APPLYING ANP TO ANALYZE THE ROLE OF DESIGN IN THE FURNITURE INDUSTRY

Majid Azizi
Professor, Department of Wood and Paper Science and Technology
Faculty of Natural Resources
College of Agriculture and Natural Resources, University of Tehran

Gholamreza Mehdikhanloo
M.S. Graduate, Department of Wood and Paper Science and Technology
Faculty of Natural Resources
College of Agriculture and Natural Resources, University of Tehran

ABSTRACT

This study was carried out due to the severe dearth of research on the role of design in furniture production and the furniture market in Iran. Accordingly, this research proposes a decision making model to select the best solution for the role of design in this industry. The four possibilities that can be considered as potential solutions include using fashion design in furniture production (S1), using engineering design in furniture production (S2), using a combination of fashion and engineering designs in furniture production (S3), and applying the leading country's design capability with an outsourcing approach in furniture production (S4). The Analytic Network Process and Super Decision software were used to synthesize and analyze the model. It was found that all of the calculated decisions were influenced by the strategic criteria. A value-weighted competency model was calculated in the first stage with the influence of strategic criteria on the model. Hierarchical design decisions were made for each of the competencies and their subsets (298 sub-criteria and 31 middle indices). Paired comparison matrices associated with the degree of importance of each of the competencies were achieved in the second stage. In the final stage, subsets of the competency's weights and their sub-options were identified with the combination of the competencies and the best solution was obtained.

Keywords: Analytic Network Process; strategic criteria; benefits; opportunities; costs; risks; furniture; design

1. Introduction

Lack of innovation and creativity in design and copying domestic and foreign works are among the most prominent problems in Iran's furniture industry. Nowadays, competition among sellers and manufacturers is greater because of an increased number of wood industry manufacturing units and an increase in the amount of supply. In this environment, the one who takes advantage of a more distinctive design while having the same raw material and machineries as others is the winner. Presenting diverse and new designs for different tastes, along with observing qualitative and ergonomic standards,

can play an effective role in developing Iran's furniture industry and gaining shares in the international furniture markets. Gazo (2005) regards a furniture manufacturer's capability to achieve design ability and the execution of this valuable tactic as the prerequisite for success in Malaysia's furniture industry.

The design of new furniture is usually done with three things in mind which include structure design i.e. the physical shape and appearance of furniture, the raw materials used, and the manufacturing technology. New design of products and technological aspects are factors for development in the furniture industry in Southeast Asia according to Ratnasingam and Ioras (2003). Merrell et al. (2018) presented an interactive furniture layout system that assists users by suggesting furniture arrangements based on interior design guidelines. Their results prove that the suggestion generation functionality measurably increases the quality of furniture arrangements produced by participants with no earlier training in interior design. Interior designers consider furniture layout according to color and material, lighting design, arrangement of art and accessories, carpeting, and detailed traffic patterns through the space.

Liu and Li (2006) presented an appealing furniture design. They indicated that in order to adapt to the needs of diverse aesthetic values, the appearance of modern furniture should pay great attention to the use of space and should emphasize the concept of appeal design. Like humanization design, appeal design embodies more human concerns and creates a personalized design on a deeper level. Appeal design is also the important content that people pursue in the information age. They also explored the new trends of furniture design by researching the role of the concept of appeal in furniture design and discussed anglicizing appeal design's content and characteristics, and combining humanization design concepts with the information age. Apostolou, Sakkas, and Mentzas (2004) studied big corporations that are active in the furniture industry internationally and came to the conclusion that most of them tend to use new technologies to develop a new measure. These companies transferred a part of their shares to their customers through the Internet, and have also displayed information about their products on the Internet for customers. This has resulted in a high level of customer satisfaction and a commitment to the company itself.

The use of design is very widespread such as design for performance, requesting modification in terms of aesthetics, ease of production, sustainability, and reliability, quality, and business processes. Identifying the best solutions for the use of the role of design in furniture production and its market improvement is the objective of this research. A study by Swann & Birke (2005) showed that creativity and design influence R&D, and creativity and design play an important role in the innovation and performance of a business. Research conducted for this study also shows that companies with a higher intensity of design are more likely to produce an innovative product. Design costs have a positive correlation with the company's productivity growth (Bessant, Whyte & Neely, 2005), A study by Gemser and Leenders (2001) on Dutch companies shows that design integration in the development of new products has a significant positive impact on the company's performance (profit, turnover, sales, and exports).

A model for using the ANP in supplier selection is developed and implemented in an electronic company (Gencer & Gurpinar, 2007). ANP models are also used for locating

facilities strategically, selection of the appropriate energy policy for Turkey, and for product mix planning in a semiconductor fabricator (Partovi, 2006; Ulutas, 2005; Chang, et al. 2005). ANP was also used to determine the best alternative for a raw material mix in Iranian facial tissue plants. The results of this study showed that using virgin pulp mixed with rejected paper makes the production more efficient. Furthermore, the long fibers of the pulp prevent environmental harm, and benefits and costs are more sensitive than opportunities and risks in this study (Azizi & Modarres, 2010).

These facts encouraged us to carry out this study as a steppingstone toward further environmental oil terminals site selection studies, and also encouraged us to focus on their criteria selection. The Analytical Network Process (ANP) is a flexible method that is able to demonstrate the mutual interactions between all factors in decision-making procedures. This method is an independent decision support model, belonging to the family of multi-criteria analyses, which has been developed by Saaty (2005) and Saaty and Vargas (2006).

Ocampo et al. (2018) developed a Fuzzy-BOCR-AHP framework. They indicated that the identification of drivers is performed by individually taking into account the benefits, opportunities, costs and risks (BOCR) associated with these drivers. Due to the hierarchical structure of the proposed framework and the complexity of the decision, a Fuzzy-BOCR-AHP approach was adopted in order to address the uncertainty in judgment elicitation in AHP. The results show that market demand is the most significant driver while the most significant sustainable practice is lean practice. The prioritization of drivers based on the Fuzzy-BOCR-AHP decision making framework and their prioritization targeting the triple bottom line (TBL) perspectives suggest useful and interesting results. This study proposes the use of the Analytic Network Process to develop a decision making tool for the best use of Paraguay's hydroelectric surpluses within the framework of a sustainable policy while considering quantitative and qualitative aspects that are difficult to identify through usual evaluation approaches. This tool has a highly scientific and avant-garde component that enables essential decisions to be made that would produce the greatest benefits for the integral development of the country (Amarilla et al., 2018).

The Analytic Network Process is a tool used to evaluate reverse logistics features because it considers interdependence relations. It uses a model that applies ANP and seeks to achieve a sustainable business performance by analyzing triple bottom line (TBL) using reverse logistics practices which are measured and evaluated (Guimaraes & Salomon, 2015). Due to the interdependencies between given selection criteria, site selection for wind power plants is made by using the Analytic Network Process. An application of site selection is made in Turkey for five alternatives sites by using the proposed decision model to demonstrate that it is suitable for the wind energy plant site selection (Aksakal et al., 2015). Kao et al. (2015) developed ANP with the following four criteria: control device, product design, product reliability and market environment. Each criterion consists of multiple sub-criteria. The result shows that portable control device, user friendly interface, aesthetic product design, personal information protection and product compatibility affect consumer adoption of smart home applications the most. This

research contributes to the literature by understanding consumer adoption in the area of communication activities and by extending ANP to marketing research.

2. Methodology

2.1 The Analytic Network Process (ANP)

Since the most suitable technique for our study seems to be the Analytic Network Process (ANP), we will review it briefly in this section. The Analytical Network Process (ANP), a generalization of the Analytic Hierarchy Process (AHP) method for multi-criteria decision making, provides a broader framework for decision making in complicated environments. The advantage of this theory over the AHP is its ability to extend its use to the cases of dependence and feedback and generalization of the super-matrix approach. It allows interactions and feedback within clusters (inner dependence) and between clusters (outer dependence). The ANP is a coupling of two parts. The first part consists of a control hierarchy or network of criteria and sub-criteria that control the interactions in the system being studied. The second is a network of influences among the elements and clusters. The network varies from criterion to criterion and a super-matrix of limiting influence is computed for each control criterion.

Finally, each of these super-matrices is weighted by the priority of its control criterion and the results are synthesized through addition for all the control criteria. In order to determine the effective criteria and sub-criteria as well as solutions for the role of design, the following steps were performed. After reviewing the internal and external resources and interviewing the producers and academicians, a comprehensive list of effective criteria was developed to enable us to understand all the important criteria for decision making in relation to the role of design. To do this, the views of 40 wood and furniture industry experts were used.

The aim of this study is to develop a decision network model to find the best solution for the role of design in the country's furniture production and market. In the network model, merits are divided into four sub-sections as benefits, opportunities, costs and risks (BOCR). These merits are influenced by strategic criteria (political, legal, development and technological, cultural and social and economic factors) to obtain weighting values for each. This process follows the principle of the Analytic Network Process (ANP).

There are 296 sub-criteria in 31 middle criteria and five main groups (marketing and economic, technical and workforce, supply and production, social and cultural, and environmental) (See Tables 1-4). Weighting values of criteria and sub-criteria are obtained by pairwise comparisons and feedbacks between criteria, sub-criteria and the four solutions.

Table 1
Control criteria and sub-criteria of benefits

Main criteria of Benefits	**Sub-criteria**
Economic/ Competitiveness	Access and mastery of knowledge
Economic/ Competitiveness	Share capital and technology
Economic/ Competitiveness	The expansion of cooperation between businesses
Economic/ Competitiveness	The possibility of creating static competition
Economic / Export	Cancel export tax
Economic / Export	Stimulation of demand by foreign buyers
Economic / Export	Removing foreign competitors who are active in the country's furniture market
Economic / Investment	Access to technology
Economic / Investment	Access to management techniques
Economic / Investment	Lower prices and upgrade competitiveness enterprises
Economic / Infrastructure	Taking advantage of scientific and technological infrastructure of universities
Economic / Infrastructure	Taking advantage of the capacity of clusters of furniture
Marketing and Sale / Distribution	Control over brand identity
Marketing and Sale / Distribution	Decreasing waste in direct transportation
Marketing and Sale / Profit	Decreasing fixed price
Marketing and Sale / Profit	Increase in profit
Marketing and Sale / Profit	Increase in turnover
Marketing and Sale / Services after sale	Customer satisfaction
Marketing and Sale / Branding	Possibility of upgrade the brand
Marketing and Sale / Branding	Possibility of description of firm
Marketing and Sale / Propaganda	According to tastes of the clients

Marketing and Sale / Propaganda	Taking advantage of high quality catalogs
Marketing and Sale / Marketing	Attract, retain and gain customers
Marketing and Sale / Marketing	Choosing a profitable target markets
Marketing and Sale / Marketing	Design and implementation of internal marketing
Technical/ Design	Creation of wealth and value added
Technical/ Design	Optimization of wood consumption
Technical/ Design	Savings resulting from transportation with design of assembly capability products
Technical/ Design	Remove the method of trial and error in the production of a new product
Technical/ Design	Correct advice in the field of furniture layout
Technical/ Design	Increase in apparent charm combined with suitable colors
Technical/ Design	Build products tailored to consumer space
Technical/ Ergonomics	Observance of the standards
Technical/ Ergonomics	Increase the performance of the furniture
Technical/ Ergonomics	Calculate the values of the incoming loads
Technical/ Ergonomics	Increase the strength of the structural furniture
Technical/ Ergonomics	Subtracting the weight of the furniture (mass of used materials)
Technical/ Ergonomics	Upgrade the health level
Technical/ Technology	Maximum use of capacity of the machines
Human/ Training	Consulting member of academics to the industry
Human / Training	Possibility making prototypes product for the industry
Human / Training	Supply of technical manpower for the industry
Human / Training	Possibility of training internships students for the industry

