

Research Article

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The Selection Process of Sustainable Technologic Construction Products

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ABSTRACT:

Sustainable construction products consume minimum energy through their life cycles and do not harm the environment or human health during the obtainment of their raw materials, processing, usage, maintenance – repairs and wastage. Wrong selection of these products may cause material, time and labor losses in economic terms. Also performance conditions of the structure are affected and therefore the physical life of the structure shortens, its interaction with the environment is damaged and thus the users face negative conditions.

Especially any incorrect selection of new products made from sustainable construction materials, such as steel or wood, constitutes a hindrance for the adoption and extensive usage of technology and causes the products to be diminished within time. Due to this reason, correct selection and usage of products that have sustainable characteristics in construction sector is important.

A systematic selection process is required for making the usage decision of the construction products made of sustainable materials. In this connection it is considered that, with the model proposed hereby, that is constituted from persuasion, opportunity defining, obligations, design and selection phases, the correct selection of construction products suitable for time, cost, quality, performance, new technology and environment criteria can be achieved and their usage can be widespread. The sustainable technologic construction products selection process model proposed in this paper is consisted of persuasion, opportunity defining, obligations, design and selection phases. In this model, the process of selection starts with the correct information input that comes from knowledge obtainment process.

Keywords: Sustainability, construction technology, construction products, technology selection

Sürdürülebilir Teknolojik Yapı Ürünlerinin Seçim Süreci

ÖZET:

Sürdürülebilir yapı ürünleri yaşam döngüleri boyunca minimum enerji tüketir ve hammadde, işleme, kullanım, bakım-onarım ve atık sırasında çevreye veya insan sağlığına zarar vermez. Bu ürünlerin yanlış seçilmesi ekonomik açıdan maddi, zaman ve işçilik kayıplarına neden olabilir. Ayrıca yapının performans koşulları etkilenir ve bu nedenle yapının fiziksel ömrü kısalmır, çevre ile etkileşimi zarar görür ve böylece kullanıcılar olumsuz koşullarla karşılaşır.

Özellikle çelik veya ahşap gibi sürdürülebilir yapı malzemelerinden yapılan yanlış ürün seçimi, teknolojinin benimsenmesi ve yaygın kullanımı için bir engel teşkil etmekte ve ürünlerin zaman içinde azalmasına neden olmaktadır. Bu nedenle, inşaat sektöründe sürdürülebilir özelliklere sahip ürünlerin doğru seçilmesi ve kullanılması önemlidir.

Sürdürülebilir malzemelerden yapılmış yapı ürünlerinin kullanım kararını vermek için sistematik bir seçim süreci gerekmektedir. Bu bağlamda, burada önerilen model ile ikna etme, fırsat tanımlama, zorunluluklar, tasarım ve seçim aşamalarından oluşmaktadır. Yeni teknoloji ve çevreye uygun yapı ürünlerinin doğru seçiminde zaman, maliyet, kalite, performans ölçütleri bu model kullanılarak ulaşılabilir ve kullanımları yaygınlaştırılabilir. Bu makalede önerilen sürdürülebilir teknolojik yapı ürünleri seçim süreci modeli ikna, fırsat tanımlama, zorunluluklar, tasarım ve seçim aşamalarından oluşmaktadır. Bu modelde, seçim süreci bilgi edinme sürecinden gelen doğru bilginin elde edilmesi ile başlamaktadır.

Anahtar Kelimeler: Sürdürülebilirlik, Yapı Teknolojisi, Yapı Ürünleri, Teknoloji Seçimi

INTRODUCTION

In general, sustainability means using of natural resources in such an equilibrium condition that they do not reach decay, depletion and unrenovable point and handing down the next generations by developing them. In this context, sustainability seems to be a concept branding to every field ranging from global development policy to usage of energy sources and from production planning to architectural design (Hoşkara, 2007) in our age.

People need a lot of buildings for sustaining their lives during civilization. These facilities cause a lot of environmental problems during their construction, operation and maintenance, and destruction. Buildings consuming huge amount of energy and natural resource have and impact on climate change by affecting quality of air and water in cities (Vyas et. al., 2014).

Selection of the optimal material, while considering objectives for sustainable design comprehensively early in a design process, can significantly improve the overall impacts of products. Material selection is one of the most important factors that affect the quest to achieve more sustainable products (Ljungberg, 2007).

Sustainable construction materials consume minimum energy through their life cycles and do not harm the environment or human health during the obtainment of their raw materials, processing, usage, maintenance – repairs and wastage. Construction materials in sustainable architecture have an importance in terms of energy consumption of the structures, preservation and utilization of natural resources and environmental health (Celebi and Aydin, 2001).

