied interacts with the other constituents of the system—a set of elements that interact to produce behavior—of which it is a part. This means that instead of isolating smaller and smaller parts of the system being studied, systems thinking works by expanding its view to take into account larger and larger numbers of interactions as an issue is being studied. This results in sometimes strikingly different conclusions than those generated by traditional forms of analysis, especially when what is being studied is dynamically complex or has a great deal of feedback from other sources, internal or external" (Aronson, 1996).

Briefly, the differences may appear according to principles of systems thinking. Firstly, traditional analysis makes an analysis by breaking problems or issues into smaller parts. But, systems thinking tries to see all interactions between parts of the systems. In other words, it tries to see the big picture. Also, when people consider about dynamic and complex problems, systems thinking is better than traditional analysis.

3.6 Systems Thinking as a Language

So far, systems thinking is called as a discipline, as a tool, as an approach. In addition to these, systems thinking is also better as a language. The idea that emphasizes this is as follows: "Although systems thinking is seen by many as a powerful problem-solving tool, we believe it is more powerful as a language, augmenting and changing the ordinary ways we think and talk about complex issues" (Senge and et al., 1994).

Also, as a language, systems thinking has some unique qualities which are described as follows: (Anderson and Johnson, 1997)

1) It emphasizes looking at wholes rather than parts, and stresses the role of interconnections. Most important, as we saw earlier, it recognizes that we are part of the systems in which we function, and that we therefore contribute to how those systems behave.

2) It is a circular rather than linear language. In other words, it focuses on "closed interdependencies" where x influences y, y influences z, and z comes back around to influence x.

3) It has a precise set of rules that reduce the ambiguities and miscommunications that can crop up when we talk with others about complex issues.

4) It offers visual tools, such as casual loop diagrams and behavior over time graphs. These diagrams are rich in implications and insights. They also facilitate learning because they are graphic and therefore are often easier to remember than written words. Finally, they defuse the defensiveness that can arise in a discussion, because they emphasize the dynamics of a problem, not individual blame.

5) It opens a window on our mental models, translating our individual perceptions into explicit pictures that can reveal subtle yet meaningful differences in viewpoints.

To summarize, systems thinking is not only a tool. It is also powerful as a language and has some qualities to create communication between people in many different way. By this way, people can work together on understanding and solving complex problems as an organization.

3.7 Systems Thinking Tools

Systems thinking is used by managers to understand complex and dynamic systems or environment. Also, systems thinking offers some managerial tools. Because, to comprehend the complex and dynamic systems, managers need some tools. These tools are shown in Table 3.2.

Table 3.2 Systems thinking tools

1. Brainstorming Tools	1. Double-Q Diagram
2. Dynamic Thinking Tools	2. Behavior Over Time Diagram 3. Casual Loop Diagram 4. Systems Archetypes
3. Structural Thinking Tools	5. Graphical Function Diagram 6. Structure-Behavior Pairs 7. Policy Structure Diagram
4. Computer-Based Tools	8. Computer Model 9. Management Flight Simulator 10. Learning Laboratory

There are at least ten distinct types of systems thinking tools. Kim (1994b) categorizes these tools in four broad categories: 1) brainstorming tools, 2) dynamic thinking tools, 3) structural thinking tools, and 4) computer-based tools.

"Although each of the tools is designed to stand alone, they also build upon one another and can be used in combination to achieve deeper insights into dynamic behavior" (Anderson and Johnson, 1997).

Brainstorming tools are not included in this study. A brief information will be given for three important categories which are dynamic thinking tools, structural thinking tools, and computer based tools.

3.7.1 Dynamic thinking tools

Dynamic thinking tools can be divided into three. These are behavior over time diagram, casual loop diagram, and systems archetypes.

3.7.1.1 Behavior over time diagram (BOT diagram)

Behavior over time diagram is used to graph the behavior of variables over time and gain insights into any interrelations between them. Behavior over time diagrams are also known as reference mode diagrams in literature. Figure 3.5 shows an example of behavior over time graph.

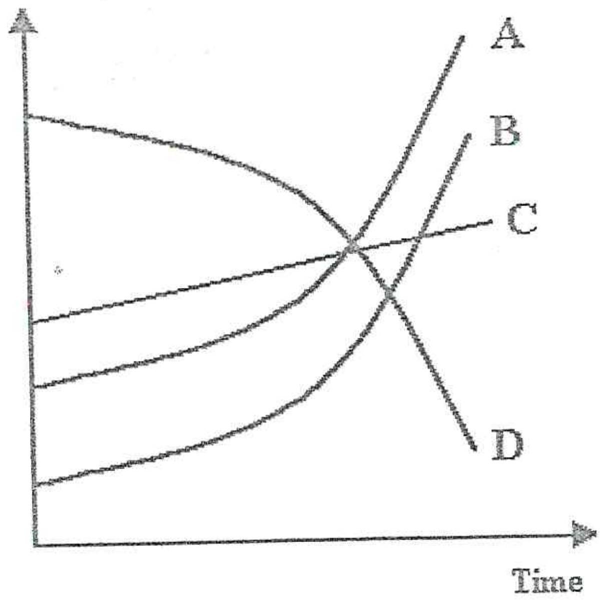

Figure 3.5 Behavior over time diagram

3.7.1.2 Casual loop diagram (CLD)

Casual loop diagram is used in conjunction with behavior over time diagrams. CLDs can be used to identify reinforcing (R) and balancing (B) processes. Figure 3.6 shows an example of casual loop diagram.

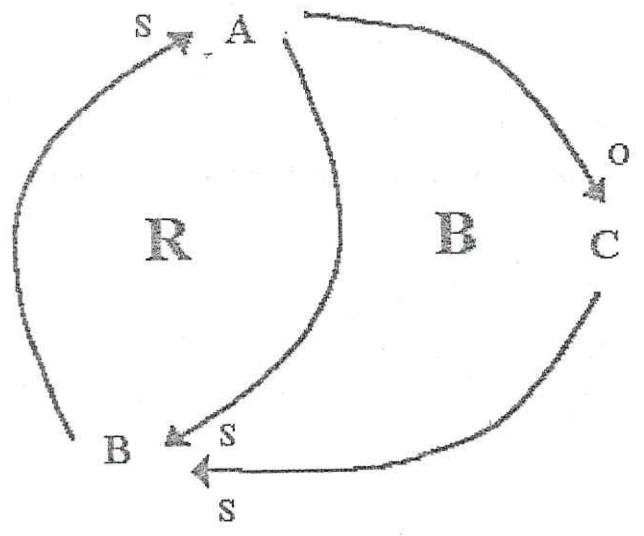

Figure 3.6 Casual loop diagram

Casual loop diagrams are commonly used as a systems thinking tool. A casual loop diagram consists of system variables as shown in Figure 3.6 A, B, and C. These variables are all related to one another as dependent and independent variables. Arrows show the direction of which variable influence to which variable. For instance, A influences B, also B influences A as shown in Figure 3.6. The connection between two variables is considered positive (+) or negative (–), in other words support (s) or opposite (p). For instance, the connection between A and B is supportive. When A increases, B increases or when A decreases, B decreases. A and B support each other so that there is a reinforcing loop between them. But, between A, C, and B, there is a balancing loop, because C has opposite connection with A and B.

To understand these easily, some terminologies should be examined. These are feedback and feedback loops.

Feedback is the most fundamental word in systems thinking. As it is mentioned before, the term feedback comes from definition of systems. According to systems thinking, every influence is both cause and effect and the key to seeing real world in systems perspective is to see circles of influence that is called dynamic thinking, instead of straight lines that is called linear thinking. By looking at these flows of influence, patterns can be seen. Patterns repeat themselves and making conditions better or worse.

Feedback loops has the two main building blocks that are positive (reinforcing) and negative (balancing) feedback loops. When there is a reinforcing loop, every system variable supports each other. If the sign of support is positive in other words, if there is an increasing situation, this reinforcing loop generates exponential growth. This is called positive reinforcement. When there is an opposite situation, this time, there is collapse. This is called negative reinforcement. Furthermore, there is the balancing loop that generates resistance to both exponential and collapse situation. Balancing loops try to maintain stability and achieve equilibrium. In addition, there are delays that are interruptions between actions and their results. Delays occur very frequently in dynamic systems. Their result can be seen in overshooting outcome.

Casual loop diagrams show feedbacks and feedback loops as a system. They may contain many feedback loops to form systems appropriately.

3.7.1.3 Systems archetypes

Systems archetypes are one of the systems thinking tools to recognize common system behavior patterns such as drifting goals, shifting the burden, limits to growth, and so on. Systems archetypes compelling, recurring common stories of organizational dynamics. Figure 3.7 shows and example of systems archetypes.

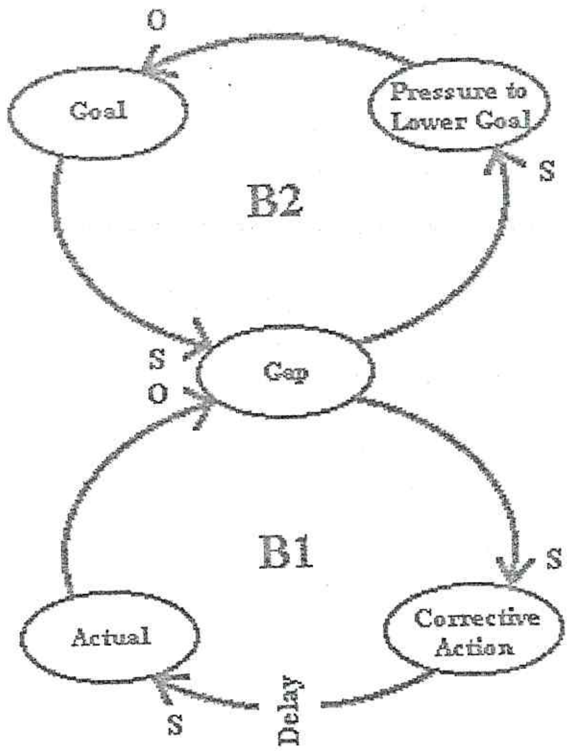

Figure 3.7 Systems archetypes (Drifting Goals) (Anderson and Johnson, 1997)

In Figure 3.7, there can be seen an example of systems archetypes which is drifting goals archetype. "The "Drifting Goals" archetype states that a gap between a goal and a an actual condition can be resolved in two ways: by taking corrective action to achieve the goal, or by lowering the goal. It hypothesizes that when there is a gap between the goal and the actual condition, the goal is lowered to close the gap. Over time, the continual lowering of the goal will lead to gradually deteriorating performance" (Anderson and Johnson, 1997).

Systems archetypes show common stories. Managers can use systems archetypes if their situation or problem seems like these archetypes or they can compare their problem with archetypes. If managers can do, they are going to be lucky. Because, solution is obvious under this condition.

3.7.2 Structural thinking tools

Structural thinking tools can be divided into three. These are graphical function diagram, structure-behavior pair, and policy structure diagram. Graphical function diagram can be used when one variable affects another or more that one. It shows the functional relationship between them. Structure-behavior pair includes basic dynamic structures that can serve as building blocks to develop computer models such as exponential growth. Policy structure diagram can be used as a conceptual map of the decision-making process or represents the decision-making processes that drive policies.

3.7.3 Computer based tools

Computer based tools include computer models, management flight simulators, and learning laboratories. These tools require high level of technical proficiency. Computer models are used to understand relations between variables by representing mathematical equations. Management flight simulators are based on computer models. Managers use them to make a decision and creating strategies. Learning laboratories are like manager's practice field. They uses all the systems thinking tools.

In this study, computer-based tools will be examined with a case study. Therefore, the extended information about computer-based tools which are computer models, management flight simulators, and learning laboratories will be given in the fourth part of this study.

4. SYSTEM DYNAMICS

System dynamics was created at Massachusetts Instute of Technology by Professor Jay W. Forrester in the 1960's. It was a powerful tool to understand the complex systems. Firstly, it was used for management and engineering sciences. Nowadays, it is used as a tool to understand social, economic, physical, ecological or other systems.

4.1 Definition of System Dynamics

Forrester (1991) who is the creator of system dynamics, defines system dynamics as "System dynamics combines the theory, methods, and philosophy needed to analyze the behavior of systems in not only management, but also in environmental change, politics, economic behavior, medicine, engineering, and other fields. System dynamics provides a common foundation that can be applied wherever we want to understand and influence how things change through time."

Another definition that supports Forrester's definition is as follows: "System dynamics provides theory to explain how problems in complex systems arise, a language to describe them, and tools to relate system structure to behavior... Systems dynamics offers a framework for conceptualizing complex business (and other) situations, tools to identify the physical, organizational, and decision-making structure of the systems, and simulation methods to infer correctly the dynamics of these structures" (Graham and et al., 1992).

The other similar definition is that "System dynamics is a discipline which enables computer models of systems (e.g. organisations, industries, global economy) to be built which reproduce the historical behaviour of the system. This enables scenarios to be simulated which are primarily used to develop insights into the system rather than predict the future course of events" (Whalley, 1998).

System dymanics can be defined by using the terms system and dynamics. This definition gives deeper understanding what system dynamics really is. The definition is as follows: "In the field of system dynamics, a system is defined as a collection of elements that continually interact over time to form a unified whole. The underlying relationships and connections between the components of a system is called the structure of the system... The term dynamics refers to change over time. If something is dynamic, it is constantly changing. A dynamic system is therefore a system in which the variables interact to stimulate changes over time. System dynamics is a methodology used to understand how systems change over time. The way in which the elements or variables composing a system vary over time is referred to as the behavior of the system" (Martin, 1997).

In conclusion, system dynamics 1) can be used to understand the behavior of systems, 2) offers tools like computer models, managemant flight simulators, and learning laboratories to make effective decisions and also to understand the behavior of systems.

4.2 The Relationship Between Systems Thinking and System Dynamics

Systems thinking and system dynamics are related each other. System dynamics uses the computer-based tools of systems thinking. These tools are computer models, management flight simulators, and learning laboratories.

"System dynamics is a field within systems thinking that is particularly rich in the area of conceptualization and synthesis of complex systems. It also provides a methodology for synthesizing disperate kinds of variables that have traditionally been considered too fuzzy to measure" (Kim, 1997).

4.3 The Link Between Structure and Behavior

System dynamics can be thought as a methodology or an approach. Because, system dynamics is necessary to understand structure and behavior relation of a system. There is a link between them, and this link can be expressed as follows: "...a system's structure determines the system's behavior. System dynamics links the behavior of a system to its underlying structure. System dynamics can be used to analyze how the structure of a physical, biological, or literary system can lead to the behavior that the system exhibits" (Martin, 1997).

Figure 4.1 shows the link between structure and bahavior. It shows how the underlying structure of a system determines the system's behavior. "The upward-pointing arrow on the left symbolizes the relationship. The downward-pointing arrow on the right indicates the deeper understanding that is gained from analyzing a system structure. Full understanding can only come when one dives beneath the behavior to understand the structure causing the behavior" (Martin, 1997).

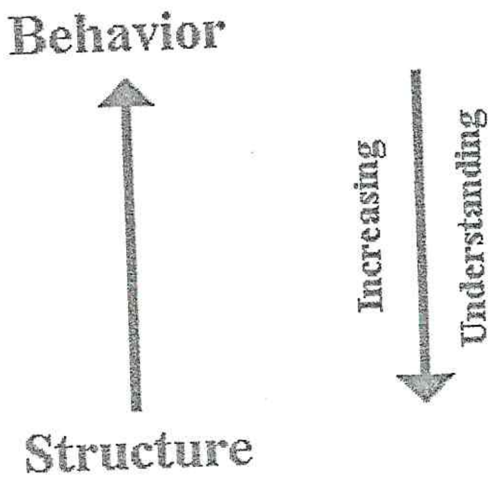

Figure 4.1 The link between structure and behavior (Martin, 1997)

In addition, "System dynamics can also be used to analyze how structural changes in one part of a system might affect the behavior of the system as a whole. Perturbing a system allows one to test how the system will respond under varying sets of conditions… Most importantly, with system dynamics, one can make the mental link between the structure of a system and the behavior that the system produces" (Martin, 1997). Therefore, "system dynamics can be used as a method to systematically elicit and share mental models" (Vennix, 1996).

4.4 System Dynamics Models

Remembering that system dynamics uses computer models, management flight simulators, and learning laboratories as system dynamics models. System dynamics models can be used to deal with strategic problems or issues, and also they are very useful for organization especially for management teams to make effective decisions. In addition, they can be used to understand the link between structure and behavior.

Therefore, system dynamics is a good methodology. "Over recent decades system dynamics has evolved as a well accepted method to support strategic decision making and strategic change in organizations. The primary goal of a system dynamics model is to enhance understanding of the system's behavior and to find robust policies to tackle strategic problems" (Vennix and et al., 1996). "Causal modeling and computer simulation allow insights into the behavior of systems" (Milling, 1996).

"System dynamics models are particularly suited to understanding the coordination between strategy and operating policies – how to distinguish goals from strategies designed to achieve goals; how to design a set of policies and programs that support rather than frustrate strategic objectives. In addition, at the business unit level, models can illuminate the administrative issues (goal formation, incentives, motivation, time allocation, information availability, etc.) as well as market, economic, and political environment issues" (Graham and et al., 1992).

System dynamics models offer a real world experimentation. "…simulation models and model-based games as microworls, which are simpler and create outcomes faster than reality… Computer simulations can be used to execute meaningful experiments designed to illuminate the structure and dynamics of the business environment, or to search for winning strategies, with no idea as to why those strategies are effective" (Graham and et al., 1992).

"...the simulated environment is rich, containing multiple actors, feedbacks, nonlinearities, and time delays. The interaction of individual decisions with the structure of the simulated firm produces aggregate dynamics which diverge significantly and systematically from optimal behavior" (Sterman, 1989).

Also, there is the relationship between system dynamics tools and system dynamics models. "Computer simulation is the imitation of system behavior through numerical calculations performed by a computer on a system dynamics model. A system dynamics model is the representation of the structure of a system. Once a system dynamics model is constructed and the initial conditions are specified, a computer can simulate the behavior of the different model variables over time" (Martin, 1997).

To conclude, system dynamics models attempt to imitate some aspect of real life. Models give the power and opportunity to change system structure and analyze the behavior of the system under many different conditions. In addition, models are also powerful in influincing the learning process when people or managers combined with real experimentation. Because, this is an ideal learning environment that contains topics to discuss, direct research on models, laboratory experimentations, building models and exploration, and also computer simulations to confirm the link between model behaviors and experimental observations. The modeling process always gives an opportunity to managers to improve their decision making, and to render their mental models.

4.4.1 Computer model

Computer models are one of the system dynamics models. "Computer model lets you translate all relationships identified as relevant into mathematical equations. You can then run policy analyses through multiple simulations" (Anderson and Johnson, 1997).

Generally, computer models are not used alone. They are converted into management flight simulators or learning laboratories which are easy to use.

4.4.2 Management flight simulator (MFS)

Management flight simulators are commonly used system dynamics model. "Management flight simulator provides "flight training" for managers through the use of interactive computer games based on a computer model. Users can recognize long-term consequences of decisions by formulating strategies and making decisions based on those strategies" (Anderson and Johnson, 1997).

"Management flight simulators have two uses. First, they help managers understand better the interconnected nature of their organizations, and the consequences of their own actions. But the frontier of this work involves the second use, where managers build a theory about the organization through an ongoing process of refining their understanding and translating that into the simulator model" (Senge and at al., 1994).

Management flight simulators are also called microworlds. In fact, a management flight simulator is a learning laboratory which gives opportunities to managers to simulate their system dynamics model like playing a computer game. When managers simulate the system dynamic model, the management flight simulator helps managers to see link between system and behavior. Managers can change conditions according to their new strategies and decisions by using management flight simulator. They can create scenarios in long-run. Briefly, they can see their decisions results like real life consequences. This means that they can learn from management flight simulators. Because, they can know the answers of questions of their mind. Also, they can change their mental models according to answers.

4.4.3 Learning laboratory

Learning laboratories are one of the most important systems thinking tool, also system dynamics model too. Learning laboratories are as "a manager's practice field. Is equivalent to a sport team's experience, which blends active experimentation with reflection and discussion. Uses all the systems thinking tools" (Anderson and Johnson, 1997).

Similar idea that support above idea is that learning laboratories are "the management learning laboratory, a "practice field" where teams will regularly go to reflect on how they are thinking and interacting, to surface and improve their mental models, and to enhance their capacity for high-leverage coordinated action" (Senge and at al., 1994).

Management flight simulators, learning laboratories, microworlds, and strategy laboratory have almost the same meaning. The relation between management flight simulators and learning laboratories can be expressed as in this way:

"Learning laboratories represent a natural context within which tools like management flight simulators seem to have greatest impact – as tools for learning, rather than tools for predicting. Without that context, experts may develop "management flight simulators" with little clear idea of how they will be used, and managers may play them as if they were playing a computer game – with little learning. Conversely, without a management flight simulator, the learning laboratory lacks one of its most effective elements" (Senge and at al., 1994).

