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**THE SCIENCE
AND EDUCATION
AT THE BEGINNING
OF THE 21ST CENTURY
IN TURKEY**



Volume

3

THE SCIENCE AND EDUCATION AT THE BEGINNING OF THE 21ST CENTURY IN TURKEY

VOLUME: 3

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IV.
SCIENCES
AND TECHNOLOGY

SYSTEM APPROACH AND ITS USE IN THE FIELD OF ARCHITECTURE

Z. Sevgen PERKER

CONCEPT OF SYSTEM

From a scientific approach, system can be defined as an assemblage of ideas – principles which pose a logical unity and consistency, a whole element comprising of parts which have mutual relations and interaction or a mechanism that functions in accordance with some specific rules (Churchman, 1968).

A system has got two main features. One of them is that the system has got a target and the second is that the system is composed of particles which are interacting each other. Every system has got an aim to reach. Aim is the main reason of the existence of the system. Therefore; it is not possible to define a complement having no aims as a system. System is a complement, which is composed of parts working together to reach the defined target and interacting with each other during this interaction (Sariaslan, 2009).

A change that occurs on any part of the system affects the other parts and consequently the functioning of the whole system. The smallest piece which poses an effect on the functioning of the system and which is regarded as an individual item is defined as the system element. System elements usually comprise of pieces smaller than themselves. The elements of the determined system gather together and generate sub-systems in order to fulfill a specific role within the system. (Subaşı Direk, 2003: 86 - 92). In addition the system itself is a sub-system of a bigger system. And that bigger system to which the system is affiliated to is named as upper-system. In this regard we can group the systems as follows:

- Upper-system
- System
- Sub-system
- Sub-system elements
- The pieces that form the sub-system elements.

Systems are divided into two groups; 1- Systems which are relating to the environment that they are in (open system) and 2- Systems which are not relating to the environment that they are in (closed system). Closed systems; are systems having no input. Closed system elements never interact with the features of the environment and never contact with the environment. If there is a relation between one of the system elements and at least one of the elements of the environment; the mentioned system is qualified as an open system (Sariaslan, 2009). Closed systems; are systems having no input. Closed system elements never interact with the features of the environment and never contact with the environment. If there is a relation between one of the system elements and at least one of the elements of the environment; the mentioned system is qualified as an open system. The various forms which the inputs create by

getting through a process are defined as the output of the system. In closed systems; only inner operation elements are taken into consideration while outer elements are accepted non – existent, (or although they are presumed but they are not taken into consideration in analysis and decisions) In open systems it is believed that there is an reciprocal interaction. Open systems get inputs continuously and act in a dynamic balance and they protect their balance by making necessary changes according to the alterations occurred around them. Within this extent; there is always a relation of ‘input – change – output’ in open systems. In such occasions; an output of one system could be the input of the other system. By feedback process; open systems are provided to arrange themselves due to the changes around them. By feedback method; systems find an opportunity of evaluating and arranging their activities if necessary (Bertalanffy, 1950; Mattessich 1978; Dinçer 2009) (Figure 1).

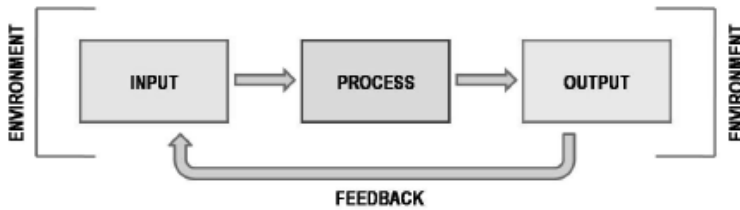


Figure 1. Open System Operation Model (Perker 2010)

SYSTEM APPROACH AS A SCIENTIFIC METHOD

System approach is derived from ‘General System Theory’ of Von Bertalanffy which he introduced in 1920’s. General System Theory is an approach that is aiming to establish a common analytic model for all the scientific fields. The aim of the system approach is to develop a hypothetical frame in order to explain the general relations in the world (Johnson and others, 1964: 367 - 370; Dinçer, 2009).

The purpose of the system approach is developing a systematic and corporate frame in order to explain the general relationships in the world. According to the system approach, it is possible to generate a general thesis which will enable us to bring all scientists, who carry out their studies in order to handle every formation in our world (which can also be defined as a hierarchy of systems itself) as a whole together, to explain the relations among these formations and define the formations in subject individually, together within a meaningful chain of relations. In this context, the final purpose of the system approach is forming a universal science through the usage of common elements and processes in all scientific fields. (Johnson and others, 1964: 367–370; Dinçer 2009).

Basically; system approach which was generated by various scientist in the historical process and created from the general system theory of Bertalanffy and it is actualized under the light of principles such as following a certain system and directing different point of views to the complement, considering the complement. System approaching

events signify the conditions and problems under the enlightenment of the system view and system attitude. System approach is to divide problems into small pieces and get the pieces together regarding the defined target.