Human / Training	Art and architecture students encouraged to fashion design in the field of furniture
Human / Training	Engineering design students are encouraged to design engineering in the field of wood furniture
Human / Management	Proper management of human resources
Human / Management	Increase employee satisfaction
Human / Management	Enhance enterprise communications outsourcing
Human / Management	Correct management of expectations
Human / Management	Reducing complaints
Human / Work force	Activating market of academic disciplines
Human / Workforce	Rest of the labor force (easier to understand how to cut and assemble structures)
Human / Workforce	No need to research and use of force skilled in the design (in the case of outsourcing the design section)
Human / Innovation	Increasing creativity and innovation
Human / Innovation	Possibility of correct modeled (the lack of a working copy)
Supply/ Raw material	Use of indigenous raw materials
Production/ Productivity	Improve the performance
Production/ Productivity	Reducing time to build a product
Production/ Productivity	High speed Assembly
Production/ Productivity	Reducing duplication
Production / Quality control	Increased accuracy and quality in work
Production / Quality control	Possibility of product rating
Production / Quality control	Becoming mechanized quality control
Production / Quality control	Ease of control and inspection during production
Production / Quality control	Connect the control unit with the purchase process, warehouse, production
Production / Efficiency	Reducing waste
Production / Efficiency	Create a good working environment
Production / Efficiency	Increase the efficiency of the production
Production / Efficiency	Enhance the ability of individual skills

Production / Packaging	Possibility of economic packaging design
Production / R&D	Move the boundaries of design knowledge
Production / R&D	Create welfare for human beings
Production / R&D	Increasing belief next to simplify and expedite matters
Production / R&D	Increasing competitive power
Production / R&D	Improve the quality of the product
Production/ Production process	Increased accuracy in the work machine
Production/ Production process	Ease of manufacture
Production/ Production process	Reducing production cost
Production/ Production process	Speed of the production of new products on the market (reverse engineering)
Production/ Production process	Keep track of production strategy ETO
Production/ Production process	Keep track of production strategy MTO
Production/ Production process	Keep track of production strategy MTS
Social, Cultural & Politic/ Social	Ability to meet the needs of the customer
Social, Cultural & Politic/ Cultural	Restoring the credibility of the Iranian furniture
Environmental/ Environmental	Reducing energy consumption in the use of new technology
Environmental/ Environmental	Principle of operation of forests
Environmental/ Environmental	Possibility of green supply chain management (GSCM)
Environmental/ Environmental	Reducing use of chemicals and contaminants
Environmental/ Environmental	Reducing the production of carbon (using less resources, recycle more and reduce waste production)

Table 2
Control criteria and sub-criteria of opportunities

Main criteria of Opportunities	**Sub-criteria**
Economic/ Export	Facilitation and export promotion
Economic/ Export	Non-oil exports of technology exchange
Economic/ Export	Move is in line with an economy measure
Economic/ Export	Development of a mandatory standard for export
Economic / Export	Offering bonuses to new designs
Economic / Export	Contribute to the inbreeding and extraversion economy to export
Economic / Investment	Reducing risk of investment
Economic / Investment	Steer outbound investments with high added value
Economic / Investment	Possibility of production based on cheap labor
Economic / Investment	Improvement of performance of the domestic industry
Economic / Investment	The possibility of contracting marriage, TTC and KHTC
Economic / Infrastructure	Development of intellectual property law
Economic / Infrastructure	Increase Government incentives
Economic / Infrastructure	Using capacity of the graduates
Economic / Infrastructure	Awareness of the rules of international trade
Economic / Competitiveness	Increasing share of foreign markets
Economic / Competitiveness	Possibility of creation of dynamic competition
Economic / Competitiveness	Stabilization of domestic markets
Economic / Competitiveness	Creation a competitive atmosphere in the industry
Economic / Competitiveness	Proving competitive advantage
Economic / Competitiveness	Proving relative advantage
Economic / Competitiveness	Possibility of adoption of competitive policies
Marketing and Sale / profit	High profit margins for designed products
Marketing and Sale / Warranty	Product warranty
Marketing and Sale / After sales service	Customer relationship management
Marketing and Sale / After sales service	Increasing after sales service

Marketing and Sale / Propaganda	Contribution of the effective and targeted advertising of the product
Marketing and Sale / Propaganda	Taking advantage of the appropriate headline in advertising
Marketing and Sale / Propaganda	Possibility of receiving awards and certifications (development of advertising)
Marketing and Sale / Branding	Branding Iranian furniture
Marketing and Sale / Branding	Contribute to the development of the brand
Marketing and Sale / Branding	Customer loyalty to the brand
Marketing and Sale / Branding	Possibility of receiving awards and certifications
Marketing and Sale / Branding	Development of cultural branding
Marketing and Sale / Marketing	Contribution of products marketing
Marketing and Sale / Marketing	Possibility of segmenting market
Marketing and Sale / Marketing	Contribution of product pricing strategy
Marketing and Sale / Marketing	Possibility of the creation, Exchange and providing value to customers
Marketing and Sale / Marketing	Opportunity of design and compilation of performance measurement program
Technical/ Design	Revision of beauty and elegance of the product
Technical/ Design	Development of multi-purpose modular furniture
Technical/ Design	Differentiation of the product with other competitors
Technical/ Design	Possibility of customization of the product
Technical/ Design	Possibility of using handmade ECO-CHIC pieces
Technical/ Design	Possibility of design in imitation of nature-biomimetic
Technical/ Design	Management of amount of textiles and furniture accessories
Technical/ Ergonomics	Applying more frequently
Technical/ Ergonomics	Possibility of research on raw materials
Technical/ Ergonomics	Possibility of research on fashion and furniture style
Technical/ Ergonomics	Increasing safety of furniture
Technical/ Ergonomics	Feasibility analysis of human body system
Technical/ Ergonomics	Possibility of assessing the physical dimensions (Anthropometry)
Technical/ Ergonomics	Taking advantage of bio-mechanics in furniture design

Technical/ Technology	Conversion of knowledge and technology to new product
Technical/ Technology	Opportunity to use the new machines
Technical/ Technology	Possibility of the use of new technical knowledge
Technical/ Technology	Possibility of export of technical and engineering services to other countries
Human/ Training	Possibility of research contracts with universities
Human / Training	Possibility of consultations and the implementation of industry research
Human / Training	Access of Industry to Universities' Labs
Human / Training	Possibility of establishment of technological firms by alumni
Human / Training	Enhancement of role of universities to create new high-tech industries
Human / Management	Taking advantage of outsourcing opportunities
Human / Management	Development of applying physical capital
Human / Management	Improvement of employee's motivation, beliefs and thoughts
Human / Management	Ease of management of human resources
Human / Management	Promote strategic management practices
Human / Work force	Increasing level of employment
Human / Workforce	Increasing expertise and skills of the workforce
Human / Innovation	Design of appropriate structure for supporting creativity
Human / Innovation	Possibility of innovation in process, product and services
Human / Innovation	Possibility of innovation in marketing
Human / Innovation	Increasing culture of teamwork
Human / Innovation	Promotion of innovation in firm strategy
Supply/ Raw material	use of new raw materials

Supply/ Raw material	Correct choice of materials for manufacturing
Supply/ Lateral	Use the proper fabric and accessories
Supply/ Lateral	Development of auxiliary industries
Production/ Productivity	Complete using production technologies
Production/ Productivity	Growth of productivity
Production / Quality control	Feasibility analysis of various experiments
Production / Quality control	Possibility of record test results
Production / Quality control	Documentation and records management quality tests
Production / Quality control	Taking advantage of previous experience in testing
Production / Quality control	Possibility of support a variety of measuring methods
Production / Quality control	Possibility of definition of quality indicators
Production / Efficiency	Ease employees performance evaluation
Production / Efficiency	Improvement of production per capita
Production / Efficiency	Possibility of timing produce
Production / Efficiency	Possibility of capacity assessment
Production / Packaging	Contributing low volume packaging
Production / Packaging	Ease of Assembly by the consumer
Production / Packaging	Ease of visualizing and understanding contents of the package
Production / Packaging	Identity of building in the packaging design
Production / Packaging	Help to maintain healthy goods
Production / Packaging	The possibility of using different packaging shapes
Production / R&D	Possibility of establishment of the R&D unit in companies
Production / R&D	Feasibility of aesthetic furniture research
Production / R&D	Optimization of processes
Production / R&D	New product design
Production / R&D	Transfer and uptake of technology
Production / R&D	Defensive strategy formulation
Production/ Production process	Development of mass production approach
Production/ Production process	On time delivery
Production/ Production process	Flexibility of prices respect to customers
Production/ Production process	Flexibility of the machines, production lines and workforce
Production/ Production process	Track production strategy OEM
Production/ Production process	Track production strategy ODM

Production/ Production process	Track production strategy OBM
Social, Cultural & Politic/ Social	Improving quality of life
Social, Cultural & Politic/ Social	Upgrading level of industrial unions
Social, Cultural & Politic/ Social	Growth of consumption of household furniture
Social, Cultural & Politic/ Social	Increasing sense of national confidence
Social, Cultural & Politic/ Cultural	Presenting culture of Iranian by design
Social, Cultural & Politic/ Cultural	Production respect to culture and need of the society
Social, Cultural & Politic/ Cultural	Change and development of consumption pattern
Social, Cultural & Politic/ Politic	Increasing political influence (with the design of a new product)
Social, Cultural & Politic/ Politic	Increasing political relations
Social, Cultural & Politic/ Politic	Taking advantage of the strategic advantage
Environmental/ Environmental	Possibility of recycling furniture (biological degradation)
Environmental/ Environmental	Lack of using plastic packaging
Environmental/ Environmental	Effective using available energy and resources
Environmental/ Environmental	Possibility of receiving environmental certificates for export to Europe
Environmental/ Environmental	Optimization of exploitation of raw materials
Environmental/ Environmental	Possibility of return of the products to the company for recycling

Table 3
Control criteria and sub-criteria of costs

Main criteria of Costs	**Sub-criteria**
Economic/ Export	Transference of foreign markets to leading competitors
Economic/ Export	cost analysis of the export target markets
Economic/ Export	Decreasing global furniture exports
Economic/ Export	Negative competition between domestic exporters
Economic / Export	Lack of awareness of the export target markets
Economic / Import	sharp rise of imports
Economic / Import	Exit of currency to the abroad
Marketing and Sale / Marketing	Cost of detailed study of the market
Marketing and Sale / Marketing	Lack of awareness of needs of the market
Marketing and Sale / Marketing	Cost of marketing a new product
Marketing and Sale / Marketing	Cost of participation in the exhibitions
Marketing and Sale / Sale	Cost of creating continuous shops
Technical/ Design	Lack of appropriate idea for new products
Technical/ Design	Spending time and cost for new product design
Technical/ Design	Cost of salaries, taxes and social security of design branch
Technical/ Ergonomics	Cost of testing product in laboratories
Technical/ Ergonomics	Cost of materials research
Technical/ Ergonomics	Lack of national anthropometry
Technical/ Ergonomics	Weakness of science in Kinesiology joints
Technical/ Ergonomics	Cost and time for the Nordic questionnaire analysis
Technical/ Ergonomics	Possibility of assessing the physical dimensions (Anthropometry)
Technical/ Ergonomics	Cost of test centers creation and testing furniture
Technical/ Technology	Lack of specialized data collection and processing

Human / Management	Problem of attracting creative employees in furniture design
Human / Management	Cost of management remuneration
Human / Workforce	Cost of skilled and professional manpower supply
Human / Workforce	Unemployment of graduates
Human / Workforce	Cost of holding periodic training
Human / Innovation	Weakness of creativity and innovation power
Human / Innovation	Cost of the dignity befitting the bonus
Human / Innovation	Cost of the failures and mistakes of the staff in the field of innovation
Supply/ Raw material	Increasing cost of raw materials
Supply/ Raw material	Sudden cessation of supply of raw materials
Supply/ Raw material	Dependency to the suppliers of raw materials
Supply/ Raw material	Drop in the quality of supply of raw materials
Supply/ Lateral	Secondary industry downturn related to furniture
Production / R&D	Financial, machines and equipment problems
Production / R&D	Cost of aggressive strategy (In field of development of a new product and technological change)
Social, Cultural & Politic/ Cultural	Lack of pay attention to Iranian culture in the production
Environmental/ Environmental	Taking indiscriminate sources of wood (the destruction of the forests)
Environmental/ Environmental	Increasing greenhouse gas emissions
Environmental/ Environmental	Accumulation of waste resulting lack of flexibility of recycling
Environmental/ Environmental	Ban on exports to the European Union due to disagree with the Green supply chain

