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The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

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ABSTRACT

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BEER'S VIABLE SYSTEM DIAGNOSIS IN ACTION

This thesis stands for modelling an organisation with the help of Viable System Diagnosis (VSD) as a cybernetic tool that is created by Stafford Beer. The Viable System Model aims to instruct managers for designing their organisations by using cybernetic tools and principles to make sensitive organisations to their environments which can control all of the characteristics of viability. In this study, the origin and the history of systems thinking, its practices in different disciplines, and its application in management and organisations area are illustrated. The principles and tools of cybernetics are also explained to understand organisational cybernetics. The illustration of an organisation (TÜBİTAK, Science Fellowships and Grant Programmes Department) is presented. To appreciate VSD clearly an application for diagnosing the organisation is made. According to the diagnosing process's results the organisation has been reformed.

Key words:

Viable System Diagnosis, Viable System Model, Cybernetics, TÜBİTAK, Science Fellowships and Grant Programmes Department

KISA ÖZET

Ayşe ÇOBAN **Haziran 2011**

BEER'İN YAŞAYAN SİSTEMLER TEŞHİSİ'NİN BİR UYGULAMASI

Bu tez Stafford Beer tarafından sibernetik bir araç olarak ortaya çıkarılan Yaşayan Sistemler Teşhisi (YST)'nin bir organizasyonun modellenmesinde kullanılmasını anlatmaktadır. Yaşayan Sistem Model (YSM)'i yöneticilerin çevrelerine karşı duyarlı ve canlılığın bütün özelliklerini kontrol edebilen organizasyonları tasarlayabilmelerini amaçlamaktadır. Bu çalışmada Sistem Düşüncesi'nin kaynağı, tarihi, farklı disiplinlerdeki uygulamaları ve yönetim ve organizasyon alanına uygulamaları anlatılmıştır. Buna ek olarak organizasyonel sibernetiği anlamak için prensipleri ve araçları tasvir edilmiştir. TÜBİTAK, BİDEB'in bir tasviri yapılmış ve Yaşayan Sistem Modeli'ni daha iyi anlamak için bu organizsyona bir uygulaması yapılmıştır. Sistem teşhisi sürecinin sonuçlarına göre kurum yeniden yapılandırılmıştır.

Anahtar Kelimeler:
Yaşayan Sistem Teşhisi, Yaşayan Sistem Modeli, Sibernetik, TÜBİTAK,BİDEB

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LIST OF ABBREVIATIONS

VSD	Viable System Diagnosis
GST	General System Theory
SOSM	System of Systems Methodologies
VSM	Viable System Model
TÜBİTAK	The Scientific and Technological Research Council of Turkey
SFGPD (BİDEB)	Science Fellowships and Grant Programmes Department
EU	European Union
E-SFGPD	Online Application Site of SFGPD
S1	System 1
S2	System 2
S3	System 3
S4	System 4
S5	System 5

INTRODUCTION

Today's organisations have to confront with increasing complexity, change and diversity. Most of the complex problems can be solved individually but in today's dynamic world, these problems happen concurrently. These interrelated problems need different strategies to be solved. Another important dimension for the organisations is change in the environment. Since many technological, social, political and economical changes are happened, organisations are forced to manage change. In addition to these, diversity problems make pressure for the managers. The changes in the work environment cause the need for qualified stuff and learning organisations. Diversity problems may occur in these situations and organizations should find ways to fix them.

Many consultants, academicians and advisers have helped managers to cope with these situations in work life. Scenario planning, benchmarking, rightsizing, value chain analysis, total quality management, balanced scorecard and customer relationship management are some quick ways to find solutions about complexity, change and diversity. However, these solutions focus on parts rather than evaluating the whole organization so they are not *holistic*. This means a solution for one part of the organization can damage another part of the organization. At this point, "Systems Approaches" rose in the literature to solve the problems in holistic ways.

Stafford Beer's Viable System Model is one of these "Systems Approaches" and this model bases on Cybernetics and Systems Thinking. Viable System Model is used for diagnosing problems of an organisation so it can also be called as Viable System Diagnosis like that is used in this study. Viable System Diagnosis use cybernetic concepts of black box, negative feedback and variety so they are also explained in this study. The Viable System Model involves five elements that are called as System 1, System 2, System 3, System 4, System 5 and these elements are interrelated through a complex of information and control loops. In Chapter 1, System Thinking and its methodology is introduced to understand the approach. Chapter 2 includes information about cybernetics, its tools, and VSD methodology which is used in this study. Chapter 3 gives brief information about The Science Fellowships and Grant Programmes Department and The Scientific and Technological Council of Turkey. The Chapter 4 which is the application part of the study includes redesigning and diagnosing process of The Science Fellowships and Grant Programmes Department.

CHAPTER 1

SYSTEMS THINKING

The purpose of this chapter is to tell about a general agreement about Systems Thinking, Systems Theory and its application in Management and Organisations. To this end, the roots of classical scientific thinking has mentioned and its debilities to understand the social phenomenon. The important role of holism has been focused on to differentiate the perception of classical scientific thinking and systems thinking about complex real world problems. The effects of Systems Theory on various disciplines like philosophy, biology, control engineering and organisation and management theory has also discussed. A short brief in the management and organisation theory history has told to make clear the reductionist and holistic views so the benefits of systems thinking for management and organisation theory could be easily conceived. At last, the applied systems thinking part has focused on the process of using "Systems Methodology" in different areas and the development of systems thinking and management science.

1.1. The origin of systems thinking

The term system can be defined as a complicated whole that relies on its parts and the relationships between these parts. There have been many systems like physical, biological, abstract, social, designed, etc.

The most known conventional method to study these systems is known as reductionism (Jackson, 2003). Reductionism was determined as dividing the problems into parts and starting to solve firstly these small parts and going on step by step until having the knowledge for solving the complex problem by Descartes (1968) at the beginning of scientific revolution. The major aim is to understand the parts and getting an understanding of the whole problem by this way (Jackson, 2003). On the other hand, complex problems include many interconnected parts and the relations among these parts can be more important than character of these parts. When the problems arise in these organised parts, dividing the organised structure will not be helpful to solve the problems of it because the problems will disappear after dividing. Also, the human factor in social problems is important because it is needed to think of different beliefs and objectives, different assessments of the situation, the threat of self-fulfilling estimations, and the bloody-minded capability of people to distort any prediction made about them. As a result, implementing reductionism and the natural scientific method to social and organisational problems has not been successful (Jackson, 2000).

1.1.1. Systems Theory

There should be another option rather than reductionism for studying systems. The option is holism that takes into consideration systems as more than the sum of their parts (Jackson, 2003). According to holism, systems can not be divided into their parts and each of the parts can not be studied in an isolated mode. In this condition holism can be seen as a Gestalt type approach and it considers the system as not a reconstituted one; but as an unbroken one (Schoderbek, 1975). As a result, holism got an important role in many different academic disciplines since reductionism could not struggle with problems of complexity, diversity and change in complex systems. After that the meeting of holism with philosophy, biology, control engineering, and organisation and management theory was come true. Systems thinking has come together with holism in all these disciplines. Especially, biology and control engineering had been important areas in 1940s and 1950s since they had made systems thinking a transdiscipline by studying systems in their own right (Jackson, 2003).

Since the beginning of the history, man has asked questions about himself and the external world. Search for knowledge has been defined by Greeks as philosophy but human kind discovered the complexity of external world as time passes, so they distinguished the external world from his internal world. After that knowledge has been classified as philosophy in the narrower expression and as science in the broader expression. According to Schoderbek (1975), science had reached its top point with the publication of Newton's Principia and its extensive empirically dominated perspective had an important impact on the classical physics so it had been important for a long time in the area of scientific thinking. Then, classical physics developed a perspective that prefers to solve the problems by dividing them into smaller parts and this type of perspective was also applied to smaller classes of physical phenomena. In this way, multiple sub disciplines had been created. Scientists had noticed that there had been many hybrid disciplines that formed a footstep toward interdisciplinary research but they could not make real interdisciplinary research for the social problems since most phenomena have definite features. So, the scientists have become aware of solving social problem through only one disciplinary approach is not possible (Schoderbek et al., 1975). This has caused to conceptualize the world by systems thinking and its main aim according to Schoderbek (1975), is to avoid the subdivision of the sciences into smaller and highly specialised fields through an interdisciplinary combination of current scientific knowledge. Schoderbek (1975) concerns that systems thinkers think different than analytical thinkers and they have different pillars for investigating the universe:

The analytical method's four pillars are;

1) Concern with external or physical portion of the universe
2) Value on division and latter composition of phenomena
3) Measurement of causal relations
4) Certainty as the final ideal of every researcher

On the other hand, systems thinker considers the universe according to;

1) Organicism; the understanding of putting the organism in to the centre of one's conceptual plan
2) Holism; focusing on the whole rather than its parts
3) Modelling; the way that of matching the conception of systems thinker of real phenomena on to the real phenomena
4) Understanding; noticing that (a) life in an organismic system is continuous process, (b) people can get the knowledge of the whole not by observing the parts but by watching over the processes that occur in the whole, (c) the observed thing is not the reality but it is the observer's concern of reality.

As a result, systems thinkers think that it is more expressive to study the processes combining the "parts" rather than to "micro-analyze" them. The systems perspective has been shaped by the development of two uncommitted movements despite they had the same goal: general systems theory (GST) and cybernetics (Schoderbek et al., 1975).

Bertalanffy (1968) gave the origins of GST in the organismic conception of biology. He described organismic conception or organismic revolution as:

> "In contrast to physical phenomena like gravity and electricity, the phenomena of life are found only in individual entities called organisms. Any organism is a system, that is, a dynamic order of parts and processes standing in mutual interaction."

Furthermore, Boulding (1971) offered two approaches for GST to use. First one is viewing the empirical universe and taking definite phenomena that can be found in many variant disciplines and trying to develop general theoretical models related to these phenomena. The other one is aligning the empirical areas according to their "individual" or unit of behaviour in a hierarchical complex organisation and trying to improve a degree of abstraction that fits each of them (Schoderbek, 1971). According to second approach, biology, mathematics, physiology and economics are the main areas that GST is used. GST's basic assumption is the process of growth and evolution at the end. This can be the growth of a single organism or a group of organisms or society. Different disciplines can borrow this assumption from each other. This shows that there can be "isomorphism" of processes of different disciplines rather than the things or the objects they involve. As a consequence, the structure of any system can be important as its morphology to determine the behaviour of itself. Furthermore, GST does not have a definite body of discipline because it intends to discover the laws and order that are involved in all systems and it is the most dissatisfied of all systems theories. The general characteristics of GST that can be seen most are interrelationship/interdependence, holism, goal-seeking, inputs/outputs, transformation, negative entropy, regulation, hierarchy, differentiation and equifinality. However, GST could not be appropriately used after World War II period. It has been effectively used in the definition of open-systems theory with the help of GST's main ingredients that are organisation, wholeness, self-regulation (homeostasis), and teleology (Schoderbek et al., 1975).

1.2. Systems Thinking in Management and Organisation Theory

Since 1930s three approaches has affected the organisation and management theory (Kast and Rosenzweig, 1981). These approaches are known as traditional approach, human relations theory, and systems thinking. Taylor's scientific management, Fayol's administrative theory and Weber's bureaucracy theory were foundations for the traditional approach since they considered organizations as machines. The studies of Mayo, Maslow, Herzberg, and McGregor had opposed to the traditional approach and focused on human needs in the organisations. However, human relations theory was not a sufficient parameter to measure the organisation's performance. There had been debilities about traditional approach and human relations theory since traditional approach had a view as seeing organisations as machines and closed systems and human relations theory refused the effects of environmental conditions of the organisations that may be more effective on organisations. Therefore, the systems approach began to control management and organization theory (Jackson, 2000). Because, systems thinking provides many benefits for managers of organisations and these benefits can be listed as four items: 1) viewing the task of manager in a wider range and determining the subsystems of his system; 2) seeing the relatedness of his goals with broader goals of the organisation; 3) enabling the manager for constructing the subsystems according to subsystems goals; 4) evaluating the organisational and subsystems effectiveness with the help of systems perception of goal achievement model (Schoderbek, 1975).

According to systems approach, other management theories did not concern all perspectives that are needed for high performed organisations. This proves that other management and organisation theory approaches were reductionist since they had focused on parts of organisation rather than on whole (Jackson, 2000). First initiatives of *holism* to meet organisation and management theory were systems engineering that compromised with scientific management tradition and biological analogy that was purified by von Bertalanffy (Jackson, 2003). Systems approach provides the benefits of seeing the organisation as an "open system" that has relations with its environment, but the traditional approach and human relations theory rejected the effect of environment and they had a closed perspective (Jackson, 2000). The "open system" perspective has contributed to systems thinking through von Bertalanffy's efforts and he has named this as "general systems theory" (Jackson, 2003).