System approach is based on three main principles;

- Holistic Approach Principle: It comprises of dealing with the system you examine as a whole. The problems that the system examines must be conceived as a whole, not as individual elements. The solution put forward for one of the mentioned problems is related with the solution of another problem.
- Interdisciplinary Approach Principle: It comprises of directing different points of views over the examined system.
- Scientific Approach Principle: This principle is regarded as the tangible and systematic method that gathers the first two principles together. (<http://www.pdrforum.net/index.php?topic=1584.0> 2009).

The questions which must be considered and answered when a specific whole is analyzed with the approach of system are as follows:

- What is the purpose/purposes of the system?
- What are the pieces that form the system (sub-systems or processes)?
- What are the characteristics of the pieces (sub-systems or processes) that form the system?
- How is the relation among the pieces (sub-systems or processes) that form the system?
- What does the surrounding environment of the system (if it is an open system) comprise of? In other words, what are the upper-systems that affect the system?

System approach is a research method widely accepted in the scientific world.

The major reasons why system approach is preferred as a scientific method are as follows:

- The fact that it enables us to handle the internal and external environmental aspects as a whole within the scope of our research,
- It enables us to make a detailed classification about the problem areas,
- It enables us to recede from the common mistakes in which the problems faced during a research are linked to a single reason,
- It enables us to develop comprehensive solutions as a result of handling the subject matter in a holistic way,
- It accepts that change is inevitable for each field. (Dinçer, 2009).

System approach was initially developed by some certain scientific fields such as biology and mathematics, however over time it became possible for people to use the system approach for explaining the social incidences and organizations, defining and interpreting the cause-result effects. The fact that the system approach is used as a scientific method in various scientific fields and in various ways indicates that it is a valid approach in an extensive area from theory to application, and this fact

consequently makes this approach universal. (Johnson and others, 1972).

In 2007 an interesting research which was conducted in order to question the validity of the idea of system in our time was published. Within the research in subject, the researchers studied 314 research articles which were written in various scientific fields between the years 1970-2004 based on the general system theory and probed the findings of these researches. After this examination it was concluded that general system theory is still a valid one used as an analysis method in the fields of physical sciences, social sciences, educational sciences and health sciences. (Drack and Apfalter 2007: 537 - 546).

The 'General System Theory' put forward by Ludvig Von Bertalanffy in 1920s works based on the idea that the universe consists of sub-systems which are interrelated with each other. Thus, the theory in subject aims to explain this holistic structure and how it functions via benefiting from the findings of all sciences. In order to understand the approach which concerns the whole universe and system, we have to take the findings of several sciences such as astronomy, mathematics, biology, physics, chemistry, physiology, architecture, computer and economy into consideration. For instance; human organism is a highly complicated system. When we approach this complicated system from the view of architecture, two things catch our attention. First of all, the human body is considered as a space. In this point of view, the body is a tiny space in which all organs are fitted in a harmony and function in the ideal way. The other situation is the fact that the human who is a highly complicated system, has a qualification that leads the formation and use of a tangible architecture space. The human beings are biological systems that consist of several sub-systems such as 'nerve system', 'digestion system' and 'circulation system'. In order to examine and understand human body, we first of all need to examine the sub-systems in subject and understand their functions and relations with each other. Through system approach the possible defects that might occur on the parts that form the human body such as the DNA, cells, tissues, organs etc. or the systems such as nerve, digestion, circulation systems etc. are examined, and treatment methods are considered. On the other hand, as 'human' is a part of the sub-systems of the upper system we name 'society' such as 'social system', cultural system', 'economic system', the need for studying and understanding some other fields such as sociology, economy, culture etc. with the system approach gains currency. Regarding mathematics, on the other hand, human is a whole of variations in which the components are in balance (Şahin, 2003: 57; Dinçer, 2009).

According to a research conducted in 2007, the scientific fields in which the system approach is most frequently used is social sciences. And the social sciences field in which system approach in most densely used is the field of administrative sciences. According to the system approach which is among the contemporary approaches of administrative sciences today, each facility generates a system for itself. According to the system approach, facilities are open systems which offer the input they receive from their surroundings as goods or services after a

specific transformation process. In order the facilities to continue their existence, they have to adopt their environment which poses an upper system for them, and meet the expectations of the society which is another upper-system for them. When we examine the field of administrative sciences, we see that there isn't any administration or organization which does not put any stress on the system approach and contemporary administrations and organizations are designed by taking the system approach as a basis. In addition to the facilities, families, associations, schools, institutions etc. are also considered as subjects of study regarding social systems in the field of social sciences.

In the fields of physical sciences and health sciences, while various components of the complicated system that we name human are examined under the light of the system approach on one hand, herbs, animals and other creatures are also accepted as specific study subjects regarding the system approach on the other hand. Another research subject of the physical sciences is the mechanical systems such as the planes, automotives, computers etc. which are dominant topics of engineering (Şahin, 2003: 57).