Table 4
Control criteria and sub-criteria of risks

Main criteria of Risks	**Sub-criteria**
Economic/ Competitiveness	Fierce competition among domestic manufacturers
Economic/ Competitiveness	Monopoly of information in the market
Economic/ Competitiveness	Anti-competitive practices such as import
Economic/ Competitiveness	Anti -competitive cartel action
Economic/ Competitiveness	Absence of codified rules and regulations regarding competition
Economic / Export	Risk of increasing fixed price of the products
Economic / Export	Lack of liquidity and working capital for export products
Economic / Export	Lack of understanding tools and machines in producing furniture
Economic / Investment	Powerful presence of foreign competitors
Economic / Investment	Risk of net use of the investment market
Economic / Investment	Pure using capital for resources instead of productivity
Economic / Investment	Possibility of increasing competition level
Marketing and Sale / Warranty	Loss of trust to internal product
Marketing and Sale / Branding	Rising foreign brands of furniture
Technical/ Design	Lack of familiarity with modern software design
Technical/ Design	Risk of copying designed products by domestic and foreign competitors
Technical/ Technology	Low level of technical knowledge
Technical/ Technology	Dependency to leading countries in knowledge of design
Human / Training	Lack of training and experience of graduates
Human / Training	Lack of compatibility between industry needs and university training
Human / Management	Lack of ability of protection of investment in sector of design and creativity
Human / Management	Lack of flexibility of managers
Human / Management	Lack of agility of firm

Human / Workforce	Lack of stability of skillful workforce
Supply/ Raw material	Risk of security of raw materials supply
Supply/ Raw material	Risk of reduction of materials quality
Supply/ Raw material	Using non-native raw materials
Production / R&D	Lack of copyright law
Production / R&D	Lack of trust to the degree of usefulness
Production / R&D	Lack of logical and scientific programs
Social, Cultural & Politic/ cultural	Promoting consumption culture with foreign brand
Social, Cultural & Politic/ politic	Risk of economic sanctions
Social, Cultural & Politic/ politic	Risk of changing economic policies of government
Social, Cultural & Politic/ politic	Risk of foreign investment security

2.2 Data/model analysis

The overall structure of decision making is as follow (Figure 1):

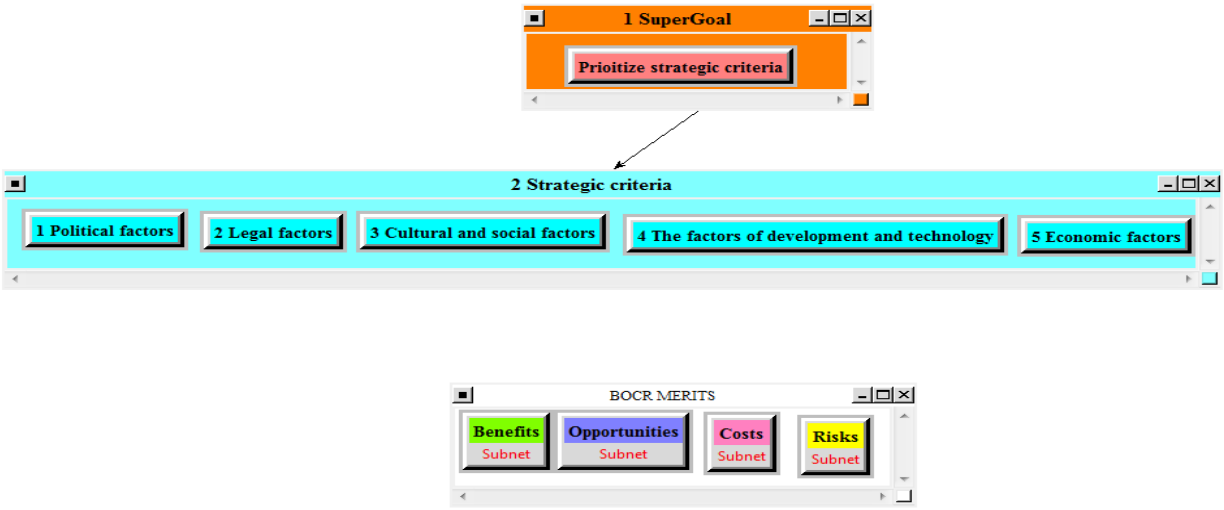

Figure 1 Overall structure of decision making

In the current research, the ANP model is described by the above elements. The sub-networks are shown in Figures A1-A9 in the Appendix.

2.3 Alternatives

There are four potential alternatives for the role of design:

1) Using fashion design in furniture production (S1). Cooperation among academic members is the topic of this approach. Furniture production considers interior architecture, arts, crafts, etc.

2) Using engineering design in furniture production (S2). The steps of the engineering design process are to a) define the problem; b) do background research; c) specify requirements; d) brainstorm solutions; e) choose the best solution; f) do development work; g) build a prototype; and h) test and redesign.

3) Using a combination of fashion and engineering design in furniture production (S3). Innovative design and engineering design are topics of this approach.

4) Applying the leading country's design capability with an outsourcing approach in furniture production (S4). S4 means working in partnership with the leading countries in interior design as well as a reverse engineering procedure (working copy) production of furniture.

The Analytic Network Process and Super Decision software were used to synthesize and analyze the model.

2.4 Strategic criteria

In this research, the merits of benefits, costs, opportunities, and risks are weighted by five general factors that fit into one of the following broad categories: development and technological (0.193), cultural and social (0.105), economic (0.299), political (0.24), and legal (0.154). Ratings of general factors are done by pairwise comparison of the lower level factors and summation of the main factors at the top level. The final weight of the strategic criteria shows that the economic criteria with the weight of 0.299 have the highest priority. The economic criteria have the highest impact on decision making for the role of design in the furniture industry.

2.5 Prioritizing BOCR

To categorize the criteria which have been used in the current research, we divided them into favorable and unfavorable categories. The decision maker considers the favorable criteria as benefits and the unfavorable criteria as costs. The possible events are also divided into opportunities and risks depending on whether they are considered to be positive or negative (Saaty, 2001a). Since BOCR are not equally important, it is necessary to prioritize them. Five possible ratings ranging from "very high" to "very low" are used. The results of the influence of the strategic criteria on the merits of benefits, costs, opportunities, risks, and the priority of the above mentioned merits are reported in Table 5.

Table 5
Rating of the model to obtain BOCR weighing values very high (1), high (0.51), medium (0.252), low (0.124), very low (0.065)

	Benefits	**Costs**	**Opportunities**	**Risks**
Economic (0.299)	Very high	medium	Very high	high
Political (0.246)	high	high	Very high	high
Legal (0.154)	Very high	high	high	high
Cultural &social (0.105)	high	low	high	medium
Development and technological (0.193)	high	medium	high	high
Overall normalized priorities	**0.313**	**0.146**	**0.332**	**0.207**

2.6 Control criteria network

The network of control criteria under benefits, costs, opportunities and risks are as follows**: e**conomic and marketing, the workforce and technical, supply and production, social, cultural and political, and environmental. The structure of the framework for benefits, merits and its control criteria and sub-criteria are extracted from Super Decisions software, as illustrated in Appendix Figures A1-A9. The framework for costs, opportunities and risks can be developed similarly. To apply the ANP, the Super Decisions software was used. In the BOCR structure the following formula is used in calculations (Saaty, 2001a):

(Benefits)*(Opportunities)/ (Costs)*(Risks) (1)

3. Results

After the hierarchy is drawn up for criteria and sub-criteria which influence the selection of the appropriate alternative, the questionnaire was prepared to gather the opinions of the experts. The criteria and sub-criteria were evaluated based on pairwise comparisons. An example of these comparison questions is shown in Figure A10. Then, the priority rate of each criterion and sub-criteria were compared. First, the geometric mean was calculated for each one of the matrix cells by the following formula (Saaty, 2000). BOCR was ranked with the same method with respect to overall factors in the previous section (Table 1).

Group judgments $a_{ij} = (a_{ij}1 \times a_{ij}2 \times \ldots \times a_{ij}N)^{1/N}$ $i, j = 1, 2, \ldots N$ (2)

Where a_{ij} represents the comparison ratios between element *i*th row and element *j*th column in the pairwise comparison matrices and N is the number of decision makers.

After the geometric means of all matrix cells are calculated, the results are normalized and the criterion and sub-criterion weighting values are obtained through the integration of the weight of the low-level elements into the weight of the related upper-level elements. The results of geometric mean matrices and weighted supermatrix for benefits, costs, opportunities and risks criteria and sub-criteria are extracted from Super Decisions software and the standard formula is the multiplicative formula.