According to Bourdeau (1999) the purpose of sustainability approach is summarized as follows:

- to set forth the short, medium and long term benefits and to realize them, and
- to determine how to integrate the technical data, methods and the experiences obtained at other phases with the preliminary design process.

Whilst sustainable construction relates to both a building's structure and the use of proper life-cycle processes, the selection of the most appropriate material/s is deemed a considerable undertaking. The suitability of building materials for various practical uses is determined by their particular properties. Timber, concrete and steel are the most commonly used structural materials

in the built environment, and they typically behave quite differently under various loads (Gharehbaghi, 2015)

The concept of technology in building sector is the product output of tool, material, technical and information inputs, that is obtained by using processes and administrative systems; in other words is the whole of the phases of constructing the building. Building technology is effective on the development of new products and construction of buildings. When it is considered in terms of building sector, the main two outputs of technology are technologic products and systematic arrangements that are in connection with technologic products. In this sense the concept of building technology does not only contain scientific development, but it also covers a more efficient approach to social, cultural and environmental dimensions.

The inadequacy of the technologic product related systematic arrangements hinders the adoption and extensive usage of the technology. This situation can cause the products to diminish within time. Especially when sustainable technologies are in question, the adverse effects of this inadequacy increase incrementally.

Selection of construction products is a practice generally in connection with each building's peculiarity in terms of function, design and construction technique, construction and usage duration, with the variability of the deciders, their effectiveness on the decision, their purposes, internal and external environmental conditions, product information, and economical and technological possibilities (Balanlı, 1997).

Decisions concerning product selection are appeared in all phases of the structure. Making optimal decision depends on assuming the responsibility, fulfilling the duties by the designer who makes decision and also inspecting the results by the relevant institutions and calling into decision by the users (Karaçar Ercoşkun, 2010).

Incorrect selection of these products may cause material, time and labor losses in economic terms. Also the performance conditions of the structure are affected and therefore the life of the structure shortens, its interaction with the environment is damaged and so negative conditions arise for the users. Due to this reason, proper selection and usage of the material with sustainable characteristics is necessary for achieving above mentioned purposes and targets.

A systematic selection process is required for making the usage decision of the construction products made from sustainable materials. However, in order to realize this selection process, necessary information inputs are needed. At this point, an information conveyance from information obtainment process to selection process has to be achieved. In this way the selection process can be built properly.

THE SELECTION PROCESS OF SUSTAINABLE TECHNOLOGIC CONSTRUCTION MATERIALS

The aim of technology selection is to obtain new knowhow, components, and systems which will help the company to make more competitive products and services and more effective processes (Torkkeli and Tuomine, 2002).

Technology selection is to decide on the most suitable technologic information for a country's economical structure, the form of production in which the economy is, its production power and production conditions, and also the targets to be achieved (Ercağ, 2000).

Selection of technology constitutes a very important decision field for businesses. While the problem of deciding is sometimes fairly easy to solve, sometimes it becomes a quite complicated and inextricable situation. The matter of fact that is formed as a result of the decider's evaluation of the alternatives to be chosen among, from the scope of the purposes to be considered, is the determination of the optimum choice (Dinç, 2001).

Rapidly changing technology and ever increasing technologic alternatives result in the businesses to face difficulties while choosing the most convenient technology. None the less, selection of the correct technology provides the businesses with very competitive advantages in the ever developing complicated business life. Also the application of new technologies by the businesses offers opportunities both for product range and new business ideas (Gürler and Güler, 2009).

Selection of technology is a technology preference made among the available alternatives of a technique for producing a single product in a certain location. When considered from a macro angle, technology selection is to decide on the most suitable technologic information for a country's economical structure, the form of production in which the economy is, its production power and production conditions, and also the targets to be achieved (Erçağ, 2000).

Selection of technology is a matter with wide dimensions and the technological developments carried out abroad have to be observed as well as the needs of the country. For this reason, technology selection is determined by many external factors. Economical, organizational, educational and cultural factors determine technology selection. The variety of the mentioned factors necessitates a very delicate approach while making the selection decision, and a detailed study (Tiryaki, 1990).

The best way to examine selection criteria is to separate technology into two headings and make the decision accordingly. First heading is to select the technology developed for producing a known product, and the second is to decide on a technology that would enable the production of a product unknown and completely new for a company. For the first situation selection is easier. That is due to the fact that the company has a general experience on the production and marketing of the product. Therefore it is very easy for the company to implement the developed technology on its own system. As for the second situation the matter is much more complex and requires an intensive R&D activity and consequently great expenditures.