Systems thinking has first specified in mechanical equilibrium model that was taken from Pareto and made known as "Pareto Circle" by Henderson (Jackson, 2000). The concept of Pareto's perception about social systems was defining the general characteristics of social equilibrium by cycles of mutual interdependence (Aron, 1967). Because of this base of thinking that comes from Pareto's ideas, Henderson shaped his analysis in accordance with the concepts of equilibrium and stability. Another important study for mechanical equilibrium model was made by Roethlisberger and Dickson in 1956. They explained the results of Hawthorne experiments by this model. In this study, Roethlisberger and Dickson focused on the causes of the disequilibrium of workers and also, they realized that work effectiveness of a worker could not be explained by one simple cause. Because of that Roethlisberger and

Dickson moved their attention and explanation to the "Social Conditions Outside Factory" part of their analysis. "Organism or Individual in Equilibrium" and "Social Conditions Outside Factory" elements had disproved their analysis's "closed system" point of view. But this did not make this an "open systems" approach like von Bertalanffy's perception. On the other hand, von Bertalanffy's "open systems" sense had been a root for Selzinck's adaptation of "structural functionalism" and Katz and Kahn's Parsonian ideas for organisations. Selzinck had noticed that organisations have to realign themselves according to inside and outside determinants so they behave like organisms to survive. Sociological systems theory has helped Selzinck to develop his studies about organisations and their subsystems' jobs for organisational requirements. Moreover, Katz and Kahn's (1966) *The Social Psychology of Organisations* accomplished to associate the open-systems idea with opinions from psychology and Parsons's sociology. As Craib (1992) was summarized, Parsons think that a social system's action has needs and these needs have to be met if it is to survive and a social system includes a number of parts that function to meet those needs. In addition to this, Parsons sees all living systems tend to be in equilibrium and they have different parts which are stable and have a balanced relationship and these systems carry on themselves separately from other systems. The most well-known portion of Parsons's equilibrium-function model is the maturation of the four functional necessities which have to be performed by the system's subsystems if the system wants to survive. These four necessities form the AGIL mnemonic by their first letter and can be listed as adaptation, goal attainment, integration and latency. The explanation of these terms is as follows:

Adaptation: the system must build up the relationships between itself and its external environment

Goal attainment: defining goals is a must and resources have to be mobilized and managed according to these goals

Integration: the system must have a form for coordinating its efforts

Latency: the first three necessities must be solved with minimum stretch with assuring that organisational "actors" are encouraged to behave in suitable manner

1.3. Applied Systems Thinking

According to Checkland (1981), there should be a differentiation between work applying systems thinking in other disciplines and work related with the study of systems as such. The next category level can be divided as theoretical development of systems thinking and the "problem solving" application of systems thinking for real world problems. Checkland has branched "problem solving" applications as hard systems thinking, systems ideas for decision making process and soft systems thinking. Checkland's differentiation of systems thinking provided to use systems ideas in many other disciplines and encouraged the researchers to study on systems own identifications. However, from 1981 these two strands have not seen as important as the "problem solving" strand in systems movement. The current map for Checkland's differentiation of systems movement can be seen in Table 1. According to Jackson (2000), systems movement was more fashionable in 1940s and 1950s than recent past since its relation with an unfashionable style of functionalism in people's mind. This situation has been changing because systems ideas can contribute difficulty and importance to a variety of theoretical positions. The main classes of research in other disciplines that systems thinking support are "scholarship" and "hypothesis testing". In "scholarship" case, theorists think that using systems approaches is good for their disciplines and they applied systems ideas to their theoretical dealing to have a more intensive formulation and to organise the concepts of the discipline. In "hypothesis testing", disciplines can gain hypothesis about the character of the part of interest of the discipline and these hypotheses can be tested through experiment and observation. The results have been added to theoretical aggregation through the relation with reality of that part (Jackson, 2000).

Table 1 Current map of the systems movement

The Systems Movement		
Systems thinking in the disciplines	Study of systems in their own right	Systems thinking for "problem solving"

The second strand of systems movement focuses on the study of systems in their own right. According to Jackson (2000), some of systems approaches serve themselves as nominees for giving a general theory for systems. The most important of these are cybernetics, autopoiesis, chaos and complexity theory and also general system theory. Some of these areas have the most generality so they can offer the "purest" form of general systems theory that have to be open to debate. The research type that the followers of general system theories can be seen as "scholarship". Generally, this causes reordering of the concepts of general system theory or the concepts of discipline that general systems theory is used. For example, von Bertalanffy's general system theory has an impact on organisation theory, Maturana and Varela's notion of autopoiesis has an impact on family therapy and chaos and complexity theory has an impact on management thinking. On the other hand, it is rare that general systems theories have been used to lead hypothesis testing or research that is purposefully to users. This is a problem for Checkland(1981) and he has mentioned it as:" The problem with GST is that it pays for its generality with lack of content (Jackson, 2000).

"Systems methodology" has been used by systems practitioners to improve a problematic condition by collecting different systems ideas and techniques together. During the Second World War and after it, some of the systems methodologies like Operational Research (OR), Systems Analysis (SA) and Systems Engineering (SE) were born. After the war, OR workers were employed in government departments for OR groups in the large nationalized industries (Jackson, 2003). The forerunners of OR in the United States who was Churchman, Ackoff and Arnoff (1957) have mentioned systemic aspects of operations research in *Introduction to Operations Research* (Schoderbek et al., 1985). They mentioned this as: "Central to this discussion is the notion that the aim of Operations Research is to obtain a system or overall approach to problems" (Churchman, Ackoff, Arnoff, 1957). SA was employed by RAND (Research And Development) Corporation to help US military and SE was used to adopt its engineering profession in to the large industrial engineering projects (e.g. the chemical and aerospace industries). These approaches due to their structural similarities have been considered by Checkland 1981) "hard systems thinking" methodologies. Hard systems thinking suggested to managers and management scientists to optimising the performance of the organisation according to obviously identified aims. Scientific modelling, rational testing, implementation and evaluation processes had been used in this methodology. However, hard systems thinking could not cope with complexity that is a result of variability of different beliefs and values, and issues of politics and power. Another problem of hard systems thinking is its incapability of answering adequately all perceptions of reality. It wants to know the aim of the system before the analysis progresses. As a result, after 1970s applied systems thinking has been improved to overcome the crisis about hard systems thinking's shortcomings to solve the problems (Jackson, 2003).

Table 2 Jackson's expanded version of Jackson and Keys' "ideal-type" grid of problem contexts

		PARTICIPANTS		
SYTEMS		UNITARY	PLURALIST	COERCIVE
	Simple	Simple-Unitary	Simple-Pluralist	Simple-Coercive
	Complex	Complex-Unitary	Complex-Pluralist	Complex-Coercive

These improvements can be achieved with the help of a framework that classifies systems methodologies and has been developed by Jackson and Keys in 1984. This framework is called as System Of Systems Methodologies (SOSM) (Jackson, 2003). Also, SOSM provides to see how management science and systems thinking have advanced and improved over the last century (Jackson, 2000). To understand SOSM, an "ideal type" grid of problem contexts and problem situations have been produced in several ways by Jackson and Keys (1984), Jackson (1993), and Flood and Jackson (1991). A more comprehensible one is in Table 2 that is made by Jackson (2003). According to systems thinkers, increasing complexity, diversity and change come from two causes: the "systems" become larger and more confused and the "participants" become to have more diversified values, beliefs and interests. These aspects helped to construct the grid (Jackson, 2003). The horizontal axis bases on an increasing diversity of values, beliefs and interests between those affected by a problem condition. The terms of unitary, pluralist and coercive come from the industrial relations literature to name this continuum divergence. If "participants" and "stakeholders" have a homogenous agreement about their values, beliefs and interests, they have a unitary relationship. They would be a pluralist relation since values and beliefs of "participants" are different but they have enough common interests to make up a system or organisation. However, they can have a coercive relationship if they have too diversified interests and some of the "participants" who has power can follow their own way at the expense of those who are compelled. Increasing complexity on a continuum from simple to complex is represented in the vertical axis. Simple systems have a small number of elements with few and regular interactions between them. These systems are controlled by well understood laws, closed to their environments and composed of parts that do not have different purposes. On the other hand, complex systems have large number of elements that are interrelated. They are probabilistic, open to troubled environments and their parts have their own purposes (Jackson, 2000). The combination of two dimensions gives us six ideal-type forms of problem situation: simple-unitary, simple-pluralist, simple-coercive, complex-unitary, complex-pluralist, and complex-coercive. The grid can not ensure to define the real-world problems according to its six forms. Weber (1969) suggests the use of ideal types in order to build abstract models of realities. In addition, the capacity for goal seeking and remaining viable in turbulent environments is served by the grid (Jackson, 2003).

In Table 3, simple-unitary problem contexts include hard systems approaches and complex-unitary problem contexts include systems dynamic, organisational cybernetics and complexity theory. Simple pluralist and complex pluralist problem contexts can use soft systems approaches in SOSM. At last, simple-coercive problem contexts include emancipatory systems approaches and complex-coercive problem contexts include postmodern systems approaches (Jackson, 2003)

Table 3 Systems approaches according to problem contexts in the System of Systems Methodologies (SOSM) (Jackson, 2003)

PARTICIPANTS				
SYTEMS		*Unitary*	*Pluralist*	*Coercive*
	Simple	Hard Systems Approaches	Soft Systems Approaches	Emancipatory Systems Approaches
	Complex	Systems dynamics Organisational Cybernetics Complexity Theory		Postmodern Systems Approaches

CHAPTER 2

CYBERNETICS

In this chapter, firstly, a short explanation about the history of cybernetics and its philosophical and theoretical base is introduced. The basic tools of cybernetics have been told and cybernetics' contributions to management and organisational thought have been discussed. Lastly, the implementation of cybernetic principles for designing organisations and Stafford Beer's "viable system model" with its diagnosing methodology is explained.

2.1. History of Cybernetics

The history of *cybernetics* has started with Plato since he had used the term *kybernetike* that means "the art of steersmanship" in his *Republic* (Schoderbek et al., 1985). The literal meaning of the term is directing a vessel but in Plato's manner the term refers to leading the "ship of state" (Jackson, 2000). The Greek root had evolved the word *gubernator* in Latin and from the Latin to the English word *governor* was inferred. In 1790s, James Watt used the term "governor" for his invention that is a mechanical regulator that keeps the speed of rotation of the steam engine and as a result, cybernetics domain has been controlled by the mechanical engineering for many years (Schoderbek et al., 1985). In World War II, many of the scientists from different disciplines had been come together for the military problems and one group of them became aware of the problems about communication and control, whether in the machines or organisms. Norbert Wiener was the key person in this group (Jackson, 2000). He had been motivated in 1947 to find the term *cybernetics* for indicating a group of studies which would have worldwide applications (Schoderbek et al., 1985). According to Wiener (1948), *cybernetics* is "the science of communication and control in the animal and the machine". Wiener (1950) had found this definition too limited and applied the perceptions of cybernetics to human interests. In this way, cybernetics was to be an interdisciplinary science. Wiener supported this idea since he thought that cybernetics handle general laws that managed control processes, whatever the nature of system under governance. To understand the control, the idea of negative feedback was very important. Communication is also important in control processes because if we want to control the behaviour of a machine or another human being, we must communicate with that machine or human being (Jackson, 2000).

When it came to 1950s, W. Ross Ashby published his book *An Introduction to Cybernetics* and added the significant notion of “variety” and “law of requisite variety” to cybernetics field of study (Jackson, 2000). According to Wiener (1956), the notion of variety means that the number of distinct elements in a system or the number of possible states a system can exhibit. Also, he formulated “law of requisite variety” as only variety can destroy variety that is very significant for management like Newton’s or Einstein’s laws for physics. Moreover, Ashby presented in his book that cybernetics could affect different areas of scientific thought (Jackson, 1991).

Thus, cybernetics had spread beyond different fields of science and Stafford Beer published his *Cybernetics and Management* in 1959 and then J.W. Forrester served his *Industrial Dynamics* in 1961, so that these two men have become popular in management cybernetics after this time (Jackson, 2000). Beer has defined management as the science and profession of control in his book and also, he added a new definition of cybernetics as the “science of effective organisation” in 1979 (Jackson, 1991). His Viable System Model has been developed during 1960s and 1970s that could diagnose the mistakes of any organisational system or to arrange new systems according to cybernetic lines. Furthermore, Forrester (1961,1969) created system dynamics that helps understand the behaviour of whole systems by modelling the dynamic feedback processes going on within them and his study had applied a large field of studies like industrial to urban to world dynamics (Jackson, 2000).

Consequently, the work of Maturana and Varela (1980) on autopoietic systems that are organisationally closed or “information tight” has been the last significant improvement in the field of cybernetics studies (Jackson, 1991).

2.2. Philosophical and Theoretical Base of Cybernetics

In the classification scheme of Beer (1964) two criteria which are complexity and predictability had been demonstrated for grouping the systems. Beer grouped the systems as simple, complex and exceedingly complex according to complexity criteria of the scheme. A simple system can be defined as with few components and few interrelationships. On the other hand, a complex system is highly interconnected and highly complicated and also, an exceedingly complex system cannot be defined exactly. The other criteria of Beer (1964) grouped systems as deterministic or probabilistic. The system which is deterministic has parts that interact in a predictable way. On contrary, the probabilistic system cannot be predetermined in behaviour and it cannot be described what may occur (Schoderbek et al., 1985).