3.1 Result of marketing and economic control criteria of benefits

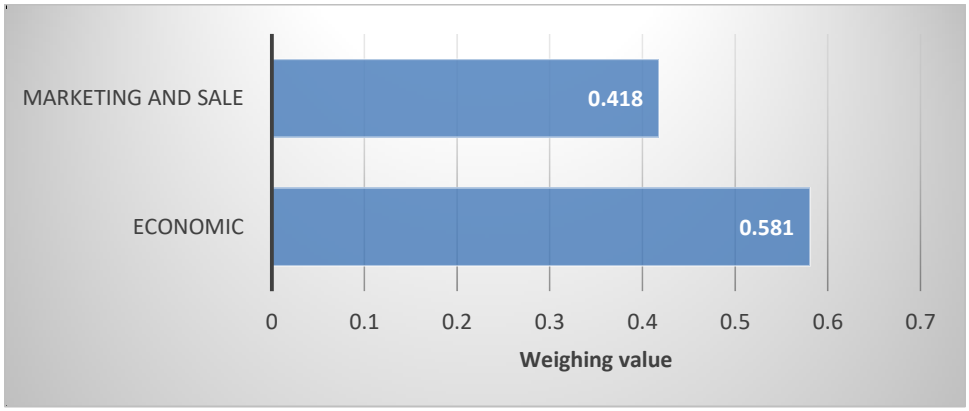

Figure 2 Result of control criteria under benefits

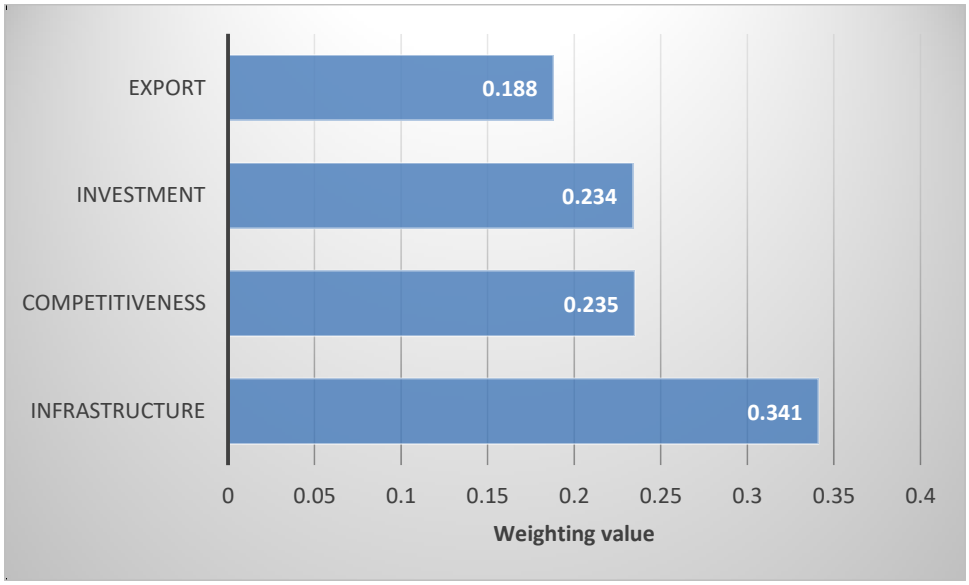

Figure 3 Result of subnetwork under economic of benefits

3.2 Result of marketing and economics control criteria of opportunities

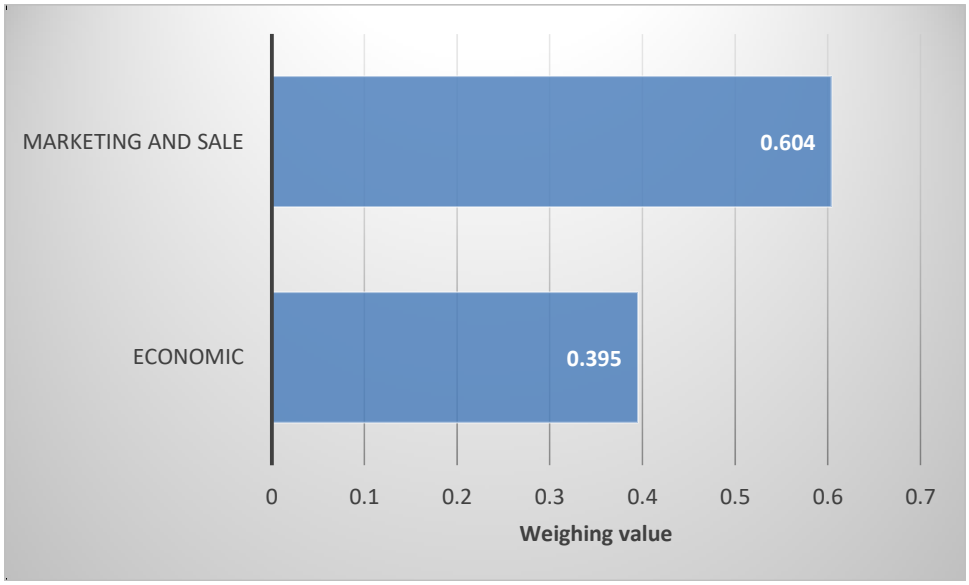

Figure 4 Result of control criteria under opportunities

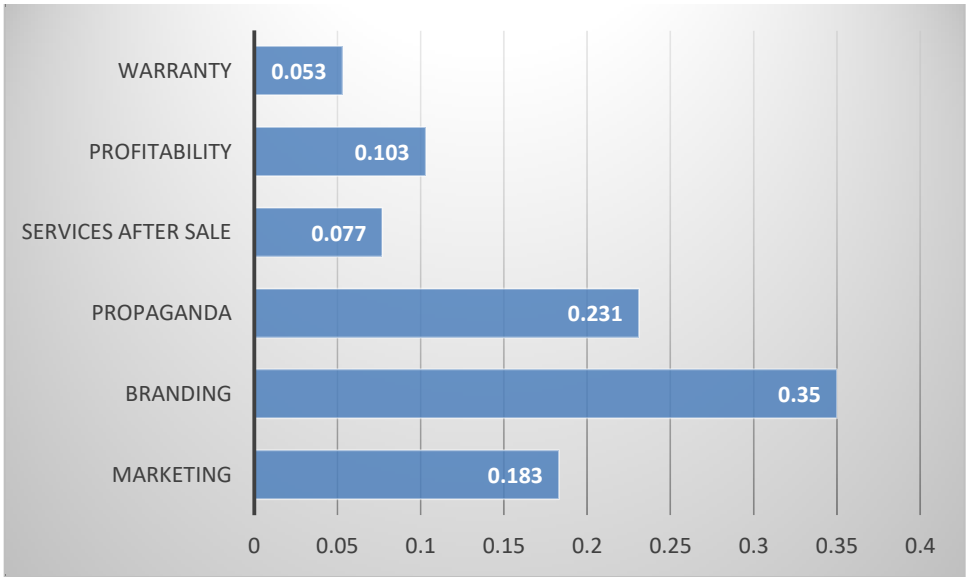

Figure 5 Result of subnetwork under marketing and sale of opportunities

3.3 Result of marketing and economics control criteria of costs

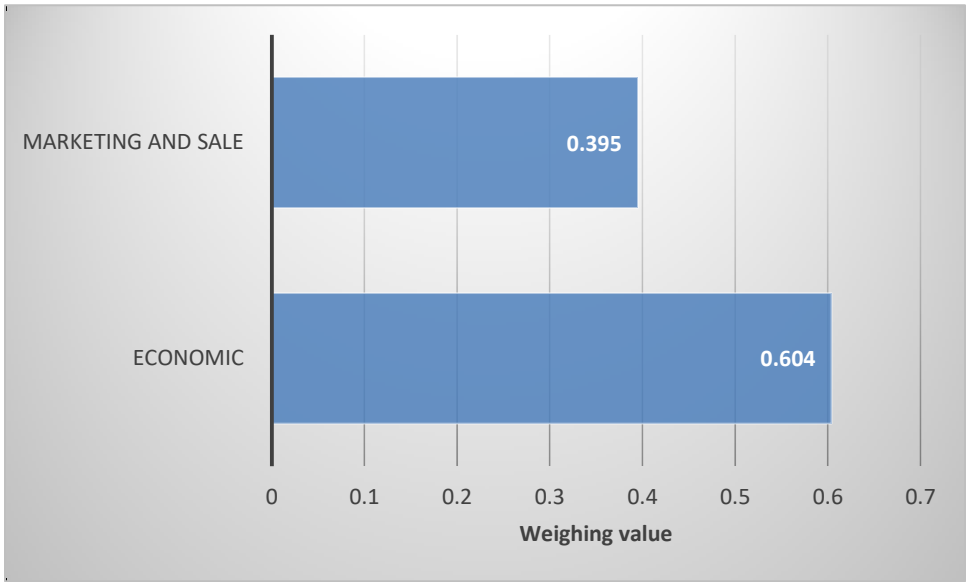

Figure 6 Result of control criteria under costs

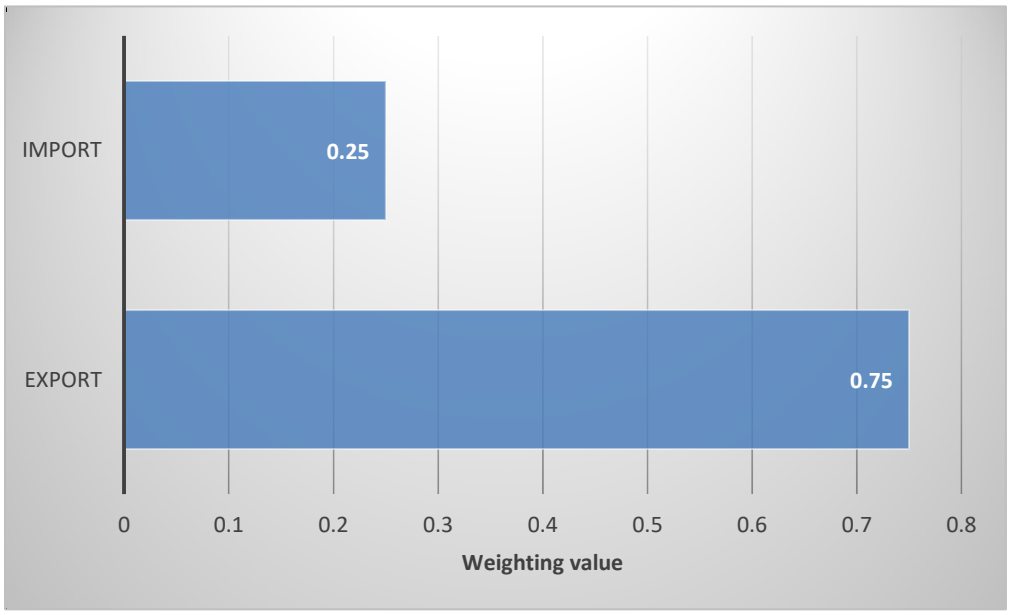

Figure 7 Result of subnetwork under economic of costs

3.4 Result of marketing and economics control criteria of risks

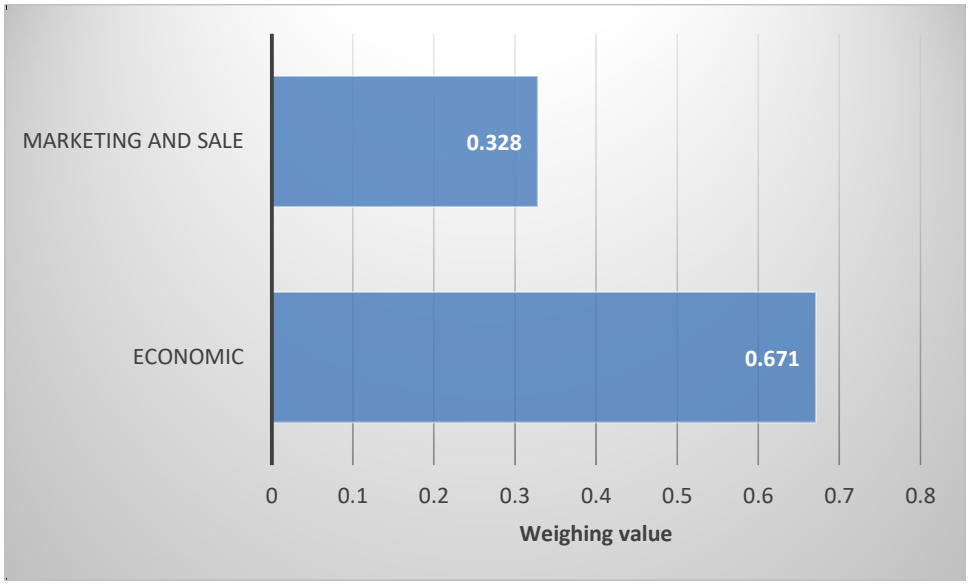

Figure 8 Result of control criteria under risks

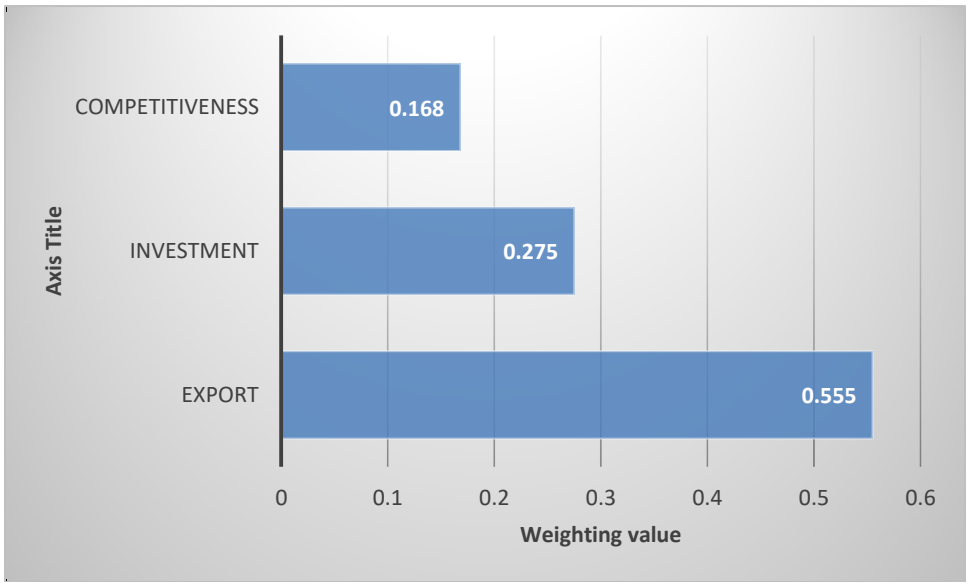

Figure 9 Result of subnetwork under economic of risks

3.5 Results of solutions with respect to infrastructure under subnetwork of economics control criteria of benefits

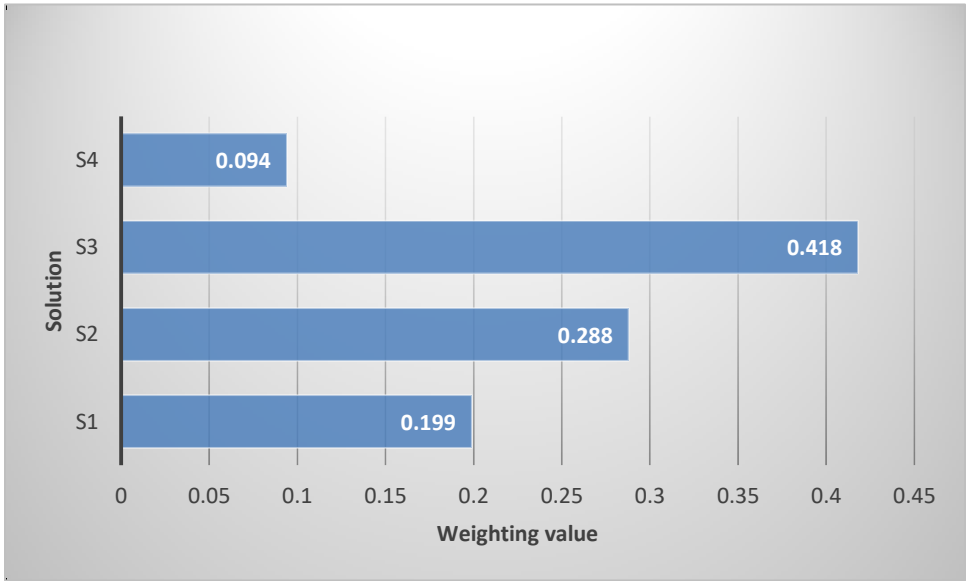

Figure 10 Results of solutions with respect to infrastructure under subnetwork of economics control criteria of benefits