The learning process can be divided into three stages which are:

1) Mapping mental models – explicating and structuring assumptions via systems models.

2) Challenging mental models – revealing inconsistencies in assumptions.

3) Improving mental models – continually extending and testing mental models (Senge and Sterman, 1992).

In fact, these stages show the way to managers about how they can learn by using learning laboratories. Managers can improve their shared mental models and become more systemic and more dyanmic by experimenting learning laboratories. Also, they can develop abilities to view new situations systematically and dynamically.

Also, the benefits of learning laboratories can be listed as follows:

1) Shortening the learning curve for new managers.
2) Improving communication skills.
3) Creating an atmosphere for organizational learning.
4) Clarifying and testing assumptions.
5) Making mental models explicit.
6) Integrating qualitative with quantitative measures of performance.
7) Providing a shared experience for decision making and problem analysis (Senge and Sterman, 1992).

"Managers and organization theorists often point to high-performing teams in sports or the performing arts as role models of flexibility, learning, and consistent quality. Yet most firms, unlike a basketball team or symphony orchestra, have no practice fields where managers' skills can be developed and team competencies enhanced. Opportunities to reflect, to experiment, to challenge and revise mental models may be even more important for learning in firms than in sports or the arts. While much further research is needed, learning laboratories are becoming an important tool which helps organizations create meaningful practice fields to accelerate team learning. Simulation is increasingly important in recreating the full range of interpersonal and substantive challenges confronting managers attempting to think globally while acting locally" (Senge and Sterman, 1992).

In this study, the learning laboratory example will be given with a case study in the fifth part. It can be understood that how learning laboratories are effective as a tool for learning organizations. Also, learning laboratories help management teams to develop strategies and make decision on problems or issues.

4.5 Sources of Information and System Dynamics Models

Sources of information that is used to build a system dynamic model is an important subject. "Effectiveness of a model depends on how it uses the wide range of information arising from the system being represented" (Forrester, 1980). Unlike other modeling techniques, system dynamics models use wide range of information sources. Generally, other modeling techniques use numerical database to build models. "In creating a system dynamics model, information is used in a substantially different way from that in other branches of the social sciences. The differences arise from the system dynamics focus on policy statements as the basic building blocks of a model and from a broader range of information sources used for creating a model" (Forrester, 1991).

System dynamics models use broder range of information resources as illustrated in Figure 4.2 which represents three types of information which are the mental data base, the written data base, and the numerical data base. The mental data base includes much more information than the written data base which contains much more information than numerical data base. "As one moves down the diagram, each category of information contains a smaller fraction devoted to structure and to description of policies. That is, the written and numerical data bases contain not only less information, but progressively smaller proportions of the information needed for constructing a dynamic model" (Forrester, 1991).

"Mental models contain a vast wealth of information that is available no where else. Mental models contain information about the structure and policies in systems. By structure I mean the elements in a system and the connections between the elements—who has what information, who is connected to whom, and, what decisions are made and where. By policies I mean the rules that govern decision making—what factors influence decisions, what is a particular decision point trying to accomplish, and what goals are sought. At this detailed level of structure and policies, mental models are rich and reasonably reliable sources of information" (Forrester, 1994).

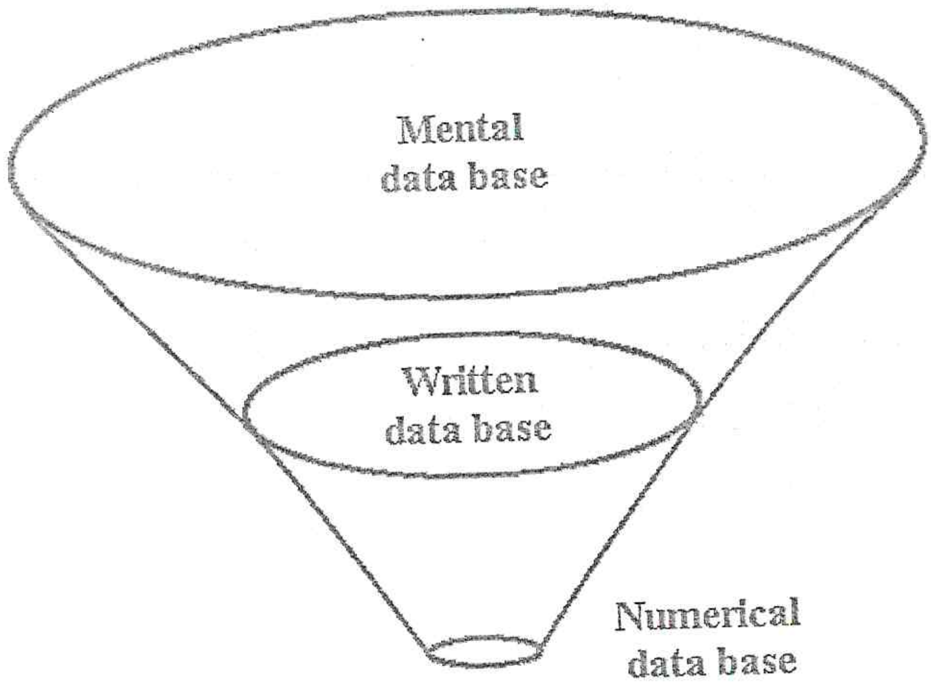

Figure 4.2 Decreasing information content in moving from mental to written to numerical data bases (Forrester, 1991)

"The mental data base is rich in structural detail; in it is knowledge of what information is available at various decision-making points, where people and goods move, and what decisions are made. The mental data base is especially concerned with policy, that is, why people respond as they do, what each decision-making center is trying to accomplish, what are the perceived penalties and rewards, and where self-interest clashes with institutional objectives" (Forrester, 1991).

Mental models show briefly information in people's head. Therefore, mental models contain far more information. Sometimes, mental models are incomplete. System dynamics models help people and managers to draw correct or appropriate conclusions and help them to understand and learn the structure and policy behind situation, problem, or issue. Also, they can make some judgments about mental models are correct or not. Also, system dynamics suggests a source of direct and immediate feedback for people and managers to test their assumptions about their mental models of reality through the use of computer simulation.

"System dynamics computer simulation goes a long way toward compensating for deficiencies in mental models. In model building, one must remedy incompleteness and internal contradictions before the system dynamics software will even allow simulation. After a logically complete model has been created, one can be certain that the computer is correctly simulating the system based on the assumptions that were incorporated in the model. It is in simulation, or determining consequences of the structural and policy assumptions, that mental models are unreliable, but computer models are completely dependable" (Forrester, 1994).

"A two-way street runs between mental models and computer models. Mental models contribute much of the input for computer models. Creating a computer model requires that the mental models be clarified, unified, and extended. From the computer simulations come new insights about behavior that give new meaning to mental models. Mental models will continue to be the basis for most decisions, but those mental models can be made more relevant and more useful by interacting with computer models" (Forrester, 1994).

The next data base is written data base which represents all the information that people have on paper or stored electronically like computers. "The written data base contributes to a dynamic model at several stages. Published material makes information more widely available than if it is only exchanged between mental data bases. In terms of usefulness for modeling of business and economic systems, the daily and weekly public and business press is frequently more useful than the professional press or historical accounts that adopt a longer time horizon. The current press reports the pressures of the moment that surround decisions. The temporal nature of a decision sharply restricts the kind of literature in which operating policy will be revealed. Policies govern decisions and decisions control action. Decisions are fleeting. There is only a single instant in time when one can act. That time is now. Action must take place in the present moment that separates history from the future" (Forrester, 1991).

The last data base is numerical data base. It represents numerical information. "The numerical data base is of narrower scope than either the written or mental data bases. Missing from numerical data is direct evidence of the structure and policies that created the data. The numerical data do not reveal the cause and effect directions among variables. In complex nonlinear feedback systems, statistical analysis of historical data should be used cautiously. Even so, numerical data can contribute to system dynamics model building in three ways. First, numerical information is available on some parameter values. For example, average delivery delays for filling orders, typical ratios of factor inventories to production, normal bank balances, and usual inventory coverages can be determined from business records. Second, numerical data has been collected by many authors in the professional literature summarizing characteristics of economic behavior such as average periodicity of business cycles and phase relationships between variables. Third, the numerical data base contains time series information that in system dynamics is often best used for comparison with model output rather than for determining model parameters" (Forrester, 1991).

In conclusion, system dynamics is a powerful strategy to deal with problems and to make effective decisions. Because, it uses wide range of information sources. So that, it is more effective than other methodologies. Generally, the most methodologies uses numerical data base. But, it uses mental, written, and numerical database. Shortly, it is stated that it can give better results on strategies and decisions.

5. BUILDING A LEARNING LABORATORY

So far, the concepts of learning organizations, systems thinking, and system dynamics are examined. The importance of the five disciplines which are personal mastery, mental models, shared vision, team learning, and systems thinking have been emphasized to build a learning organization. The necessity of systems thinking as the fifth discipline to integrate other four disciplines, and system dynamics as a methodology to understand complex environment are important subjects of this study.

In this part of the study, learning laboratories will be examined. Learning laboratory is a management tool to create awareness and enhance learning organization disciplines. Also, learning laboratories help managers to make strategic decisions. This is the reason why learning laboratories are also called strategy laboratories. Learning laboratories are important to build a team learning among managers. Remembering that team learning is one of the discipline for building a learning organization. Learning laboratories offer a computerized environment by combining various systems thinking and system dynamics tool. Managers try to develop strategies and make decisions on problems or issues by rendering their mental models in learning laboratories as a team. When managers learn the real cause of their problems by developing strategies in learning laboratories, they and their organizations will succeed to gain competitive advantage by applying these strategies.

An important goal of most system dynamics modeling projects is to support strategic decision making. "Strategic decisions can have a profound impact on the organization. Even thorough analysis is insufficient for such a decision to become fully implemented. It is necessary that the main stakeholders, in particular managers, are prepared to back up the strategy. In other words, the primary objective in strategic decision making is frequently not to find a robust policy, but rather to encourage team learning, to foster consensus and to create commitment to the resulting decisions, in particular when divergent opinions are involved" (Vennix and et al., 1996).

In this part of the study, the objective is that to apply a system dynamics model to build a learning laboratory for strategic change and to construct consensus and commitment among management team members. In other words, learning laboratories can create an environment to integrate five disciplines and show how. Also, in system dynamics modeling effort is devoted to changing and sharing the mental models of participants.

In order to render mental models and to build a learning laboratory, a software is needed. Today, there are many software packages like ithink, STELLA, PowerSim, VenSim, or DYNAMO. In this study, ithink will be used as a software language.

5.1 Software to Render Mental Models

In this study, ithink will be used. It has powerful features and its using is very easy. Therefore, is one of the most popular system dynamics modeling tools. It allows managers to draw stock-and-flow diagrams on the computer screen, entirely mapping the structure of the system before they enter equations. Managers can add more detail and then group elements into submodels, and they can zoom in for more detail in complicated models.

5.1.1 System dynamics modeling language

There are four basic building blocks in the system dynamic modeling language. These are stocks, flows, converters, and connectors. Model builders can construct every system on computer screen by using these building blocks even their system is qualitative or quantitative. Brief definitions of these building blocks is as follows: (Martin, 1997)

Stock—A stock is a generic symbol for anything that accumulates or drains. For example, water accumulates in your bathtub. At any point in time, the amount of water in the bathtub reflects the accumulation of what has flowed in from the faucet, minus what has flowed out down the drain. The amount of water in the bathtub is the stock of water.

Flow—A flow is the rate of change of a stock. In the bathtub example, the flows are the water coming into the bathtub through the faucet and the water leaving the bathtub through the drain.

Converter—A converter is used to take input data and manipulate or convert that input into some output signal. In the bathtub example, if you were to turn the valve that controls the water flow in your bathtub, the converter would take as an input your action on the valve and convert that signal into an output reflecting the flow of water.

Connector—A connector is an arrow that allows information to pass between converters and converters, stocks and converters, stocks and flows, and converters and flows. In Figure 5.1 below, the connector from converter 1 to converter 2 means that converter 2 is a function of converter 1; in other words, converter 1 affects converter 2.

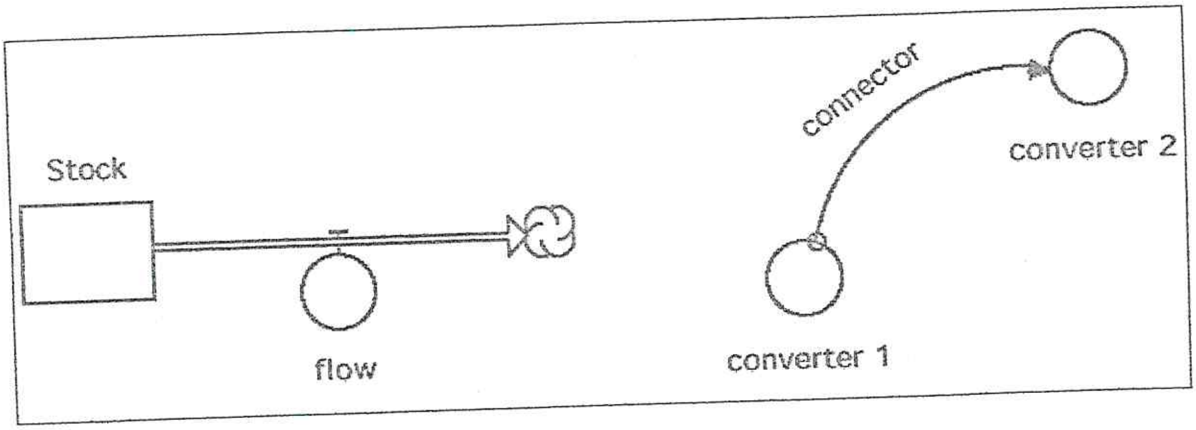

Figure 5.1 Representations of a stock, flow, converter, and connector
(Martin, 1997)

5.2 Methodology

The four step methodology will be used in system dynamics modeling process to build a learning laboratory. These steps are illustrated in Figure 5.2. These are define the issue / problem, develop and represent hypothesis, test hypotheses, and making learning available, in other words designing a learning environment.

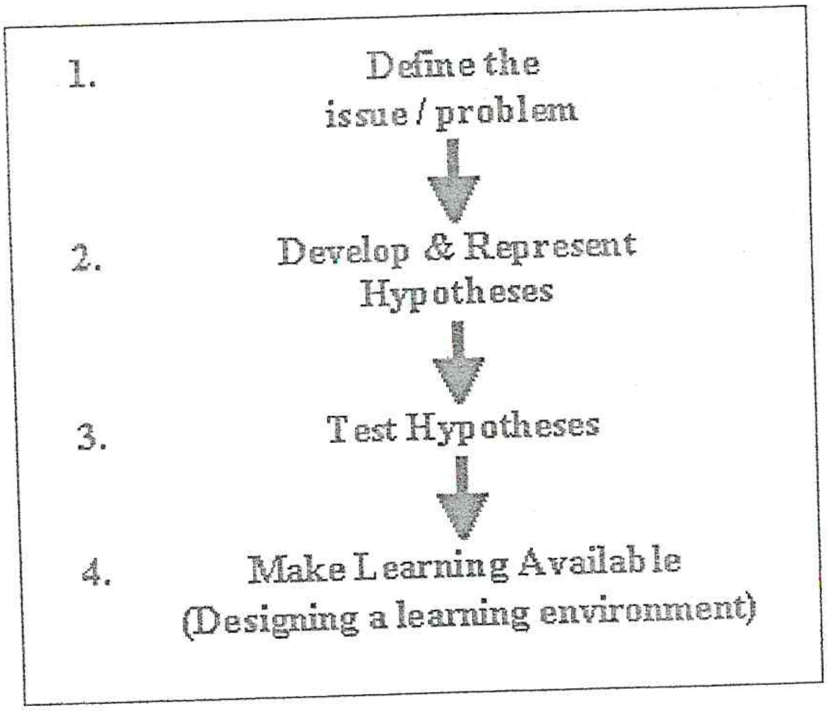

Figure 5.2 Steps in modeling process

5.2.1 Define the issue / problem

In step 1, model builders need to develop a focus for their effort as a team on defining the problem or issue. There are three sub-steps in step 1 as shown in Figure 5.3. These are explicitly state the purpose, develop a reference behavior pattern, and develop a system diagram.

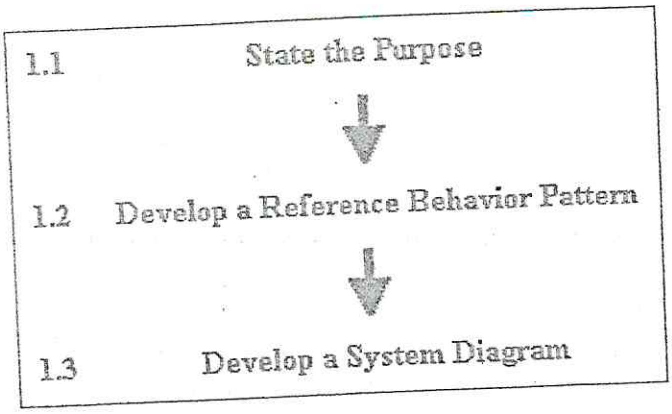

Figure 5.3 Sub-steps in step 1

In sub-step 1.1, model builders should express the statement of purpose clearly. They should use verbal description to state their purpose. When they have developed this, two more tools will help them to make their purpose more operational. Firstly, in sub-step 1.2, model builders try to translate their verbal purpose statement into reference behavior pattern which is a graph over time of one or more variables. The reference behavior pattern shows the dynamic phenomenon that model builders are trying to understand. Also, the reference behavior pattern helps them to focus their effort in the behavioral dimension. Secondly, in sub-step 1.3, model builders try to develop a system diagram which consists of necessary key sectors, key actors, or key processes. A system diagram helps them to focus their effort in structural dimension. For example, key sectors can be marketing, production, human resources departments in firms. Key processes can be production process, marketing process, selling process. Key actors change according to models. For instance, managers, employees are some of the actors within a production system.

5.2.2 Develop and represent hypotheses

In step 2, model builders develop and represent the hypotheses that are responsible for producing the behavior patterns which are identified in step 1. Like in step 1, there are three sub-steps in step 2. These are seek a dynamic organizing principle, map the hypotheses, and make the map simulate as shown in Figure 5.4.

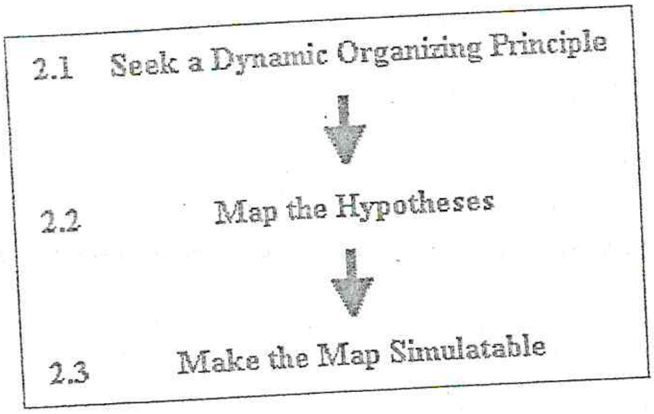

Figure 5.4 Sub-steps in step 2

In sub-step 2.1, model builders should look for some dynamic subject which can serve to organize and form their thinking about the phenomenon that they are seeking. They can use casual loop diagrams, systems archetypes or any other tools to describe this phenomenon. In sub-step 2.2, they have to consider key sectors, key processes, or key actors in detail to find the relations and feedback loops like reinforcing or balancing among variables. In sub-step 2.3, after they mapped the hypotheses in sub-step 2.2, they should try to make the map simulatable. Model builders have to proceed in three steps process to make the map simulatable. These steps are characterizing the flows, specifying the algebra, and closing loops. The first step is characterizing the flows refers determining the inflow or inflows and outflow or outflows to a stock according to the nature of the process. The second step of this process which is specifying algebra refers determining the mathematical equations or numerical values to each building blocks of the model. The final step of this process is closing loops refers seeking for feedback relations that arrange the various flows.

5.2.3 Test hypotheses

When model builders simulate their hypotheses on a computer, they become more confident about their model. Also, they become more aware of the limitations of their model's utility. Therefore, they become more confident about what their model can do, and more knowledgeable about what their model cannot do.

There are only one sub-step in step 3. It is reference behavior test. Reference behavior tests are used to see suitability between beginning or defined reference behavior patterns and after simulating the model of reference behavior patterns. When two of them are replicated, model builders can begin to search for attempts to improve their model to solve problem or issue. Because, when two reference of behavior are replicated, this means that model builders discover the systemic structure that causes this problem or issue. Therefore, they can change the structure by using simulations according to situations that they desire. In other words, they can find the leverage point to solve problem.

5.2.4 Designing a learning environment

The last step of modeling process is designing a learning environment. The objective of designing a learning environment is to help model builders while they are making decisions and facilitating to improve their performance.