THE IMPACT OF SYSTEM APPROACH IN THE FIELD OF ARCHITECTURE

System approach is a well accepted method in the field of architecture as well. It is possible to handle architectural problems in the context of system approach and classify these problems afterwards. When we make such a classification, we see that we can consider the system which contains architectural problems in three sub-systems. The sub-systems that form the architectural problems are as follows:

- The sub-system regarding the design process
- The sub-system regarding the construction process
- The sub-system regarding the examination process

The sub-system related with the design process deals with the physical systems and behavioral systems as a whole. The designer comes across with these two systems in an array of complicated relations, and these two systems continue being interrelated with each other throughout the utilization of the building as well. The behavioral sub-system which is one of the sub-systems that forms the design process sub-systems is based on the characteristics and behaviors of the users who live inside the building. In order to study and understand this system, we have to take the purposes, action types, the relations between the actions and the organization of the actions into consideration. Another sub-system that forms the sub-system of the design process is the physical system. The physical system includes the spatial and physical environment. The spatial environment contains the dimensional and geometrical characteristics of the building and its divisions as well as the spatial relations between these divisions. The physical environment on the other hand, is the environment people perceive through their sense organs. It comprises of several conditions of space such as heat, light, sound, structure and smell. The relationship between the building and the user occurs and continues within this kind of a design system. (Subaşı Direk, 2003: 86 -92).

System approach as a design strategy can be defined as handling the tools which fulfill the function of meeting specific human needs within a system identity by benefiting from our current resources and offering a solution or reaching a decision within the frame of a specific array.

The sub-system related with the construction process considers the construction production sub-system and construction management sub-system as a whole. During the construction activity, all physical elements from the construction materials to construction equipment as well as the labor force and technology generate the construction process together and these items form the sub-system of construction production. The sub-system related with the management of the construction consists of all physical and behavioral factors that are in subject as of the completion of the construction until the end of the building's life.

The sub-system related with the examination process consists of the pieces that form the building and how the building fulfills its function. If we want to examine a building, we have to isolate it as a system. Only this way can we examine the pieces which are effective for the building to continue its functioning and the relation of these pieces with each other, detect if there are any problems and use the data we obtain as a basis for future designs and buildings. (Berköz, 1972: 26 – 57).

In various scientific research conducted from the past to our day, important data were obtained, analysis were made and findings were put forward by based on the system approach in the problem fields stated above. In this context we can say that system approach has precious contributions in terms of the scientific knowledge produced in the field of architecture. Some researchers such as Wooster, Napier, Handler, Marcus have developed some models which enable us to analyze the Construction through System Approach. The structural models developed by the aforementioned researchers aim to define a current situation in the field of construction as it is, to characterize it and especially to examine the relations among the elements that generate the situation in subject.

The model developed by Wooster with the purpose of analyzing the construction industry in England is one of the pioneering examples of adjusting the system approach to construction field. In the scope of this study, a model which aimed analyzing and isolating the whole construction industry in England was prepared. The model in subject consists of three sub-systems: decision sub-system, construction sub-system and built environment sub-system and all these sub-systems are divided into other sub-systems in themselves. It was also a fundamental element of this model to analyze the relations among the systems.

It is known that the model of Napier for examining the construction industry in Sweden was mainly focused on the decision system regarding the building. In this study the generation of a construction process with the effects of the decision makers is considered as a system. In this scope the actions of the relevant groups such as customers, consultants, contractors, sub-contractors and material suppliers are considered as individual systems, and the upper-systems that affect the construction

process are classified as financial systems, corporate structure, authorities, political systems and other related systems.

It is known that Markus's model which is based on the system approach, was generated in order to develop methods to measure and evaluate the performances of the buildings. In this context, with the model generated in the scope of Markus's studies, it was aimed to provide the designers with techniques which shall enable them obtain a lot of trustworthy performance data in order to help the architect with his decisions regarding the design.

Handler's study which is named 'Architecture System' and which sets forward the system approach as a basis, is the most comprehensive research conducted by then with the aim of using system approach in architecture. It is known that Handler published a book on this subject matter as well. As this is the most comprehensive study in the international scope regarding the system approach, it is necessary to address some details on Handler's study. In the scope of the study, in addition to design, construction and management, human behaviors were also taken into consideration. Handler examined architecture by dividing it into four sub-systems which are design sub-system, construction sub-system, building management sub-system and human bionomic sub-system. In the scope of his study, Handler aimed to define the inputs, processes, outputs, restrictions and feedbacks of all sub-systems and the mutual interactions between these sub-systems. In addition he discussed the restrictions of each sub-system as targets, obligations and criteria (Handler, 1970: 38 – 49; Berköz, 1972: 26 – 57).

In Handler's model, the design process comprises five main steps: conceptualization, programming, analysis, selection and integration (Figure 2). The construction process comprises three main steps: site preparation, component fabrication and component connection (Figure 3). The facility operation process comprises four main steps: activation of building and its subsystems, maintenance and repair, replacement and use (Figure 4). The human bionomic process comprises two main steps: environmental stimuli and human responses (Figure 5). The relation between architectural subsystems in Figure 6 (Handler 1970).