Table 4 The classification scheme of systems according to Beer (Schoderbek, 1985)

	Simple	*Complex*	*Exceedingly Complex*
Deterministic	Pulley Billards Typewriter	Computer Planetary system	Empty set
Type of control required	Control of inputs	Control of inputs	Control of inputs
Probabilistic	Quality control Machine breakdowns Games of chance	Inventory levels All conditional behaviour Sales	Firm Humans Economy
Type of control required	Statistical	Operations research	Cybernetic

The six categories of the two criteria can be seen in Table 4. In deterministic systems the output of the system can be controlled by the way of managing the input of the system. These kinds of systems can be listed as pulley, billiards, a typewriter, computer planetary system and empty set. All of these systems behave in a predictable manner even if they are complex or exceedingly complex. In the second situation of the table that serves for the systems, they all become probabilistic. Games of chance, quality control and machine breakdowns are the examples for simple-probabilistic problem contexts according to Table 4. Since flipping a coin can show two possible states, and also, humans can show many states of nature in quality control process and the usage rate to a wide scope can determine the time period that the machine will be functional, simple statistical methods can be used as a control tool for these systems. If the complexity level of a probabilistic system increases, prediction and control of systems behaviour will be difficult, so that in deterministic systems control of the inputs can give the prediction of the outputs, whereas in probabilistic systems control of the inputs can provide some of the possible outputs. As it is shown in Table 4, complex probabilistic systems category includes inventory levels, all conditional behaviour and sales and need more sophisticated methods like operations research to be controlled. The traditional analytical approach could not be sufficient for highly complex systems that include the firm, the individual and the economy and Beer suggested cybernetic principles and the black box technique for extreme complexity. Moreover, Beer added self-regulation characteristic to cybernetic systems if systems want to sustain their structure. Cybernetic systems offer specialised tools according to each characteristic of it for defining, operating and controlling systems. It offers black box technique for extremely complex systems, variety engineering for probabilistic systems and negative feedback system for self regulative systems as it can be

seen in Table 5 (Schoderbek et al., 1975).

Table 5 Characteristics and Tools for Analysis of Cybernetic Systems (Schoderbek, 1975)

Characteristics of a System	*Tools for Analysis*
Extreme complexity	Black box
Probabilism	Variety engineering
Self-regulation	Negative feedback

2.2.1. The Black Box Technique

Defining complexity can be a good starting point to explain the black box technique. Beer (1964) thought that the idea of complexity meant "the probability of a system's being in a specific state at a given time". According to Schoderbek (1985), complexity can be defined as "the quality or property of a system which is combined outcome of the interaction of four main determinants". These four determinants can be listed as:

- The number of elements composing the system

- The attributes of the specified elements of the systems
- The interactions between the specified elements of the systems
- The degree of organisation in the system (i.e. the being or absence of predetermined rules which direct the interactions or indicate attributes)

The general view to measure complexity included two important criteria that are the number of elements and the number of interactions among the elements, but this view had defects for perfect measuring of complexity. For instance, a car engine seems to be very complex since there have been many numbers of elements and interactions between all the parts of the car engine and two-person communication seems to be simple since there have been only two elements and two interactions. However, the interactions of the car engine are based on definite rules and the characteristics of the system's elements can be predetermined easily. Also, two-person communication includes attributes of elements that cannot be predetermined and the degree of organisation is low. Thus, a car engine is a simple system however a two-person communication is a complex system. This proves that complexity can be defined by the interaction of all four determinants (Schoderbek et al., 1975).

These four determinants show that complexity can grow easily in organisations and it is hard to explain what processes cause this kind of behaviour in complex systems. So that, cybernetics called this kind of systems as "black boxes" in other words, a box with observable possible states and that is "transparent". Since organisations and their environments are black boxes, the managers should have the knowledge about system behaviour to deal with black boxes. Ashby (1956) concerned that black boxes cannot be determined by reductionist analysis which separates parts of the system. The black box technique of input manipulation and output classification should be used to understand the system behaviour. This technique gives the advantage of finding the regularities of the system that make it more predictable. Ashby (1956) pointed that any experimental change in the system causes problem about application of the black box technique. Furthermore, Beer (1979) stated the importance of observing the conclusions of the system behaviour for a sufficient length of time. With the help of black box technique managers do not have to fight with lots of details in the organisations and they would have the information to apply the technique in to all parts of the organisation for controlling (Jackson, 2000).

2.2.2. Negative Feedback

The understanding of self-regulation is significant for controlling complex probabilistic systems. Self-regulation provides advantages for managers like a degree of stability to the environment of organisations and to bring the self-regulation to the organisations that they manage. Wiener (1948) established the negative feedback tool to guarantee the self-regulation (Jackson, 2000). This feedback control system can be described by its closed-loop structure (Schoderbek et al., 1985). This structure works with the help of continuous feedback information about the output of the system. The output of the system is compared with the goal of the system, and unless the system achieves the desired goal, the negative feedback will be used for new adjustments that will design the system to accomplish the desired goal. A simple closed-loop system should include four elements which are a *desired goal* (that is carried to the comparator from outside), a *sensor* (method of sensing the current situation of the system), a *comparator* (that compares the current situation and the desired output) and an *activator* (a decision-making tool which is an answer of comparator's findings to bring the system in to the desired goal) to work correctly.

Managers should know the importance of quick and continuous comparison between the actual performance and the desired goal and the need for taking quick and continuous corrective action in feedback control systems (Jackson, 2000).

2.2.3. Variety Engineering

Managers of organisations have to cope with unexpected situations that may happen in the organisations or in their environments if they want to be successful at directing organisations. For this kind of probabilistic systems Ashby (1956) has created the concept of *variety*. This concept has been described as the number of possible situations that can be seen in the system, as a result, it become a measure of complexity. Ashby's "law of requisite variety" indicated a problem for managers that only variety can destroy variety. Managers should control at least equal variety as the system has if they want to control effectively their organisations and the environmental changes (Jackson, 2000). Beer (1964) indicated the optimistic demand for simple systems can be a trouble to cope with variety in the environment since they do not have enough variety in their own (Schoderbek et al., 1985). As he stated: "Only variety in the control mechanism can deal successfully with variety in the system being controlled (Beer, 1964:50)."

Managers have to reduce the variety of the system (variety reduction) or increase their own variety (variety amplification) in order to deal with massive variety in the systems and Beer (1979) named this process as “variety engineering”. If managers balance varieties and accomplish control, they can get the skills about variety engineering (Jackson, 2000). Beer (1981) recommended some methods for variety reduction and variety amplification in the *Brain of the Firm*. These methods are illustrated in Table 6 and Table 7.

Table 6 Methods of Variety Reduction (Beer, 1981)

Class	*Name*	*Meaning*	*Danger*
STRUCTURAL	Divisionalisation	By factories or products	Loss of corporate synergy?
	Specialisation	By market segments	Loss of market synergy?
	Functionalisation	By profession or service	Loss of collaborators' surplus
	Massive delegation	Top men free to think	Withdrawal symptoms?
	Utter involvement	Immediate problem-solving	Loss of wider opportunities?
PLANNING	Short-term horizon	Ignore distant future	Lack of continuity/investment?
	Long-term horizon	Let immediate problems solve themselves	"in the long run we are dead"
	Settling priorities	Sequential attention	Destroy economic interaction?
	Very detailed planning	Well-oiled machinery	Obsession with trivia?
	Management by objectives	Decide where we are going	Loss of adaptability?
OPERATIONAL	Management by exception	Ignore routing chance results	Using wrong model?
	Close administration	Cut down argument and anomalies	Curbs freedom to react?
	Averaging/aggregating	Taking one year with another, etc.	Unassailable optimism?
	Sacking innovators	Prevent rocking the boat	Creeping paralysis?
	Management auditing	Keep a continuous check	Stifling initiative?

Class	*Name*	*Meaning*	*Danger*
STRUCTURAL	Integrated teamwork Work through henchmen Diversification/ acquisition Reorganisation	Share knowledge and experience Amplifiers of the boss Generate acquire/new areas of business Broadening everyone's experience	Loss of accountability? Transmit his faults? Overstretch managerial ability? reverse takeovers? Hopeless confusion?
AUGMENTATION	Recruit managers Recruit experts Consultants to advise Consultants to implement Consultants to absorb variety itself	Add to existing managerial capability Enhance existing managerial capability Gain from best practice Increase power to hatchet Inhibit action while *sub judice*	Face does not fit? Wrong advice? Political involvement? Slanted? irresponsible? Hatchet wrong people? Illusion that problems solved?
INFORMATIONAL	Conferences Improve management information systems Training Management development by T-Groups Open door arrangement	Encourage participation Enrich specific knowledge Enrich general knowledge Enrich self-knowledge Employees come first	Open-flood fates of criticism? Inundation by data? Unrequited ambitions? Disintegrate personality? Collapse of authority?

Table 7 Methods of Variety Amplifying (Beer, 1981)

2.3. Managerial Cybernetics and Organisational Cybernetics

The sum of all ideas about cybernetics was used for management cybernetics and organisational cybernetics in managerial studies.

Management cybernetics has been mostly controlled by machine analogy and it is based on the input-transformation-output schema to describe main operational activities of the organisation. Also, management cybernetics provided the black box technique and feedback tool to managers for regulating their operations. However, management cybernetics could not make huge sense in managerial field since it could not cope with subjectivity and extreme complexity in organisations.

On the other hand, organisational cybernetics has an original direction rather than the traditional management science has and the studies of Stafford Beer (1959b, 1966, 1972) provided a momentum in the development of this approach. Beer (1979) generated his VSM (Viable System Model) by making references to cybernetic principles without mechanical and biological demonstrations of cybernetics. Beer's VSM included all the significant characteristics of organisational cybernetics.

2.4. Viable System Diagnosis

Beer (1981) claimed that the traditional organisation chart cannot reflect the model of a real organisation. He built up Viable System Model that is more useful and utilizable for organisations which have to cope with increased complexity. VSM means that a model which includes the organisational characteristics of any viable system and Beer (1972) supported this definition with relating the viable system of the human nervous system. This was a good example because the human body is the richest and most flexible viable system. Also, Beer (1979) presented that the model is extracted from cybernetic first principles and can be applied to all kinds of organisations. In *Diagnosing the System for Organisations* (1985), the model served as application of principles in organisations for managers as a “hand-book”. All these considerations showed that Beer used different tools and ideas of cybernetics to get ideas about organisations and by the help of these tools organisations' effectiveness can be improved (Jackson, 2000). Furthermore, the VSM is a tool for diagnosing the problems of complex probabilistic “systems”, therefore it has been known as “viable system diagnosis” in the literature of organisational cybernetics (Jackson, 1991).

2.4.1. Viable System Model

As it has been mentioned before, viability can be understood by the help of human nervous system which is formed as a two-dimensional system. These dimensions are vertical command axis which merges the local activity of an organ with organic balance and lateral command axes that makes the organ autonomous. The human nervous system can show the main five performs of the viability of a system with the assistance of some organs and the secondary systems of the human body. First one is organs, muscles and receptors from the skin that are independent and making the real functions of the body. Second one is sympathetic system that has to make stable the actions of the organs and muscles. Third one is base brain that contains pons and medulla and has the role of internal control. Fourth one is senses like sight, hearing, taste and smell and these senses provide the body a relation with the external environment. The fifth one is the cortex the place of plan formulation (Beer, 1981). Beer (1981) used these opinions and cybernetics principles for his *neurocybernetic* model that contains five elements of viability. These elements were appointed as System 1 to System 5 and have the roles of implementation, coordination, control, development and policy. The characteristics of System 1 to System 5 will be mentioned below (Flood and Jackson, 2003).