3.6 Results of solutions with respect to branding under subnetwork of marketing and sale control criteria of opportunities

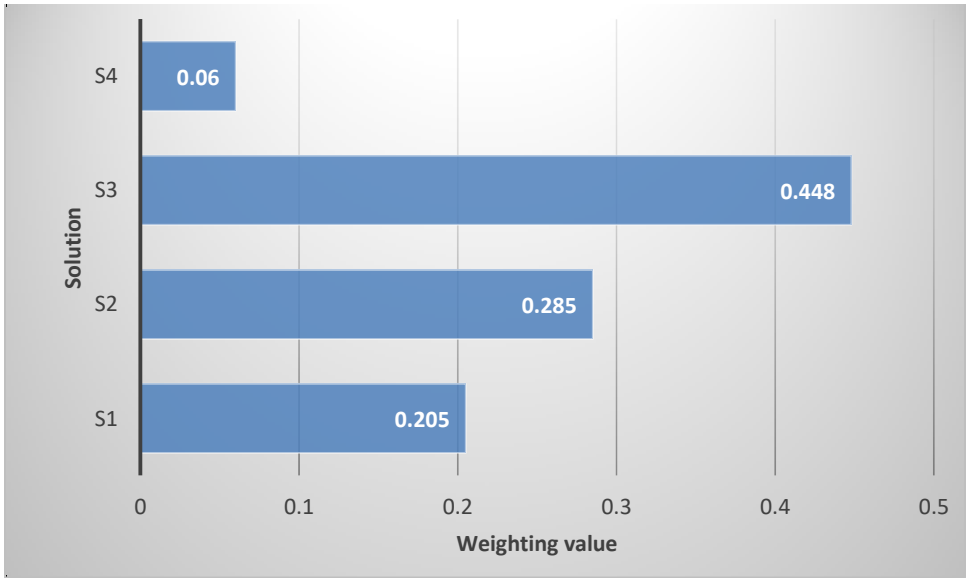

Figure 11 Results of solutions with respect to branding under subnetwork of marketing and sale control criteria of opportunities

3.7 Results of solutions with respect to export under sub- network of economic control criteria of costs

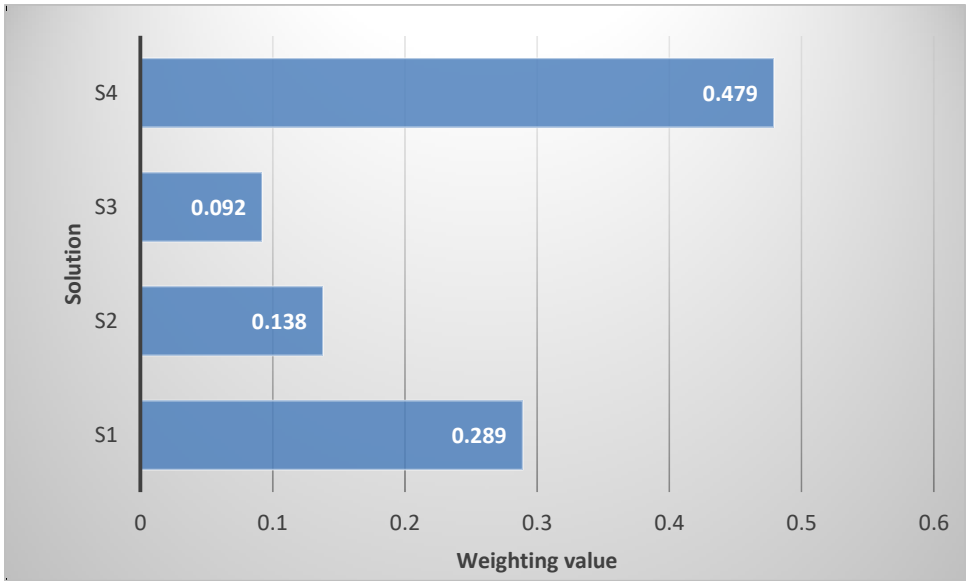

Figure 12 Results of solutions with respect to export under subnetwork of economic control criteria of costs

3.8 Results of solutions with respect to export under sub- network of economic control criteria of risks

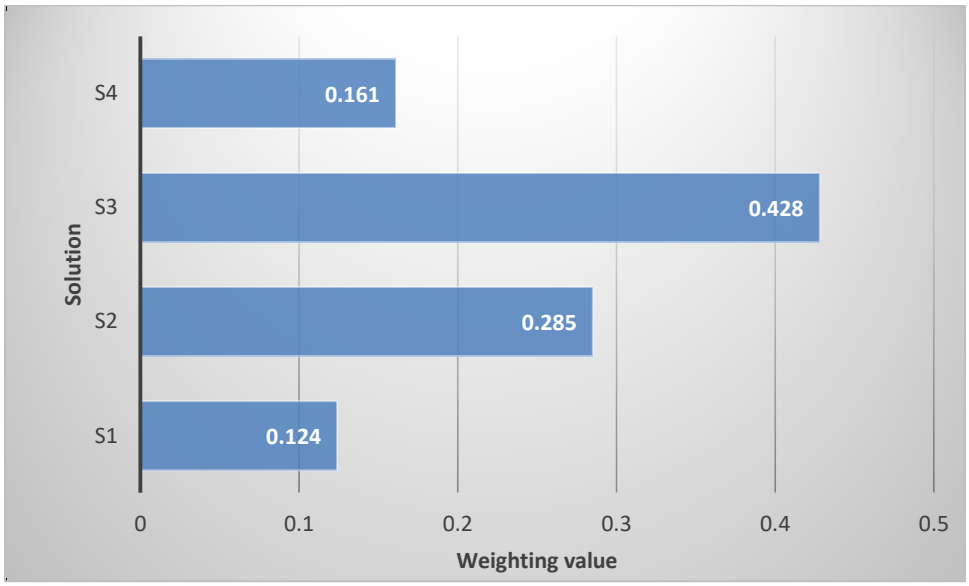

Figure 13 Results of solutions with respect to export under subnetwork of economic control criteria of risks

By integrating the weights of the merits of benefits, costs, opportunities and risks and the weights of choices against the above mentioned merits, the final scores are reported in Table 6.

Table 6
Final outcome for priorities of the alternatives

Mer. / Alter.	Benefits (**0.313**)	Opportunities (**0.332**)	Costs (**0.146**)	Risks (**0.207**)	Final Outcome Additive	Ranking
S1	0.218	0.177	0.217	0.188	0.225	2
S2	0.228	0.211	0.233	0.227	0.217	3
S3	0.301	0.362	0.222	0.296	0.396	1
S4	0.252	0.249	0.327	0.287	0.161	4

As Table 6 shows, using a combination of fashion and engineering designs in furniture production (**S3**), has the highest priority and is the most suitable solution for the role of design in furniture production and marketing. The second, third and fourth highest priorities respectively are using fashion design in furniture production (**S1**), using engineering design in furniture production (**S2**), and applying the leading country's design capability with an outsourcing approach in furniture production (**S4**).

4. Discussion

The results of the control criteria**,** marketing and economic, have the highest priority with respect to benefits (0.328), costs (0.409), opportunities (0.365) and risks (0.406) for the role of design in the furniture industry. This result is due to the motivation of economic activity, the success in decision making and the profitability of economic activity according to the view point of furniture experts.

The results show the economic criteria under benefits (0.581) have a higher priority in comparison to marketing and sale (0.418) (Figure 2). Also in the subnetwork of economics under benefits, infrastructure (0.341) has the highest priority. The weighted values of the other criteria are as follows: competitiveness 0.235, investment 0.234, and export 0.188 (Figure 3). It is not possible for the furniture industry to succeed in the fields of export, investment and competitiveness without creating a science and technology infrastructure, a government support infrastructure and a furniture clusters capacity.

The results show marketing and sale under opportunities (0.604) have a higher priority in comparison to economics (0.395) (Figure 4). In the subnetwork of marketing and sale, branding (0.35) has the highest priority. Marketing (0.183), propaganda (0.231), services

after sale (0.077), profitability (0.103) and warranty 0.053 respectively are other leading factors (Figure 5). By focusing on branding, the product can be distinguished from other products that rivals offer, and with the help of advertising, providing after-sales service and a product warranty, the customer's perspective can lead to creating marketing goals and profitability for the company.

The results indicate economics under costs (0.604) has a higher priority in comparison with marketing and sale (0.395) (Figure 6). In the economics sub-network, export (0.75) has a higher priority in comparison with import (0.25) (Figure 7). Lack of knowledge about the conditions of the export target markets reduces the motivation of domestic producers to export furniture. The result will be the loss of beneficial export markets for the benefit of foreign competitors, the tendency towards weak domestic markets and negative and unhealthy competition.

Economic under risks (0.671) has a higher priority in comparison with marketing and sale (0.328) (Figure 8). In the economics subnetwork, export (0.555) has the highest priority (Figure 9). Investments (0.275) and competitiveness (0.168) follow respectively in priority. Rising prices of the product is a risk and the rules and regulations of competition are not clear, also the risk of a monopoly of information on the Iranian furniture market makes it impossible to export investment.

Results indicate that using a combination of fashion and engineering designs in furniture production (S3) (0.418) has the highest priority with respect to infrastructure under benefits (Figure 10). Using engineering design in furniture production (S2) (0.288), using fashion design in furniture production (S1) (0.199) and applying the leading country's design capability with an outsourcing approach in furniture production (S4) (0.0937) respectively, are other leading solutions. Utilizing the combination of fashion and engineering designs (S3) in furniture production can lead to the greatest use of the capacity of the scientific and technological infrastructure of the universities.

With respect to the results, using a combination of fashion and engineering designs in furniture production (S3) (0.448) has the highest priority with respect to branding under opportunities (Figure 11). Using engineering design in furniture production (S2) (0.285), using fashion design in furniture production (S1) (0.205) and applying the leading country's design capability with an outsourcing approach in furniture production (S4) (0.06) respectively, are other leading solutions. Using a combination of fashion and engineering designs in furniture production (S3) can restore the potential of branding Iranian furniture at the international level.

With respect to export under **costs,** applying the leading country's design capability with an outsourcing approach in furniture production (S4) (0.479) has the highest priority and the second, third and fourth are using fashion design in furniture production (S1) (0.289), using engineering design in furniture production (S2) (0.138) and using a combination of fashion and engineering designs in furniture production (S3) (0.092) (Figure 12). The solution S4 will lead to the loss of export markets for the benefit of leading foreign competitors. This is because in the field of furniture design dependence on leading countries is a major weakness and the market will tend towards the leading countries.

Results show using a combination of fashion and engineering designs in furniture production (S3) (0.428) has the highest priority with respect to export under risks (Figure

13). Using engineering design in furniture production (S2) (0.285), applying the leading country's design capability with an outsourcing approach in furniture production (S4) (0.161) and using fashion design in furniture production (S1) (0.124) respectively are other leading solutions. With respect to the high risk of the export criteria, S3 will lead to increased costs of skilled designer employment, the risk of job security for skilled labor, and the risk of not using machinery related to the design of a product engineered and compatible with customer's requirements.

The final result of the strategic criteria shows that economic factors with a weight of 0.299 are the most important ones. For managers and employers of the country's furniture industry, these factors are more effective than other factors in influencing people's decision making role. Also, BOCR indicates that opportunities have higher significance than other competencies regarding the role of design in the production and furniture market. In terms of selection, the third solution (S3) or the use of the combination of fashion design and engineering design in the marketplace and furniture manufacturing is considered the best solution. Accordingly, we can list the following with respect to the control criteria:

Economic Index: If this solution (S3) is planned and implemented by companies and furniture manufacturing workshops in the country, the maximum available capacity in the scientific and technological infrastructure of universities can be provided. Therefore, it would be possible to be considered a serious competitor among the foreign competitors and be able to protect the share of the country's furniture market in favor of domestic power. This solution creates a new competitive advantage which utilizes the strengths of the country in order to promote self-reliance in furniture design and production. By adopting this solution in the field of foreign investment, the country's furniture industry tends towards high value-added products. On the other hand, investment contracts will transfer the technical knowledge and method of doing business and will use the capabilities of graduates who have learned the design knowledge.