The studies of Berköz, Demirel, Yaman, Subaşı Direk and Perker in Turkey are attracting attention among the scientific studies based on system approach in the field of architecture as they examine different subject areas of architecture. In the study he conducted in 1972, Berköz analyzed construction via the system approach which he used as an examination strategy (Berköz, 1972). Subaşı Direk, benefited from the system approach as a decision making model for the design of curtain wall façade (Subaşı Direk, 2003). Demirel, considers the space as an open system in the study he conducted regarding the space management (Demirel, 2005), while Yaman used the approach in subject on construction production system (Yaman 2009). The latest study conducted in Turkey taking the system approach as a basis in the field of architecture is the study of Perker (Perker, 2010). In this respect I feel that it is necessary to address to the study of Perker

in more detail here. In his study Perker used the system approach as a model in making the traditional Anatolian residence suitable for contemporary usage. Protecting the traditional buildings which are important elements of the cultural inheritance in local, regional, national and universal aspects and transferring them to future generations by adopting them to today's utilization circumstances is one of the priorities of the whole world (Figure 7, Figure 8). In Perker's conceptual analysis model, it was believed that setting forward the problems regarding the protection and adjustment of Anatolian residences for contemporary utilization circumstances, the reasons that cause these problems and the relationships between these problems would generate an important step in solving the aforementioned problems (Perker 2010).

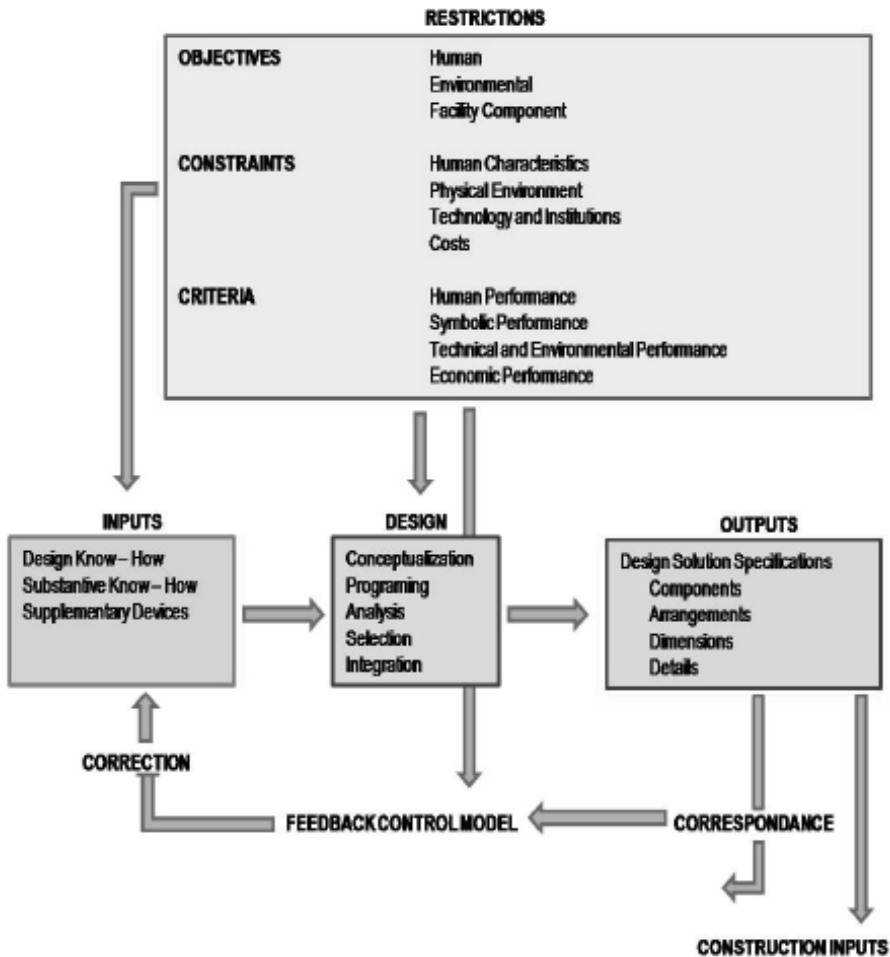


Figure 2. Structure of the Design Subsystem (Handler 1970)