When the factors affecting the technology selection are generally considered, the relative parameters can be listed as follows (Tiryaki, 1990);

- State of development (attribute) of the technology to be chosen and the workmanship level required by it,
- Market demand status of the product to be produced with the technology to be chosen,
- Status of the raw materials to be processed with the technology to be chosen (quality, quantity, sustainability and prices),
- Process and energy usage status of the technology to be chosen (energy types, quantities, sustainability and prices),
- Status of the resources allocated for the technology to be chosen,
- Way of obtaining the technology to be chosen (license, partnership, etc...),
- Ecology problem (adaptation to environment - economy it will bring forth),
- Safety status,
- If the technology to be chosen is licensed annual payment status,
- Input usage quantities on the unit required by the technology.

In consequence of the evaluation of the factors that affects the technology selection, the technology found to be the most convenient is chosen. The main purpose in the selection is to determine and agree on a technology suitable to the conditions of the company, as well as increasing productivity that would boost quality and quantity.

Selection of technology arises as a problem mostly in underdeveloped countries. The difficulties experienced in technology selection also cover the problem of accessibility of the technologies that are the most suitable for the structure of the underdeveloped countries. In underdeveloped

countries in a struggle of industrialization, the effects that cause capital-intensive technologies to be selected are explained with the factors that affect technology selection (Erçağ, 2000).

These factors can be listed as follows:

- The necessity of holding to the technologies developed by developed countries,
- The fact that manpower cost is artificially high,
- Weakness of scientific and technologic infrastructure,
- The tendency of the entrepreneurs to chose capital-intensive technologies for the sake of their prestige,
- The difficulty of management in technologies with high manpower intensity,
- The effect of the experts under the influence of the industrial systems of the developed countries,
- Evaluation of obtaining information and technological alternatives.

Model proposal for the selection process of sustainable technologic construction products

The relation between organizations and technology is important in terms of technology selection. Every organization and their sub sections have a technology selection that they decide on, in accordance with the activities they carry out in the sector they are involved in. The decision making bodies have to make a selection regarding the technology to be utilized within the organization. While doing this selection, the elements that are in interaction with the technology are to be considered. Therefore the decision making bodies on technology have to be more than just “technology users”, but “technology managers”.

The decisions made on product selection manifest themselves on all phases of the building. Making the right decision depends on the decision making designer to undertake the responsibility during product selection and carry out its duties, concerned organizations to evaluate the results and the users to question the decisions.

The sustainable technologic construction products selection process model proposed in this paper is consisted of persuasion, opportunity defining, obligations, design and selection phases. In this model, the process of selection starts with the correct information input that comes from knowledge obtainment process. Along with the correct knowledge that is taken from knowledge obtainment process, also precedents are transferred into the phase of persuasion. The decisions given in persuasion phase constitute inputs for opportunity definition phase. The agendas that are formed in opportunity definition phase are directed to design and selection phases as input. The control and restrictions that originate from the obligations phase without being dependent to any other phase affects the design and selection phases. The prototype that is formed in the design phase, in which the opportunity definition originated input and obligations phase originate control is included, constitutes input for selection phase. And appropriate technologic options originated from selection process are transferred into the decision process as inputs (Figure 1).