Marketing and sale index: By using the solution (S3) in the market and furniture industry of the country, it is possible to restore the potential of the country to brand Iranian furniture. This also provides the opportunity to create the basis for the emergence and prosperity of Iranian brands in the international market. Most of the major exporting countries have been able to use fashion and engineering design simultaneously and create strong and reputable brands in their global markets which in turn creates gains in market share. Through the design of new and diverse products in the market which are not only beautiful and colorful but vary in price and have the right structural and ergonomic power, customer's attraction will be enhanced and market development increased**.**

Supply index: (S3) can be used to design and manage the use of indigenous and even non-indigenous materials. Furniture products such as fabric, foam, paint, metal, glass and fittings can be used. Products must work reliably and be readily available. If there were problems, suitable alternatives could be found by trial and error.

Production index: The use of solution (S3) could lead to the creation or development of a R&D unit in companies that would be beneficial. A precise understanding of an execution plan can reduce the trial and error of production to a minimum as well as

replication due to human error. These errors are the greatest contributors to reduced efficiency in production, and by reducing their affect the accuracy and quality of work increases, but the production time decreases. Identifying the production time of the product can provide a fair judgment of labor productivity. Also, with the planning of production capacity and per capita production for each individual, the productivity of the workforce can be enhanced by some incentives. Reducing duplication and increasing production efficiency will lead to savings in raw material consumption, and on the other hand increasing labor productivity and reducing human error can reduce production time and increase production. Furthermore, the positive outcome of these events in production leads to lower production costs and increased margins which, in addition to raising the competitiveness of the product, leads to the timely scheduling and delivery of production orders. On the other hand, the proper design of the product, allows assessment of the packaging of the product in various forms, so that in the case of export, the shipping costs could be reduced significantly.

Technical Index: By using the third solution (S3) a design change can always be made to a product that is not in line with competitor's products, and is distinct and different from other products. If the use of new machines is not mandatory, a market share can only be achieved by differentiating the design. The development of modular furniture is an example of this distinction in design. In addition, it is possible to issue technical and engineering services in the field of product design and set up of production units in other countries and provide an appropriate valuation for the country. It also provides for the development of design and ergonomics and can design and manufacture products in accordance with national and international anthropometric standards that, in addition to the beauty and elegance in terms of structural strength and bearing loads, can match the standards of the day.

Workforce index: The third solution (S3) offers the possibility of job creation for college graduates in the fields of architecture, art, industrial design, and wood industry. They can operate in the field of designing and producing new products by establishing new knowledge-based companies. Universities can also produce industry-specific portfolio designs for the furniture industry, tailor-made with up-to-date designs.

Social, cultural, and political index: By using the third solution (S3) a sense of self-confidence is created in the domestic producer. The industry can be restored and offered to world markets by designing in accordance with the culture of the community, in the form of national furniture and creating unique charm, while respecting the customer's sensitivity. If we can continuously apply beauty, quality, precision, elasticity and elegance in the field of furniture production, over time, a national cultural identity will be formed internationally, indicating quality and trust in the furniture of the country.

Environmental indicator: By using the combination of fashion and engineering design (S3) we can use the optimal amount of raw materials available to reduce the harvest and utilization of forest resources. With principled design, it is possible to recycle most of the consumables in the furniture and achieve success in reducing the production of waste from the use of furniture. Even in the design of furniture, green raw materials can be used that can be degraded in the event of their release into nature. Green supply chain management (green supply, green design, green production, green transportation, green

packaging) can be planned and implemented in the furniture industry. In this case, it will be possible to obtain environmental certifications for the furniture manufacturers.

5. Sensitivity analysis

Since there may be different judgments about the comparison of priority rates of benefits, opportunities, costs, and risks or their sub-criteria, Saaty (2001b) suggests a sensitivity analysis of the results.

To perform a sensitivity analysis, we apply the software developed by Saaty (2001b). The results are illustrated in Table 7. From Table 6, the solution using a combination of fashion and engineering designs in furniture production (S3) has the highest priority and is the most suitable solution for using a design role in furniture production and marketing. The second, third and fourth priorities are using fashion design in furniture production (S1), using engineering design in furniture production (S2), and applying the leading country's design capability with an outsourcing approach in furniture production (S4). After changing the weights of one criterion, the priorities also change as shown in Table 7.

Table 7
The results of sensitivity analysis
S3>S2>S4>S1

Merits	Basic Weight	Number of changes	New Weight	New Priorities
Benefits	0.313	1	0.134	S3>S2>S1>S4
Costs	0.146	1	0.255	S3>S4> S2 > S1
Opportunities	0.332	2	0.06 0.42	S3>S2>S1>S4 S3>S1>S2>S4
Risks	0.207	1	0.294	S3> S4 >S2> S1

Opportunities is more sensitive than benefits, costs and risks because the sensitivity analysis of opportunities shows (Table 7) that there are two times the changes in priority of alternatives while the sensitivity analysis of the other merits shows that there is only one change in the priority. Figures A11 and A12 in the Appendix show a sensitivity analysis of Benefits, Costs, Opportunities and Risks which has been done in Super Decisions software.

6. Conclusion

To present the best approach on the role of design in the country's furniture production and market, the four following options were analyzed through a combination of multi-criteria decision techniques:

Using fashion design in furniture production (S1);
Using engineering design in furniture production (S2);
Using a combination of fashion and engineering designs in furniture production (S3);
Applying the leading country's design capability with an outsourcing approach in furniture production (S4)

In the first stage, the overall strategic factors were identified, and based on those factors, the weighting values of BOCR (benefits, opportunities, costs, and risks) were determined. Weighting values of the merits were derived by the influence of the strategic criteria on benefits, costs, opportunities and risks in the second stage. In the third stage, the weighted values of the alternatives derived in the prior stages were synthesized using the Analytic Network Process (ANP) and Super Decisions software. Our conclusion is that the Analytical Network Process shows using a combination of fashion and engineering designs in furniture production (S3) is a proper solution to apply to the role of design in the furniture industry. Using a combination of fashion and engineering designs has the highest priority in parts of Benefits, Opportunities, and Risks. In the research, there are eight main control criteria. With respect to the economic index, S3 would create the greatest use of available capacities in the scientific and technological infrastructure of universities. According to the marketing and sale index, S3 restores the potential of the country to brand Iranian furniture. Regarding the supply index, S3 can be used to design and manage the use of indigenous and non-indigenous materials in design. With respect to the production index, creation of an R&D unit in companies that can provide significant benefits for companies is possible by applying S3. According to the technical index, by applying S3 a design change can lead to a product that is not in line with a competitor's products and distinguished from other products. In terms of the manpower index, S3 offers the possibility of job creation for college graduates. From the social, cultural, and political point of view, using S3 provides a sense of self-confidence in the domestic producer, and makes it possible to respond to customer needs. From the environmental point of view, applying S3 leads to using the optimal amount of raw materials available to reduce the harvest and utilization of forest resources. Results of the sensitivity analysis revealed that the opportunities are more sensitive than benefits, costs and risks. The result can be used since there may be different judgments about the comparison of priority rates.

REFERENCES

Aksakal, E., Aktas A., Kabak, M. & Dagdeviren, M. (2015). *Site selection for wind energy plant by using Analytic Network Process.* 23rd International Conference on Multi Criteria Decision Making (MCDM 2015). Hamburg, Germany.

Amarilla, R., Osorio, A., Blanco, G., Liamosas, C., Fernandez, F. (2018). *Integrated multi criteria planning model of the use of hydroelectricity surplus of Paraguay based on Analytic Network Process*. International Symposium on the Analytic Hierarchy Process (ISAHP2018). Hong Kong.

Apostolou, D., Sakkas, N., & Mentzas, G. (2004). Enabling knowledge sharing in supply chain management: a case study in the wood/furniture sector. Retrieved from imu.iccs.ntua.gr

Azizi, M., and Modarres M. (2010). A decision model to select facial tissue raw material - a case from Iran, *OR Insight, 23(4),* 207-232. Doi: https://doi.org/10.1057/ori.2010.12

Bessant, J., Whyte, J. and Neely, A. (2005). *DTI Think Piece: Management of creativity and design within the firm*, Advanced Institute for Management (AIM) and Imperial College.

Chang, S.H., A.H.I.Lee, and Pearn, W.L. (2005). Analytic Network Process approach for product mix planning in semiconductor fabricator. *International Journal of Production Economics. 96(1),* 15-36. Doi: https://doi.org/10.1016/j.ijpe.2004.02.006

Gazo, R. (2005). A review of competitive strategies of furniture manufacturers. *Forest Product Journal, 55(10),* 66-73.

Gemser, G. and Leenders, M.A.A.M. (2001). How integrating industrial design in the product development process impacts on company performance, *The Journal of Product Innovation Management, 18,* 28-38. Doi: https://doi.org/10.1016/s0737-6782(00)00069-2

Gencer, C., and Gurpinar D. (2007). Analytic network process in supplier selection: A case study in an electronic firm. *Applied Mathematical Modeling, 31,* 2475-2486. Doi: https://doi.org/10.1016/j.apm.2006.10.002

Guimaraes, J., Salomon, V. (2015). *A compatibility study of priorities vectors for reverse logistics indicators: a footwear industry case developed in Brazil.* 23rd International Conference on Multi Criteria Decision Making (MCDM 2015). Hamburg, Germany.

Kao, L., Chiu, C., Lu, C. & Kao, H. (2015). *Applying Analytic Network Process to explore consumer adoption of radical innovation: a case study of smart home technologies*. 23rd International Conference on Multi Criteria Decision Making (MCDM 2015). Hamburg, Germany.

Liu, Y. & Li, J. (2006). *The furniture design and research based on the concept of appeal.* 7th International Conference on Computer-Aided Industrial Design and Conceptual Design. Hangzhou, China.

Merrell, P., Schkufza, E., Li, Z., Agrawala, M. & Koltun, V. (2018). Interactive furniture layout using interior design guidelines. Berkley: Stanford University & University of Retrieved from vis.berkeley.edu/papers/furnitureLayout

Ocampo, L., Vallecera, J., Nunez, D. & Galagar, K. (2018). *Identifying drivers of sustainable manufacturing at firm level using a fuzzy- BOCR0- AHP framework*. International Symposium on the Analytic Hierarchy Process (ISAHP2018). Hong Kong.

Partovi, Y.F. (2006). An analytic model for locating facilities strategically, *Omega*, *34(1),* 41-55. Doi: https://doi.org/10.1016/j.omega.2004.07.018

Ratnasingam J., Ioras F. (2003). The sustainability of the Asian wooden furniture industry, *European Journal of Wood and Wood Products, 61(3),* 233-237. Doi: https://doi.org/10.1007/s00107-003-0382-9

Saaty, T. (2000). *Fundamentals of decision making with Analytic Hierarchy Process*. Pittsburgh, PA: RWS Publications.

Saaty T. (2001a). *Decision making with dependence and feedback: The Analytic Network Process*. Pittsburgh, PA: RWS Publications.

Saaty T. (2001b). *Decision on National Missile Defense Program*, 6th International Symposium on the AHP. Bern, Switzerland.

Saaty, T. (2005). *Theory and applications of the Analytic Network Process*. Pittsburgh, PA: RWS Publications.

Saaty, T.L., Vargas, L.G. (2006). *Decision making with the Analytic Network Process*. New York, New York: Springer Science.

Swann, P. and Birke, D. (2005). *DTI Think Piece*: *How do creativity and design enhance business performance*? *A framework for interpreting the evidence?*, University of Nottingham Business School.