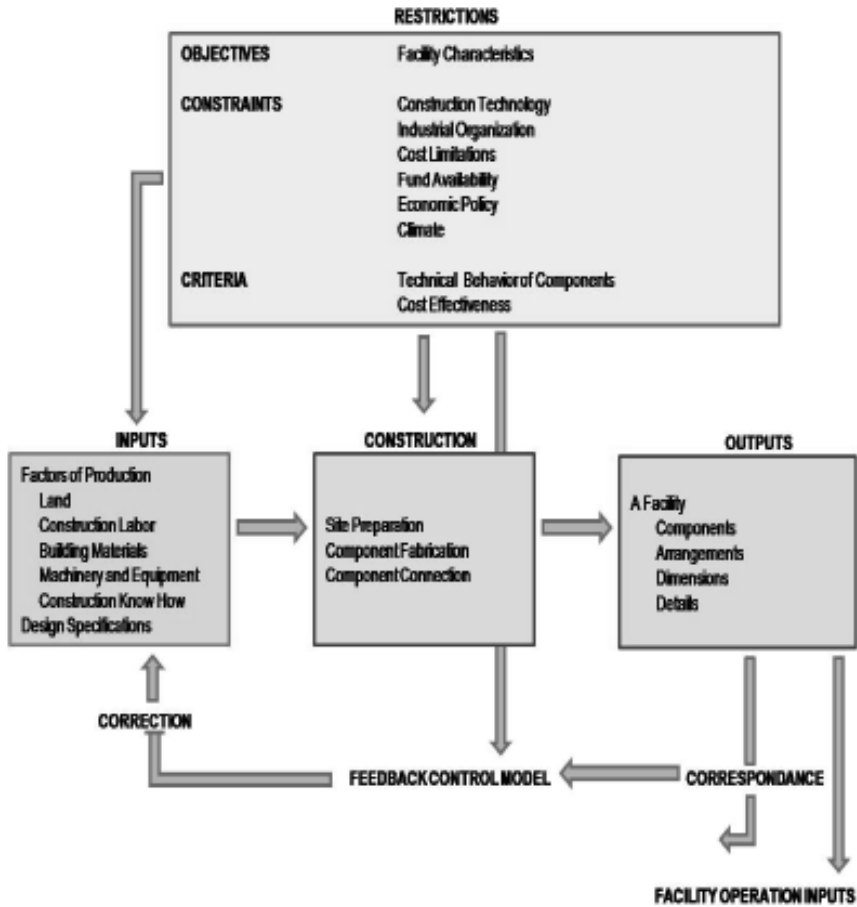


Figure 3. Structure of the Construction Subsystem (Handler 1970)

In the improved conceptional analysis model in Perker's study; the adaptation of the traditional house is taken into consideration as a system. The target of the abovementioned system is to adapt the traditional house up to date and the input of the system is derived from 'Traditional House System'. Physically; Traditional house system is derived from constructional elements (basement – wall – wall spaces, floors, stairs and other elements such as shore and roof); the locations of the mentioned elements (outer space, inner space, basement), the constructional materials (stone, wood, adobe, brick, metal, plaster) and installments (water, electricity, heating). Nevertheless, Traditional House System is formed of not only the sum of those components, but also the relation among them. In Figure 2 the distribution of the construction elements of the traditional house according to their locations. Regarding to the locations of building elements inside the building; the reasons of the deterioration will change, so Figure 9 is becoming more significant (Perker, 2010).