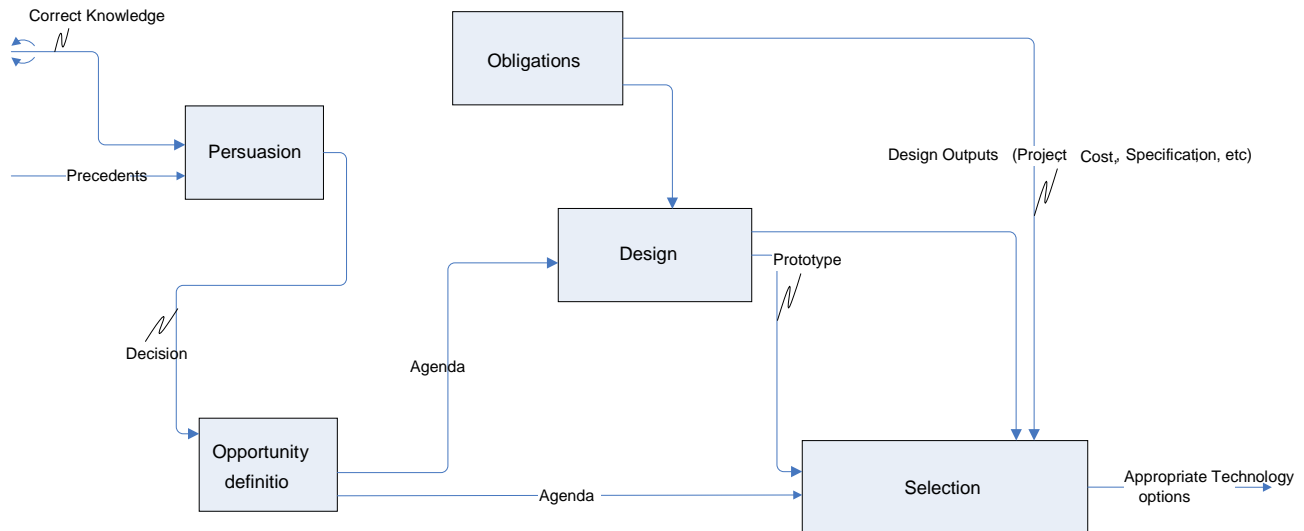


Figure 1. Construction product selection process

Persuasion Phase

Those who are willing to adopt technology are quite interested in innovation. They research details and active information regarding innovation. Evaluation information are accessed through interpersonal networks (Narayanan, 2001). Persuasion phase is the individuals' attitude of preferring or not preferring innovation in innovation decision.

Attitude is a tendency that regularly forms the beliefs, ideas, feelings and behaviors of individuals in an organization regarding an object. Attitudes are not inherent, they are acquired by the individuals while they get socialized. In another expression, attitudes are learned through experiences. Attitudes are not temporary, they exhibit permanence for a definite period. That is to say that, individuals have the same ideas in certain periods of their lives. Attitude is not a way of reaction, but rather a tendency to show reaction. Attitudes may result in negative or positive behaviors. The main elements that constitute attitude are cognitive element, sentimental element and behavioral element. It is generally assumed that there is an internal consistency among these elements (Rogers, 2003).

Intellectual activities are mostly cognitive in information phase, but persuasion phase is a sentimental phase. Persuasion is equivalent to attitude development. Physiologically, individuals are mainly interested with innovation in persuasion phase. In this phase, they try to obtain information regarding innovations.

Selective perception is important on the behaviors of the individual in the persuasion phase. The perception of innovation is developed in this phase. Especially relative advantage, compatibility and complexity have an importance in this phase. Whether innovation attitude is preferred or not makes the individuals anticipate the current and future status of a new object and take a decision of trying it. In case the individual adopts the innovation in the persuasion phase, it makes its comparison in the future. All innovations bring along many ambiguities for the individual. It feels the need of getting other individuals' opinion while adopting an innovation. It considers the messages received from media channels. The individual examines what advantages and disadvantages may come with the innovation (Rogers, 2003).

Correct information and precedents are the inputs in persuasion phase. The controls and restrictions of this process is composed by relative advantage, complexity, compatibility, trialability, and noticeability. Attitude and behaviors are determined to be the mechanisms of the

process. A decision is made by the end of the persuasion process. This decision is the output of persuasion phase and is used as the input of opportunity definition phase (Figure 2).

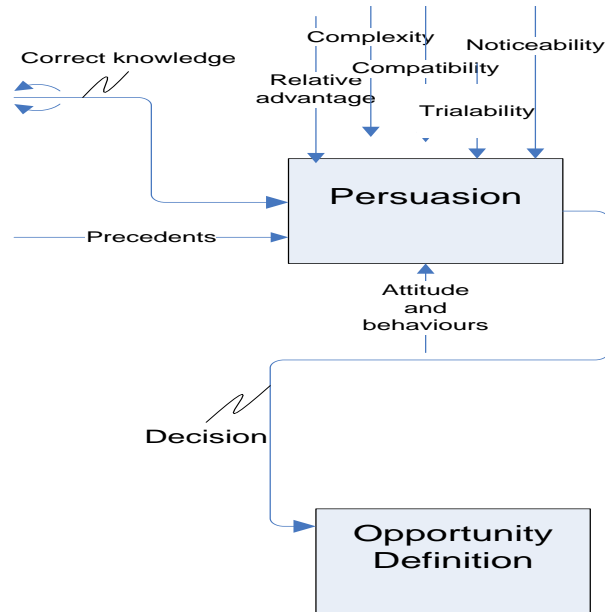


Figure 2. Persuasion phase

Opportunity definition phase

In opportunity definition phase, technology estimations for the product to be chosen are to be made and opportunities and risks are to be evaluated at first.