In this study, the aim is not building a perfect model. The model that built in this part helps to describe how model builders construct learning laboratories by using system dynamics model and its contribution to team learning and building a learning organization. So that, only reference behavior test is used to test hypotheses. In fact, there are some series of tests to build validation and confirmation of the model. Therefore, the modeling process is simplified. The next step is to build a learning laboratory by using a case study.

5.3 The Case

In order to present how to use this methodology and to implement a learning laboratory, a hypothetical case will be used. This case was developed by discussion with a real company managers who have the issue on their hands. The hypothetical company is Baby Toys. It is a toy maker company. It produces dolls for little girls. Baby toys is a well-known company in the toy market especially doll production. Therefore, its profit and sales are really good, and the company has a good customer portfolio.

While the company produces, and sells its products, recently it faced a serious problem. The problem is decreasing the amount of profit continuously. Managers got agitated when they recognized this problem. Management team assembled immediately to handle this problem. All managers suggested various ideas to solve problem while they were meeting. Production managers suggested that the increasing level of production would increase the profit level. So that, production capacity should be increased. Marketing manager suggested that increasing marketing expenditures like advertising would increase the profit. Because, when marketing expenditures increase, customers become more aware of products, and they want to buy them. Other manager suggested other ideas, or some of them supported production manager or marketing manager.

Finally, to understand the real cause of this problem, managers decided to build a learning laboratory environment. They have started to build a learning laboratory by using modeling methodology which was introduced in this part.

5.4 Modeling

5.4.1 Defining the issue / problem

State the purpose: The purpose of this modeling is to understand the structure and dynamics that behind the decreasing profit problem that Baby Toys faced, and also finding the solutions to discover the reason of this problem.

Developing a reference behavior pattern: In this model, hypothetical data is used. Because, Baby Toys is a hypothetical company. So that, the reference behavior pattern will be based on these data. Apart from these hypothetical data, results are real. Because, they are based on these data. The data is listed in Table 5.1.

Table 5.1 Data for reference behavior pattern of profit

Months	0	1	2	3	4
Profit ($)	500000	479000	458000	430000	401000

The reference behavior pattern is plotted by using hypothetical data on Table 5.1. Figure 5.5 illustrates that decreasing profit of Baby Toys company.

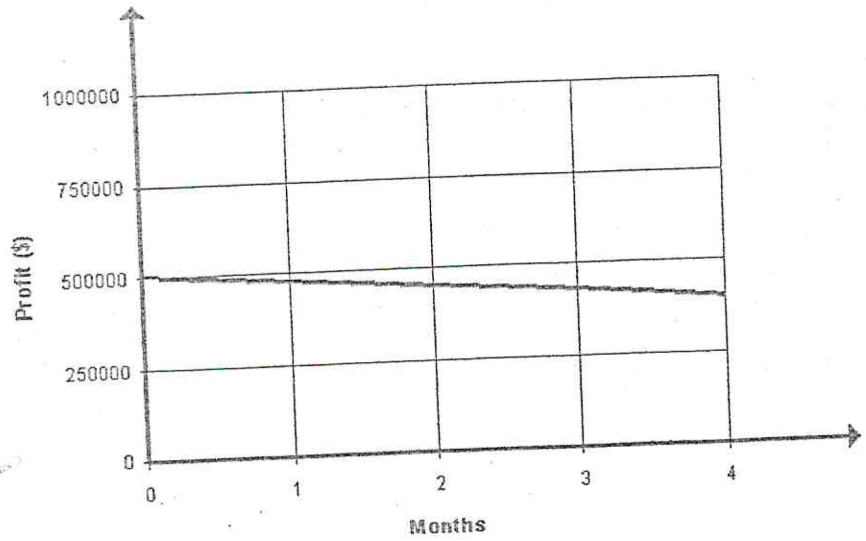

Figure 5.5 Reference behavior pattern of profit

Developing a system diagram: The system diagram for Baby Toys is illustrated in Figure 5.6. This diagram contains three main sectors which are production, finance, and market. The arrows on the diagram shows the relations among sectors.

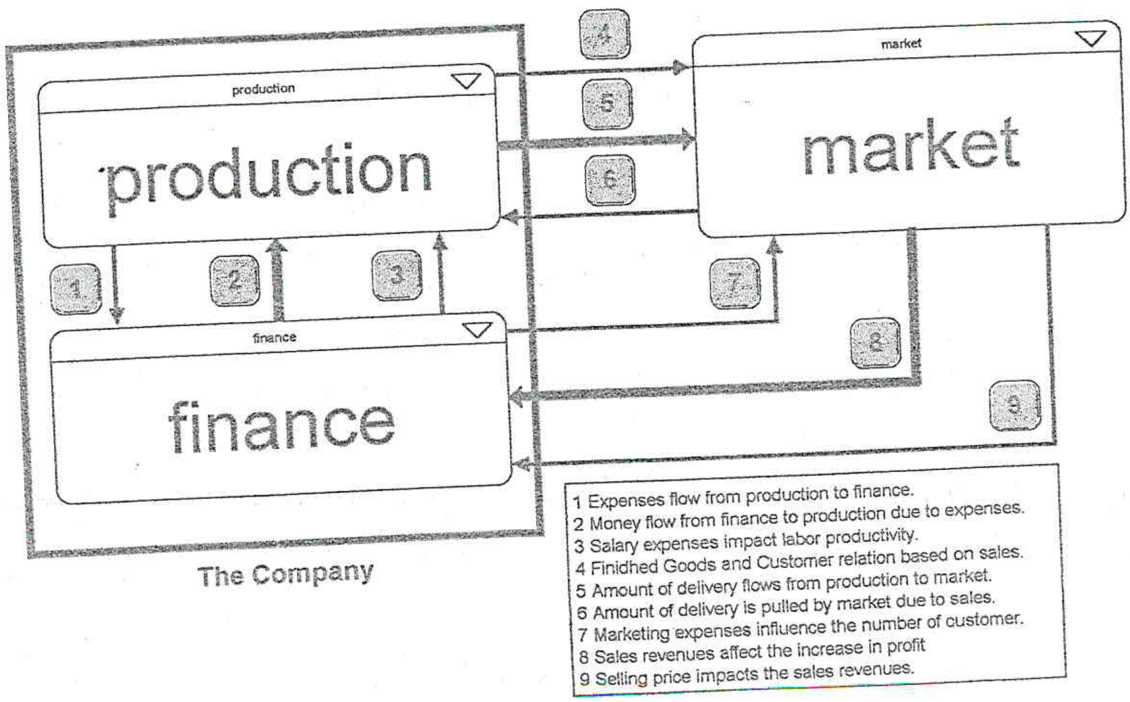

Figure 5.6 The System Diagram

The production and finance sectors are within the company. The market sector is outside of the company. In fact, the market sector indicates the place where the company sells its products to customers. These sectors are the key sectors.

As the reference behavior of pattern illustrates, the amount of profit on hand is decreasing. The amount of profit is directly related to market. So that, managers of the company think that one key sector may be market sector. Another sector should be production. The important point in production sector is production process which is directly related to the company production capacity. This capacity depends on the number of labor, and the average productivity of labor. So that, this capacity can be calculated by using the number of labor, and productivity. If the number of labor and productivity do not change, generally, it can be said that the production process capacity stays constant. When the number of customer increases, the company cannot produce enough products to cover all products which are demanded by customers. Labor productivity can increase by increasing labor salaries. The last sector should be finance sector. This sector includes mainly profit which is related to expenditures and revenues from sales.

5.4.2 Developing and representing Hypotheses

Seeking a dynamic organizing principle: Building the casual loop diagram of these sectors helps managers to understand and to see the big picture which portrays upper most dynamics of the issue. Because, casual loop diagrams* are dynamic systems thinking tool. As the reference behavior pattern of profit indicates, the amount of profit is decreasing. Managers believe that limiting factors cause this problem. So that, there should be at least one reinforcing loop that indicates the increase in amount of profit, and one or more balancing loop that limit the increase in profit. The casual loop diagram is exhibited in Figure 5.7.

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* Discussed in the third part of this study.

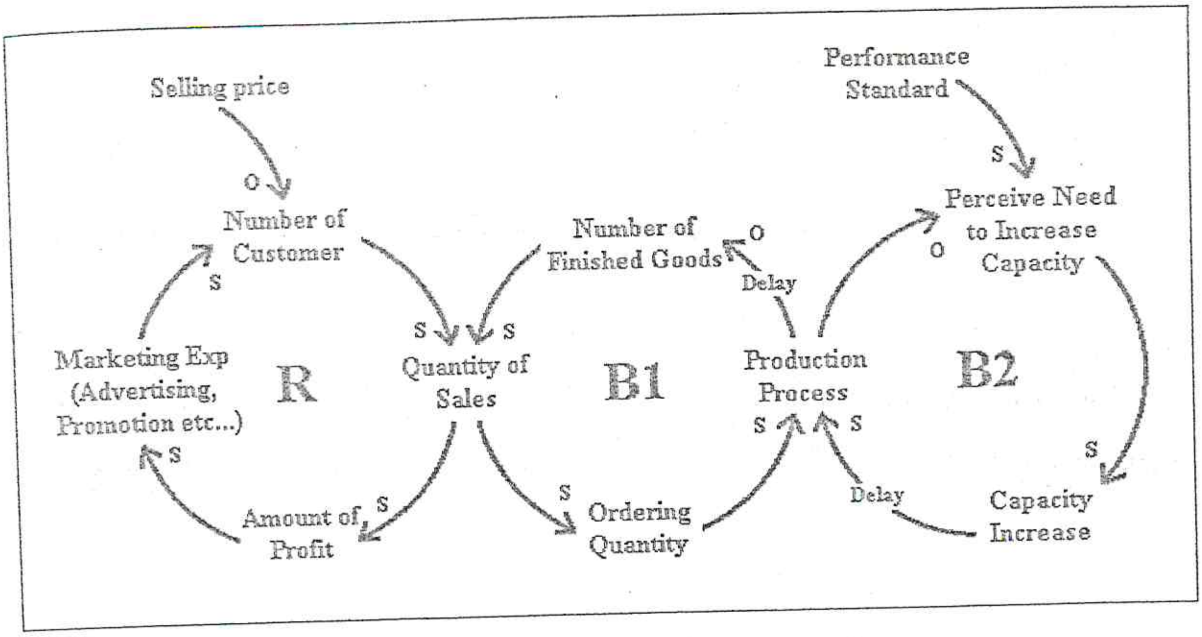


Figure 5.7 The Casual Loop Diagram

As Figure 5.7 shows, there are three feedback loops which are one reinforcing feedback loop and two balancing feedback loops. These loops was discovered by managers through skillful discussions. R represents the reinforcing loop. B1 and B2 represent balancing loops. The letter of S and O which show the relation like S (supportive) or O (opposite) between variables. It can be started to tell the story to understand the dynamic of the issue on hand by using the casual loop diagram in Figure 5.7. Firstly, it can be started from quantity of sales and R feedback loop. The quantity of sales influences the amount of profit. In other words, when the quantity of sales increases, the amount of profit also increases. If the amount of profit rises, marketing expenses increases. Increase in marketing expenses causes the increase in number of customer. But, the selling price affects the number of customer oppositely, but it also increases the amount of profit by sales. When the company has increasing number of customer, also its quantity of sales rises. This R loop reinforces itself continuously. This indicates growing action.

But B1 and B2 feedback loops limit this growing action. If the quantity of sales rises, the company increases the ordering quantity. This requires the capacity increase in production process. In fact, the company has idle production process capacity. When the company does not increase its production process, the number of finished goods on hand begins to decrease. When the number of finished goods decreases, of course the quantity of sales decreases. Because, the company cannot produce enough products to cover all products which are demanded by customers. So that, R1 loop begins to reinforce opposite side like collapsing action. Finally, the amount of profit begins to decrease. This is the effect of B1 loop.

When managers go one step further, they can see another loop which is B2 loop. In fact, the real problem is here. The production process capacity should be increased to produce enough. The company can use idle capacity to increase the production process capacity. The company uses 3000 units of production process capacity. But, it has 4000 units capacity totally. This means that the company has 1000 units for production process capacity. Also, the company should hire labors to use idle capacity and to meet the capacity increase. Furthermore, B2 loop contains performance standard which is determined by the number of labor and the average productivity of labor.

Based on these explanations, it can be started to tell the situation in B2 loop. Production process affects the perceive need to increase in capacity oppositely. Because, managers think that there is no problem while the company produces. Even the decreasing R loop appears, the perceive need to increase capacity decreases. But, performance standard affects the perceive need to increase capacity supportively. When the performance increase, managers think that the capacity should increase. When the perceive need to increase capacity rises, the probability of capacity increase rises. If the capacity increases, production process become more faster than before, and delay time to produce becomes less. The increasing capacity requires time, so delay occurs here. When the production process is faster, the number of finished goods increases. Finally, the quantity sales increases. Based on sales, the amount of profit rises.

This casual loop diagram is similar with the growth and underinvestment system archetype. This is shown in Figure 5.8.

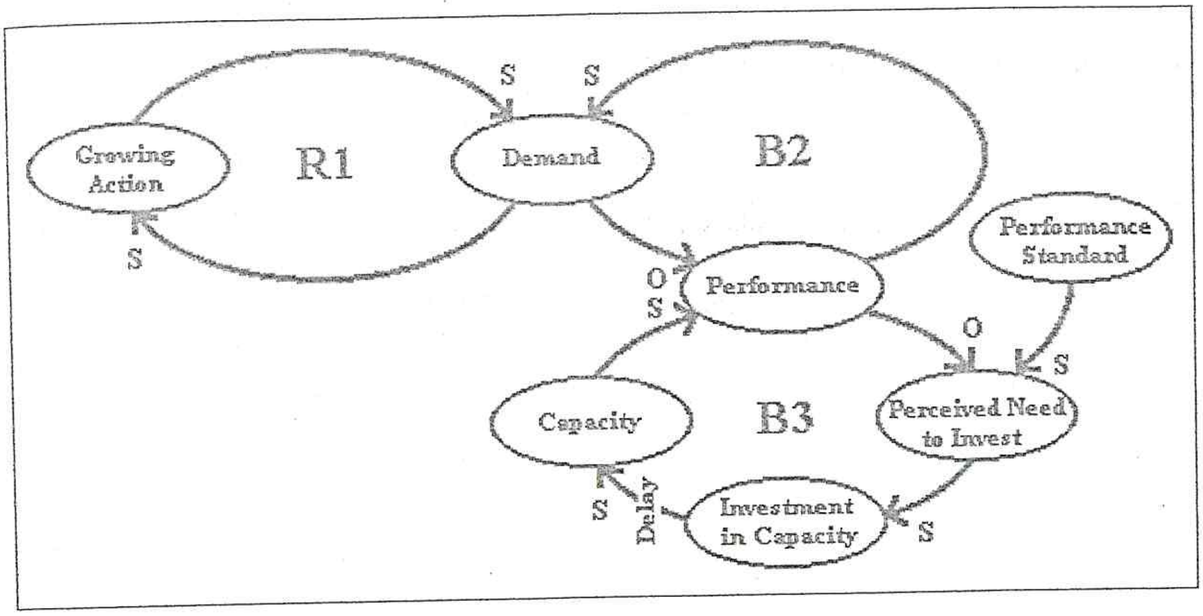


Figure 5.8 Growth and Underinvestment System Archetype (Anderson and Johnson, 1997)

Mapping the hypothesis: Managers of the company use sector to map their hypothesis. There are three sectors. These are production sector, market sector, and finance sector.

The first sector is production sector. There are three accumulators. Raw materials, production process, finished goods are accumulators. Raw materials stock keeps the quantity of raw materials on hand, and it rises with ordering, drains with starting production. Production process represents the products that are in process. Production process starts with starting production, drains with completing production. Production process has capacity of 4000 units. But, the company uses 3000 units currently. This means that the company has 1000 units idle capacity for production process. Finished goods accumulates the finished products that come from production process. As it is mentioned before, starting production is based on performance standard which are labors and productivity. The preliminary map of production sector is exhibited in Figure 5.9.

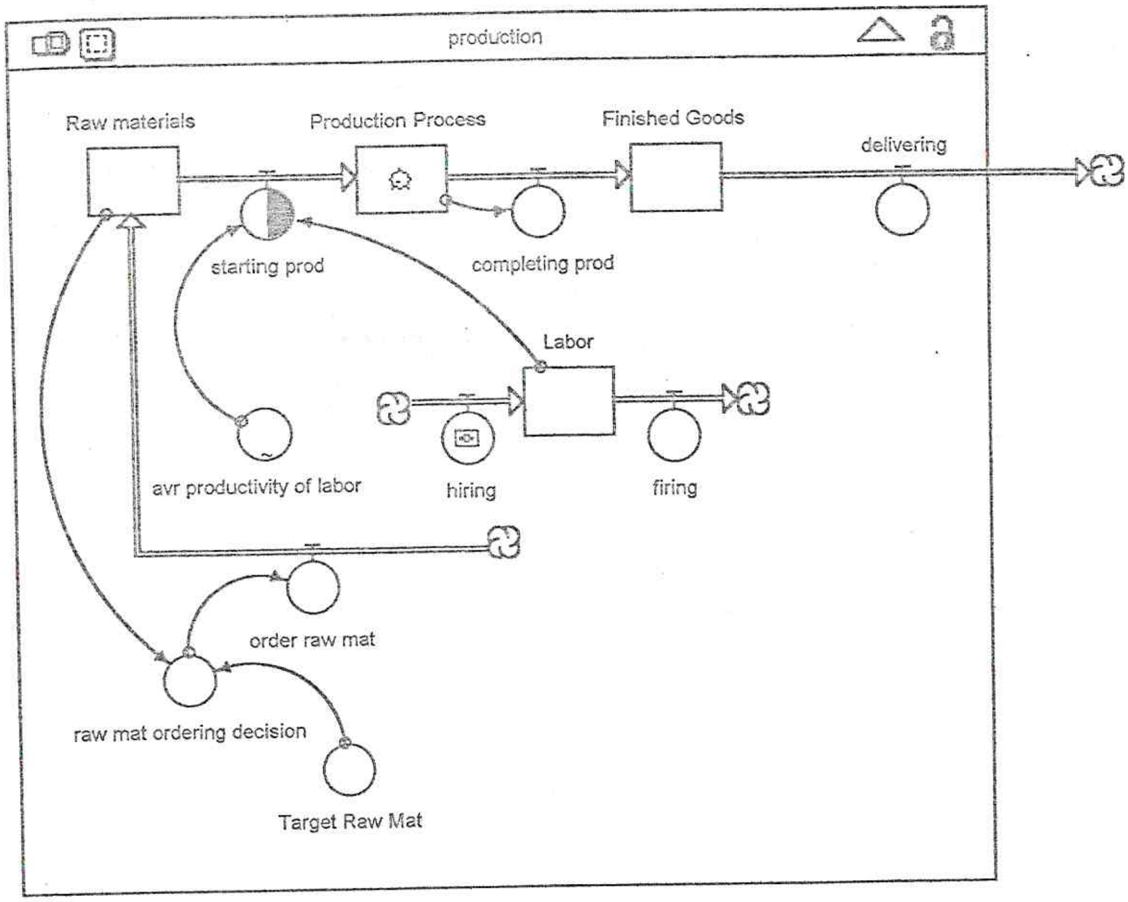


Figure 5.9 The preliminary production sector map

The second sector is market sector. In market sector map, there is only one accumulator which is customer. Increase or decrease or customer designates the number of customer. Delivering comes from production to market. The quantity of sales changes according to delivery and customer quantity. Increase or decrease in customer is directly related to price and marketing expense per product. Maybe, one question comes to some managers' mind. Why marketing expense per product. The simple answer is that adjusting the marketing expense according to per product is easy. Selling price is negatively related to increase in customer, but positively related to decrease in customer. Marketing expense like advertising or promotion, is positively related to increase in customer, but negatively related to decrease in customer. Figure 5.10 shows the preliminary map of the market sector.