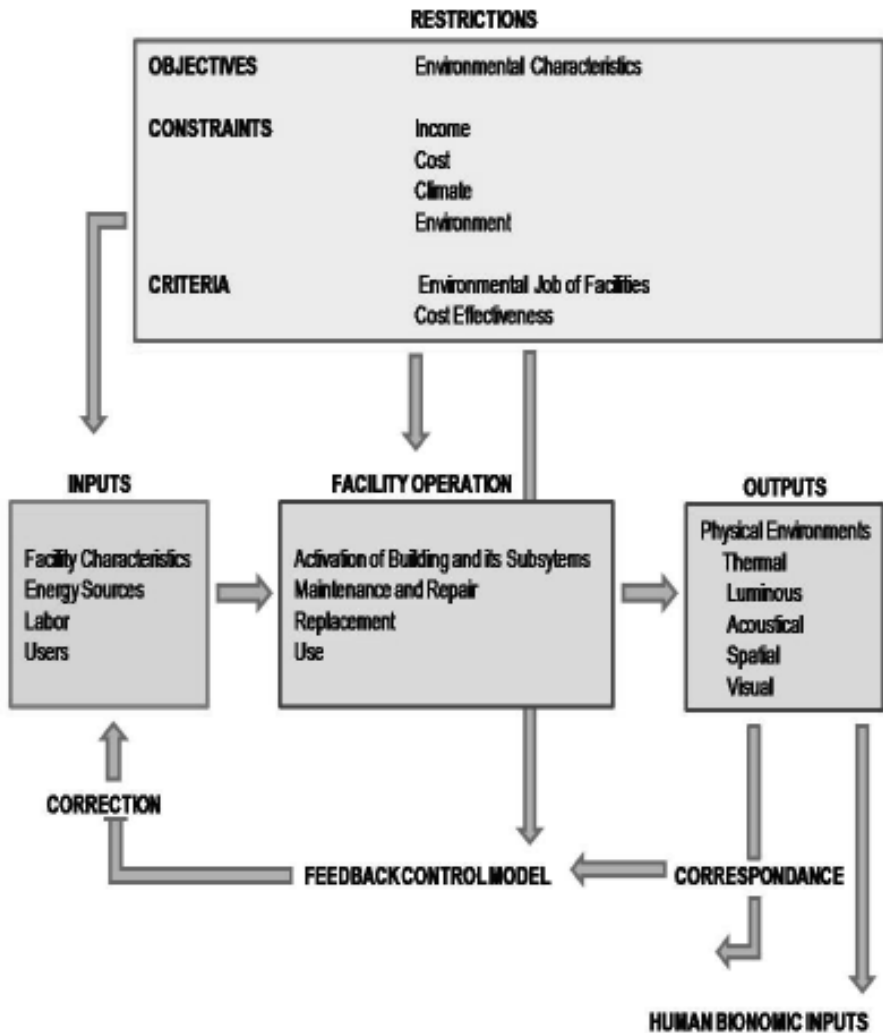


Figure 4. Structure of the Facility Operation Subsystem (Handler 1970)

As seen in Figure 9; the construction elements only related with the outer environment; outside stairs, shore, floor layer; the elements only related with the inner environment; mid floor inner walls, inner door, mid floor coverings, inner stairs and interior architectural elements; construction element related only with basement; construction elements related both with the inner and the outer environment; the main door, window, roof; construction elements related with both the inner environment and the basement; the inner wall of the basement and basement floor covering and the construction element which is related to all the three environments is the external wall (Perker, 2010).

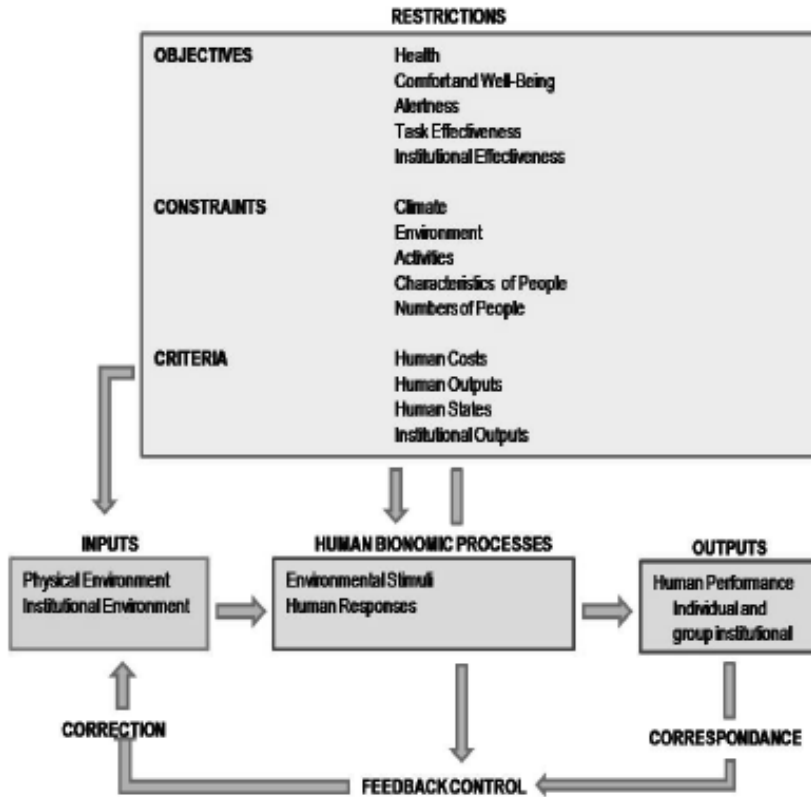


Figure 5. Structure of the Human Bionomic Subsystem (Handler 1970)

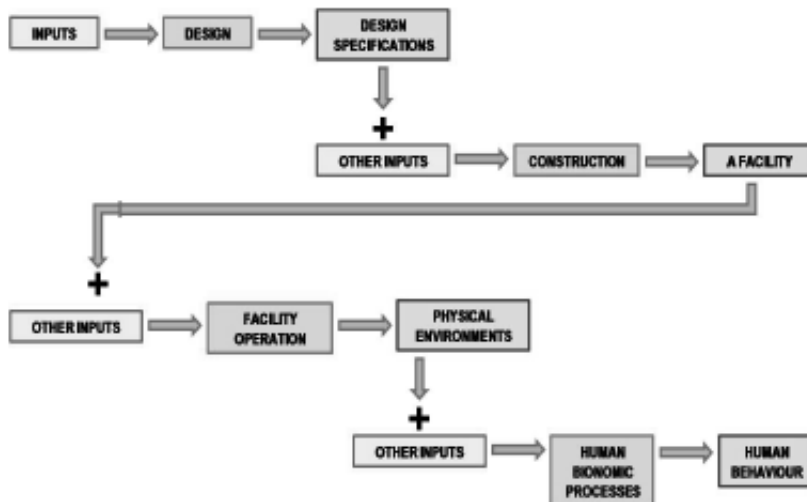


Figure 6. The Relation Between Architectural Subsystems (Handler 1970)