A technologic estimation is related with the attributes of the used technology such as performance level and speed. The individual making technology estimated does not have to know, or discover during the estimation, how these attributes are achieved. However, by considering the obtained values the limits of the current technology and the attributes that can exceed these limits have to be determined. One other task of the individual making the estimation is to exhibit when the limits of the technology will be extended and to unfold when new requirements have or will arise (Karakan and Koc, 2008).

The necessary technology-related data has to be provided from persuasion phase to the opportunity definition. In order to make opportunity screening and definition, the opportunities to be evaluated in terms of technique, market and production are to be set forth. In the opportunity screening process, production, product and market development statuses have to be evaluated and potential opportunities are to be manifested (Gerard H., Guynor G, 1996).

Technology estimation techniques are to be used in opportunity definition phase. Technology estimation aims to examine the long term technology level and the probable effects of this technology.

According to this, the inputs in opportunity definition phase, except for the decision taken from the persuasion phase, are composed of market and technology knowledge, process, method and the current developments in the tools. Controls and restrictions include product data management systems and applications. The mechanisms of the process are opportunity screening, anticipation ability, benefit analysis, changing and maintenance and technology estimation methods. Agenda is the output and it is also the inputs of both design and selection processes (Figure 3).

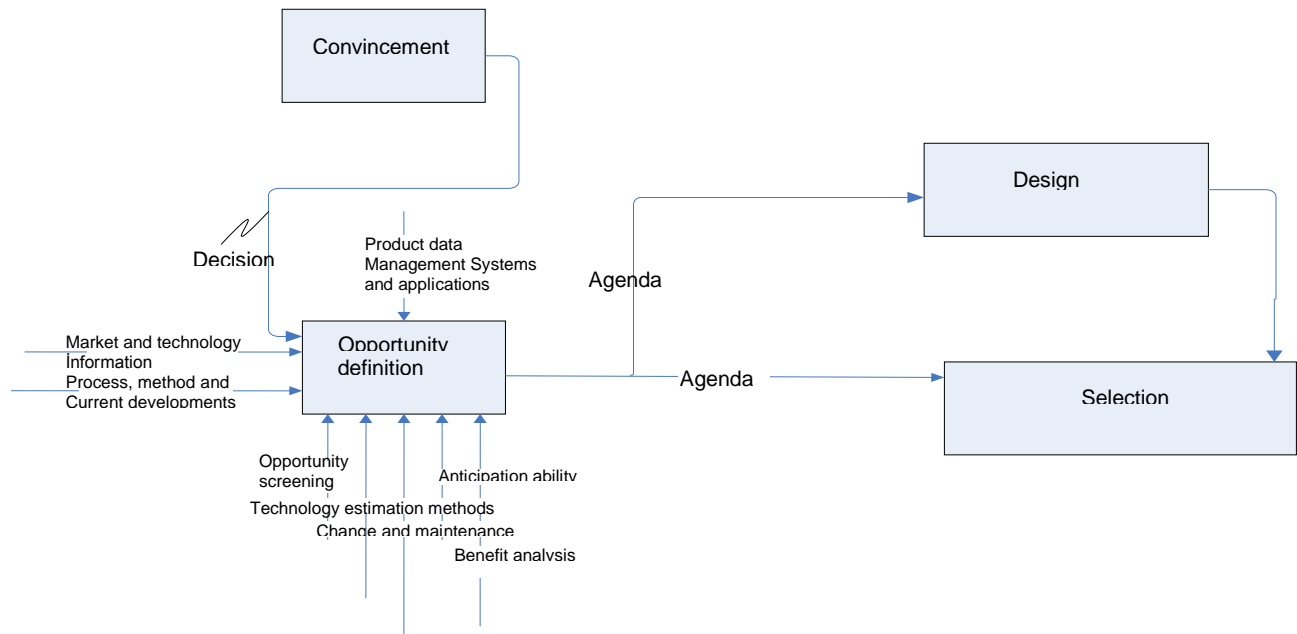


Figure 3. Opportunity definition phase

Obligations phase

Obligations cover all of the rules that are to be complied with, set by the corporations around the building and building generation system. Relative necessities have to be considered while the criteria which the options are to be evaluated with are being determined (Balanlı, 1997). Private documents, directives, laws, specifications, legislations, standards and regulations are the inputs in determining the necessities. Controls and restrictions of this process is the conditions in which the country is, and the mechanism is bureaucracy. As outputs of both design and selection phase’s obligations require control and restriction (Figure 4).