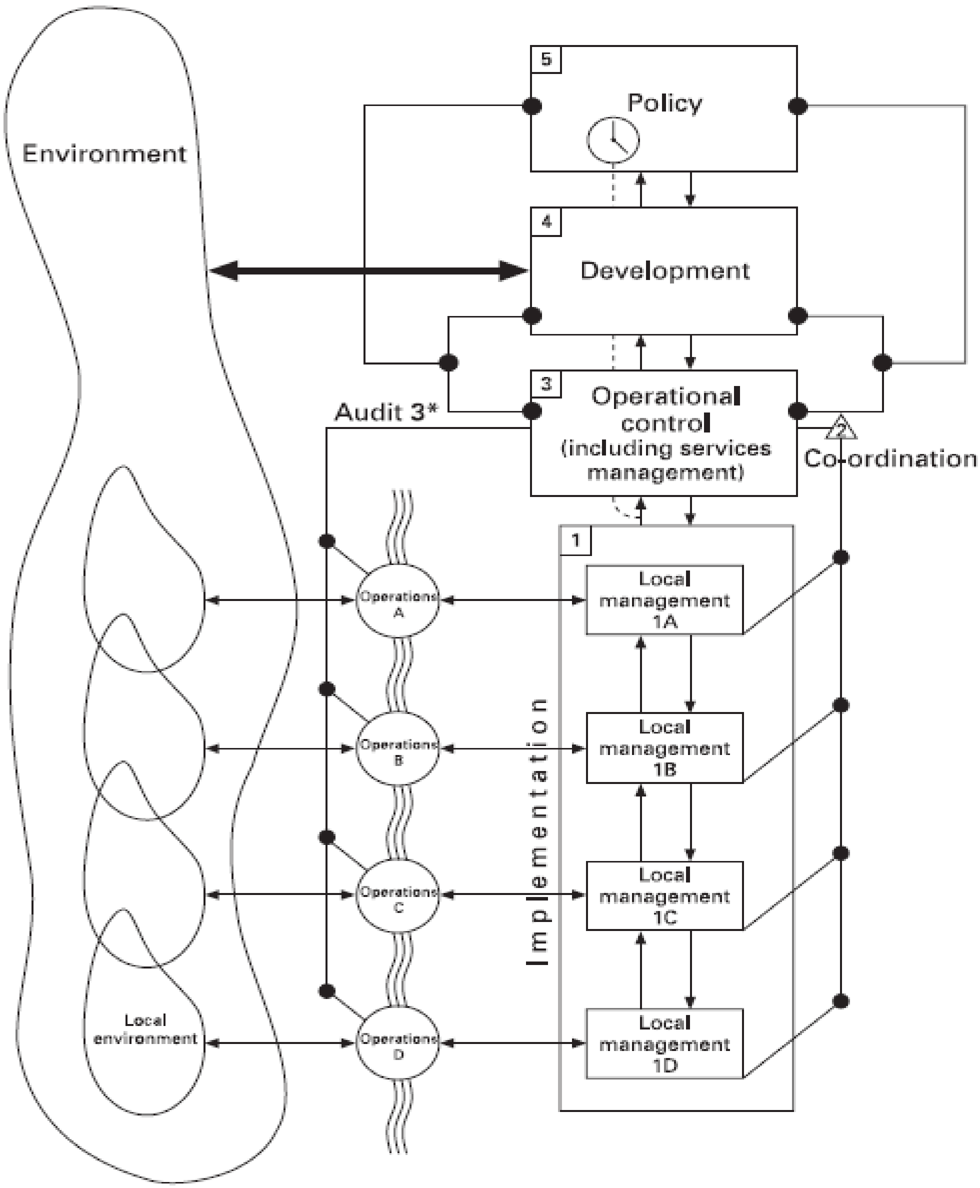

Figure 1.The Viable System Model (Flood and Jackson, 2003)

System 1

System 1 carries on the operational activities of the organisation that can be concerned as implementation. All parts of the System 1 are viable since each of them has its own relations with the environment, has relations with other parts and has its local management. The local management of each part of System 1 gets the directions from the higher systems to each part and monitors the operations to higher level systems. This mechanism provides negative feedback in the whole system. Additionally, each part of System 1 must be autonomous to take in variety in the environment of the system. In this way, higher management levels will not be flooded because of environmental variety. This autonomy can be achieved with designing each part of System 1 according to VSM. In addition, the viability of each part provides recursion for the system and to make their own decisions according to changes in their sub environments. The parts of System 1 should be controlled and coordinated by System 2 and System 3 since they are responsible for effective interaction and performance of all parts (Jackson, 2000).

System 2

System 2 has the coordination role for the parts of System 1. In normal conditions, the parts of System 1 operate in harmony but in extreme situations, every part can operate in accordance with their own goals that are based on local information. This kind of action may cause dangerous and uncertain outcomes for the whole system and for the parts. Since unpredictable conditions may harm the system, System 2 grants the coordination function with control centres of the parts. These control parts are connected to corporate regulatory centre which gets the information of the actions of different parts and can prevent dangerous oscillations of the parts. System 2 has to manage the interactions between the parts and make stable the conditions to balance the reactions of System 1. System 2 uses feedback mechanism to set up harmony between the parts of System 1(Jackson, 2000).

System 3

The main duty of System 3 is controlling. The interpretation of the policy decisions is made by System 3 according to internal information that comes from System 2 and 3* and external information that is sourced from System 4. Also, resource allocation to the parts of System 1 and controlling of policy implementation in System 1 should be made by System 3. Monitoring the performance of System 1 in accordance with data that comes from System 2 and System 3* is another role of System 3. Furthermore, the policy system gets the information from downward with the help of System 3. Beside these roles, System 3 has the auditing channel on the left side of the model which is called as System 3*. System 3* gives immediate information to System 3 before the local managements of the parts of System 1. By this information, System 3 can access to the situations in the operational parts directly. Therefore, System 3* has a vital function in the Viable System Model.

System 4

System 4 is the development function of the system. It has two significant tasks which are making “switch”, that Beer refers to, in the system and getting the necessary information from the environment. The task of “switch” means that carrying the instructions from System 5 to lower systems, and also carrying the necessary information for System 5 from Systems 1 and 3. In this transferring process, System 5 can be overloaded with unimportant data but System 4 should filter the data which travels upward. Furthermore, System 4 must organise the information that comes from System 3 for the top management (Jackson, 2000). Transfer of urgent information from lower systems to upward according to its importance can be made by the action of System 4 as an “algedonode” (Beer, 1981).

The second task of System 4 provides viability to the system by matching the variety of the environment and variety of the system. This matching can be done with the help of a model that System 4 supplies it for the system. By this model, predictions about the probable future of the environment can be made and the system can reply them at the needed time. System 4 sends immediate information to System 3 for speedy action and sends long-term information to System 5 for the judgement. Also, it becomes the “operations room” and “environment of decision”, that Beer calls, where the internal and external information are brought together (Jackson, 2000).

System 5

Directing the whole system is the function of System 5. System 5 formulates the policy according to information that gets from System 4 and transfers this policy to System 3 for implementation by the parts of System 1. Beside these, System 5 should balance the external and internal demands of the whole system. Also, it stands for showing the characteristics of the whole system to any wider system of which it is a part.

In addition to different functional systems in the VSM, recursion is vital for the model’s existence. This means that the design of the whole system is duplicated in its all parts, so that a higher level of recursion can be System 1 or operational part of another viable system. This function is an important variety reducer for the managers in organisations since it presents understandable diagrams of managerial situations (Jackson, 2000). Also, appropriate information flows and communication links are important in VSM since they show how the whole system and its parts act in accord with the goals. Beer (1981) suggested three levels of achievement as actuality, capability and potentiality that can be come together to obtain three indices as productivity, latency and performance which measure the performance of the resources in the whole organisation. Actuality can be determined as the current achievement with available resources and constraints; capability can be described as the possible achievement using existing resources within existing constraints; and potentiality can be described what could be achieved by developing resources and removing constraints (Flood and Jackson, 1991). Furthermore, indices can be defined as below:

Productivity: the ratio of actuality and capability

Latency: the ratio of capability and potentiality

Performance: the ratio of actuality and potentiality and also the product of latency and productivity (Jackson, 2003).

In this way, the information can be distributed in real time (Flood and Jackson, 1991).

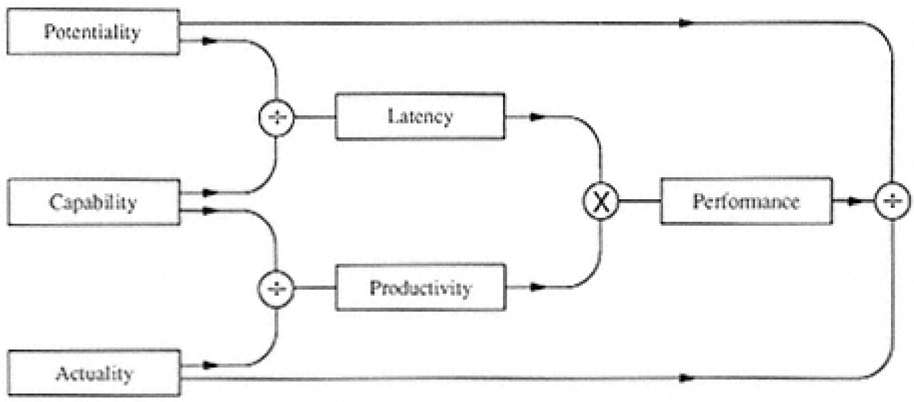

Figure 2.Indices of performance (Flood and Jackson, 2003)

2.4.2. The Use of Model

The VSM can be used by managers to design new organisations according to cybernetics principles in the model and to diagnose the defects of the organisation to guarantee the viability and effectiveness of it. The procedure of diagnosing the defects of an organisation may be achieved in two steps which are system identification and system diagnosis (Jackson, 2000).

2.4.2.1. System Identification

System identification means that reaching the identity of the system and figuring out proper recursion levels (Jackson, 2000). The first step for system identification is determining the purpose that will be followed. In the next step, the relevant system should be determined to achieve the purpose and this is called as "system in focus" and this happens at "recursion level 1". Specifying the viable parts of the System 1 of the system in focus should be made in the following step because System 1 produces the "system in focus", and also the viable parts are at recursion level 2. The last step is indicating the wider systems and environment of "system in focus" part and this occurs at recursion level 0 (Flood and Jackson, 1991; Jackson, 2000).

2.4.2.2. System Diagnosis

System diagnosis can be defined as the organisation's ability to show the cybernetic principles at each level of recursion. As a rule, the procedure of system diagnosis is based on the cybernetic principles and every system function of "system in focus" should be studied step by step (Jackson, 2000).

The diagnosis process of System 1 should start with detailing each part's environment, operations and local management. Determining the constraints that are forced on each part of System 1 by higher management and analyzing the responsibility of each part and the indicators of performance must be done respectively. Lastly, System 1 must be designed in accord with VSM diagram (Jackson, 2000).

After System 1's diagnosis, System 2 of "system in focus" has to be studied. Possible sources of oscillation and conflict among the parts of System 1 and their environments should be revealed and the elements of System 2 which have a harmonising or damping effect have to be identified. Also, the perception about System 2 in the organisation should be examined whether it is threatening or facilitating (Jackson, 2000).

Listing the components of System 3 in the "system in focus" is important for diagnosing System 3. Afterwards, the authority practice of System 3, the application of resource bargaining with the parts of System 1 and the person who have the responsibility for the performance of the parts of System 1 have to be questioned. Also, the audit enquiries into aspects of System 1's parts that are carried on by System 3 have to be examined. The relationship between System 3 and System 1 elements, whether it is autocratic or democratic, should be analysed and the amount of freedom that is hold by System 1 elements may be determined (Jackson, 2000).

Since the role of System 4 is adopting the system into its environment, the activities of System 4 are important and have to be listed to achieve successful diagnosing. Also, these activities should guarantee adaptation for the future. Since System 4 must be open to novelty, it has to monitor the happenings of the environment and estimate the trends. A management centre/operations room is essential to bring together external and internal information, and also provide an environment for decision making. The urgent developments should be conducted to System 5 by the facilities of System 4 (Jackson, 2000).

The diagnosis of systems ends with the examination of System 5. The responsible person and his or her actions should be identified at first. Then, there has to be a questioning about System 5's ability to provide an appropriate identity for the "system in focus". Another examination will be necessary how the ethos of System 5 affect System 4 and its relationship with System 3. Finally, System 5 must have a common identity with System 1 (Jackson, 2000).

The control of information channels, transducers, and control loops in the whole model fulfils the process of system diagnosis.

CHAPTER 3

THE DESCRIPTION OF SCIENCE FELLOWSHIPS AND GRANT PROGRAMMES DEPARTMENT IN THE SCIENTIFIC AND TECHNOLOGICAL RESEARCH COUNCIL OF TURKEY

As a start of this chapter, a brief history of The Scientific and Technological Research Council of Turkey and Science Fellowships and Grant Programmes Department is expressed. Also, the structure of The Scientific and Technological Research Council of Turkey and The Science Board's role is described. Finally, the structure and the operations of The Science Fellowships and Grant Programmes Department are clarified according to departmental roles in the organisation.

The Science Fellowships and Grant Programmes Department which stands for encouraging the scientists in Turkey through a set of funds, competitions, scholarships and educational programmes is one of the departments of The Scientific and Technological Research Council of Turkey. To have a better understanding of Science Fellowships and Grant Programmes Department, firstly, The Scientific and Technological Research Council of Turkey has to be explained.

3.1. The History of The Scientific and Technological Research Council of Turkey (TÜBİTAK) and Science Fellowships and Grant Programmes Department (SFGPD)

The Scientific and Technological Research Council of Turkey (TÜBİTAK) was founded in 1963 to develop basic and practical academic researches in natural sciences and to encourage young researchers for these studies. TÜBİTAK's duty is to lead research management and to finance it for the benefit of Turkey's national priorities. While TÜBİTAK is a leading research management in the country, it continues to the cooperation with all the related sectors and establishments. In addition, it plays an important role to create a science and technology culture for the country. The Council has an autonomic structure and a Scientific Board whose members are selected prominent scholars from the universities, industry and research units, has governed it. At the beginning, the basic functions of the Council were to organise, coordinate and encourage researches in natural sciences, to support academic researches, and to incite young researchers. To accomplish these functions, four research groups (now there have been ten research groups under Academic R&D funding) have been formed in Basic Sciences, Engineering, Medicine and Agriculture-Livestock with a Scientific Human Resources Development Group (now Scientific Human Resources Support Group). In 2005, the disciplines of social sciences and humanities became the area of activities of TÜBİTAK according to the new law.