Ulutas, B.H. (2005). Determination of appropriate energy policy for Turkey. *Energy 30(2005),* 1146-1161. Doi: https://doi.org/10.1016/j.energy.2004.08.009

APPENDIX

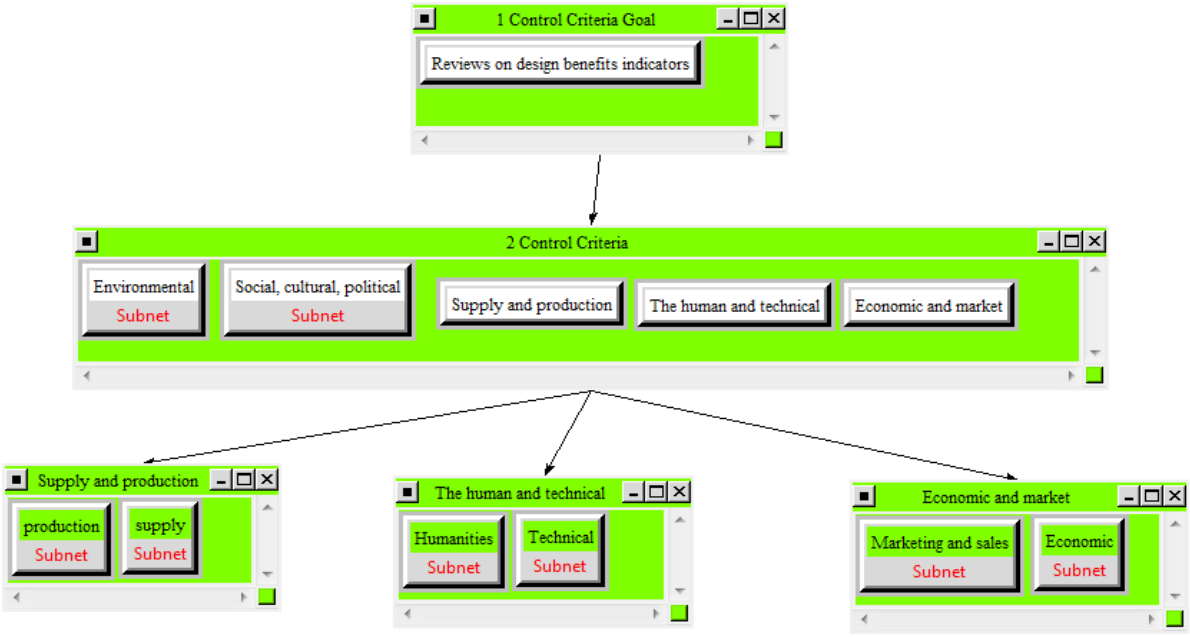

Figure A1 Control criteria network under benefits

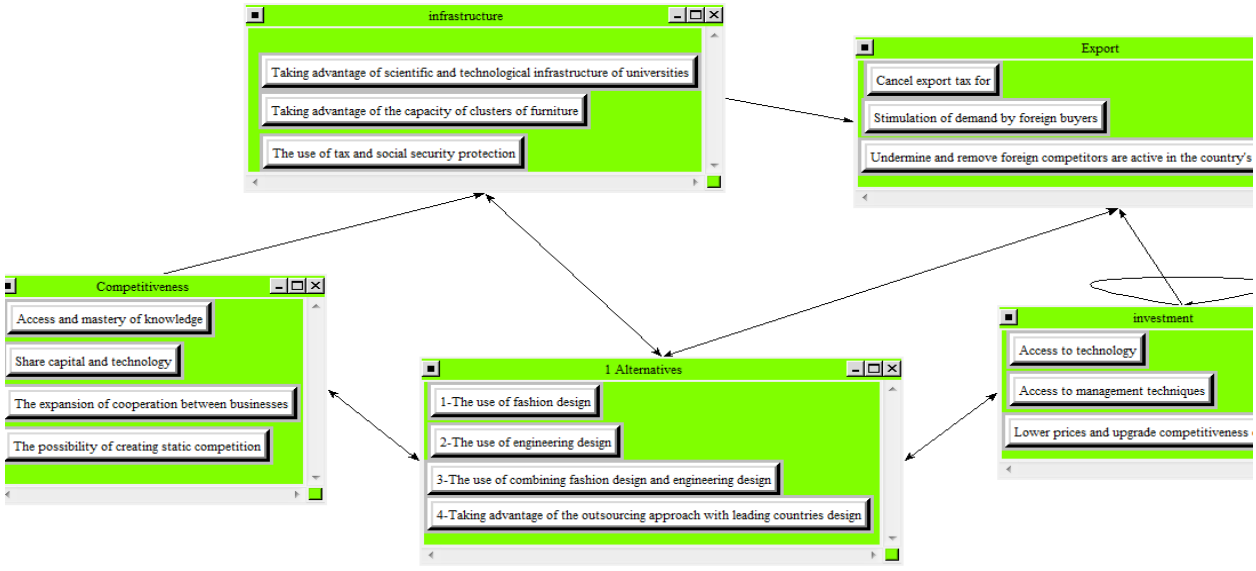

Figure A2 Subnetwork under benefits/ economics

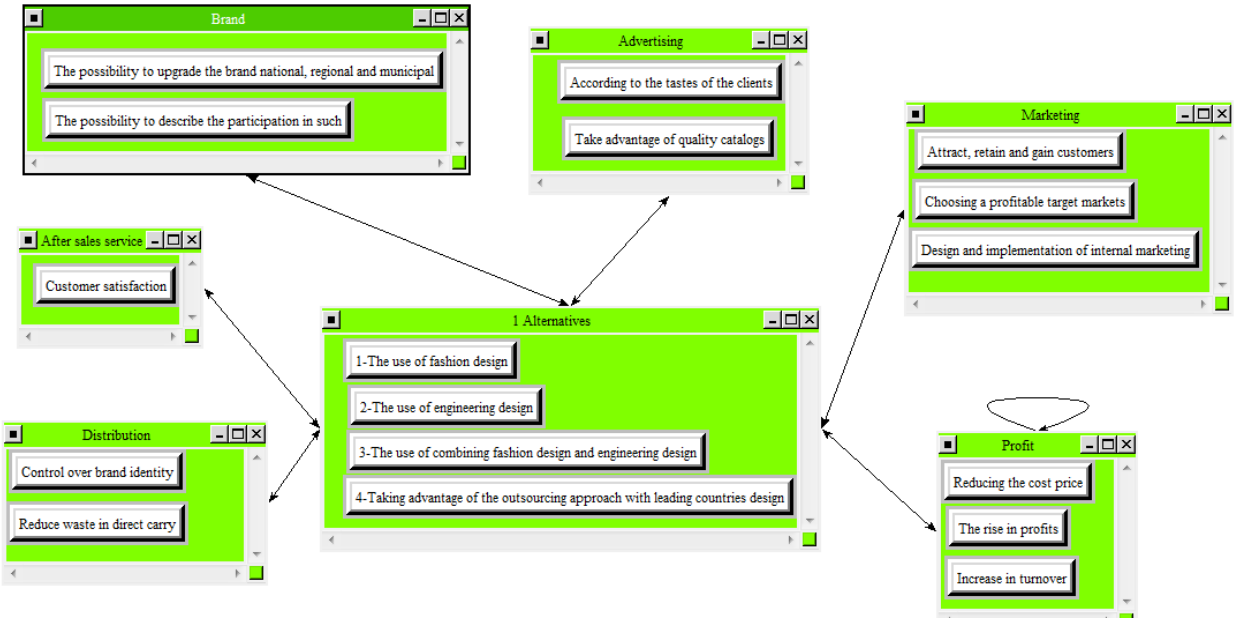

Figure A3 Subnetwork under benefits/marketing

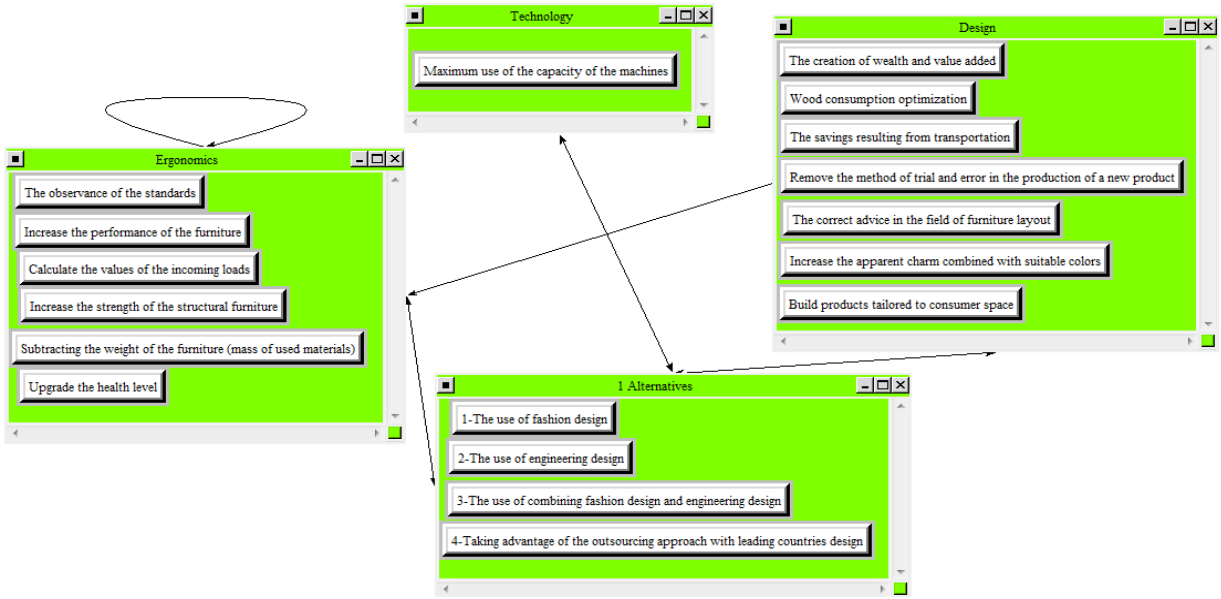

Figure A4 Subnetwork under benefits/technical

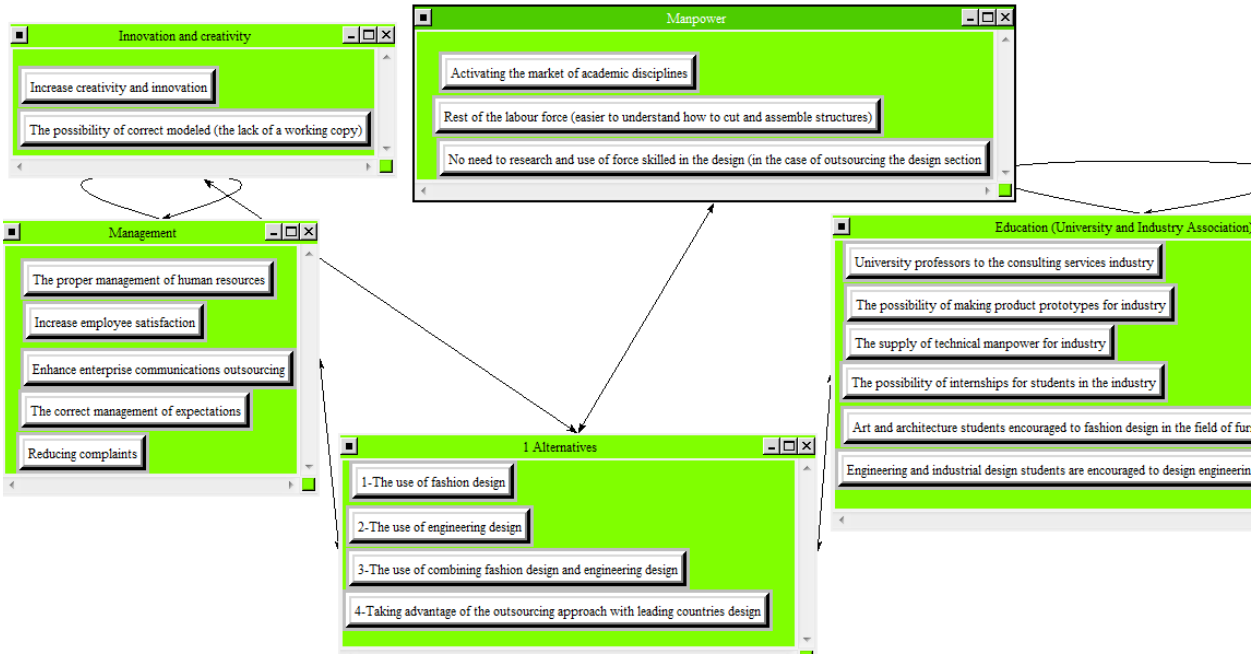