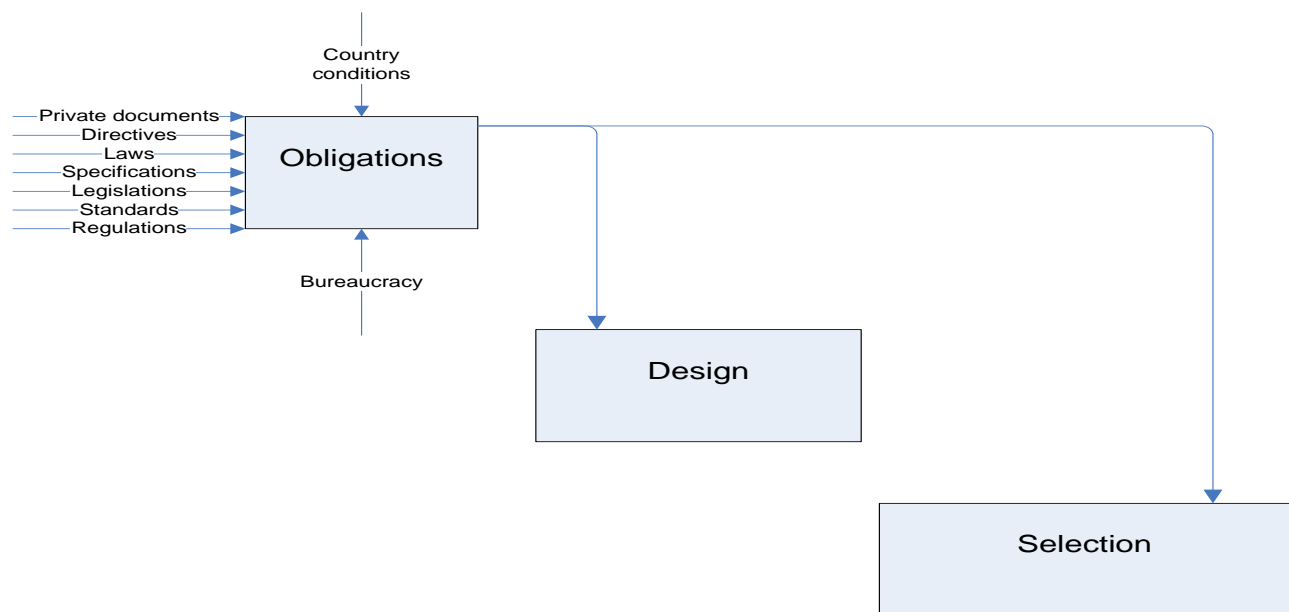


Figure 4. Obligations phase

Design phase

When design process is examined as a whole, the phase of designing the architectural structural elements, in which the technology to be used in the building is defined, is one of the stages where the structural quality of the building is discussed and evaluated in details, and a solution is formed. Structural quality problems observed in the building have effects on different areas such as user health and safety, economics and sustainability. One of the building phases that is effective on achieving the desired quality is the design of architectural-structural elements. The technologies that can be used while designing the structural element are dealt with in details, and the structural solution is made definite (Edis, 2007).

Product selection starts at the design phase of the building. As it may end in the same phase, it may be also necessary in the changes required by the functional changes of the building and in repair phase. The main purpose of product selection in the structure is to meet user needs, to contribute to the economy of the country by making the right selection, to design the products with the required qualities, and to encourage their production. In addition to these leading up to the design and development of new products, enabling them to be directly added to the selection in line with the needs of the user, assisting the designer or the design team that will make the selection on behalf of the user on product selection are also among the purposes of product selection (Ergenç, 2007). The objective here is "in design phase to determine and arrange the parameters and processes to be considered in rationally selecting the products that will constitute the structure in order to enable the user maintain its activities in a general and subjective comfort, and to determine a systematic way for selecting the most convenient option" (Arıoğlu, 1993).

Inputs in the design process are experience and expertise, previous applications, designer's objectives and values, agenda, knowledge and communication. The controls and restrictions of this phase can be restricted as necessary processes, time, performance and quality, environmental factors, applicability, complexity, project disagreements, physical characteristics and creativity. On the other hand perception, competition, supply systems, technologic factors, innovativeness, consultation, trust, aesthetic and proportion are determined as the mechanisms of the process. This process has two outputs. First is the design outputs (project, cost, specification, etc) and it is taken as the control and restriction to the selection process. As for the second output, the prototype, it enters to selection process as input (Figure 5).