Figure 7. Traditional Anatolian Houses
(Z.S.Perker, 2011)



Figure 8. Traditional Anatolian Houses
(Z.S.Perker, 2011)

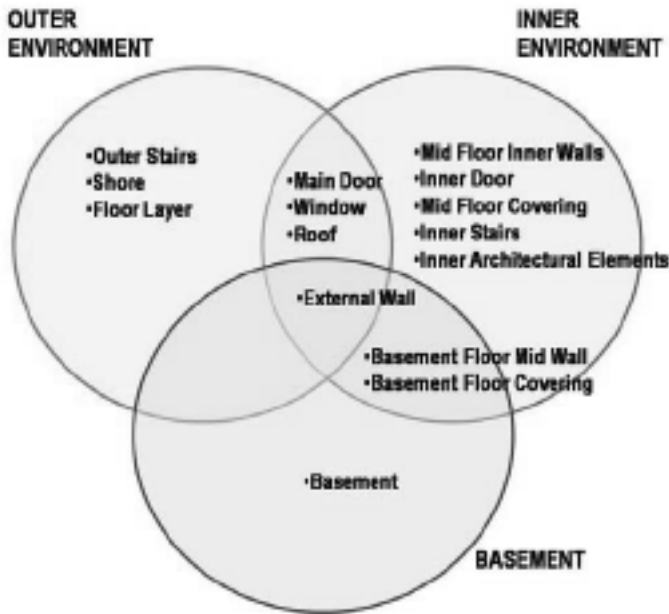


Figure 9. The Distribuiton Of The Construction Elements Of The Traditional House According To Their Locations (Perker 2010)

The functional and physical ageing of the house generates the movement point in forming subsystem of the system of the traditional house adaptation up to date. While the physical ageing process encloses the deformations occurred on the authentic construction elements and materials because of various factors; the functional ageing process is the declaration that the house could not meet the actual requirements. Within this extent; it can be said that the subsystems of the traditional house system are derived from the deterioration and the maintenance subsystem and new requirements subsystem. The output of the 'The System Of The Traditional House Adaptation Up To Date' is the traditional house adapted up to date. It seems inevitable that 'Traditional House System' will go through a process of physical ageing with various reasons by time. Physical ageing process is covering the deterioration process of the construction materials in general. The factors causing the deterioration of the construction elements are structural factors and physical, chemical, biological factors and factors related to humans are all connected to each other (Perker 2010) (Figure 10).

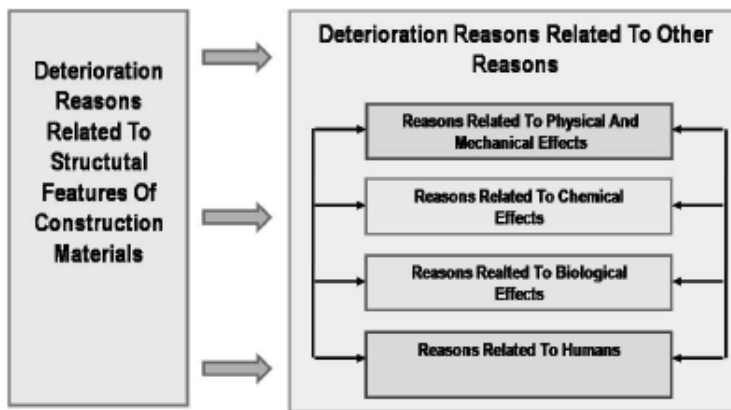


Figure 10. Deterioration On Construction Elements And Materials Of The Traditional House And Their Relations (Perker 2010)

Additionally; changing requirements of users force to change the physical structure of the house by time and for the sustainability of the house, all the new requirements have to be an essentiality (taking the wet spaces inside the building and integrating the installment systems to the building). Sometimes; a functional change can either be seen in the house. The mentioned process could be qualified as a functional ageing process. From this point of view; traditional house is getting through a process of deterioration (related to each other) – maintenance and a process of meeting new requirements and eventually; the output of the system of the the house (adapted up to date) is reached. The evaluation after comparing the output and the input is creating the feedback (Perker, 2010).

Within the extent of the system approach; it is observed that the adaptation system of the house up to date is also effected by the senior systems when moved from the existence of the senior systems effecting each system itself. Those systems are Sociocultural, Economical and Legal – Institutional Senior Systems. From the point of view of Sociocultural Senior System, the houses found in Turkey have been being affected by the relation between the social structure and physical structure and social, cultural, economical and technological alterations and requirements needed for new functions formed by the new actions and by the rapid change of the family structures, industrialisation; by some facts such as rapid urbanization and population increases and by the level of consciousness and education about protection of the traditional house and by the situation of quantity and quality of the human resource who will work for protection

Within the extent of the Economical Senior System; traditional houses in Turkey are effected by the correlation of the country with the financing of its protection of the economical development model, by the economical situation of the resident user and by the formal or civil originated economical inducements. As for the Legal - Institutional Senior System; it is observed that traditional houses in Turkey are influenced by the problems in the control mechanism and projection – implementation relations and by the decisions of protection planning and policies aiming new constructions. Furthermore; the Sociocultural Senior System that has been very effective on adapting the traditional house up to date and there have been relations between the Economical Senior System and Legal – Institutional Senior System. The mentioned senior systems have been effecting the system of adaptation of traditional houses up to date one by one and what is more they have effects on the traditional houses because the relations between them. The senior systems which have been effecting the adaptation process and the correlations among them (Figure 11). Adaptation System Of The Traditional House Up To Date And Conceptional Analysis Model seen in Figure 12 (Perker 2010).