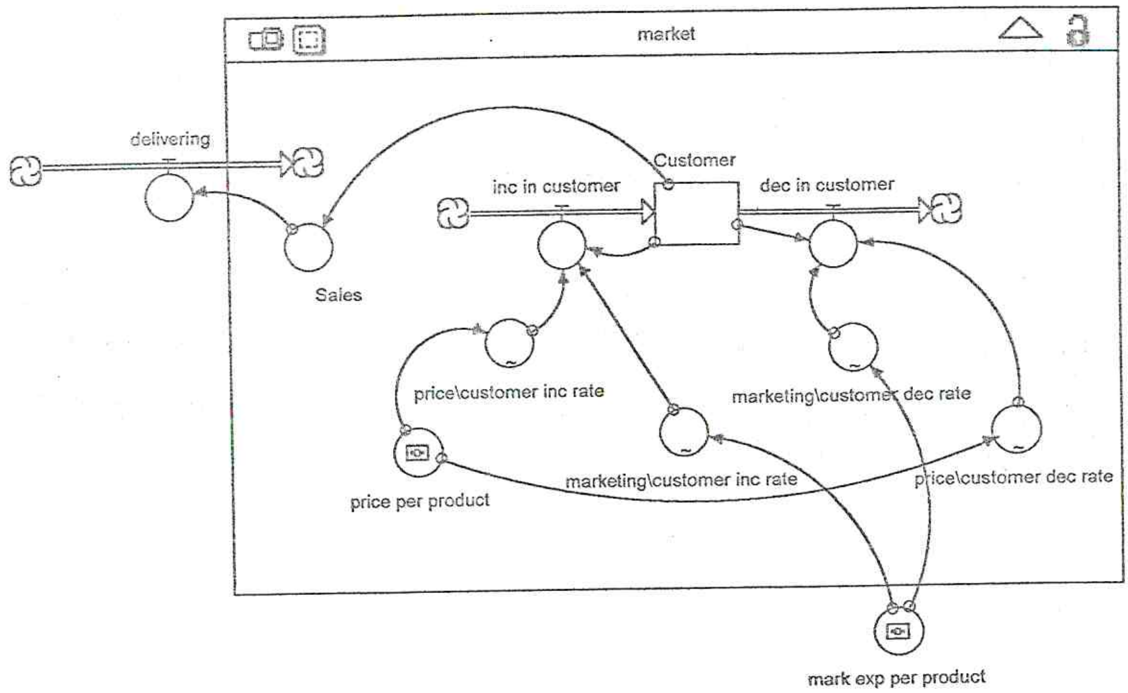


Figure 5.10 The preliminary market sector map

The final sector is finance sector. In this sector map, the amount of profit works as an accumulator. The quantity of sales increases the amount of profit. Also, there are some expenses that drain the amount of profit. These expenses are production expenses, salary expenses, marketing expenses, and ordering raw material expenses. The preliminary sector map of finance is shown in Figure 5.11.

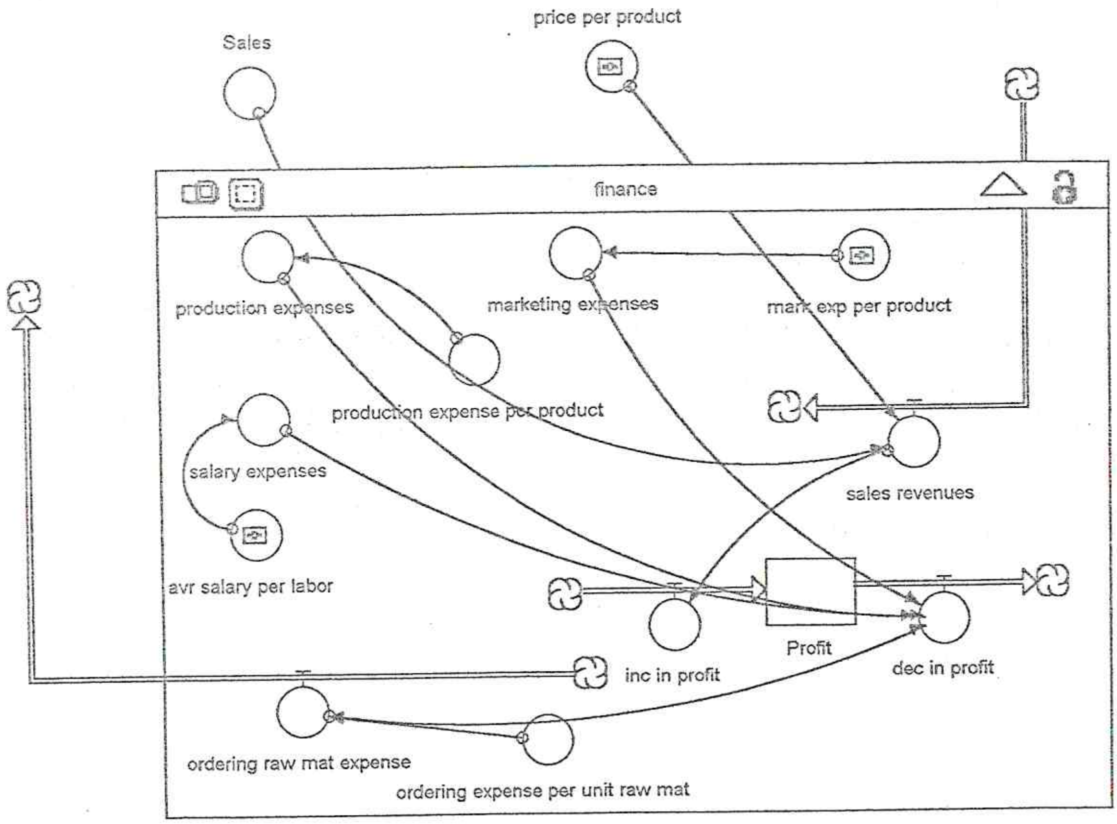


Figure 5.11 The preliminary finance sector map

So far, managers have focused each sector separately. Now, they can combine them to discover the complete model. The complete model is shown in Figure 5.12.

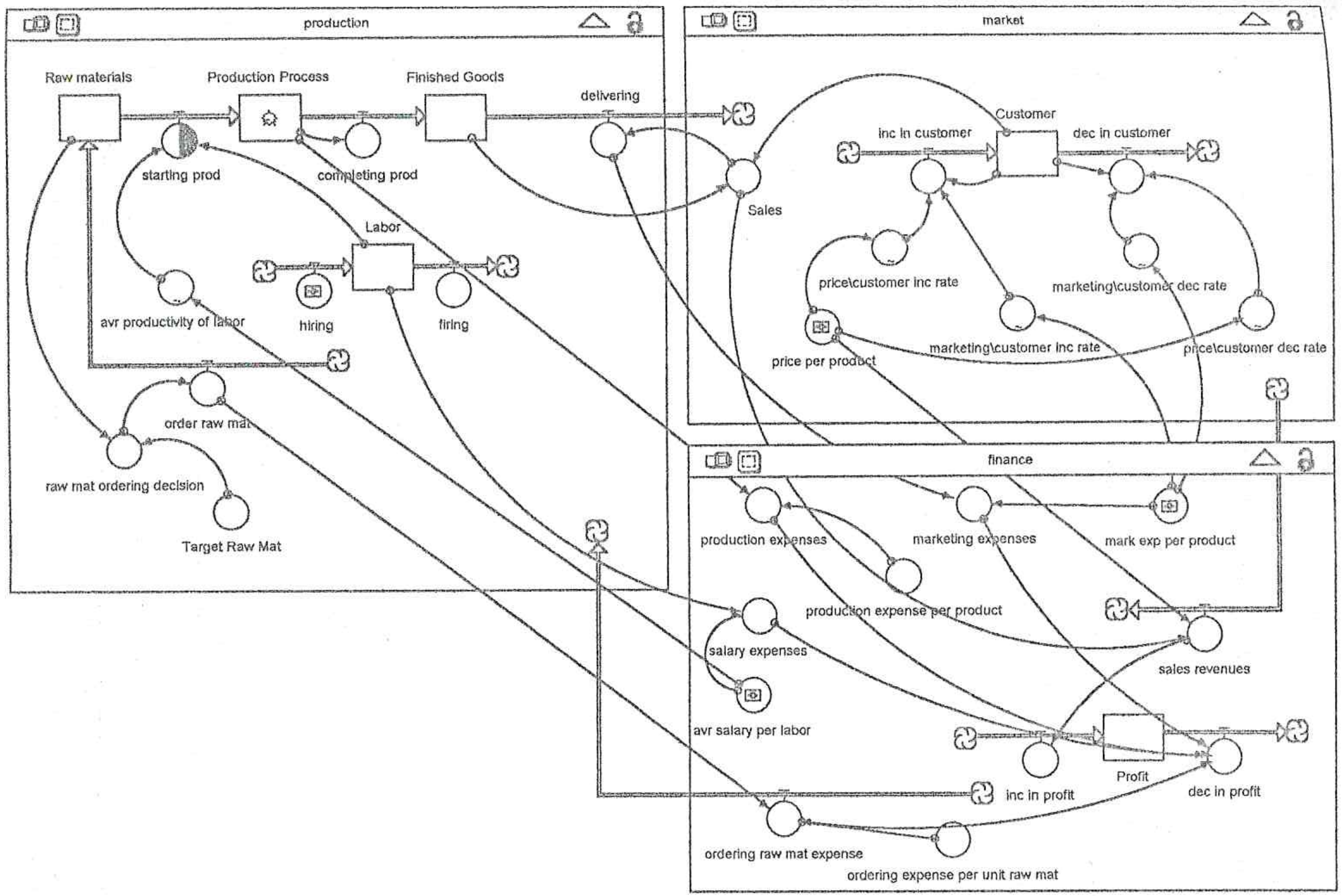


Figure 5.12 The complete model

The complete diagram indicates relationships among sectors. The amount of raw materials flows from raw material stock to production process. The amount of flow is designated by starting production or labor and average productivity per labor. Production process has 3000 units capacity. After the production process completes, finished products flow from production process to finished goods stock. Finally, products flow from production sector to market sector by delivering. While production goes on, if the quantity of raw materials goes down the certain level, the company automatically orders raw materials.

In market sector, there are customers that can increase or decrease by selling price of product, and marketing expense per product. The quantity of sales is important here. The quantity of sales is determined by comparison of delivering and number of customer. Finished goods stock keeps the quantity of products on hand. In other words, it keeps the available quantity to sell. The company wants to deliver all of them to earn money. The number of customer stock indicates the customer number on hand. When delivery quantity is much more than the number of customer. The company can sell only the same quantity with its customer number. Because, managers assume that every customer buys only one product logically. When delivery quantity is less than customer number, the company can sell only the same quantity with its deliver quantity. Because, the number of customer is not enough to sell all products.

In finance sector, the amount of profit is important. There are expenditures and revenues. The company can get revenues from its sales. This causes to increase in profit. There is money flow from market sector to finance sector. Expenditures cause to decrease in profit. Ordering raw material expense is directly related to the quantity of raw material orders by the company. Therefore, there is money flow from finance to production sector. Production expenses are related to production process. Salary expenses are important, because, these are related to average productivity of labor. When salaries increase, morale of labors increases. This causes to increase in productivity. When salaries decrease, morale of labors decreases. Then, this causes to decrease in productivity.

Make the map simulatable: There are algebraic equations and graphical functions between variables. These make the map or complete model simulatable. Algebraic equations are illustrated in Appendix 1. Graphical functions are shown in Appendix 2. Algebraic equations and graphical functions are based on surveys and researches that are made by the company's related departments.

5.4.3 Testing hypotheses

Reference behavior test: This test shows the reference behavior that meet the reference behavior of decreasing profit problem. But, this reference behavior is plotted from the model. Under this circumstance, we can say that we have discovered the structure that causes this problem. The reference behavior decreasing profit from model is shown in Figure 5.13.

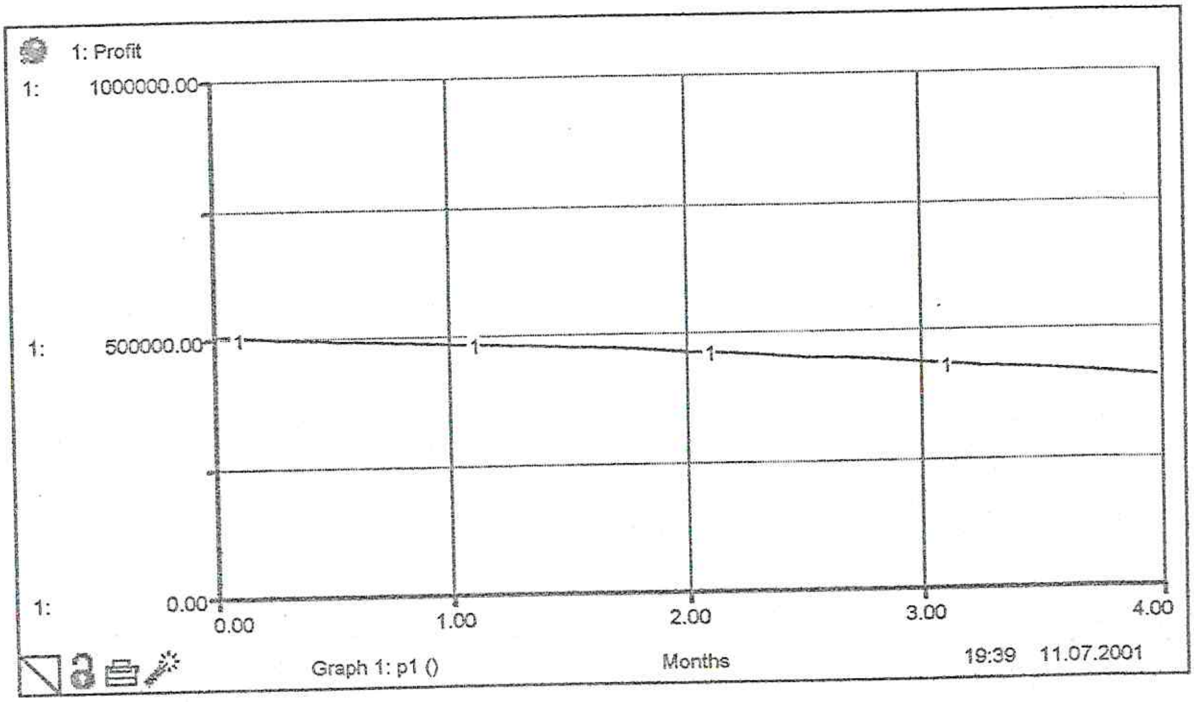


Figure 5.13 The reference behavior of decreasing profit from model

5.4.4 Designing a learning environment

In this part of methodology, managers build a management flight simulator based on model. The control panel of the management flight simulator is shown in Figure 5.14.

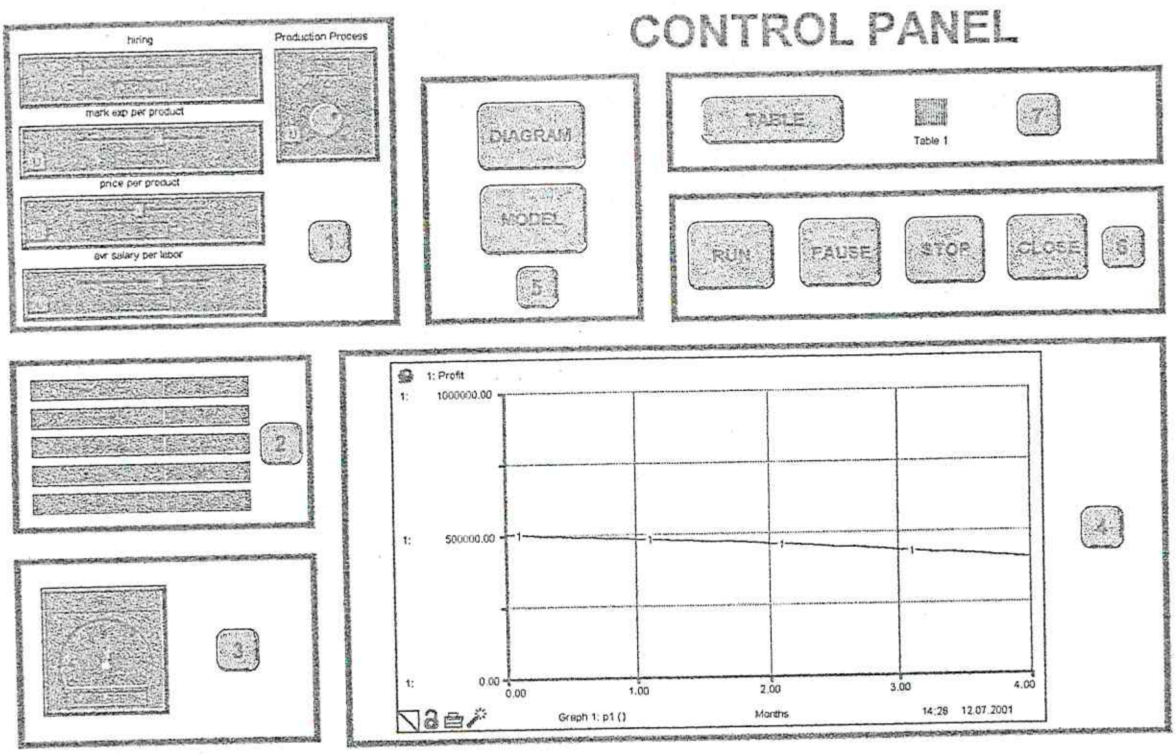


Figure 5.14 The control panel of management flight simulator

As Figure 5.14 indicates, there are seven parts on the control panel. The control panel has three main tasks. The first one is responsible for changing the structure of system. Part one is responsible for it. The second one is responsible for showing the behavior of system. Part two, three, four, and seven are responsible for this. The last one is buttons that make easy some operations like go to diagram or model, run, pause, stop, and close the model. Part five and six are responsible for this job.

The objects in part one are called slider input devices and knobs. The number of labor, marketing expense per product, selling price per product, and the average salary per labor are the slider input devices. Production process is the knob. These devices allow model users to adjust assigned variables numerically. These directly change the structure of the system. When the structure of system changes, the behavior of system changes. Remembering that, the structure of system determines the behavior of system. The difference of the slider input device and the knob is that knobs are used for changing the initial value of stocks and converters, but slider input devices are used for changing the initial value of converters and flows.

The objects in part two are called numeric display. Managers can use the numeric displays to display the current outputs. It can be assigned only one variable to one numeric display. Numeric displays show that what is going on in the model during simulation precisely. There are five numeric display on the control panel. These are finished goods, customer, raw materials, sales, and profit. While the simulation continuous, numeric displays change continuously. To see the output, the simulation can be stopped or paused at any time by using assigned buttons.

The object in the part three is called warning device. This device has several components which are speedometer type gauge, numbers, flashing colors. Also, sound can be assigned to warning device to get a sign about variable behavior during the simulation. Three different zones can be set to a warning device. These are normal, caution, and panic zone. While the simulation continuous, the value of variable passes through these zones. The warning device displays these zones as changing its color which can be green, yellow, and red like traffic lights. Red shows the panic zone. This is like a red alert. Yellow shows caution zone, and green shows normal zone. In addition, warning devices show the numerical value of assigned variable. The warning device on the control panel is assigned to show profit. Because, it is the key variable. Normal zone is set between $500.000 and $700.000. Caution zone is set between $400.000 and $500.000. Red zone is set between $0 and $400.000.

In part four, the name of object is graph. Graphs are useful to display data by plotting while simulation runs. The graph on the control panel has four pages. The first page of the graph is assigned to display the amount of profit. The second page of the graph is set to display the number of finished goods. The third page of the graph is set to display the number of customer. Finally, the fourth page of the graph is assigned to display the quantity of sales. These are all key variables to display.

There are other objects in part five and six. These are called button. Buttons help model builders to perform some interactions with model. They are assigned to perform some operations which are providing information, navigating to locations, and performing a menu command. Diagram and Model button in part five and also Table button in part seven can perform as a navigator. Run, Pause, Stop, and Close button can perform commands that are written on buttons.

The last object in part seven is called table pad. Also, there is a button and written on Table. When managers push this button, they can see table results of the model. the table pad is used for displaying the numerical outputs from simulation. The table pad on the control panel has four pages like graph. The first page of the table pad is assigned to display the amount of profit. The second page of the table pad is set to display the number of finished goods. The third page of the table pad is set to display the number of customer. Finally, the fourth page of the table pad is assigned to display the quantity of sales.

Finally, every object on the control panel have been explained. Now, all the variable are known with their function. It is time to discover some strategies to solve decreasing profit problem. The next part will introduce several strategies to deal with the decreasing profit problem. Management team will try to find a better solutions by rendering their mental models.

5.5 Strategy Design by Using the Control Panel of Management Flight Simulator

Management team members are shared their mental models while they were building the system dynamics model for Baby Toys. Also, team members explore the dynamic behavior of the system over time by simulating the model. Simulation also helps them to understand the characteristics of the system. When they notice these, they will have the opportunity to discover the high leverage points to change the system structure. In addition, if they know the structure of the system, they can change the behavior of the system. Simulating the model gives this chance to team members.

Management flight simulators can create an environment to make many experiments that are deal with real world issues but virtually. Now, it is time to explain how to make it possible. Managers will try to explore some strategies to solve decreasing profit of Baby Toys. They can learn the dynamics of the system and discover the highest leverage point while they are implementing these strategies.

Simulation strategies will start from the end of fourth month value of profit which is $401000. Also, the results of strategies will be examined in 24 months to see long term perspectives. Managers have decided to focus on four main variables in this model. These are profit, sales, customer, and finished goods.

5.5.1 Strategy 1: No change

Firstly, managers run the model with no change to see what happens in period of 24 month. The results are shown in Figure 5.15.