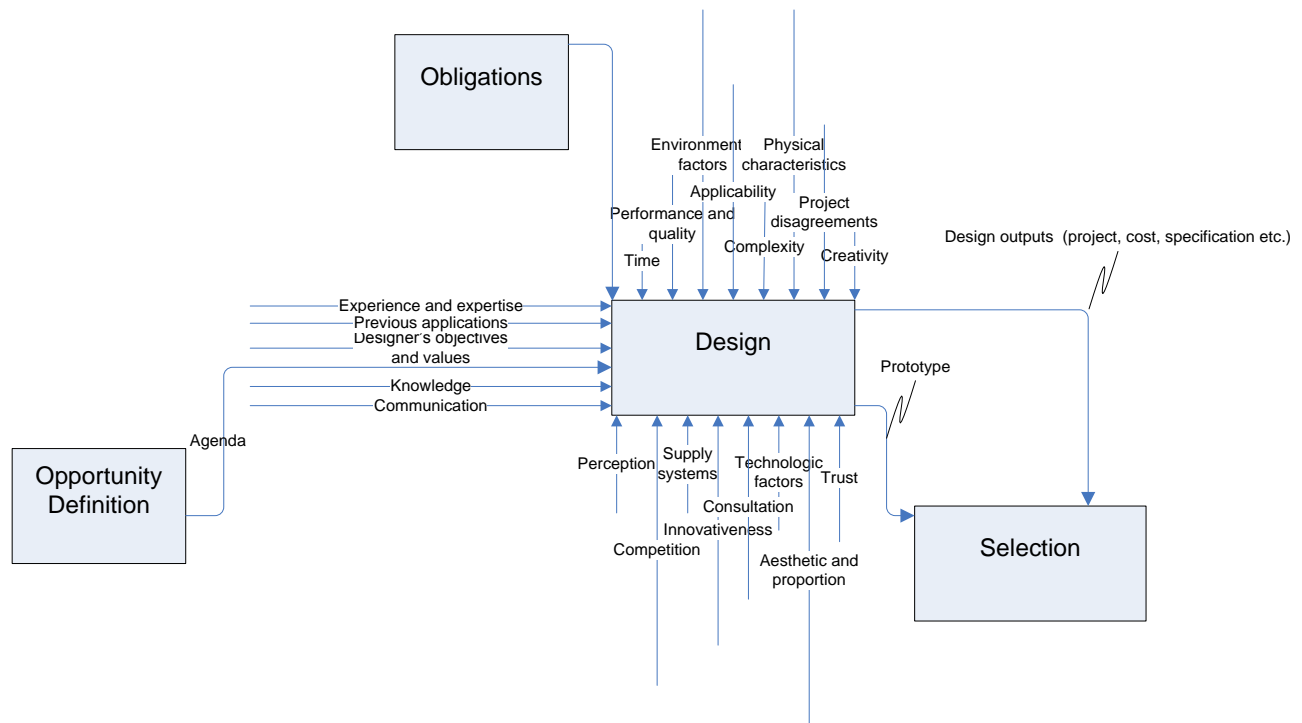


Figure 5. Design Phase

Selection phase

The technologic product selection suitable for the conditions of the country has to be made in selection phase. Appropriate technology, is the most convenient technology for the people it will affect, that makes a contribution in the solution of the problems of the user society, that considers the current useable resources of the society and in result that can be selected and applied in scientific means (Tiryaki, 1990).

The agenda that is taken from opportunity definition process enters into selection process as an input. Also the prototype made in design process enters into selection process as an input. Other inputs are respectively technical characteristics of innovation, requirements based on perception, cost and performance data, customer needs, business strategy, experience and expertise, physical characteristics, previous applications and industry characteristics. Design outputs (project, cost, specification, etc) enter into the selection process as control and restriction. Other controls and restrictions of the phase are obtainability, applicability, technologic conditions and environment, environmental factors, performance and quality, cost, organizational factors, time, conditions of the country, responsibility, complexity, innovation requirements and being in compliance with the current methods. The mechanisms of the process are decision makers, services, advertisement, organizational culture, market draw, selection methods and techniques, competition, health and protection, monitoring of the technology, trust, amendment and maintenance, availability, producers and production, market function and efficiency. Appropriate technology options come forth as the outputs (Figure 6).