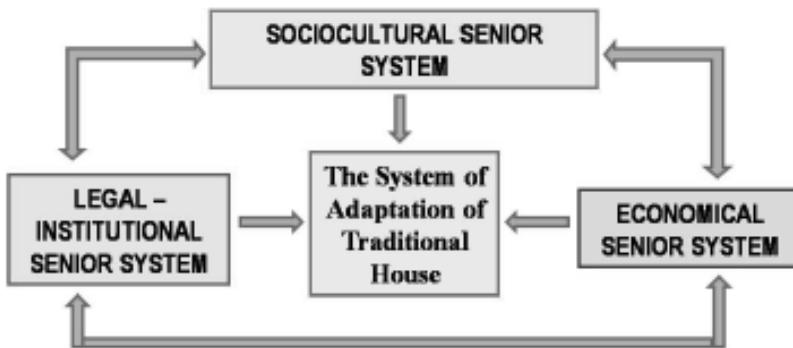


Figure 11. Senior Systems Effecting The System Of Adaptation Of Traditional House Upto Date And Relations Among Them (Perker 2010)

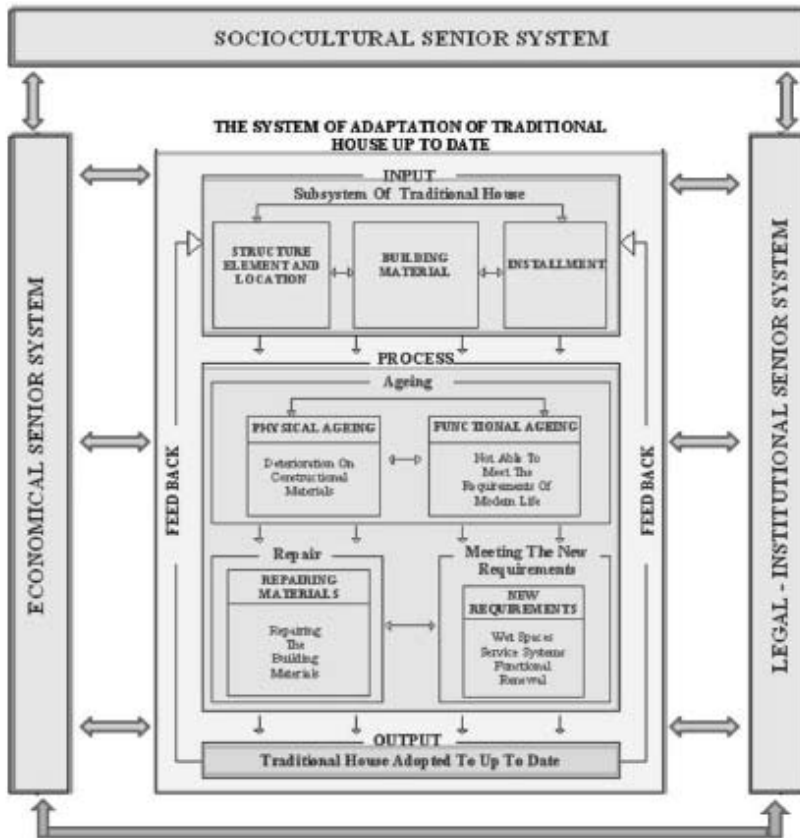


Figure 12. Adaptation System of the Traditional House up to Date and Conceptual Analysis Model (Perker 2010)

CONCLUSION

The fact that architecture is a scientific field which is positioned on the intersection of social and physical sciences and interrelated with various other scientific fields (civil engineering, city and environmental planning, sociology, economy, management etc.), the complexity of the design and construction activities, the role of human element, the increasing need for construction and the fact that the construction stock we have has a cultural and economic meaning all together make it obligatory to direct a systematical, holistic and multi-dimensional approach to architecture. Especially the system approach as a study method, enables us to consider the building and its surrounding as whole comprising of various system and to understand the systems the functions of the building involves, how the systems in subject work and what are the relations among them, to determine the failing aspects in detail, to develop solution alternatives and to choose the most suitable one for our circumstances among the alternatives we find. The situation in subject

will help to take significant steps for developing the architectural product and the field of architecture by making invaluable contributions to generating new systems (buildings). In this context, it aimed to use the system approach which is well accepted universally, in the scientific studies and researches conducted in the field of architecture as well in parallel to all scientific fields.

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