In 1967, the Documentation and Information Centre was founded to serve documentations in R&D field for the researchers. The Centre has been upgraded into the National Academic Network and Information Centre with the creation of the academic computer network in 1996. At present, different facilities like Metrology Institute, Observatory and Test & Analysis Laboratories are servicing for the researchers along with this centre.

The institute for Building Researches (1971) and Guided Vehicles Technology and Measurement Centre (now the Defence Industries Research and Development Institute) in Ankara and Marmara Scientific and Industrial Research Institute (now Marmara Research Centre) (1972) in Gebze were founded and they became the tasks of the Council. Other research institutes have been added to these in the following years, but the Institute for Building Researches has been closed.

By preparing “1983-2003 the Turkish Science Policy” document, TÜBİTAK showed that it accepted the responsibility of developing the science and technology policy of the country. The Supreme Council for Science and Technology was founded in 1983 and the assignment of secretariat functions was given to TÜBİTAK. By this way, the responsibility of developing the science and technology policy of the country has become more clear and concrete. According to this duty, an extensive project titled Vision 2023 was guided to serve as a basis for the science and technology policies for the next twenty years. Another important role of the Council was occurred with the establishment of the Technology Forecasting and Assessment Directorate by the State in 1993 for supporting research and technology development activities in industrial establishments.

TÜBİTAK has represented the Turkey in almost all international science and technology cooperation activities since it has been in international platform. In addition to this, after the participation of Turkey into the EU Framework Programmes, TÜBİTAK’s responsibilities have increased in this field and in this respect; the National Contact Point System has been set. The name of the institution which was The Scientific and Technical Research Council of Turkey was changed as The Scientific and Technological Research Council of Turkey on July 7th 2005 according to the Law Number 5376.

The name of Scientist Upbring Group was changed to Science Fellowships and Grant Programmes Department according to the decision of Senior Board. The Science Fellowships and Grant Programmes Department has been applying the panel type interview for selecting the candidates of scholarships rather than evaluation of the jury.

3.2. The Structure of The Scientific and Technological Research Council of Turkey and The Responsibilities of Science Board

TÜBİTAK is an autonomous institution which is connected to the Premiership of Turkey. It has a decision board called as Science Board which is the policy maker for the institution and its decisions are also important for the implementations of Science Fellowships and Grant Programmes Department (SFGPD). The president of Science Board is also the president of the Council. Three Vice Presidents and Secretary General are dependent upon the President and SFGPD is also connected to one of these Vice Presidents. The institution has a classical organisational structure with vertical differentiation and also, horizontal differentiation with the connection of Internal Audit Unit, Science, Technology and Innovation Policies Department, Office of the President and Advisors. In the structure of TÜBİTAK as can be seen in Figure 3, one of the vice presidents is responsible for Technology and Innovation Funding Programmes that is founded for accelerating the process of transformation of the technology in to the social benefit with supporting the research, technology development and innovation activities of private sector of the country and Science and Society Department which has the duty of forming the scientific culture and interest among the members of society from different social, cultural and economical backgrounds. Another vice president manages Science Fellowships and Grant Programmes Department which performs for encouraging scientists in the areas needed by Turkey through a set of funds, competitions, scholarships, and educational programmes and Academic R&D Funding department which consists ten research committees from different areas and this department is a link between these committees and universities, public corporations and institutions, actual and legal figures. The last vice president directs International Cooperation Department for developing, applying and supporting international collaborations and projects, Research Centres and

Institutes which are formed by Marmara Research Centre, Defence Industries R&D Institute, National Electronics and Cryptology Research Institute, Space Technologies Research Institute, National Metrology Institute and Basic Sciences Research Institute, R&D Units and Coordination for R&D Facilities Department. In TÜBİTAK, the Secretary General directs managerial departments like Vice Secretary General, Administrative Services Department that is responsible for operating the administrative functions of TÜBİTAK, Office of Legal Affairs for resolving all of the legal issues of presidency and R&D departments, and Financial Services Department that plans, carry outs, manages and controls the financial resources of the institution according to relevant regulatory obligations.

Furthermore, the responsibilities of the Science Board should be understood for realising the operations of TÜBİTAK and SFGPD. The responsibilities and privileges of the Science Board are listed below:

- Determining the institution's study principles, plans, policies and its primary fields according to goals, principles and policies that the Turkish Government, the Supreme Council for Science and Technology and development plans set.
- Establishing or removing the research groups, research centres, research institutes and relevant units, and approving the chart of organisational structure of the institution.
- Negotiating, discussing, and making the final decisions about the institution's staff positions, payment lists, and job definitions upon the offer of Presidency.
- Assigning the directors of centre and institutes, the secretary of the executive committee of research groups and general secretary.
- Approving the annual study programme of the institution; to have fundamentals and regulations about the institution and research management prepared, changing, removing, and continuing them.

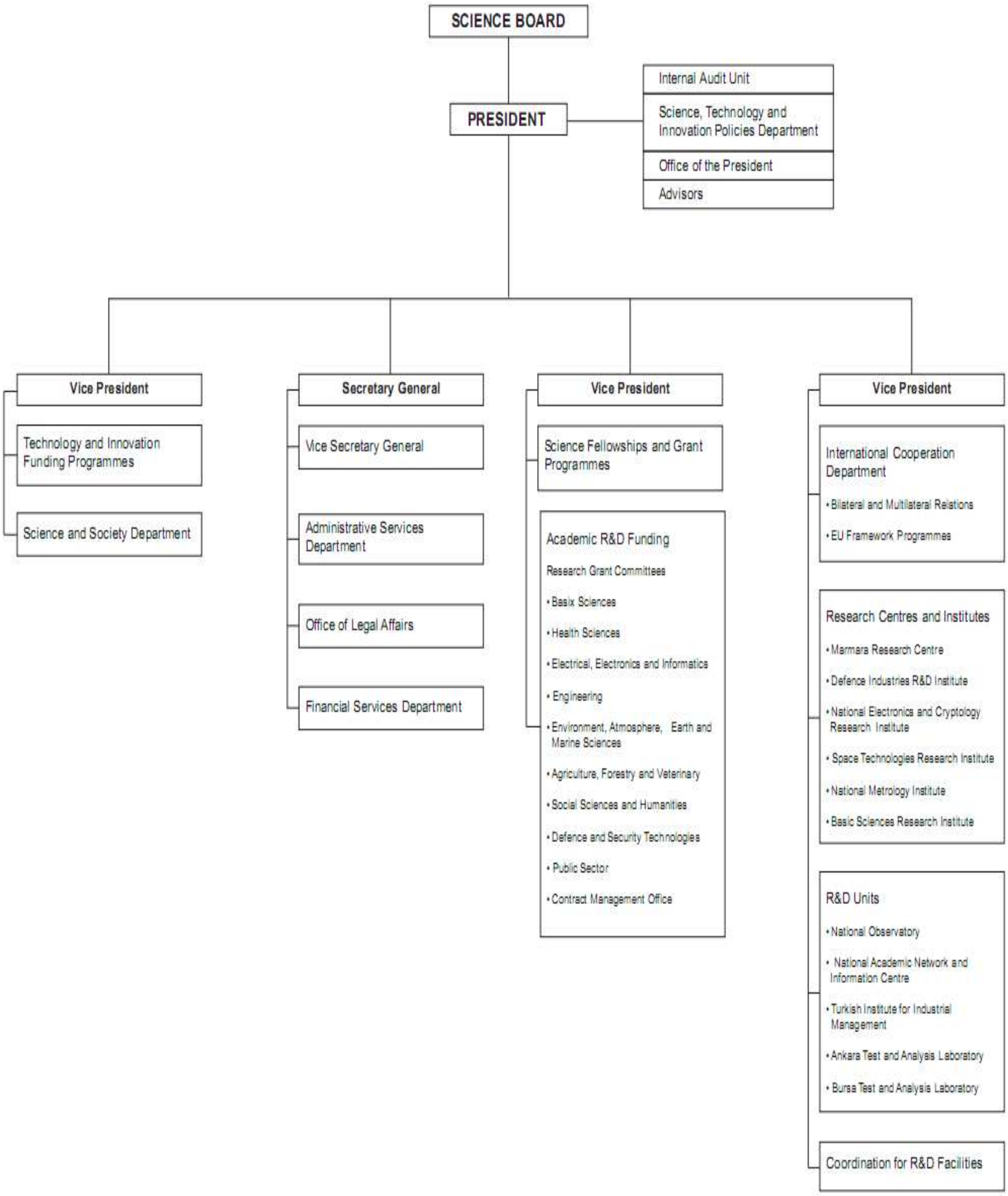

Figure 3.The Organisational Chart of TÜBİTAK

3.3. The Science Fellowships and Grant Programmes Department

The Science Fellowships and Grant Programmes Department (SFGPD) is the department that performs different supporting programmes and activities for scientists whose number and quality have to be increased for creating a country that is capable of producing science and technology and also, transforming them into social and economic benefit for contributing the science and technology accumulation in the world. The main roles of SFGPD are to provide possibilities for raising and improving scientists and researchers, to pursue young students who show great performance in their education and post education lives, to help them to improve and educate themselves, to grant fellowships to them, to prepare them for competitive contests and to make publication for this purpose.

The activities of SFGPD are distributed into 3 directories which are directory of national scholarships, directory of overseas scholarships, and directory of contracts. In addition to these directories, the support programmes for scientific activities are directly connected to the chairman of the department and form another branch in the structure of the department. There have been nine different fellowship programmes under the directory of overseas fellowships, eleven programmes under the directory of national fellowships, and eight programmes in the support programmes for scientific activities branch for this organisation. The Directory of National Scholarships involves National Undergraduate Scholarship Programme for encouraging senior undergraduate students to continue their education at graduate level, National Scholarship Programme for MSc and PhD Students for contributing the studies of them in the Turkish Universities, PhD Fellowship Programme for Foreign Citizens to support highly qualified students intending to complete their PhD studies in Turkey, and also Research Fellowship Programme for Foreign Citizens to support highly qualified PhD students/researchers to perform part of their research in Turkey, Guest Scientists Support Programme to contribute to the improvement of human resources and the research at public or private institutions by supporting scientists working at universities or research centres abroad to visit Turkey by seminars conferences, lectures, research and technological innovation, Research Scholarship for the PhD Students Programme for supporting PhD students who cannot find opportunity to carry on their researches in their own universities, National MSc and PhD Scholarship Programme for Senior Undergraduate Students to encourage senior undergraduate students to continue their education at graduate level, Postdoctoral Reintegration Fellowship Programme to grant scholarships for postdoctoral students who will make a research in national universities, National Postdoctoral Research Fellowship Programme to support national mobility of the Turkish researchers in order to create new opportunities for cooperating with their counterparts in the Turkish universities or research centres.

Furthermore, the Directory of Overseas Scholarships is formed by Overseas Scholarship Programme for MSc Students, Overseas PhD Fellowship Programme, Overseas Research Fellowship Programme, International Postdoctoral Research Fellowship Programme, International Scientific Meetings Fellowship Programme, TÜBİTAK-HUNAGRY (HAS) Scientific Exchange Programme, TÜBİTAK-LINDAOU Scientific Meetings Fellowship Programme, TÜBİTAK-GERMANY (DFG) Scientific Exchange Programme, and Meeting Regarding Scientific Cooperation Support Programme. Overseas Scholarship Programme for MSc Students stands for supporting students studying for an MSc with a thesis requirement in a university abroad in the field of Space Studies like Overseas PhD Fellowship Programme to support graduate students to get their PhD degrees at the research centres or universities abroad, in the areas which are determined by TÜBİTAK's Scientific Council. Overseas Research Fellowship Programme is formed for supporting PhD students in national universities in their researches abroad. In addition to this, the International Postdoctoral Research Fellowship Programme has a purpose of contributing to the accumulation of knowledge at transnational level by encouraging the international mobility of Turkish researchers. International Scientific Meetings Fellowship Programme and Meeting Regarding Scientific Cooperation Support Programme carry on their operations with the purpose of supporting international meetings that make science policies and route maps to develop science and technology. TÜBİTAK-HAS, TÜBİTAK-LINDAOU and TÜBİTAK-DFG Scientific Exchange Programmes have a duty to grant fellowships to the PhD students for their researches in Germany and in Hungary and to support PhD students for attending the meetings of scientists with Lindaou Nobel Prizes.