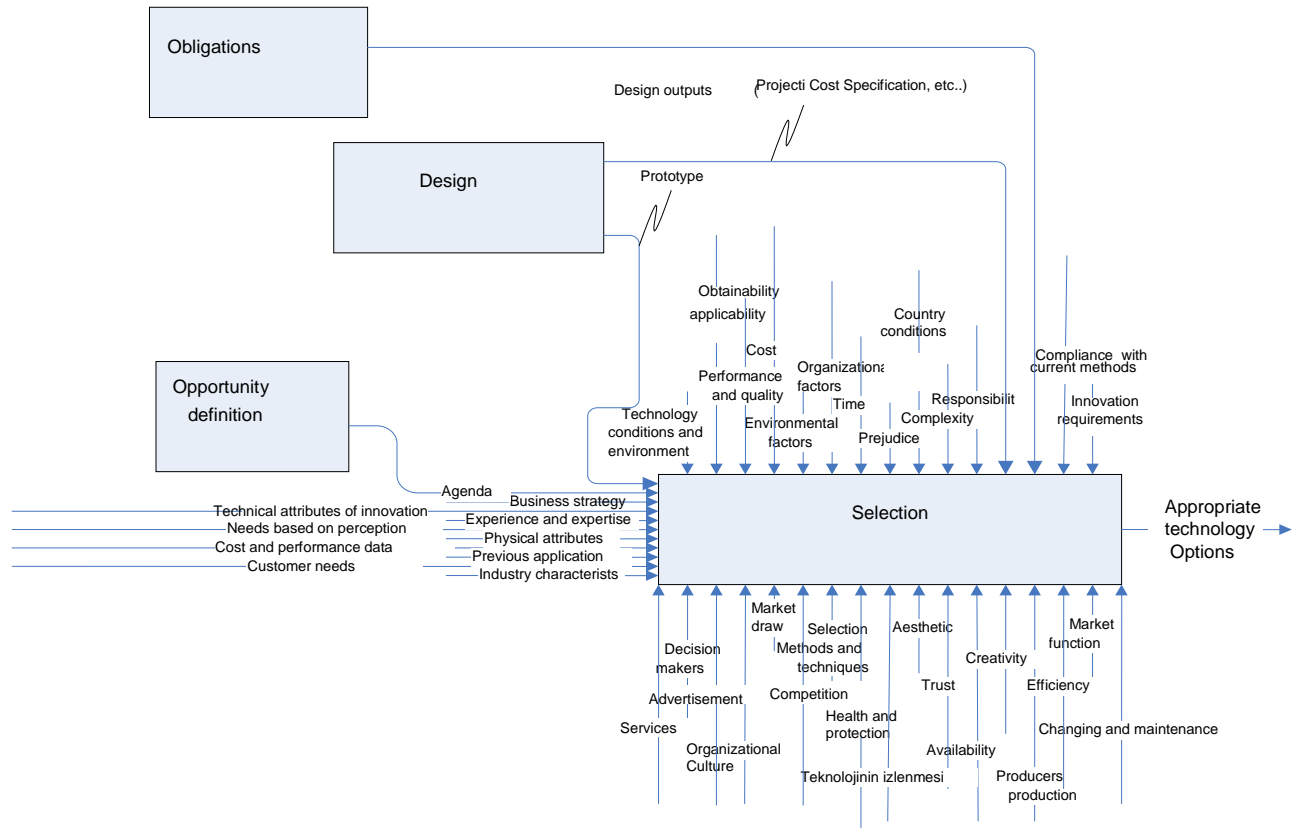


Figure 6. Selection phase

CONCLUSION

The technologic developments of the recent years in the building sector and the building sector itself that exhibits a rapid change accordingly have developed into a very complex structure with the fact that many imported building products find their place in the market in line with the development and production of new products. The fact that those who evaluate and select building products usually lack the adequate information regarding the product and the time necessary for carrying out the necessary research related with the subject, mainly causes the usage of building products that are not suitable for the work they are used in.

Sustainable development is the ability to meet today's needs without compromising the needs of future generations. In sustainable development, technology is one of the most important means that enable interaction with the environment. Usage of the technology brings along essential improvements in the life quality of mankind. For the continuity and development of sustainability a conscious approach has to be adopted and the extension of the usage of technology has to be achieved.

On the selection of sustainable technologic construction products, after the obtainment of the correct information, product selection phase is important for the designer, user or contractor that intends to use sustainable technologic products. Due to this reason it is considered that the model developed with this study will provide a contribution to the selection of the right technologic construction product.

It is foreseen that the below listed results will be achieved in a systematic way in conclusion of the selection of the building product with the proposed model and the usage of the sustainable technologic construction products:

- A flexible building design that can adapt to changing conditions and that has a long usage life,
- Efficient usage of energy,
- Effective use of the resources,
- Reduction of wastes,
- Protection of clean water resources,
- Avoidance of harmful and hazardous substances,
- Minimizing health and safety risks,
- Provision of healthy interior air quality, and
- Protection of biological variety.

Besides of sustainability, with the usage of the proposed selection model, also the usage of construction products in compliance with the time, cost, quality, performance and new technology criteria can become widespread. It is assumed that the developed selection model will provide a contribution to making the correct selection from the design phase and to the researches to be made on this matter in the future.

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