As Figure 5.15 indicates that the level of profit decreases until approximately end of the 14th month and the level of profit goes to zero. This means that the company goes to bankruptcy. Finished goods decreases like sales, because of increasing the number of customer. But, the company cannot sell many products to respond to the number of customer, because it does not have enough number of finished products to respond to this. Under these conditions, it is obvious that this is not a good strategy.

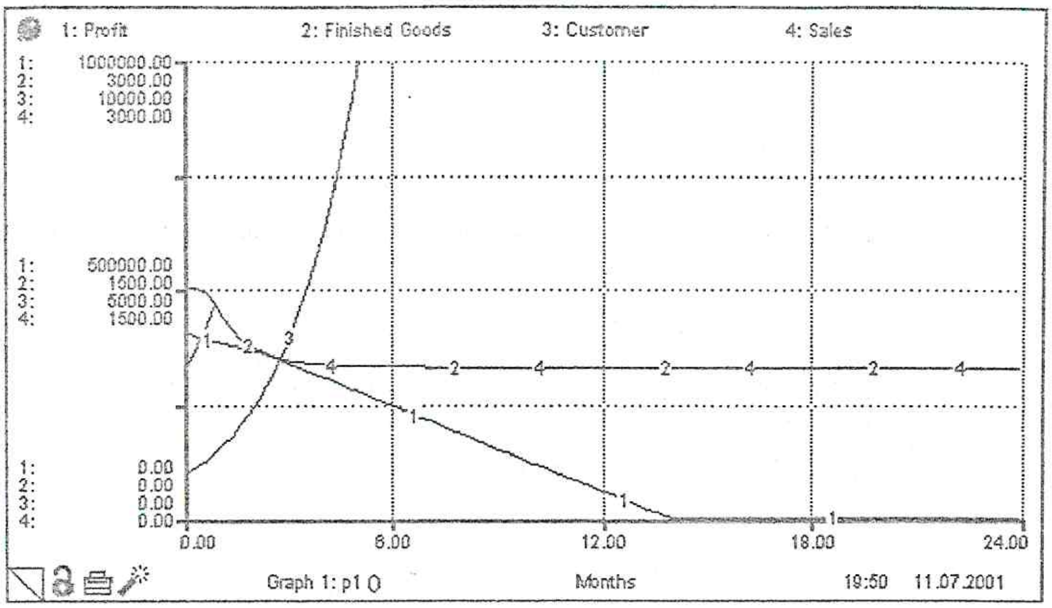


Figure 5.15 The graph of Strategy 1

5.5.2 Strategy 2: Increasing the price

Managers of Baby Toys had decided the increase the price of their product. The current price of the company is $48. Decisions for Strategy 2 are shown in Table 5.2.

Table 5.2 Decisions for Strategy 2

Line	Price ($)
Line 1	55
Line 2	75
Line 3	95

As Table 5.2 illustrates that there are three lines which represent different prices. Line 1 represents the price which is $55. Line 2 represents the price which is $75. And, line 3 represents the price which is $95. These lines are valid for all graphs for Strategy 2.

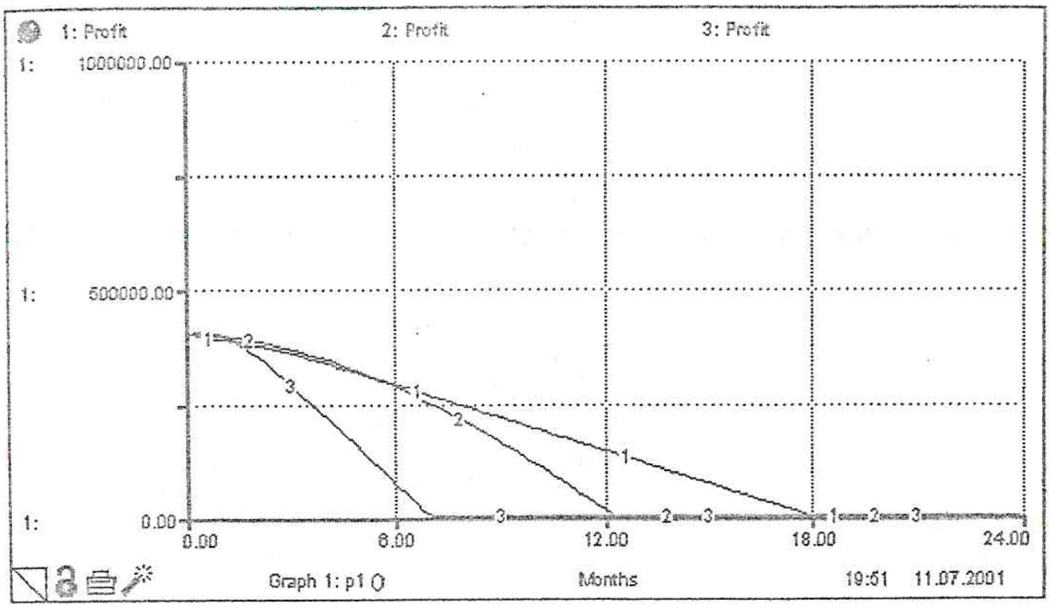


Figure 5.16 The graph of Profit for Strategy 2

Logically, managers may think that if they raise the price, the amount of profit will increase. But, this comparative graph in Figure 5.16 shows the opposite of this. To understand this, the other key variable graphs can be examined. These are finished goods, customer, and sales.

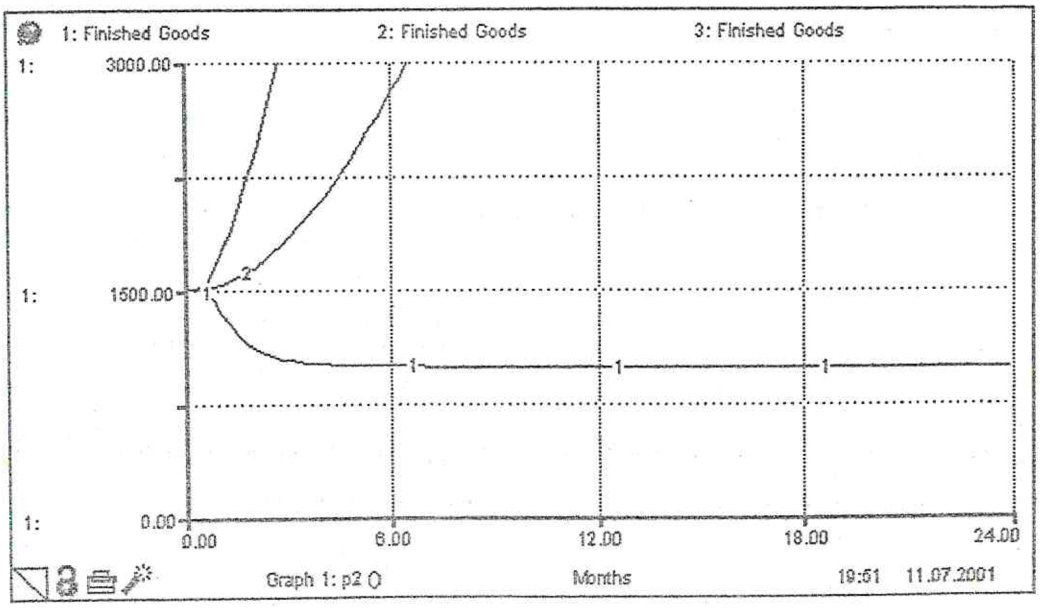


Figure 5.17 The graph of Finished Goods for Strategy 2

As it is shown in Figure 5.17, when the price is equal to $55, the number finished goods remains stable. When the price is equal to $75, the number of finished goods increases. Finally, when the price is equal to $95, the number of finished goods again increases.

Figure 5.18 shows the graph of customer. When the price is equal to $55, the number of customer increases. This may indicate that the price is still cheap. When the price is equal to $75, the number of customer decreases. It can be said that the price of product is expensive. When the price is equal to $95, the number of customer again decreases but much more sharply. Because, the price is much more expensive.

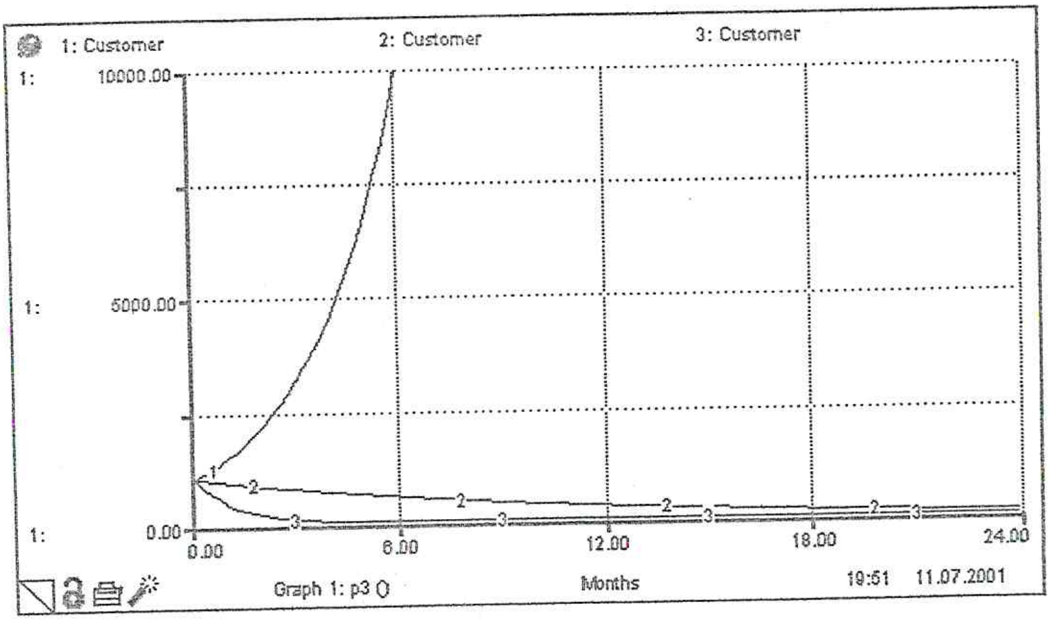


Figure 5.18 The graph of Customer for Strategy 2

Another important key variable is sales as indicated in Figure 5.19. When the price is equal to $55, the quantity of sales remains stable like finished goods. When the price is equal to $75, the quantity of sales falls because of decreasing number of customers. It is also valid when the price is equal to $95, but much more sharply.

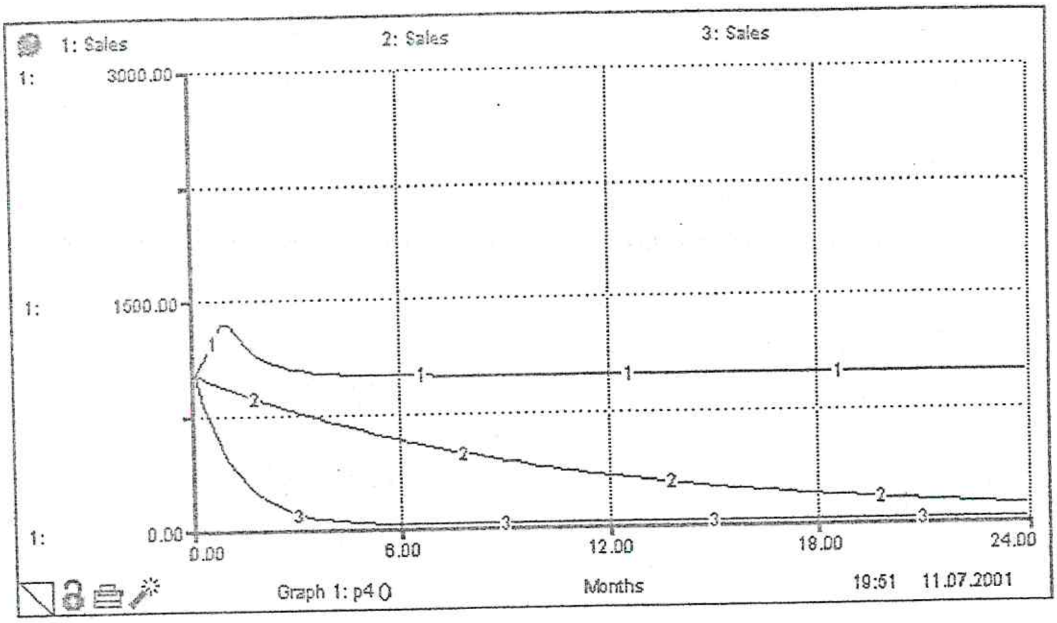


Figure 5.19 The graph of Sales for Strategy 2

To conclude, it can be said that customers are sensitive according to price, but the amount of profit would not increase by increasing the prices. If the price increases, the number of finished goods increase, because the company cannot sell while the number of customer decreases. So that, it is clear that Strategy 2 is not a good strategy to increase the amount of profit.

5.5.3 Strategy 3: Changing the marketing expense

Marketing expense per product affects the number of customer. The value of marketing expense per product may affect the amount of profit by increasing the number of customer. If the number of customer raises, the quantity of sales increases. Remembering that the current marketing expense per product is $2.

Decisions for Strategy 3 are illustrated in Table 5.3, there are four lines which refer the four different marketing expense per product. Line 1 represents the marketing expense per product which is $1. Line 2 represents $1.5. Line 3 represents $2.5. Line 4 represents $3. These lines are valid for all graphs for Strategy 3.

Table 5.3 Decisions for Strategy 3

Line	Marketing expense per product ($)
Line 1	1
Line 2	1.5
Line 3	2.5
Line 4	3

The comparative graph of the profit in Figure 5.20 indicates that only changing marketing expense per product does not make any sense.

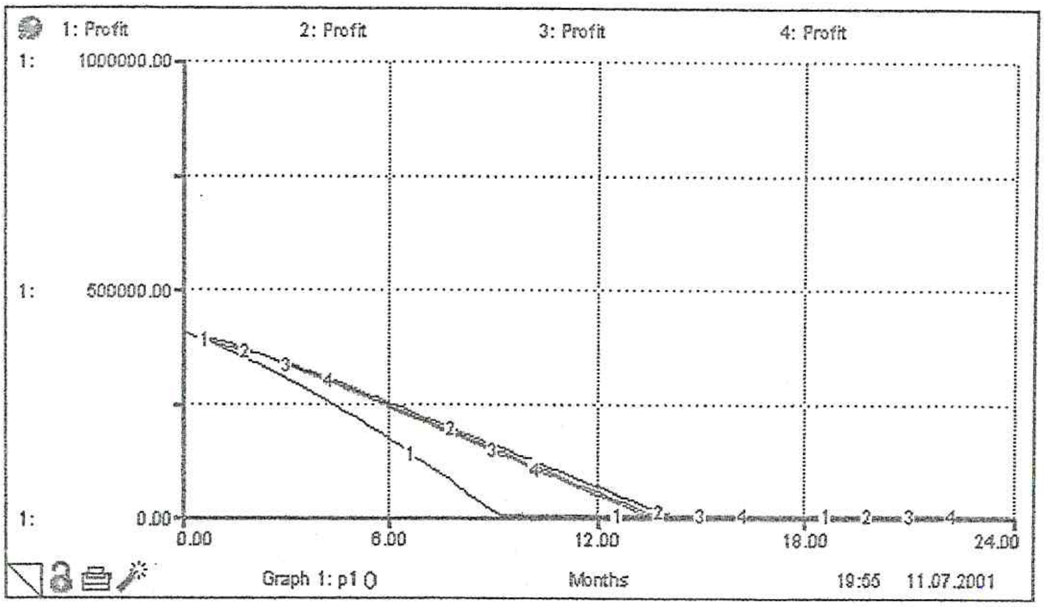


Figure 5.20 The graph of Profit for Strategy 3

As it is illustrated in Figure 5.21, when the marketing expense per product is equal to $1, the number of finished goods increases. When the marketing expense per product is equal to $1.5, $2.5, and $3, the number of finished goods diminishes.

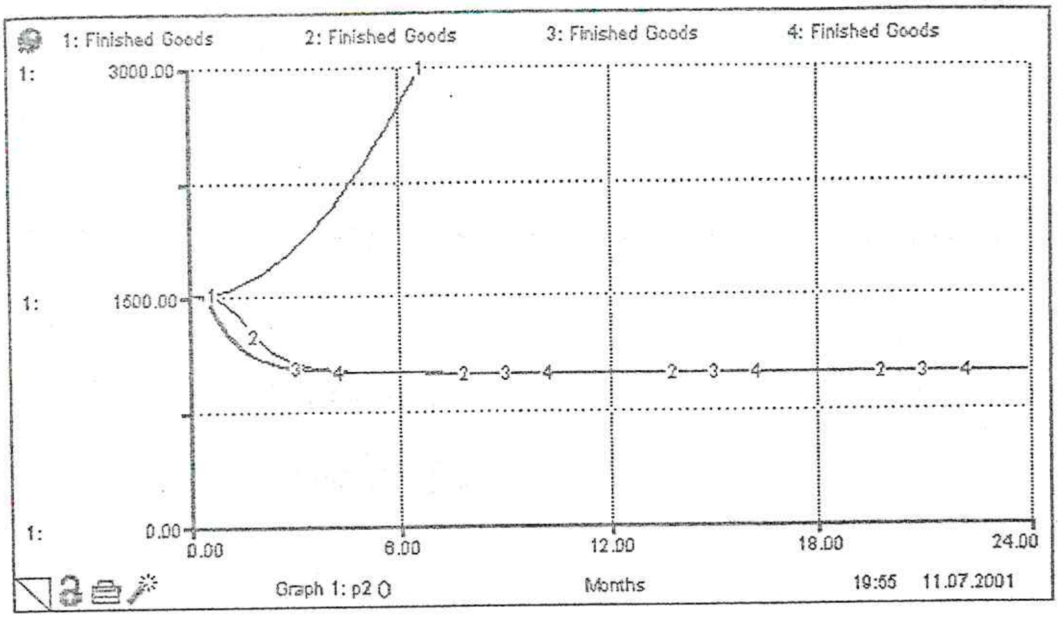


Figure 5.21 The graph of Finished Goods for Strategy 3

The number of customer graph in Figure 5.22 indicates that, if the marketing expense per product is equal to \$1, the number of customer decreases. When the marketing expense per product is equal to \$1.5, \$2.5, and \$3, the number of customer increases.

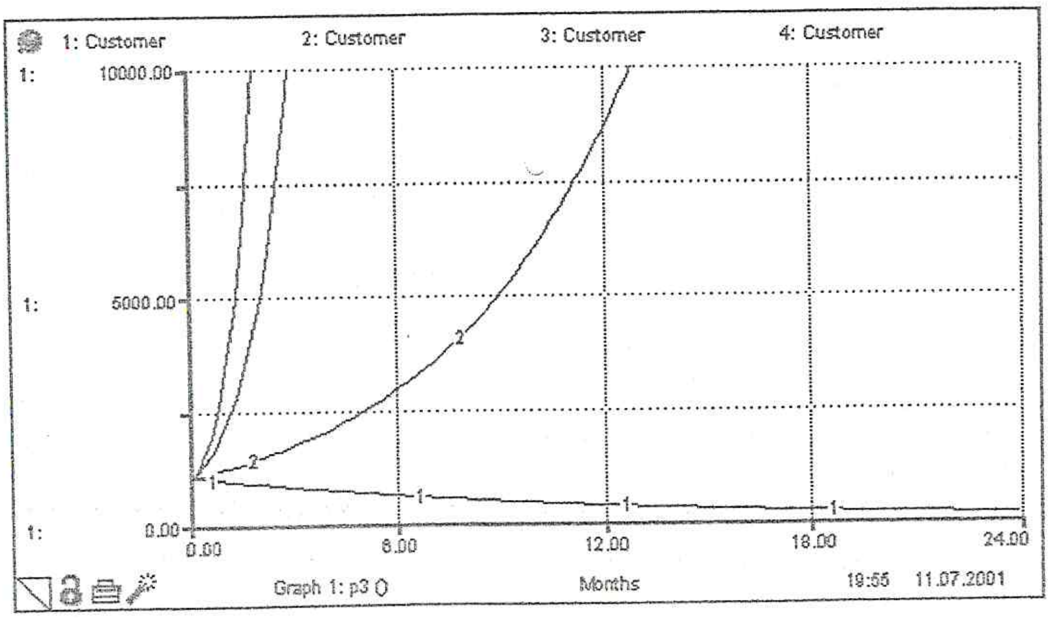


Figure 5.22 The graph of Customer for Strategy 3

As it is shown in Figure 5.23, the quantity of sales can be seen. When the marketing expense per product is equal to $1, the quantity of sales diminishes. If the marketing expense per product is equal to $1.5, $2.5, and $3, the quantity of sales remains stable.