The National Primary Mathematics Olympiads for students attending the sixth, seventh, and eighth classes of the primary school, National Science Olympiads for students attending the eighth classes of the primary schools, and secondary school first and second grade students, International Science Olympiads for successful students in the National Science Olympiads and who have the opportunity to be chosen to participate in the International Science Olympiads based on their performance in the Summer and Winter Courses, National Secondary School Research Projects Contest for revealing the creativity of the students in basic sciences by preparing projects, National/International Research Projects Fellowship Programme for Undergraduate Students to support undergraduate students for their researches in homeland and international research contests, Summer School and Related Activities

Support Programme for MSc and PhD Students to encourage them to get the current knowledge about science and technology through national courses, National Scientific Meetings Grant Programme that gives the financial support for national and international meetings and meetings with international participation in Turkey and Scientific Meetings Grant Programme Regarding Teachers, K-12 and Undergraduate Students which arranges science camps, summer and winter schools and educations about the nature for them to improve themselves in basic sciences are formed the branch of scientific activities support programmes.

The scope of grant programmes can be summarised as:

- to organise national/international science olympiads and national research project contests regarding primary and secondary school students
- to provide financial support to undergraduate and graduate students for their studies
- to contribute to the postdoctoral researchers for their research activities at both national and international level
- to promote international mobility of postdoctoral researchers within the framework of bilateral agreements
- to encourage the Turkish researchers who have been abroad to be reintegrated into the Turkish Research Area
- to grant scientific meetings in Turkey
- to finance researchers for their participation in international scientific meetings

Since the directory of contracts is responsible for only financial issues of all these programmes, it does not have any vertically differentiated structure in the organisation. This current structure of SFGPD has nearly been shaped at the beginning of 2011. Also, the directory of contracts department was constituted in 2010 and includes only the director and a subordinate. The directory of contracts is responsible for all payment applications of the grant programmes of the department. Also, the directory of contracts controls financial process of the programmes according to law and the accounting rules before the payments go to the auditing and accounting departments in TÜBİTAK. Although there have been twenty eight different programmes in the department, employees are only 23 and this causes that some employees have to carry out more than one programme. Almost all the responsible employees of the programmes perform all the stages of programme like getting the requests for the programmes, preparing the panels, informing the applicants about the results, making payments to them, and watching these scholars until the end of scholarship process. All these operations are done with online application system called as E-SFGPD and written documents that are requested from the applicants.

Even if SFGPD has limited human resources, it increased its number of scholars and the amount especially between 2005 and 2010. As seen in Figure 5, the total number of scholars from 2005 to 2010 has gone up from 3053 to 18841. Also, the paid support to the scientists has increased from 10,4 million to 59,8 million Turkish Liras between the years 2005 and 2010 as Figure 6 shows. Another proof for the increase of the operations can be seen in Figure 7. The amount of expenses of SFGPD has risen from 8,9 million TL in 2005 to 61,5 million TL in 2010. The reason for this increase is the enlargement in the number of scholars.

Figure 4.Organisational Chart of Science Fellowships and Grant Programmes Department

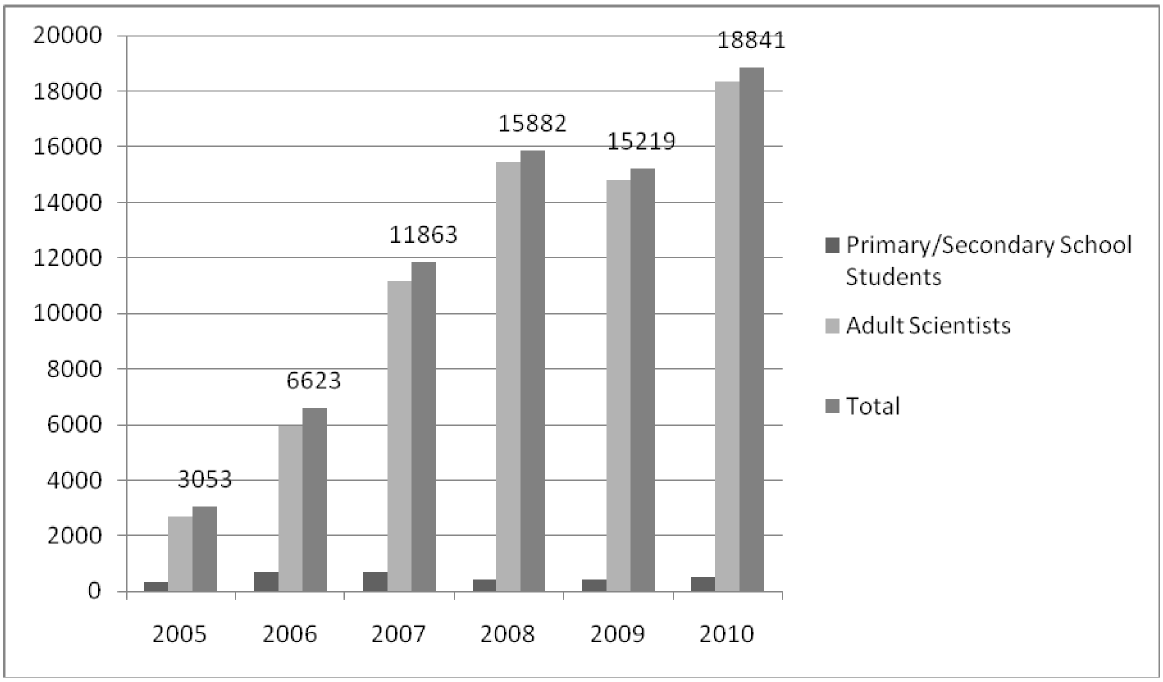

Figure 5.The Total Number of Scholars Supported in every year between 2005 and 2010

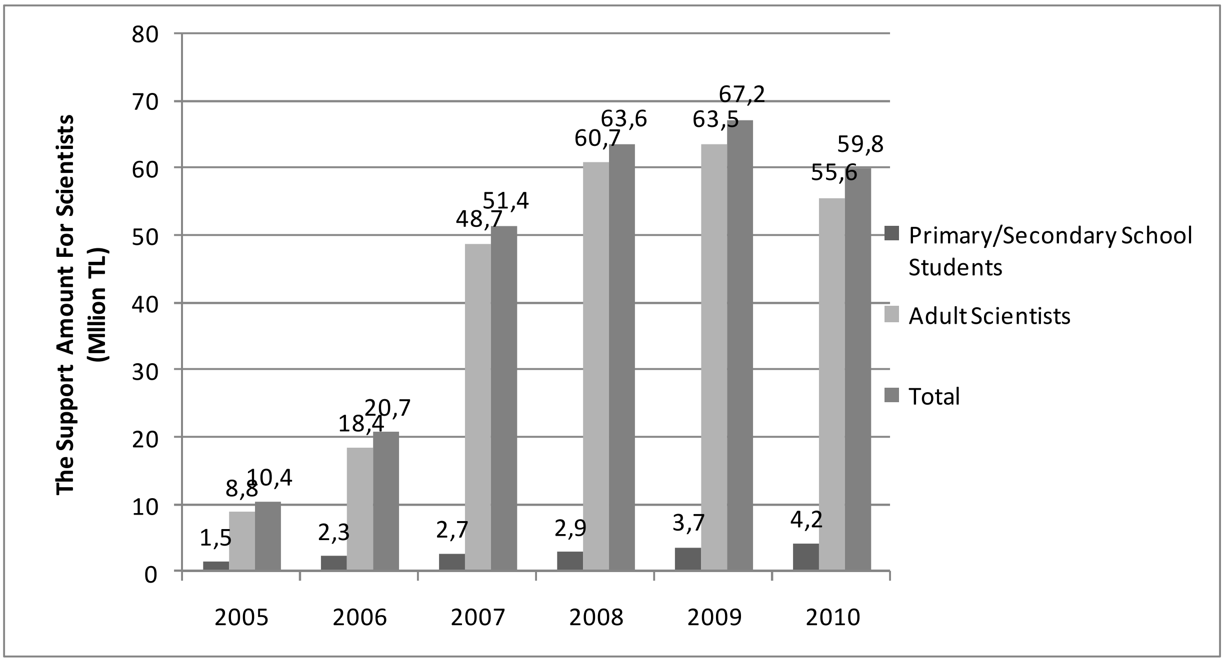

Figure 6.The Paid Support to Scientists is given from SFGP in every year between 2005 and 2010

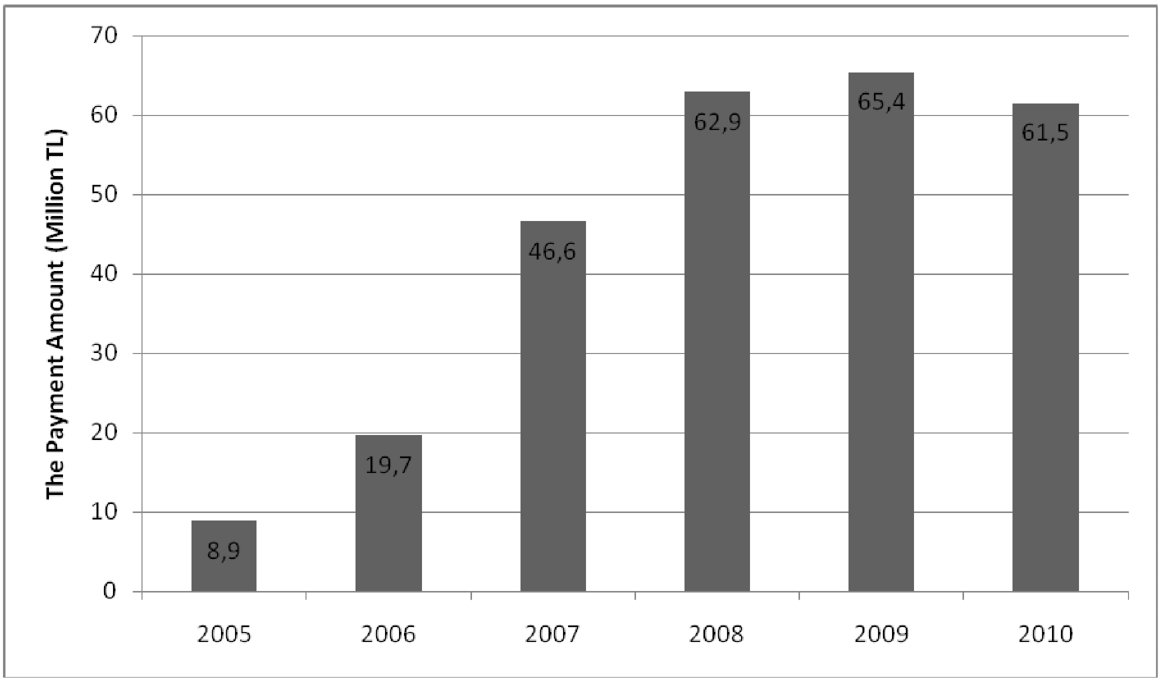

Figure 7.The Amount of Expenses of Science Fellowships and Grant Programmes Department for years 2005-2010

CHAPTER 4

THE IMPLEMENTATION OF VIABLE SYSTEM DIAGNOSIS IN THE SCIENCE FELLOWSHIPS AND GRANT PROGRAMMES DEPARTMENT AT STRCT

The chapter initially explains the reason for using Viable System Diagnosis (VSD) into the Science Fellowships and Grant Programmes Department at TÜBİTAK and determines the purposes of Science Fellowships and Grant Programmes Department with indicating the recursion levels of it. Moreover, the chapter focuses on VSD's process of application, and then provides a list of recommendations and an evaluation of suggestions about Science Fellowships and Grant Programmes Department.

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4.1. The Reason for Using Viable System Diagnosis into Science Fellowships and Grant Programmes Department

The organisations which arise in complex probabilistic "systems" that include oriented parts, function in a complex environment, and have unitary relationships about the goals of organisation amongst the participants can use Viable System Diagnosis to rearrange their organisational structures and to identify their problems (Flood and Jackson, 1991). The Science Fellowships and Grant Programmes Department is the system in focus of the study. Science Fellowships and Grant Programmes Department has a complex environment that includes accelerating number of students, researchers, academicians, private sector companies and government control mechanism and SFGPD has unitary relationships since the goals of the department are determined by the top management and the bureaucratic structure of the organisation imposes the employees to act in the same manner according to determined goals. For instance, if the SFGPD carries out the final of National Secondary School Students Research project Contest, the coordinators of different programmes have to work together to accomplish this activity. That kind of course of action is a settled organisational culture and the managers can force the employees to behave in that manner. Carrying on other coordinators' programmes together is a general rule in SFGPD and the employees share the same determined goals and objectives for the organisation while they are accomplishing jobs.

SFGPD has different kinds of fellowship programmes that have to be performed perpetually in accord with periodical applications. In particular, the support programmes for scientific meetings are the most dynamic part of the department since they have the richest application periods and the applications of some of the programmes expand to the whole year. Interrelated relationships among the programme coordinators help conduct these intense programmes. The course of action for using the model is to diagnose the defects of a suggested system design or an actual organisation which is extremely complex (Flood and Jackson, 1991). In this study, the viable system model will be used for redesigning of the organisation and determining the faults of it regarding cybernetic principles.

4.2. The Process of Application of Viable System Diagnosis

This subsection describes the use of Viable System Model (VSM). Looking at Science Fellowships and Grant Programmes Department (SFGPD) at TÜBİTAK from the viable system point of view it was essential to highlight system identification and system diagnosis. In system identification part, the purposes of SFGPD are clarified and recursion levels of it are determined and in system diagnosis part, SFGPD is reorganised according to Viable System Model.

4.2.1. System Identification: Purposes of SFGPD and Defining Its Recursion Levels

It is a need to define the recursion levels of SFGPD before reorganising the structure and diagnosing it according to VSM. SFGPD refers "system in focus" and "recursion level 1" in this triple recursion. The higher level of recursion is represented by TÜBİTAK and is called as "recursion level 0". Finally, three operational branches that are directory of national scholarships, directory of overseas scholarships and support programmes for scientific meetings form the "recursion level 2". The recursion level 0 is TÜBİTAK that consists of 15 subsidiary institutes which are managed centrically by the presidency and the decisions of the science board. These subsidiary institutes share the same mission with TÜBİTAK and this mission can be defined as:

"To develop scientific and technological policies in line with our national priorities and in cooperation with all sectors and related establishments; contribute to establishment of infrastructure and instruments to implement said policies; support and conduct research and development activities; and to play a leading role in the creation of a science and technology culture with the aim of improving the competitive power and prosperity of the country."

Even if these institutions are tied to the presidency and have to perform in order to reach goals of TÜBİTAK. These institutions are System 1 parts of TÜBİTAK and SFGPD is one of them. SFGPD is also the recursion level of this study and has a purpose of supporting scientists by means of funds, competitions, scholarships, and educational programmes that is described in their mission. The main role of SFGPD is to raise scientists according to TÜBİTAK law and this role is clearly defined by the top management of the department. SFGPD will be reformed according to VSM and Systems 1 to 5 are reorganised to ensure its viability.

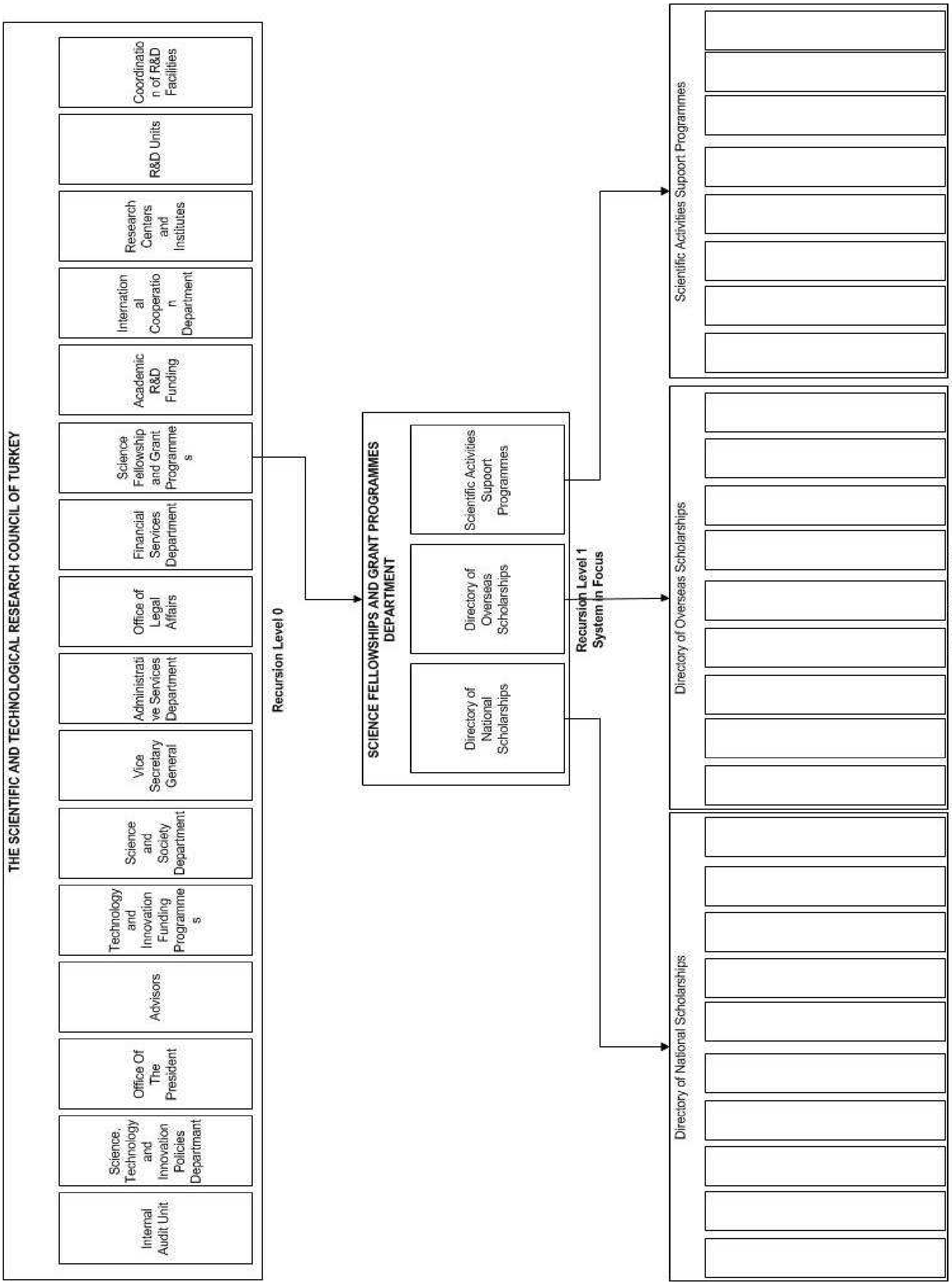

Figure 8.The Recursion Levels of Science Fellowships and Grant Programmes Department

4.2.2. System Diagnosis: Reorganisation of Science Fellowships and Grant Programmes Department with Regard to Viable System Model

The Science Fellowships and Grant Programmes department has viability since it conducts its operations according to its own managerial decisions. It is the funding centre of TÜBİTAK to support scientific researches and students in order to encourage science and technology in Turkey. It has three operational units that are directory of national scholarships, directory of overseas scholarships and scientific activities support programmes. These three units of the institution should be redesigned as viable elements of Science Fellowships and Grant Programmes Department.

System 1

There have been three operational units in SFGPD which perform main activities of it. System 1a (S1a) is directory of national scholarships and it is responsible for providing scholarships and research supports for undergraduate, MSc, PhD students even if they are foreign or national, and also support for postdoctoral studies. In addition to these, supporting guest scientists is another responsibility of S1a. These programmes in S1a are operational elements. The director of national scholarships can be defined as the local management of S1a. S1a has differentiated operations according to the content of the programmes. Scholarships for undergraduate, MSc, and PhD students are periodically paid to the scholars and the application time of them are twice in a year. On the other hand, the guest scientists support programme gets the applications of the candidates every month. This programme does not have specified application date so the coordinator of it has intense work process. The environment of S1a includes national undergraduate, MSc, and PhD students, foreign MSc, and PhD students, postdoctoral researchers, and foreign or national scientists who work for a short period in Turkey. S1a reports to the higher management and the higher management has a limitless control on the activities of the S1a like all operational units in the department. The coordination among the programmes is made by the director and also the president of the department and this shows that there is no clear System 2 in the organisation. The payments of supports are controlled by both directory of contracts, financial services department, and also the government auditors. Because of this, S1a is obviously open to controls of System 3. System 3^* which runs the auditing duty is made by accounting control directory of

TÜBİTAK. S1a takes its own decisions about operations autonomously, but the decisions about policies are taken from the science board and the presidency of TÜBİTAK. S1a has to respond to the environmental changes of its local environment so all the coordinators are responsible for System 4 functions. In that case, the coordinators of the programmes get the experience from the past processes. On the other hand, S1a does not have policy making authority in its own local management.

The local managers cannot take decision about forming panels for evaluation of the applications for the supports but they can make the formal evaluation of MSc and PhD the scholars. The measure of performance of S1a and other operational units is the number of people who is supported by SFGPD.

System 1b (S1b) is the directory of overseas scholarships that provides MSc and PhD scholarships for the students abroad, supports research and postdoctoral research, and international meetings, and have exchange programmes with Hungary and Germany. S1b's local management includes only the director of the unit like S1a. The local environment of S1b is composed of national MSc, PhD students, and postdoctoral researchers, and also the institutions from Hungary and Germany which are responsible for supporting scientific development in their own countries. S1b is also linked to its higher local management vertically. The goals are determined at the science board of SFGPD and declared by the president of the department to its local management. The payment controls are made by System 3 members. The coordination is made by the local management of the unit so like S1a there is no clear System 2 function in the organisation. S1b gets the information about its local environment with the help of coordinators and the director of the unit monitors this information to the higher management.

System 1c (S1c) consists of the scientific activities support programmes. This branch of the department includes a wide span of programmes from national and international science Olympiads to research projects contests, summer schools for MSc and PhD students, and national scientific meetings. This branch of the department does not have a local management and it is directly connected to the president of the department. S1c has the most differentiated local environment among other S1 parts and this local environment includes secondary and high school students, teachers of those students, the university professors to educate Olympiad students, professors from different universities who get support for their scientific meetings, and private organisation firms who carry out national and international arrangements of these programmes. The System 4 is performed again like S1a and S1b by the coordinators of the programmes. The objectives of S1c are determined by System 5 which is formed by the science board and the presidency. The control of the operations is made by System 3.

System 2

System 2 (S2) which provides the coordination among the operational parts of the system, is a big need for SFGPD. The viability of SFGPD has been damaged because of lack of System 2. The coordination among the coordinators is only made by the directors and the president of the department and this gives rise to a burden for the local managers of the units. The directors of the operational units and the president of the department make coordination meetings every month to solve this problem. Also the same meetings are arranged by the top management of the institute. In some periods for intense programmes, the directors cannot make the coordination and the coordinators pursue both System 1 and System 2 activities. The directors of the operational units and the coordinators are aware of the need for the coordination function of the system.

In particular, the scientific activities support programmes solve the conflicts that arise in their operations by the help of System 3 which is the directory of contracts unit. Furthermore, the activities of S1c like making national and international arrangements have been carried out by the help of other programmes' coordinators and this leads to duality for the employees among their own S1a's and S1b 's operations with S1c's operations. The staff number is insufficient and they have lack of information about other programmes when they attend other programmes. Also, the coordinators do not have enough information about the rules and principles of their own programmes and this is another source of conflict in the operational process. System 2 should have the awareness about these oscillations. The job definitions should clearly be arranged and the new staff should be added for managing System 2 activities. Moreover, the coordinators should be educated and tested about the rules and principles about their programmes. Since the local managers and the coordinators of the programmes are strictly tied to the higher management and their decisions about the operations, the bureaucratic approach should be abandoned by the top management in order to cease the disturbance of the coordination among the units.

System 3

System 3 manages the control function for the organisation. The directory of contracts is responsible for this function in SFGPD for the payment issues. The payment operations of System 1 units are only controlled by System 3 and System 3[*] activities are accomplished by the financial services department and the government auditors. The relationship between System 3 elements and System 1 elements is not very democratic since the controlling activities are based on the accounting rules and the policies which are determined by the presidency.

The directory of contracts in SFGPD does not strictly exercise authority on the units of System 1. On the other hand, the internal auditors of TÜBİTAK and government auditors can exercise authority in the control process of the operations. The control of evaluating the applications for the scholarships is made by the panel coordinators, the online control system, and the president of the department. The audit enquiries for payments and evaluation for applications are based on financial rules and the principles of the programmes. The directors of the operational units are responsible for the performance of the units and the president of the department is also responsible for the performance of the department to the higher management of TÜBİTAK. The performance of the departments is evaluated according to statistical results of the programmes and these statistics are periodically collected by one of the coordinators for the decision making authorities.

Although the directory of contracts controls the payment operations of the S1 units as System 3, it cannot meet the goals of System 5, explain these goals for the operations of System 1, and transfer them to System 1 units. These responsibilities are accomplished by the local management of S1a, S1b, and the president of the department. The resource bargaining among the operational units is directed by the directory of contracts and the president of the department. The coordinators of the programmes can report the needed financial resource and human resource for their programmes but the decision making authority of the institution generally dominates resource allocation process. Furthermore, the algedonic signal which carries the immediate information to the higher management as an information channel does not work well since the information cannot be echoed to System 5 immediately. On the other hand, filtering this information is well made by the directors of the S1 units. As a consequence, System 3 of the organisation should be reformed to transfer the goals into the operational units and the information about the operations to the higher management. Also, decisions about resource bargaining should be more democratic in the department.