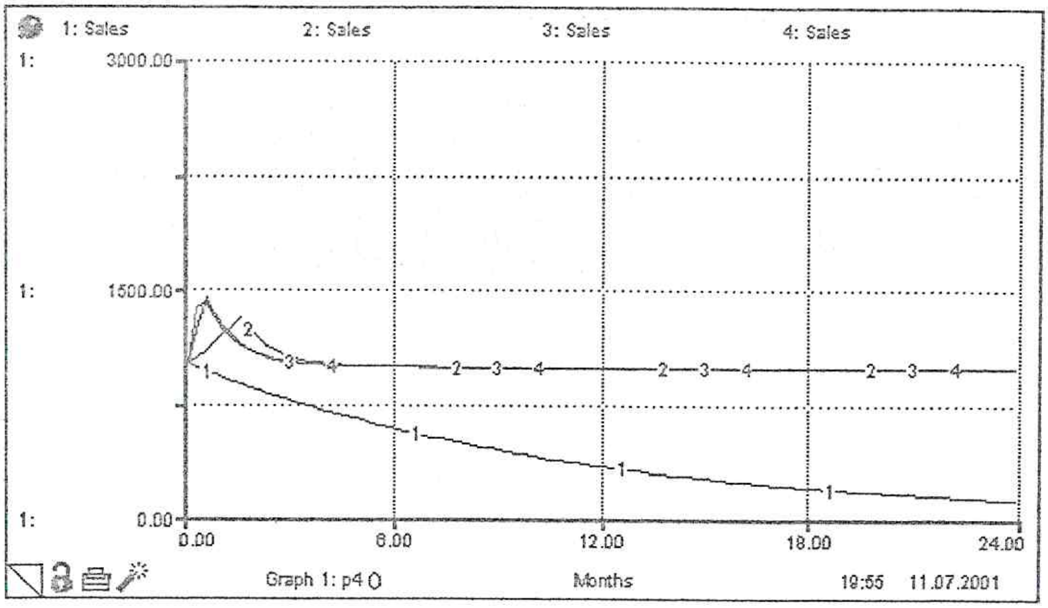


Figure 5.23 The graph of Sales for Strategy 3

In brief, when the marketing expense per product is equal to $1, the number of finished goods increases. Because, the number of customer decreases like the quantity of sales. So that, the amount of profit diminishes. When the marketing expense per product is equal to $1.5, $2.5, and $3, the number of finished goods diminishes. But, the number of customer increases while the marketing expense raises. The quantity sales remains the same like the number of finished goods. This shows that the number customer is sensitive to the marketing expense per product which refers advertising, promotion etc. Finally, it can be said that again there is a decreasing profit trend. To conclude, it is again not a good strategy.

5.5.4 Strategy 4 : Increasing the price with increasing the marketing expense

So far, managers understood that there is no possibility to solve the problem of decreasing profit by only changing the one variable. Therefore, they have decided to combine two or more variables to solve problem. In this strategy, they try to increase selling price by increasing marketing expense per product to support the increase in selling price. Because, they think that there is no possibility to increase profit only by increasing selling price.

Table 5.4 Decisions for Strategy 4

Line	Price ($)	Marketing expense per product ($)
Line 1	65	2.2
Line 2	75	2.4
Line 3	85	2.6
Line 4	90	2.8
Line 5	95	2.8

Decisions for Strategy 4 are shown in Table 5.4. There are five lines which represent the combination of increasing the price and increasing the marketing expense per product. Line 1 represents the price which is $65, and the marketing expense per product which is $2.2. Line 2 represents the price which is $75, and the marketing expense per product which is $2.4. Line 3 represents the price which is $85, and the marketing expense per product which is $2.6. Line 4 represents the price which is $90, and the marketing expense per product which is $2.8. Line 5 represents the price is $95, and the marketing expense per product which is $2.8. These lines are valid for all graphs for Strategy 4.

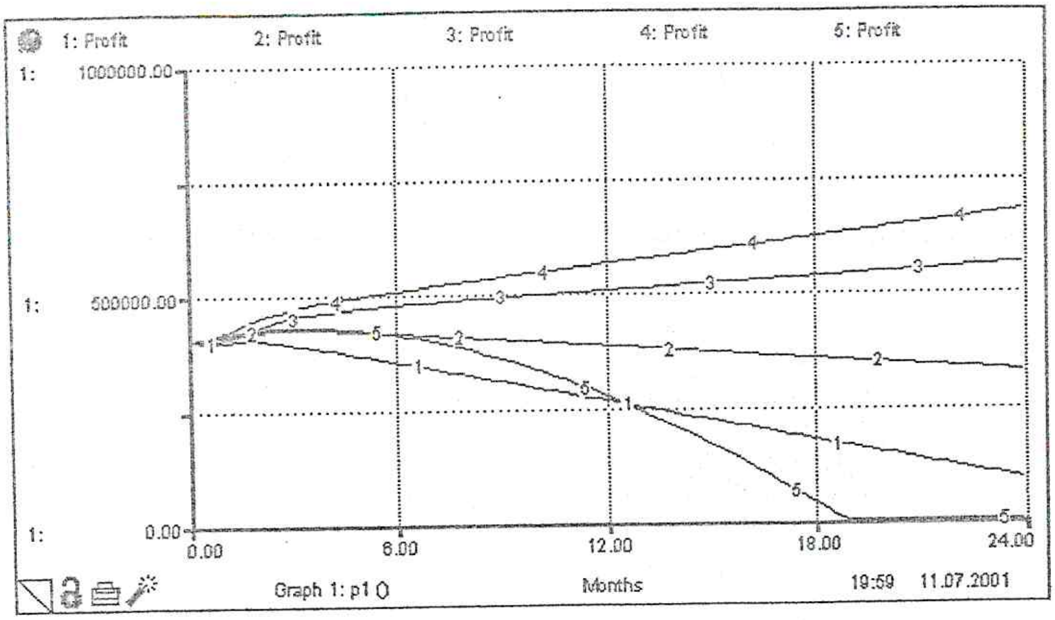


Figure 5.24 The graph of Profit for Strategy 4

Figure 5.24 shows that the amount of profit increases according to line 3 and 4. Line 3 represents the price which is equal to \$85, and the marketing expense per product is equal to \$2.6. Line 4 represents the price is equal to \$90, and the marketing expense per product is equal to \$2.8, the amount profit raises, but more sharply.

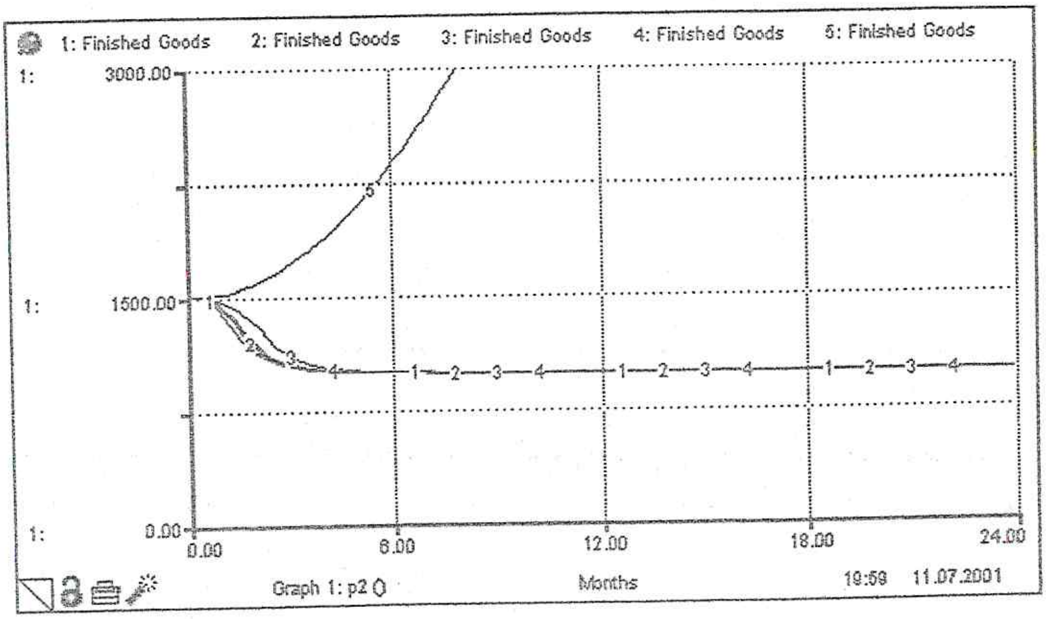


Figure 5.25 The graph of Finished Goods for Strategy 4

The results of the number of finished goods for Strategy 4 can be seen in Figure 5.25. Only, line 5 shows that the company cannot sell and the number of finished goods accumulates. Other lines says that the company sells all goods on hand.

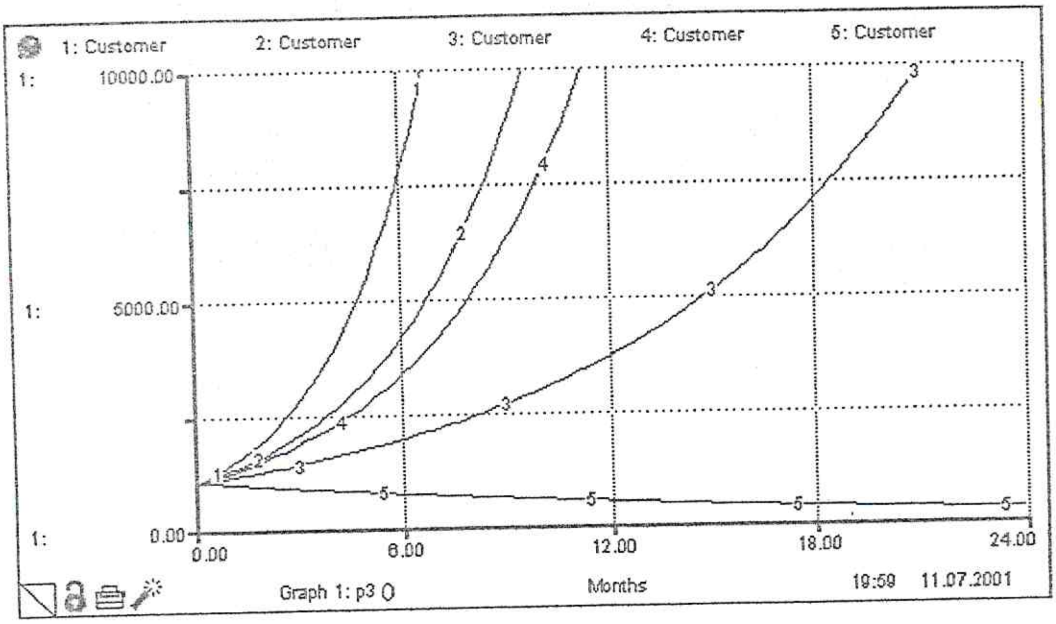


Figure 5.26 The graph of Customer for Strategy 4

The graph of the number of customer is shown in Figure 5.26. Almost, every line on graph says that the number customer increases while the price and the marketing expense per product increase. Only, there is a problem with line 5. In other words, when the price is equal to \$95, and the marketing expense per product is equal to \$2.8, the number of customer diminishes.

As it can be illustrated in Figure 5.27, line 5 indicates the problem with the quantity of sales. But, there is no problem with the other lines, because the company can sell all goods on hand like indicated the graph of the number of finished goods in Figure 5.25. Remembering that the number of customer is sensitive to the price and the marketing expense per product. But, line 5 represents very high price to the market. So that, the number of customer decreases, and also, the quantity of sales diminishes.

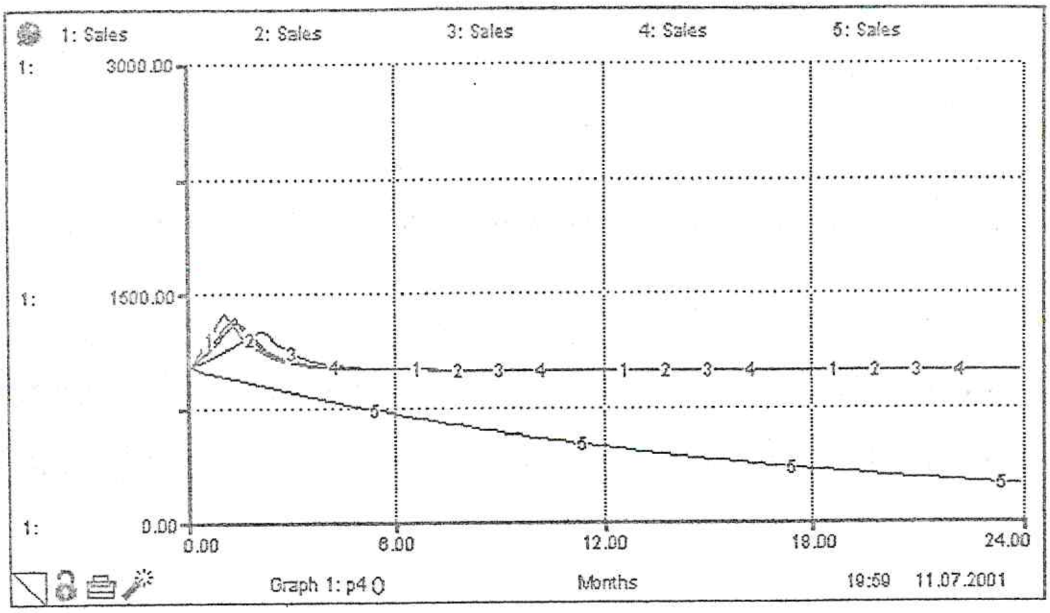


Figure 5.27 The graph of Sales for Strategy 4

Shortly, it can be said that the price of product should be between the $90 and $95. Because, line 4 represents the price which is equal to $90 and line 5 represents the price which is equal to $95. Also, line 4 indicates the increase in profit, but line 5 indicates the decrease in profit. In addition, the marketing expense per product may be taken $2.8. To conclude, it can be observed that this strategy is better one. It shows strategies to increase the amount of profit.

5.5.5 Strategy 5 : Marketing expense, price, production process, and hiring

In this strategy, there are four variables which are marketing expense per product, price, production process capacity, and hiring labors. The value of marketing expense per product raises from $2 to $2.8 by depending on Strategy 4. The value of production process capacity raises from 3000 units to 3900 units. The current number of labor is 110, and, it raises from 110 to 145 by hiring 35 labors. In this strategy, the changing variable is the price.

Table 5.5 Decisions for Strategy 5

Line	Marketing expense per product ($)	Hiring	Pro. Proc.	Price ($)
Line 1	2.8	35	3900	65
Line 2	2.8	35	3900	75
Line 3	2.8	35	3900	80
Line 4	2.8	35	3900	90
Line 5	2.8	35	3900	95

Decisions for Strategy 5 are illustrated in Table 5.5. there are five lines to represent five different price value. Line 1 represents $65. Line 2 represents $75. Line 3 represents $80. Line 4 represents $90. And, line 5 represents $95. These lines are valid for all graphs for Strategy 5.

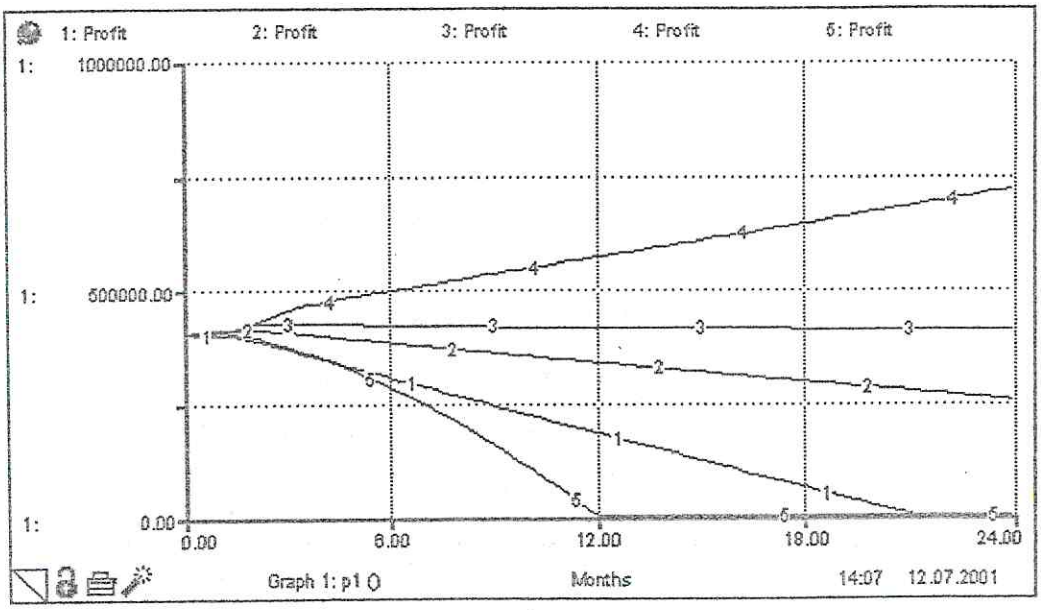


Figure 5.28 The graph of Profit for Strategy 5

As Figure 5.28 indicates that line 4 represents good decision, because it causes to increase in the amount of profit. But, the others are not valuable.

The graph in Figure 5.29 indicates the number of finished goods. It can be observed that the number of finished goods for each line approximately is equal. This shows that the company sells all goods on hand. But, line 5 indicates that the company cannot sell all of its products because of high selling price which is $95.

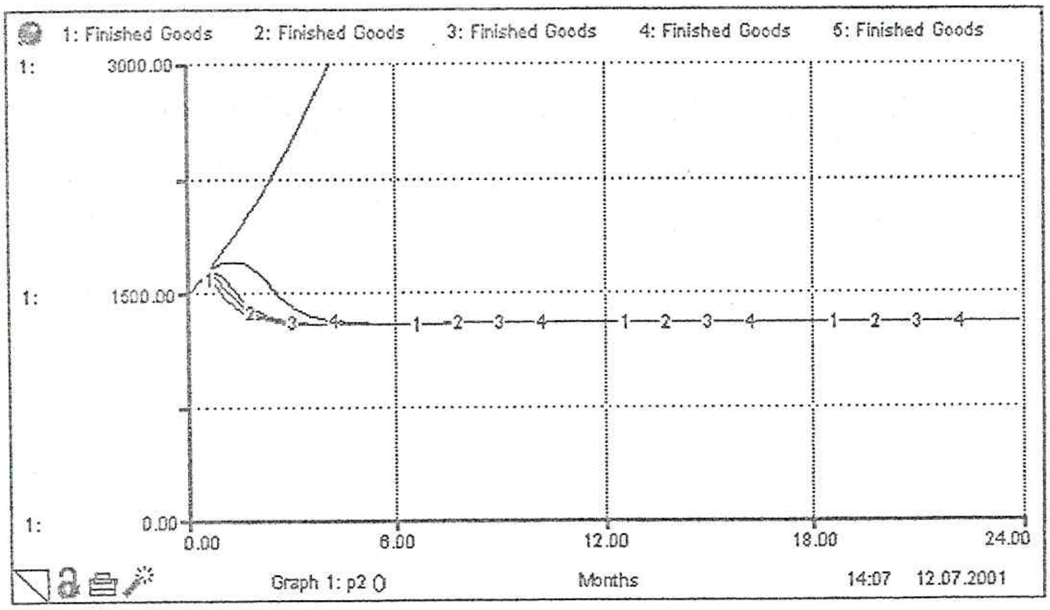


Figure 5.29 The graph of Finished Goods for Strategy 5

As it is shown in Figure 5.30, there is no problem with the number of customer. In fact, Strategy 4 and Strategy 5 prove the idea that the price should be between $90 and $95. Line 4 represents that the price is equal to $90. Also, line 4 has fallen slope, if it is compared with the other lines. Line 5 shows the reason why the company cannot sell its products. The reason is that the number of customer decreases.

Also, the graph of sales in Figure 5.31 indicates that there is no problem with the quantity of sales in the long run. The company can deliver all their products into the market without problem except line 5 which represents the decreasing trend because of the decreasing the number of customer.