System 4

System 4 stands for getting the information from the environment of the organisation and transmitting the information downward and upward. The information which is filtered by System 3 is carried by System 4 and this information is combined with external information that is also got by System 4. System 4 filters external information and distributes it downward or upward (Jackson, 1991). System 4 function of SFGPD is not separate from the department. All the coordinators of the programmes have to deal with this activity to respond urgent changes in their local environments. Transferring internal information is made by the local management of operational units and this leads to a need for creating System 4 function in the organisation. Also, in some cases the director of S1 units and S3 get the external information and transfer this information to the top management. Coordinators, the local managers, and the president of the department can improve the suggested alternative courses of actions for the problems about operations in the system. The department occasionally has to face with lawsuits that are related with the programmes and the legal affairs department deals with the processes of these lawsuits. Furthermore, the communication office of the institution follows the news about the department in the mass media and if the news is not correct, communication office informs the SFGPD. The department prepares its defence and sends it to the legal affairs department. Afterwards the legal affairs department follows the process for those kinds of cases. All the managerial and operational levels have to experience the rapid changes of the organisation’s environment. Instant responds cannot cope with the threats of the environment. The current coordination meetings of local managers of the units are not much open to the novel ideas and perceptions because of the bureaucratic rules and the structure of the institution. However, the local managers try to reflect the problems and threats of the environment to the top management of the institution. The instant mechanism of System 4 activities of the department helps adapt to the environment during the operational processes. Furthermore, the coordination meetings of the department form an operations room in System 4 activities since the local managers can present their suggestions to the president of the department. Monitoring the events of the environment can be made with the help of other departments of the institution so there has not been an integrated System 4 function in the organisation. To perform S4 functions efficiently, the local managers should get periodic information from the coordinators and transfer this information to the decision making centre of the organisation. The coordination meetings of local managers with the president of the department should be increased and the coordinators should more involve into these meetings. Also, the external information should periodically be evaluated in these meetings.

System 5

The science board, the presidency of TÜBİTAK, and the presidency of SFGPD execute System 5 activities which are to formulate policies according to the information that is transferred by System 4 and reflect the policies to downward with the help of System 3 for its use by the operational units. The general approaches of the science board and the presidency of TÜBİTAK are strict for the applications of SFGPD. This bureaucratic and rigid method of top management negatively affects System 4 activities of the department. The local managers and the coordinators cannot have domination for their own operational processes. The policies are periodically made by the science board and the presidencies every month. The institutional identity is the same in TÜBİTAK and SFGPD since it is a governmental institution and its organisational structure has recursive levels. Even if the department shares the same identity with the whole organisation, the approach of higher management about decision making process disturbs the autonomy of the department since the department's top management does not involve much in this process. Furthermore, SFGPD has close relationship with the external environment so the presidency and local managements have more information about the opportunities and threats. However, the policy making authority is not distributed to the managers of the department, and also the top management does not require information from the lower levels of the organisation. This approach for System 5 activities inhibit participation of System 3 and System 4 which is particularly performed by the coordinators of the programmes for decision making process and designation of future departmental objectives. The science board and the presidency of TÜBİTAK should be participant-driven in the decision making process in the department. In addition, the presidency of TÜBİTAK should require external and internal information of SFGPD from System 4 elements of the department to define more appropriate objectives and goals for the organisation, to give freedom to management about operational decisions, and to help generate the local ethos of the department.

4.3. A List of Recommendations and an Evaluation of Suggestions

From the diagnosis and reorganisation it became apparent that the following recommendations were necessary to the Science Fellowships and Grant Programmes Department. In light of these recommendations the participants made their assessments.

- All the operational units should have its own local managers (especially Scientific Activities Support Programmes need their own local managers). The job definitions of the coordinators should clearly be determined to prevent multiple roles of the employees in different operational units. This recommendation is accepted by the managerial level and operational unit's staff because the coordinators of the programmes do not want multiple roles and the management of the department wants to delegate its authority to accelerate the work flow of the organisation. By the way, the recursive structure that the model offers can be achieved totally.

- The new staff should be added for carrying out S2 activities in the organisation and a coordination centre should be formed to help the managerial level of the department. This improvement can remove the burden of S2 activities that are on the local managers and the president of the department. However, the participants and the managerial level think that this suggestion is impractical because the department does not have a large structure to have a coordination centre or unit. The managerial level expects that positioning the coordinators close to each other is enough for providing coordination if they carry out similar programmes.

- The top management of the institution should not involve in operational decisions of the department so as not to disturb the viability of operational units. The local managers and the participants of the organisation share the same opinion in this matter but the managerial level of the department does not predict that top management of the institution would allow this and the viability of the organisation would be damaged because of the approach of current top management. According to local managers, if top management changes, they can be more free about taking the operational decisions.

- The coordinators of the programmes should be well trained about the rules and principles of their own programmes and the actual changes in these rules and principles should be informed in time. The evaluation of managerial level of the organisation for this suggestion is that there is a need for training programmes about time management, methodical study, and filing system to encourage the staff. The lack of information of the coordinators about the current programmes is a result of employees' unwillingness to read and learn the general principles and rules of the programmes. Also, the managers of the department think that the employees have a habit of routine working and this habit prevents the rapid work flow in the operations.

- The transfer of information upward and downward direction should be accomplished by S3 and also, the top management of the institution should evaluate the information that comes from lower levels about needed resources to manage resource bargaining effectively. The participants indicate that at the end of the every year, the department prepares an annual report that includes deficiencies and the situations that have to be improved about the activities of the department to inform the top management. However, the general acknowledgement of the participants is that the top management will always be biased about the information which comes from the lower levels so that S3 cannot achieve the transmission of information upward and downward direction.

- The information flow from S4 to S5 should be increased and innovative ideas should be evaluated more by the top management of the institution. S4 activities are seen as an important need according to the managerial level of the department. They desire to be promoted for generating innovative ideas.

In this chapter we have designed SFGPD according to Beer's Viable System Model (Figure 9). Two directories and scientific activities support programmes are considered as three operational units of the model. The autonomy of S1 parts is provided by the local management of operational elements. It has been observed that there is a lack of System 2 which is the coordination function that needs to be developed more and a unit for the coordination activities is added to the structure. System 3's functions in the organisation have been determined and the responsible units have been pointed up. System 4 activities which are performed by all the coordinators of the department, the local managers and other departments of TÜBİTAK have been organised and got together. Also, the information flow between S4 and S5 is assigned. Lastly, the S5 activities and the authority of policy making are allocated to the presidency of SFGPD and the local managers of operational elements.

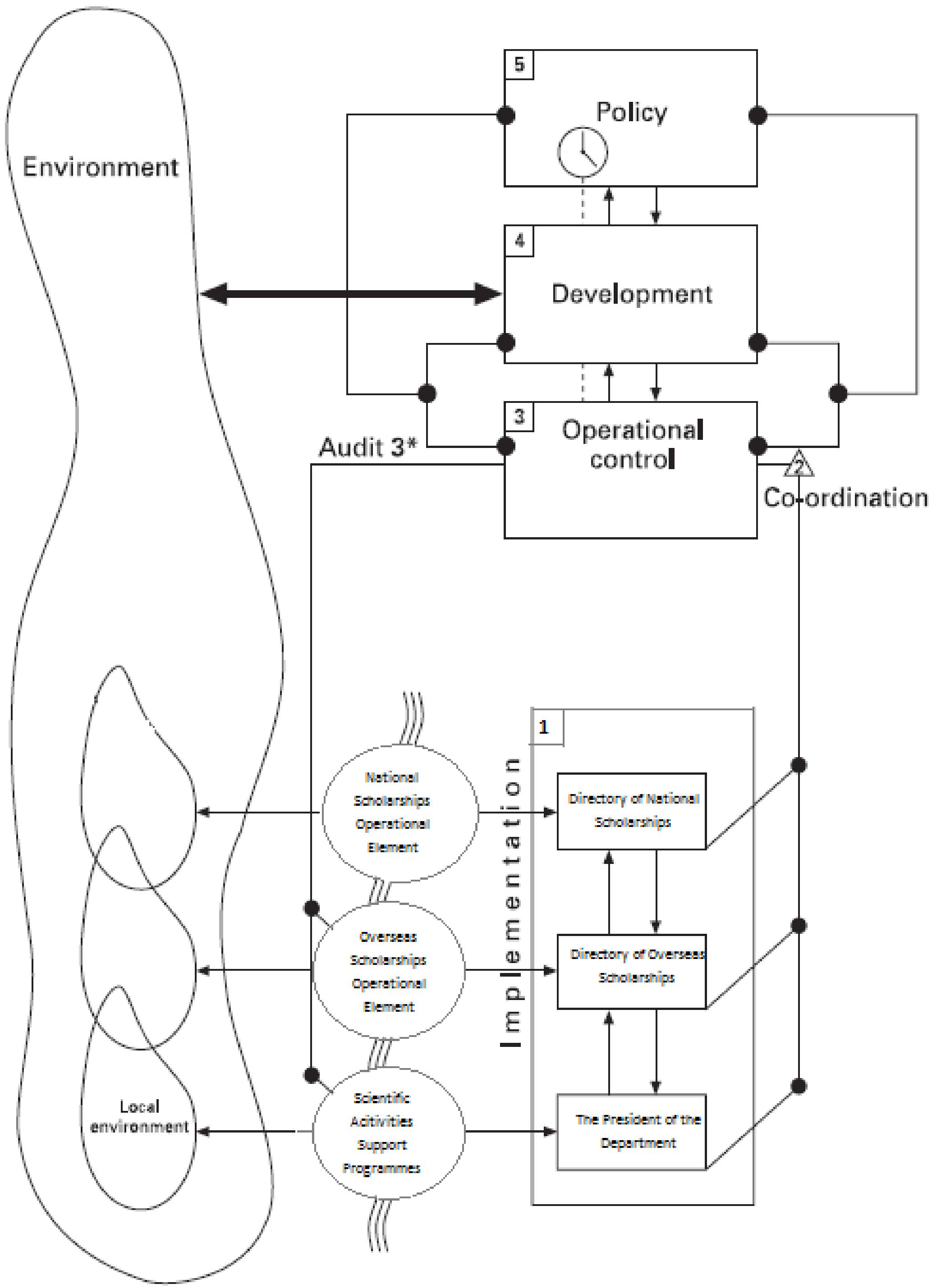

Figure 9. Science Fellowships and Grant Programmes Department According to VSM

CONCLUSION

The aims of this thesis are to get an understanding about systems thinking and design an organisation according to VSM.

To have a better understanding for the application part of the study, systems thinking, its origins, and the problem contexts which lead to use VSD to solve organisational problems are described and cybernetics and its tools for solving organisational problems are explained. In addition, the theoretical base of VSD which is used for the application part of the thesis has been elaborated.

In the application part, VSD is applied to TÜBİTAK-SFGPD which has a mission of supporting scientists, students, and researchers in Turkey for the benefits of the country. For that purpose, the general information about TÜBİTAK and SFGPD is given and the structure and working processes are introduced. Finally, the organisation is diagnosed and redesigned according to VSM, and recommendations are made and suggestions are evaluated for TÜBİTAK.

VSD solves organisational problems that ensure the viability of organisations. This approach helps managers to view the organisation as a whole and to solve concerns that arise in the complex-unitary problem contexts in organisations. The cybernetic and systemic principles are used for solving such kind of problems in organisations. Since VSM is general, it is applicable for all kinds of organisations even if they are small or big.

However, during the application part of this study, we have observed that the employees and managers do not have sufficient information about systemic and cybernetic approaches for organisations and some of them have multiple roles, overlapping responsibilities, and responsibility gaps. This gave rise to unawareness and confusion about their roles in the organisation. If VSM is well understood by the employees and the managers, the model possibly will reduce the conflicts and chaos in the organisation. On the other hand, the employees in the operation units of the organisation are not very open for change in the organisation that the model offers. Even if the employees complain about top management's general behaviour for interfering operational decisions, they have a general attitude that the decision about changing the organisational structure can only be in the control of the top management.

The logic of VSD is to give the autonomy to the operational units in their jobs since internal variety of the organisation can be reduced by this way and it prevents top level management’s much unwelcome intrusion to the operational activities. Even if the autonomy of operational elements is given, the higher management often interferes to the internal decisions of the department more than necessary. This damages the viability of operational elements and the whole organisation. Also, the internal information flow of the department is not much evaluated for the decision making process by the top management and this harms the execution of System 5 activities and the applicability of the policies that are set. As a consequence, the principles of the model cannot be applicable because of the bureaucratic structure of the organisation. The model is a beneficial tool for transforming organisations that are organic but it can be too hard to change bureaucratic structures like governmental organisations. As a result of this fact, the unitary relationships of the organisation are the result of the top management’s bureaucratic insistence to the activities of the department. Furthermore, applying System 4 activities completely is a hard task in this kind of governmental organisations since the top management as a rule does not have a need and request for innovative ideas arising from the lower levels of the organisation. This situation causes that the organisation cannot cope with the complexity of the environment sufficiently even if VSM is offered for these kinds of organisations.

VSD is an important tool for transforming the organisations since it can be applicable for all kinds of them. Five functions of viability should be performed by the organisations to survive according to the model. The model clearly defines all the tasks that must be carried out by each system and this provides easy application of the model for the practitioner. The clear definitions for cybernetic principles and VSM’s each system are very helpful for the practitioner to highlight the organisations’ deficiencies for the viability. On the other hand, some of the organisations have unique structures and the model can be insufficient to diagnose them and the practitioner does not have any initiative to change the model in order to diagnose these kinds of organisations because the reliability of the model can be damaged.

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