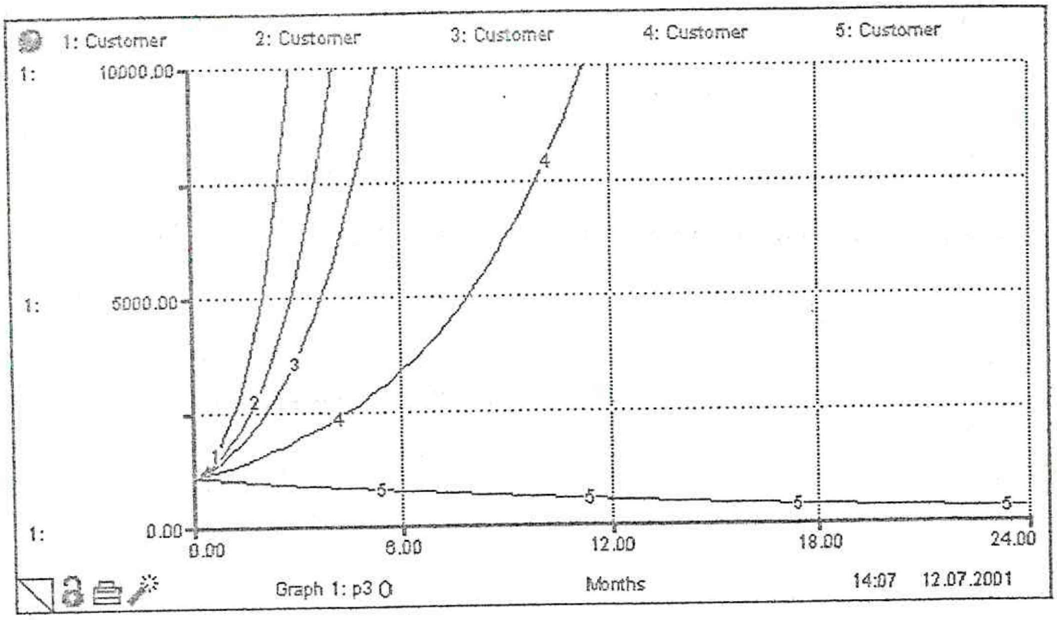


Figure 5.30 The graph of Customer for Strategy 5

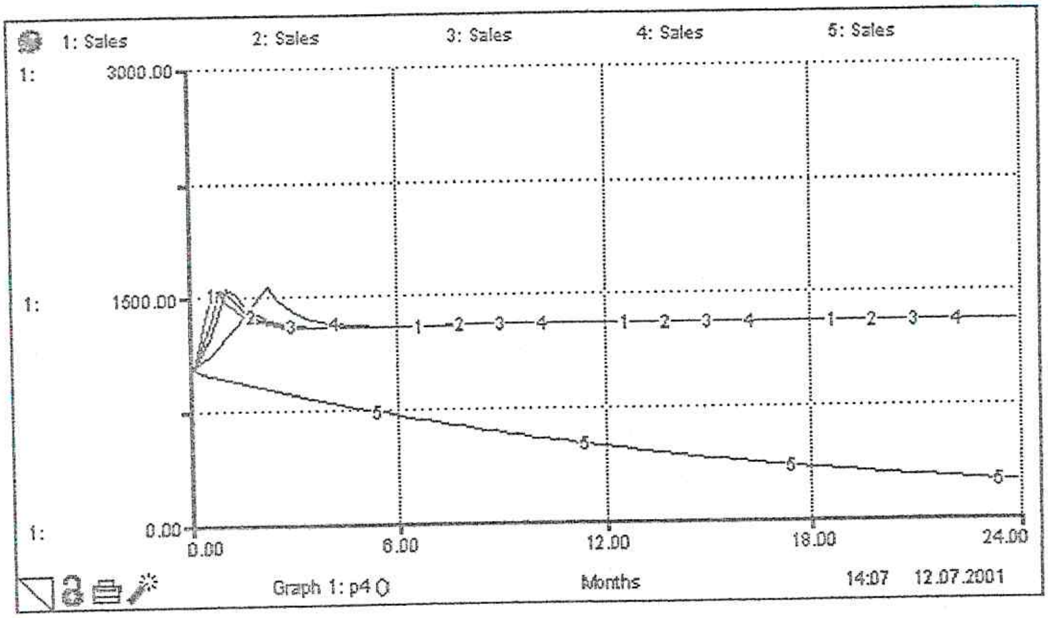


Figure 5.31 The graph of Sales for Strategy 5

Briefly, it can be observed that this strategy is better than the Strategy 4. The amount of profit seems better in the long run. But, the company should increase their production capacity to meet the number of customer. Maybe, managers adjust the price of product precisely between $90 and $95 to make the amount of profit maximum.

5.5.6 Strategy 6: Marketing expense, price, production process, hiring, and salary

In this strategy, five variables are used. These are marketing expense per product, price per product, production process capacity, hiring labors, and average salary per labor. The production process capacity raises from 3000 units to 3900 units. The marketing expense per product raises from $2 to $2.8. And, the number of labor raises from 110 to 145 by hiring 35 labors. The price per product is assigned to $92. The current average salary per labor is $660. In this strategy, salary is the changing variable to see effect of salary to increase productivity of labor.

Table 5.6 Decisions for Strategy 6

Line	Marketing expense per product ($)	Hiring	Pro. Proc.	Price ($)	Salary ($)
Line 1	2.8	35	3900	92	700
Line 2	2.8	35	3900	92	750
Line 3	2.8	35	3900	92	800
Line 4	2.8	35	3900	92	850
Line 5	2.8	35	3900	92	900

As Table 5.6 indicates that there are five lines to represent five different salary value. Line 1 represents the average salary per labor which is $700. Line 2 represents the average salary per labor which is $750. Line 3 represents the average salary per labor which is $800. Line 4 represents the average salary per labor which is $850. And, line 5 represents the average salary per labor which is $900. These five lines are valid for all graphs for Strategy 6.

As Figure 5.32 shows that line 1 and 2 indicate better result according to the amount of profit. Also, line 1 and 2 cause to increase in the amount of profit more sharply than Strategy 5.

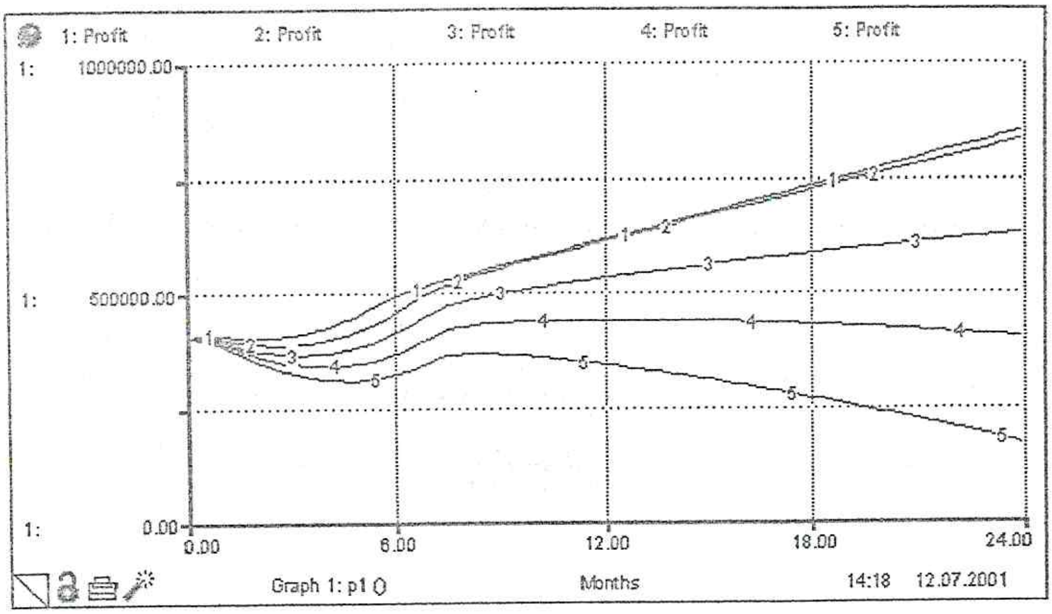


Figure 5.32 The graph of Profit for Strategy 6

Figure 5.33 shows the graph of finished goods, and it indicates that when the salary increases, the number of finished goods increases. Simply, managers think that the average salary per labor is directly related to productivity of labor. When the salary increases, the productivity increases. Also, this cause to increase in the number of finished goods.

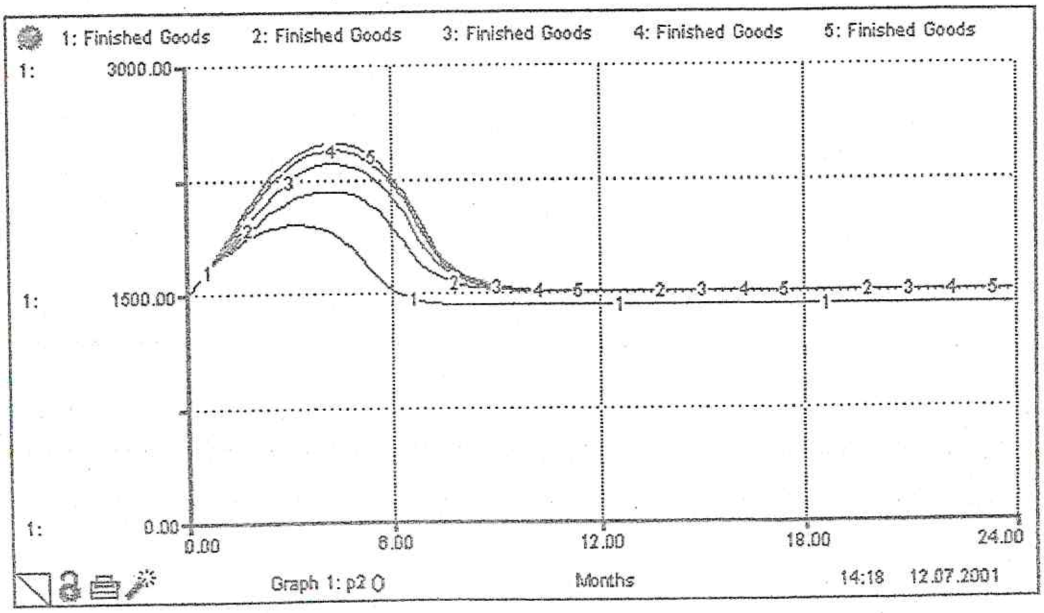


Figure 5.33 The graph of Finished Goods for Strategy 6

Figure 5.34 illustrates that there is no problem with the number of customer. Managers think that the number of customer is enough to sell all products on hand. Under this condition, marketing expense per product plays an important role.

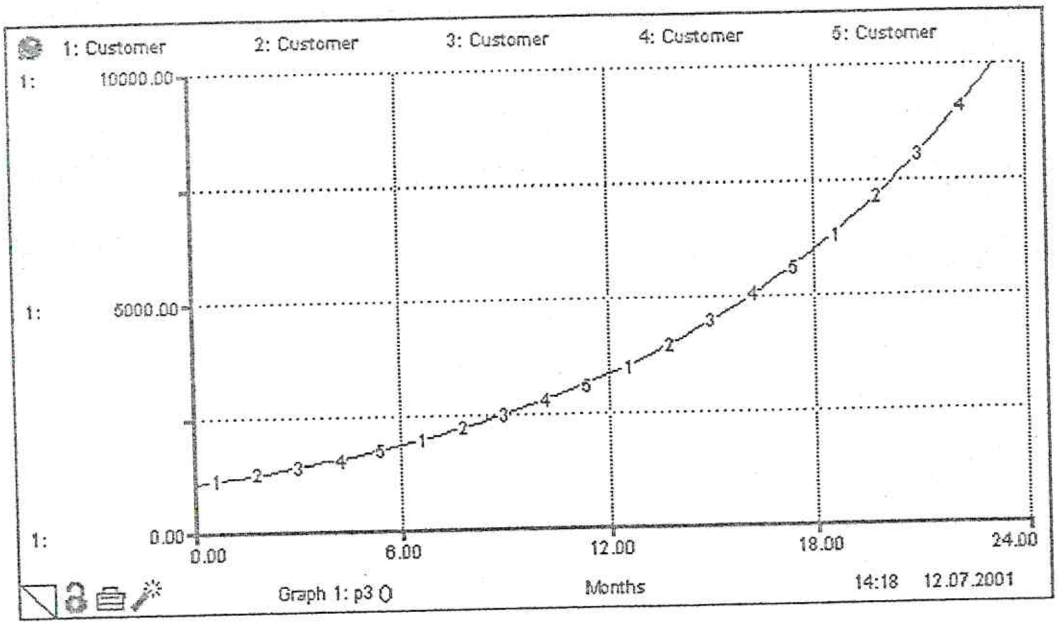


Figure 5.34 The graph of Customer for Strategy 6

As Figure 5.35 indicates that the quantity of sales is related to the number of finished goods and the number of customer. Line 1 introduces less the quantity of sales because of the insufficient number of finished goods. It can be said that there is no problem with customer by depending on Figure 5.34.

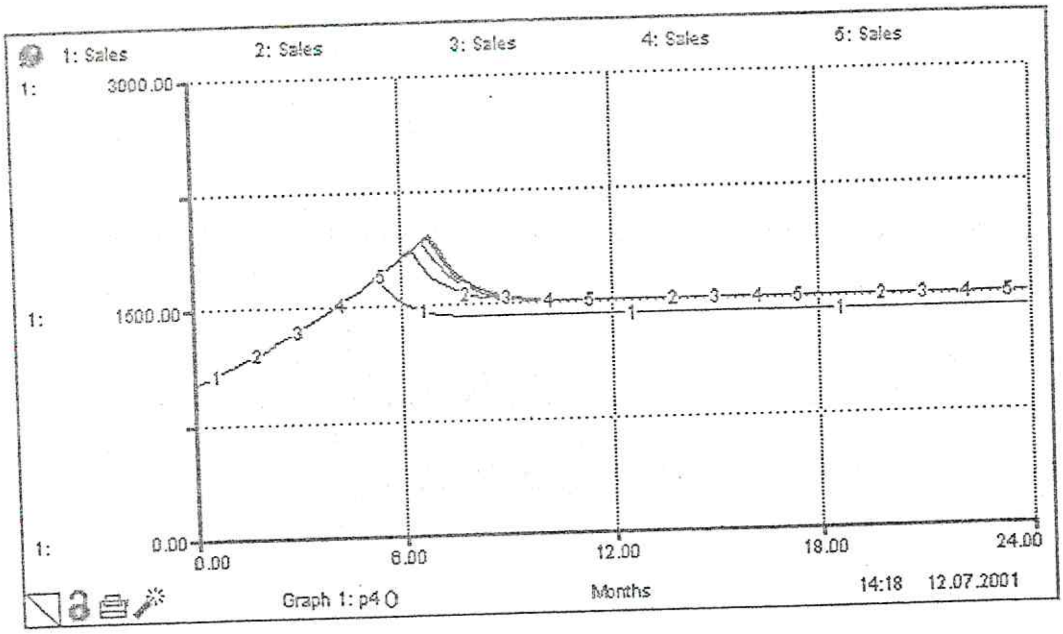


Figure 5.35 The graph of Sales for Strategy 6

In conclusion, it can be said that Strategy 6 is better than other strategies. The amount of profit increases more sharply than other strategies especially line 1 and 2. But, the number of customer increases so sharply. So that, managers should increase the production process capacity of the company to cover all demands by the customer. In addition, increasing the salary per labor causes to increase in productivity. So that, the number of finished goods increases.

5.5.7 Conclusions from the management flight simulator

The management simulator of Baby Toys gave the opportunities to managers to understand the dynamic behavior of the system over time. Also, variety of simulations to develop strategies help managers to discover the structure or characteristics of the system. Based on these simulations, they learned the highest point of leverage to change the system structure to change the behavior of the system over time. Briefly, managers have learned more about the system that they interest. Now, it is the time to say what they have learned from these simulations.

At the first glance, the problem is cheaper selling price. When the price of product is cheaper, the number of customer is becoming to increase. Because, the number customer is more sensitive to the price. Under this condition, managers may think that the solution is to increase in the price. But, only increasing the price is not a solution to solve the problem of decreasing profit. If managers do that, the amount of profit decreases again because of the sensitiveness of price by the number of customer.

Another important factor that influences the number of customer is marketing expense per product. Increase in marketing expense per product affects the number of customer positively. Therefore, managers should use price and marketing expense per product together as a strategy. This can be seen for Strategy 4.

But, the Strategy 4 is not enough. The company needs to increase its production process capacity by hiring new labors to meet the increasing number of customer. In Figure 5.7, the casual loop diagram also refers this. So that, Strategy 5 may be better. Strategy 5 requires to increase the production process capacity, and the hiring new labors to meet increasing production process capacity. This is Strategy 5 which is based on Strategy 4 and it is better than Strategy 4.

In fact, Strategy 6 seems better. Strategy 6 is based on Strategy 4 and 5, also it includes the increasing average salary per labor. When the average salary per labor increases, the average productivity of labor increases. So that, the number of finished goods raises. Under this circumstance, the amount of profit increases. Because, the company can sell more. But, to cover all demands by customers, the company should increase its production process capacity.

To conclude, the highest leverage for the problem of decreasing the amount of profit can be divided into two results. Firstly, the company should increase its price by increasing marketing expense per product. Secondly, the company should increase the production capacity by hiring new labors. Doing these can create to increase in the amount of profit.

As it is explained in above, the managers of the company from now on have a learning laboratory to understand the dynamic behavior of their issue. From now on, they can use their model to test different assumptions and strategies. By doing so, they can reach new inside and new learning levels.

6. CONCLUSIONS AND SUGGESTIONS

In this study, the basic concepts of learning organizations, systems thinking, system dynamics, and learning laboratories as a management tool are examined. Based on these, this study has proposed that systems thinking and system dynamics play an important role to build a learning organization. Learning laboratories are a management tool to help managers to make effective decisions in a computerized environment like real world experimentation.

This study indicates several conclusions. First, knowledge is the primary source for many organizations to continue their existence and to cope with and solve their problems. The concept of learning organization introduces an environment to get and produce knowledge for organizations. Therefore, organizations should transform themselves into a learning organization to continue their existence in their competitive environment.

Second, becoming a learning organization requires the practices of five disciplines. These are personal mastery, mental models, shared vision, team learning and systems thinking. Systems thinking is called as the fifth discipline. It ties and integrates the other four disciplines. So that, it is the main discipline for building a learning organization.

Third, system dynamics is a powerful methodology to understand complex systems. It offers tools to make learning available. It supports systems thinking and systemic perspective, and give the opportunity to managers to understand the behavior and structure of systems by rendering different mental models. Also, system dynamics introduces a modeling process to build a learning laboratories.

Fourth, learning laboratories are a management tool to build a team learning. Team learning is also one of the discipline to build a learning organization. Therefore, learning laboratories are very important management tool for learning organizations. Learning laboratories can create a learning environment for organizational learning by compressing time and space and give opportunities to managers to test their decisions and to render their mental models by various computer simulations. Also, learning laboratories offer a riskless environment, because the environment where managers give decisions is not a real environment. But, the results which they see, are realistic, because the simulation environment is realistic from the point of their mental assumptions.

In this study, the case is used to build a model. It is not aimed to build a perfect system dynamics model. In fact, it can be said that it is necessary to make some sophisticated tests which are mechaincal mistake tests, robustness tests, policy tests, and sensitivity tests to prove that the model is valid one. These tests are technical and should be done in real life situations. These tests can give more confidence to model builders about their model. Also, challenging the boundaries extensively and intensively help model builders to get aware of the limits of their model. These are not included in this study. The aim of this study is that to show how the managers can use learning laboratories as a management tool to solve the problems, make decisions, and develop strategies.

For further investigation, I have three suggestions for researchers who are interested in these subjects. Firstly, they can apply all the tests to the model to make it perfect, and to create a perfect management flight simulator. Secondly, they can use system dynamics approach as a methodology in different fields like marketing, engineering, so on. Thirdly, they can use survey and statistical methods to compare the effectiveness of decision making between traditional research methods and the learning laboratory.

REFERENCES

Anderson, V., and Johnson, L., (1997), System Thinking Basics: From Concepts to Casual Loops, Pegasus Communications Inc., Cambridge, Massachusetts.

Argyris, C., (1977), "Double loop learning in organizations", Harvard Business Review, September-October, pp. 115-125.

Argyris, C., and Schon, D.A., (1978), Organizational Learning, Addison-Wesley, London.

Aronson, D., (1996), "Introduction to Systems Thinking". Available on site http://www.thinking.net/Systems_Thinking/Intro_to_ST/intro_to_st.html

Ayas, K., Foppen, W., and Maljers, F., (1996), "Exploring Organizational Learning: Some Observations On Resistance And Leadership". Available on site http://www.orglearn.nl/Archives/RSM_Book/ayfoma.html

Berryman, R., (1995), "Systems Thinking and Organizations: An Initial Inquiry into the Subject". Available on site http://www.workteams.unt.edu/reports/rberyman.htm

Bixler, B., Liang, P., Patterson, J., Toci, M., Townsend, G., Wang, P., Rieker, J., Dupont, P., and Bickford, S. J., (1996), "Systems Thinking". Available on site http://www.ed.psu.edu/insys/ESD/Systems/thinking/SysThink.htm

Boyett, J. H., and Boyett, J. T., (2000), "The Necessary Conditions for a Learning Culture". Available on site http://jboyett.com/learning.htm

Buckler, B., (1998), "Practical steps towards a learning organisation: applying academic knowledge to improvement and innovation in business processes", The Learning Organization, Volume 5, Number 1, pp. 15-23.

Cooper, B., (1998), "Systems Thinking: A Requirement for all Employees". Available on site http://www.workteams.unt.edu/reports/bcooper.htm

De Geus, A. P., (1988), "Planning as Learning", Harvard Business Review, March-April, pp. 70-74.

Dodgson, M., (1993), "Organizational Learning: A Review of Some Literatures", Organization Studies, 14/3, pp. 375-394.

Drew, S. A. W., and Smith, P. A. C., (1995), "The learning organization: "change proofing" and strategy", The Learning Organization, Volume 2, Number 1, pp. 4-14.

Drucker, P. F., (1988), "The Coming Of The New Organization", Harvard Business Review, January-February, pp. 45-53.

Drucker, P. F., (1992), "The New Society of Organizations", Harvard Business Review, September-October, pp. 95-104.

Dunphy, D., Turner, D., and Crawford, M., (1997), "Organizational learning as the creation of corporate competencies", Journal of Management Development, Vol. 16, No.4, pp. 232-244.

Fiol, C. M., and Lyles, M. A., (1985), "Organizational Learning", Academy of Management Review, Vol. 10, No. 4, pp. 803-813.

Forrester, J. W., (1980), "Information Sources for Modeling the National Economy", Journal of the American Statistical Association, Vol. 75, No. 371, pp. 555-574.

Forrester, J. W., (1991), "System Dynamics and the Lessons of 35 Years". Available on site http://sysdyn.mit.edu/people/jay-forrester.html

Forrester, J. W., (1994), "Learning through System Dynamics as Preparation for the 21 st Century". Available on site http://sysdyn.mit.edu/road-maps/rm-toc.html

Fuenmayor, R., (1997), "The Historical Meaning of Present Systems Thinking", System Research and Behavioral Science, Vol. 14, No. 4, pp. 235-248.

Garvin, D. A., (1993), "Building a Learning Organization", Harvard Business Review, July-August, pp. 78-91.

Graham, A. K., Morecroft, J. D. W., Senge, P. M., and Sterman, J. D., (1992), "Model-supported case studies for management education", European Journal of Operational Research, Vol. 59, pp. 151-166.

Guthrie, D., (1996), "Transforming an Existing Organization into a Learning Organization". Available on site http://www.gdss.com/wp/transform.htm

Gyford, P., (1999), "The Systems Perspective". Available on site http://www.gyford.com/phil/uhcl/systems/perspective.html

Huber, G. P., (1991), "Organizational Learning: The Contributing Processes And The Literatures", Organization Science, February, Vol. 2, No. 1, pp. 88-115.

Kaipa, P., (1996), "3 Keys To Build A Learning Organization". Available on site http://www.smartbiz.com/sbs/arts/exe142.htm

Karash, R., (1996), "How to Find "Structure"". Available on site http://world.std.com/~rkarash/structure/

Kerka, S., (1995), "The Learning Organization". Available on site http://www.ericacve.org/docs/mr00004.htm

Kim, D. H., (1994a), Systems Archetypes I, Pegasus Communication Inc., Cambridge, Massachusetts.

Kim D. H., (1994b), Systems Archetypes II, Pegasus Communication Inc., Cambridge, Massachusetts.

Kim, D.H., (1997), Toward Learning Organizations, Pegasus Communication Inc., Cambridge, Massachusetts.

Kirkwood, C. W., (1998), "System Dynamics: A Quick Introduction". Available on site http://www.public.asu.edu/~kirkwood/sysdyn/SDIntro/SDIntro.htm

Kofman, F., and Senge, P. M., (1993), "Communities of commitment: the heart of learning organizations". Available on site http://deming.eng.clemson.edu/pub/tqmbbs/prin-pract/comcom.txt

Larsen, K., McInerney, C., Nyquist, C., Santos, A., and Silsbee, D., (1996), "Learning Organizations". Available on site http://home.nycap.rr.com/klarsen/learnorg/

Leitch, C., Harrison, R., Burgoyne, J., and Blantern, C., (1996), "Learning organizations: the measurement of company performance", Journal of European Industrial Training, 20/1, pp. 31-44.

Malhotra, Y., (1996), "Organizational Learning and Learning Organizations: An Overview". Available on site http://www.brint.com/papers/orglrng.htm

Martin, L. A., (1997), "The First Step". Available on site http://sysdyn.mit.edu/road-maps/rm-toc.html

Mason, G. L., (1997), "A Conceptual Basis for Organizational Modelling", System Research and Behavioral Science, Vol. 14, No. 4, pp. 331-345.

McGill, M. E., Slocum, J. W., and Lei, D., (1992), "Management Practices in Learning Organizations", Organizational Dynamics, Summer, Vol. 21, No. 1, pp. 5-17.

McNamara, C., (1999), "Thinking About Organizations as Systems". Available on site http://www.mapnp.org/library/org_thry/org_sytm.htm

Milling, P. M., (1996), "Modeling innovation processes for decision support and management simulation", System Dynamics Review, Fall, Vol. 12, No.3, pp. 211-234.

Nolan, T., Goodstein, L., and Pfeiffer, J. W., (1993), "Create And Nurture A Learning Organization". Available on site http://www.smartbiz.com/sbs/arts/pod2.htm

Ossimitz, G., (1997), "The Development Of Systems Thinking Skills Using System Dynamics Modeling Tools". Available on site http://www.uni-klu.ac.at/users/gossimit/sdyn/gdm_eng.htm

Schein, E. H., (1993), "How Can Organizations Learn Faster? The Challenge of Entering The Green Room", Sloan Management Review, Winter, pp. 85-92.

Schein, E. H., (1994), "Organizational and Managerial Culture as a Facilitator or Inhibitor of Organizational Learning". Available on site http://www.solonline.org/solonline/res/wp/10004.html

Senge, P. M., (1990), The Fifth Discipline: The Art and Practice of The Learning Organization, Doubleday, New York.

Senge, P. M., (1996), "Building Learning organizations", IEEE Engineering Management Review, Spring, pp. 96-104.

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, Doubleday, New York.

Senge, P. M., and Sterman, J. D., (1992), "Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future", European Journal of Operational Research, Vol. 59, pp. 137-150.

Sterman, J. D., (1989), "Modeling Managerial Behavior: Misperceptions Of Feedback In A Dynamic Decision Making Experiment", Management Science, March, Vol. 35, No. 3, pp. 321-339.

Stuter, L. M., (1998), "Systems Thinking". Avalable on site http://www.icehouse.net/lmstuter/page0026.htm

Sugarman, B., (1996a), "The Learning Organization and Organizational Learning: New Roles for Workers, Managers, Trainers, and Consultants". Available on site http://aristotle.lesley.edu/faculty/sugarman/loandtd.htm

Sugarman, B., (1996b), "Learning, Working, Managing, Sharing: The New Paradigm of the "Learning Organization"". Available on site http://www.lesley.edu/journals/jppp/2/sugarman.html

Swain, P., (1999), "Organisational learning: developing leaders to deal with continuous change – a strategic human resource perspective", The Learning Organization, Volume 6, Number 1, pp. 30-37.

Teare, R., and Dealtry, R., (1998), "Building and sustaining a learning organization", The Learning Organization, Volume 5, Number 1, pp. 47-60.

Terziovski, M., Howell, A., Sohal, A., and Morrison, M., (2000), "Establishing mutual dependence between TQM and the learning organization: a multiple case study analysis", The Learning Organization, Volume 7, Number 1, pp. 23-31.

Vennix, J. A. M., (1996), Group Model Building: Facilitating Team Learning Using System Dynamics, Wiley & Sons, New York.

Vennix, J. A. M., Akkermans, H. A., and Rouwette, E. A. J. A., (1996), "Group model-building to facilitate organizational change: an exploratory study", System Dynamics Review, Spring, Vol. 12, No. 1, pp. 39-58.

West, P., (1994), "The Concept of the Learning Organization", Journal of European Training, Vol. 18, No. 1, pp. 15-21.

Whalley, R. M., (1998), "Towards realising the full benefit of computer aided learning", Industrial and Commercial Training, Volume 30, Number 2, pp. 53-62.

APPENDIX 1: ALGEBRAIC EQUATIONS

PRODUCTION

Finished_Goods(t) = Finished_Goods(t - dt) + (completing_prod - delivering) * dt

INIT Finished_Goods = 1500

INFLOWS:

completing_prod =
IF((Production_Process/3)>1500)THEN(1500)ELSE(Production_Process/3)

OUTFLOWS:

delivering = Sales

Labor(t) = Labor(t - dt) + (hiring - firing) * dt

INIT Labor = 110

INFLOWS:

hiring = 0

OUTFLOWS:

firing = 0

Production_Process(t) = Production_Process(t - dt) + (starting_prod - completing_prod) * dt

INIT Production_Process = 3000

INFLOWS:

starting_prod(i) = starting_prod(o) * CONVERSION MULTIPLIER

CONVERSION MULTIPLIER = 21

OUTFLOWS:

completing_prod =
IF((Production_Process/3)>1500)THEN(1500)ELSE(Production_Process/3)

Raw_materials(t) = Raw_materials(t - dt) + (order_raw_mat - starting_prod) * dt

INIT Raw_materials = 2000

INFLOWS:

order_raw_mat = raw_mat_ordering_decision

OUTFLOWS:

starting_prod(o) = Labor*avr_productivity_of_labor

raw_mat_ordering_decision =
IF(Raw_materials<Target_Raw_Mat)THEN(Raw_materials+1000)ELSE(0)

Target_Raw_Mat = 2000

avr_productivity_of_labor = GRAPH(avr_salary_per_labor)
(0.00, 0.00), (100, 0.025), (200, 0.055), (300, 0.1), (400, 0.145), (500, 0.235), (600, 0.365), (700, 0.465), (800, 0.57), (900, 0.7), (1000, 0.985)

MARKET

Customer(t) = Customer(t - dt) + (inc_in_customer - dec_in_customer) * dt

INIT Customer = 1000

INFLOWS:

inc_in_customer = Customer*(marketing\customer_inc_rate+price\customer_inc_rate)

OUTFLOWS:

dec_in_customer = Customer*(marketing\customer_dec_rate+price\customer_dec_rate)

price_per_product = 40

Sales = IF(Finished_Goods>Customer)THEN(Customer)ELSE(Finished_Goods)

marketing\customer_dec_rate = GRAPH(mark_exp_per_product)
(0.00, 0.985), (0.3, 0.87), (0.6, 0.85), (0.9, 0.785), (1.20, 0.73), (1.50, 0.575), (1.80, 0.5), (2.10, 0.43), (2.40, 0.27), (2.70, 0.205), (3.00, 0.025)

marketing\customer_inc_rate = GRAPH(mark_exp_per_product)
(0.00, 0.01), (0.3, 0.07), (0.6, 0.095), (0.9, 0.125), (1.20, 0.175), (1.50, 0.225), (1.80, 0.305), (2.10, 0.47), (2.40, 0.575), (2.70, 0.72), (3.00, 1.00)

price\customer_dec_rate = GRAPH(price_per_product)
(0.00, 0.02), (10.0, 0.07), (20.0, 0.085), (30.0, 0.095), (40.0, 0.15), (50.0, 0.215), (60.0, 0.245), (70.0, 0.33), (80.0, 0.5), (90.0, 0.65), (100, 1.00)

price\customer_inc_rate = GRAPH(price_per_product)
(0.00, 0.98), (10.0, 0.965), (20.0, 0.86), (30.0, 0.805), (40.0, 0.78), (50.0, 0.725), (60.0, 0.615), (70.0, 0.425), (80.0, 0.29), (90.0, 0.19), (100, 0.00)

FINANCE

Profit(t) = Profit(t - dt) + (inc_in_profit - dec_in_profit) * dt

INIT Profit = 500000

INFLOWS:

inc_in_profit = sales_revenues

OUTFLOWS:

dec_in_profit =
ordering_raw_mat_expense+marketing_expenses+production_expenses+salary_expenses

avr_salary_per_labor = 500

marketing_expenses = delivering*mark_exp_per_product

mark_exp_per_product = 1.5

ordering_expense_per_unit_raw_mat = 0.2

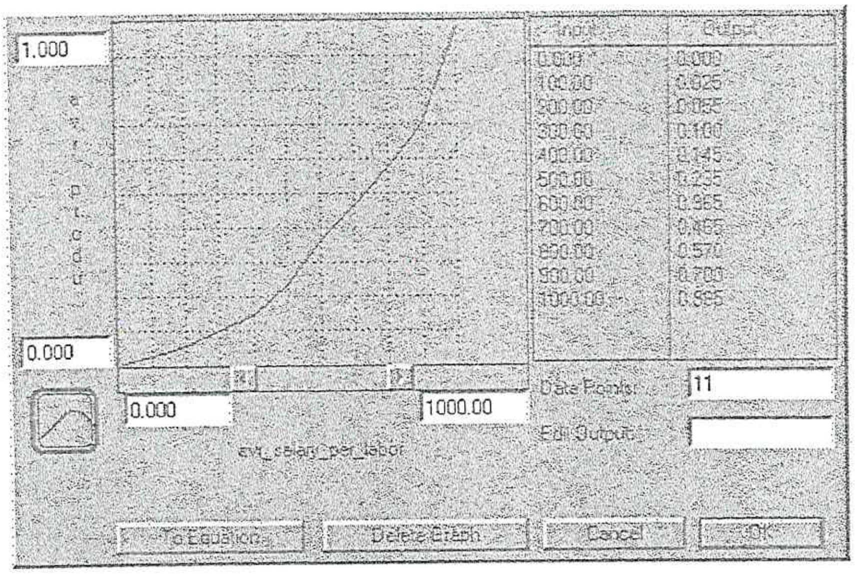
production_expenses = Production_Process*production_expense_per_product production_expense_per_product = 1.18

salary_expenses = Labor*avr_salary_per_labor

APPENDIX 2: GRAPHICAL FUNCTIONS

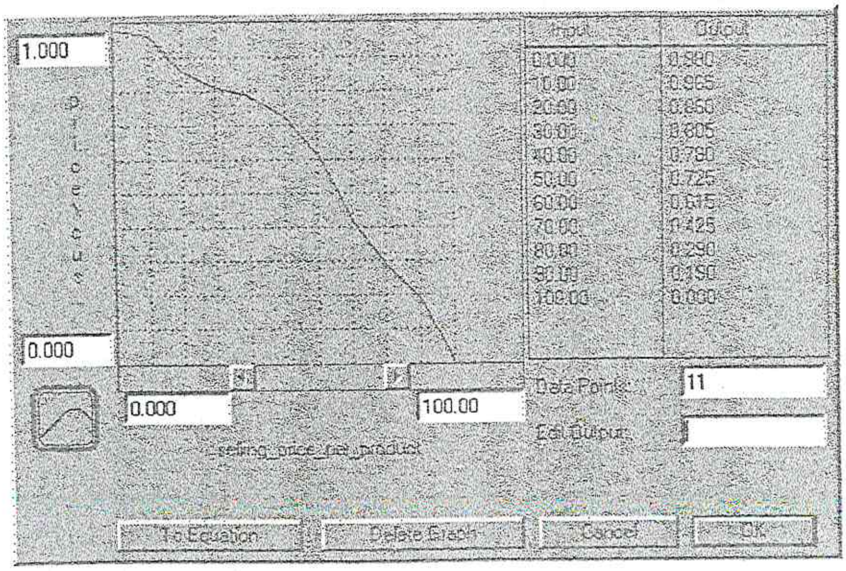
PRODUCTION

1) Average productivity of labor and average salary per labor

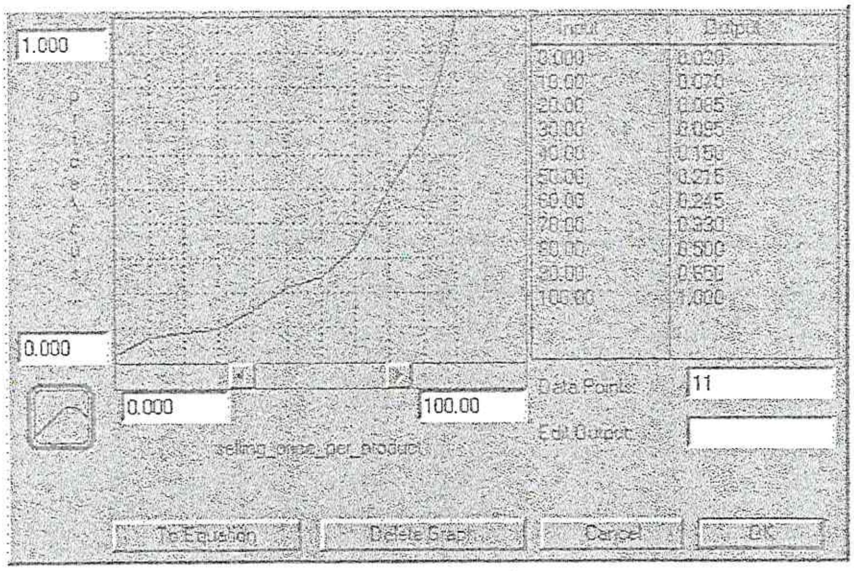


MARKET

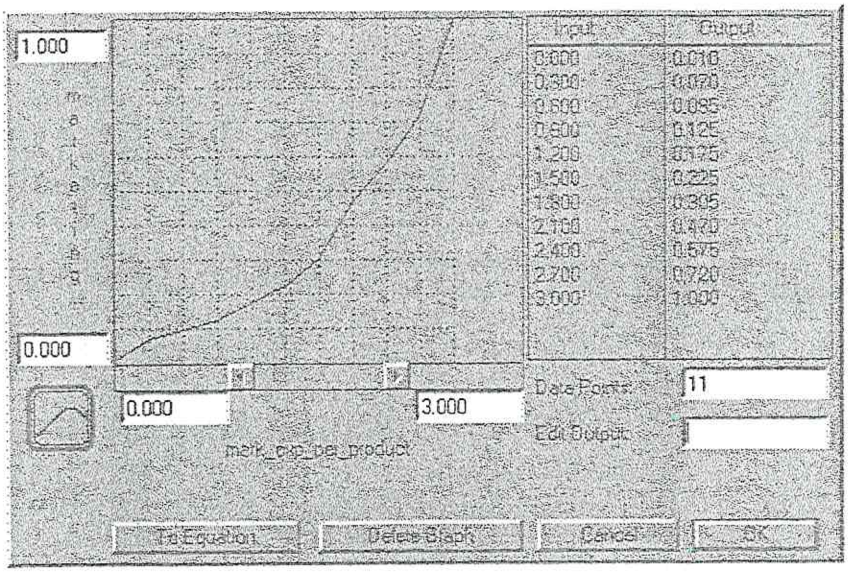
1) Price\customer increase rate and selling price per product



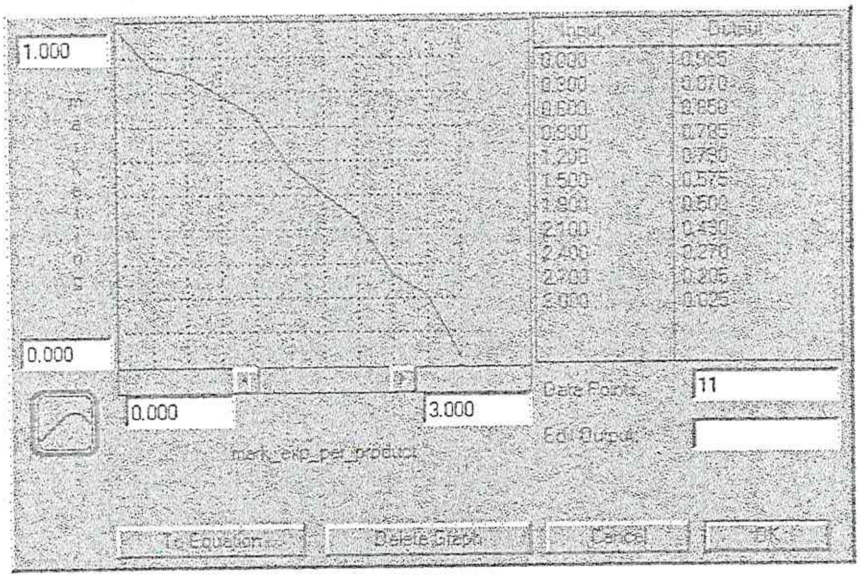
2) Price\customer decrease rate and selling price per product



3) Marketing\customer increase rate and marketing expense per product



4) Marketing\customer decrease rate and marketing expense per product



AUTOBIOGRAPHY

Personal Information

Date of birth	27.01.1974
Place of birth	Silistre
Marital status	Single

Education

High school	1989-1992	Maçka Akif Tuncel Technical Lycee
Bachelor of science	1993-1998	Marmara University Technical Education Faculty; Computer and Electronic Department, Control Main Field
Master of business administration	1998-2001	Yeditepe University Graduate Institute Of Social Sciences

Work Experience

07/97 – 08/97	HP (Hewlett Packard) Istanbul, Turkey Trainee / Authorized Support Center (SIBNET)
07/96 – 08/96	KOÇBANK A.Ş., Istanbul, Turkey Trainee / Data Processing Center Department
07/94 – 10/94	T.H.Y., Istanbul, Turkey Trainee / Data Processing Center Department