Figure A5 Subnetwork under benefits/workforce

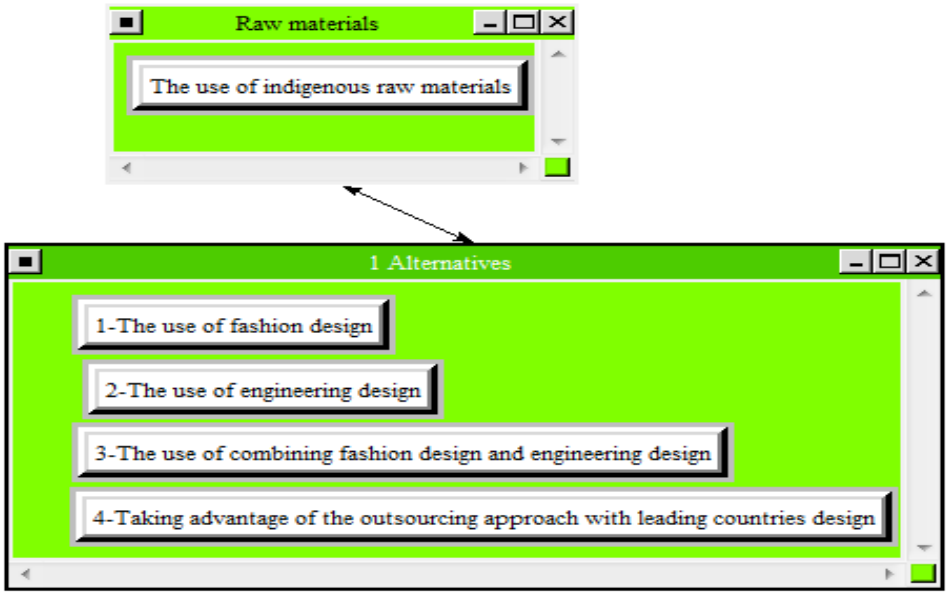

Figure A6 Subnetwork under benefits/supply

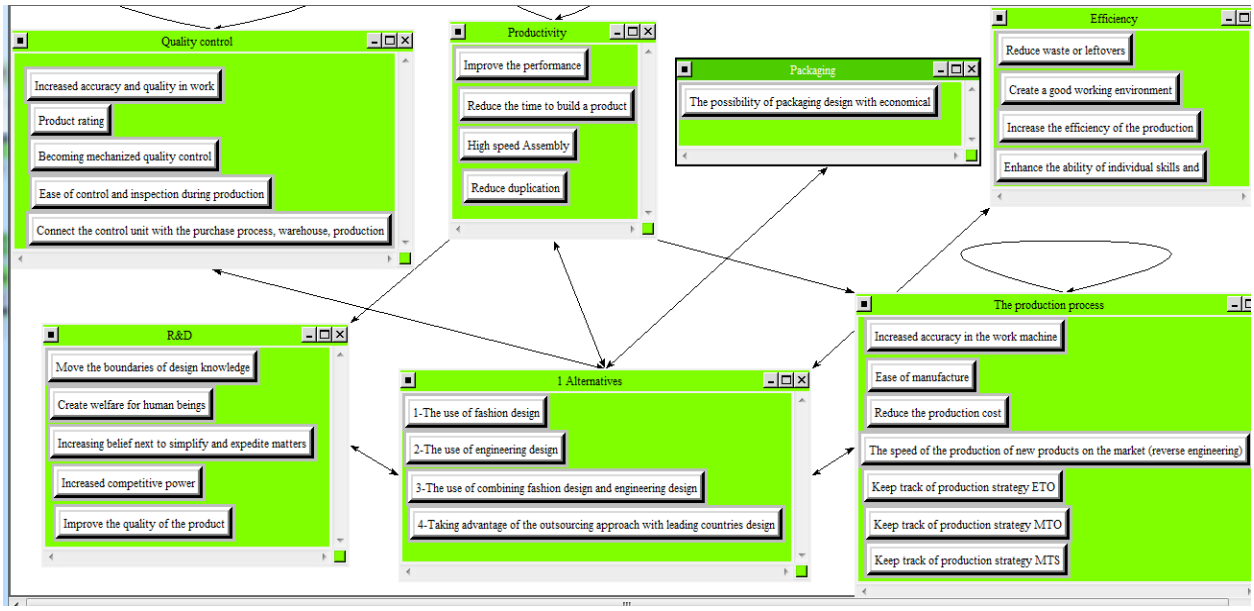

Figure A7 Subnetwork under benefits/production

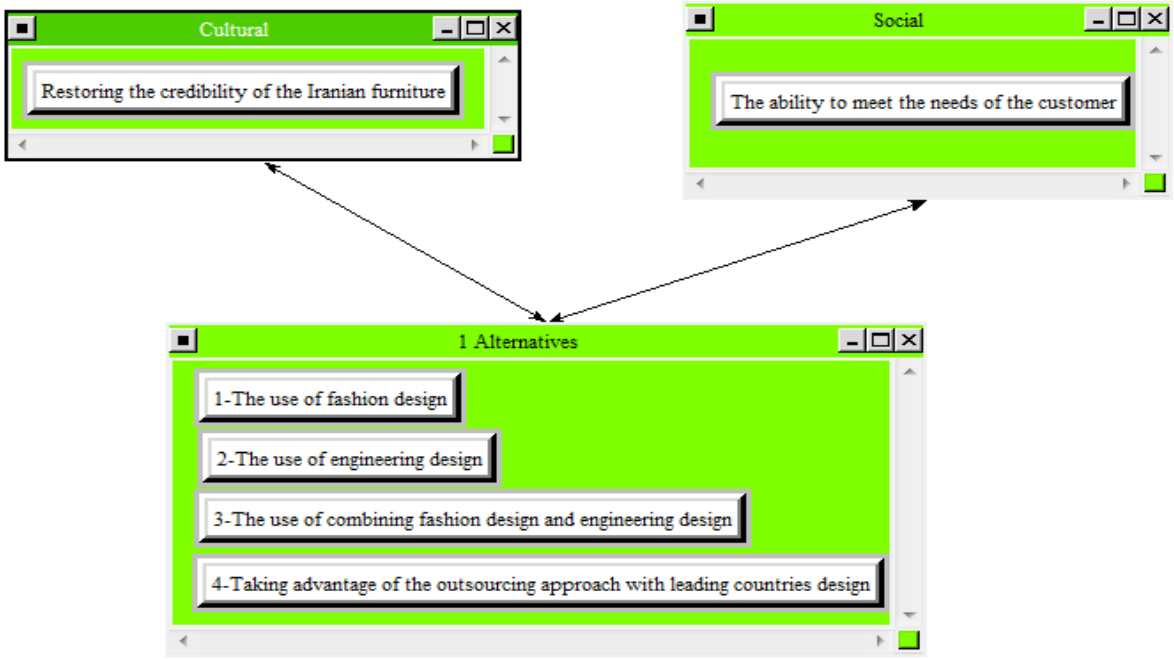

Figure A8 Subnetwork under benefits/social cultural & politic

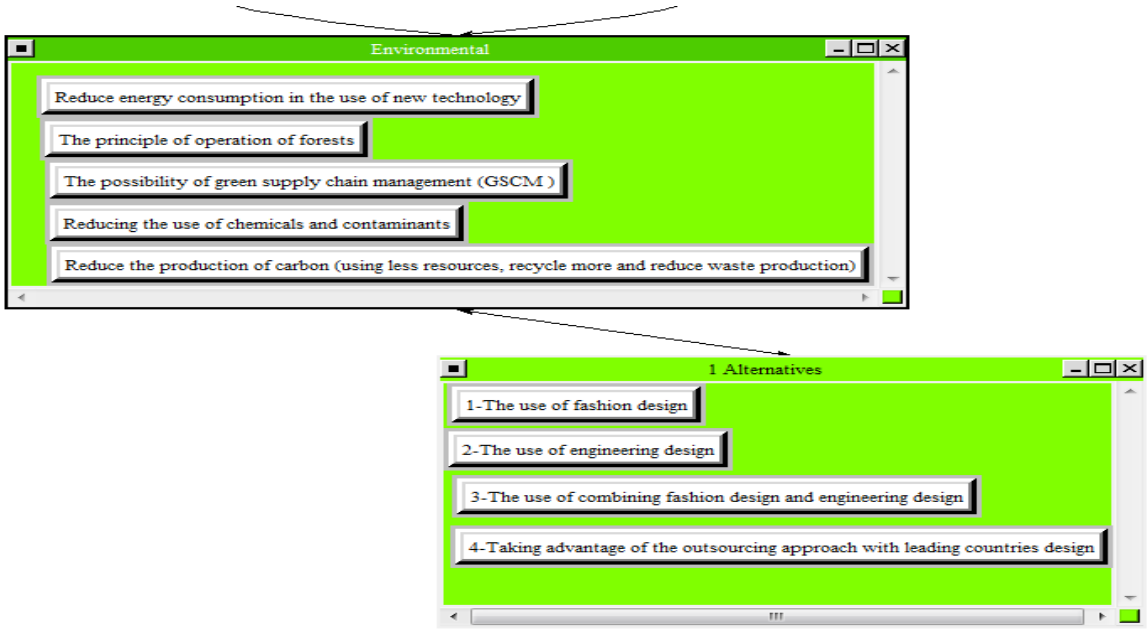

Figure A9 Subnetwork under benefits/environmental

Figure A10 Sample of questionnaire

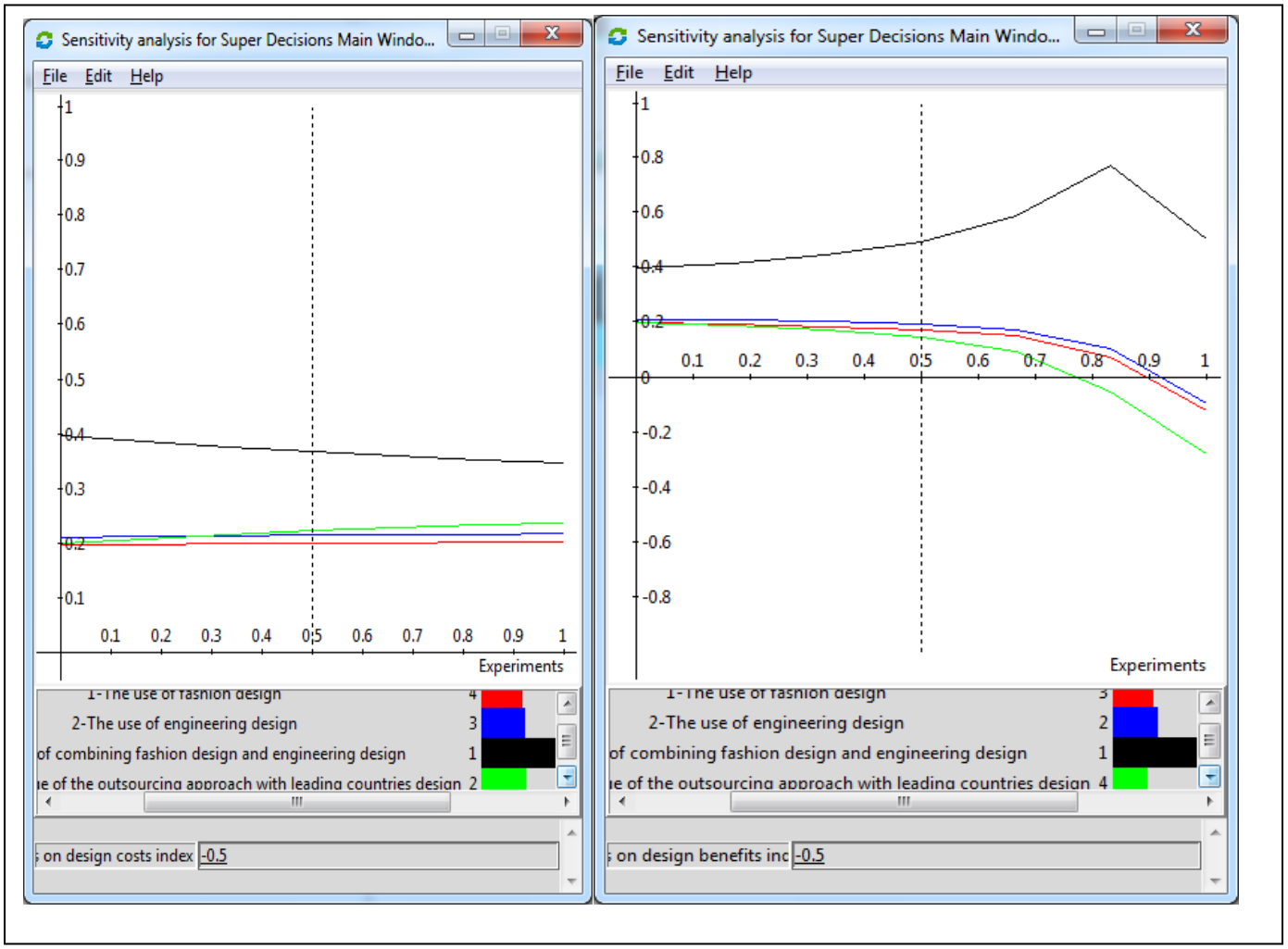

Figure A11 Sensitivity analysis with respect to benefits and costs

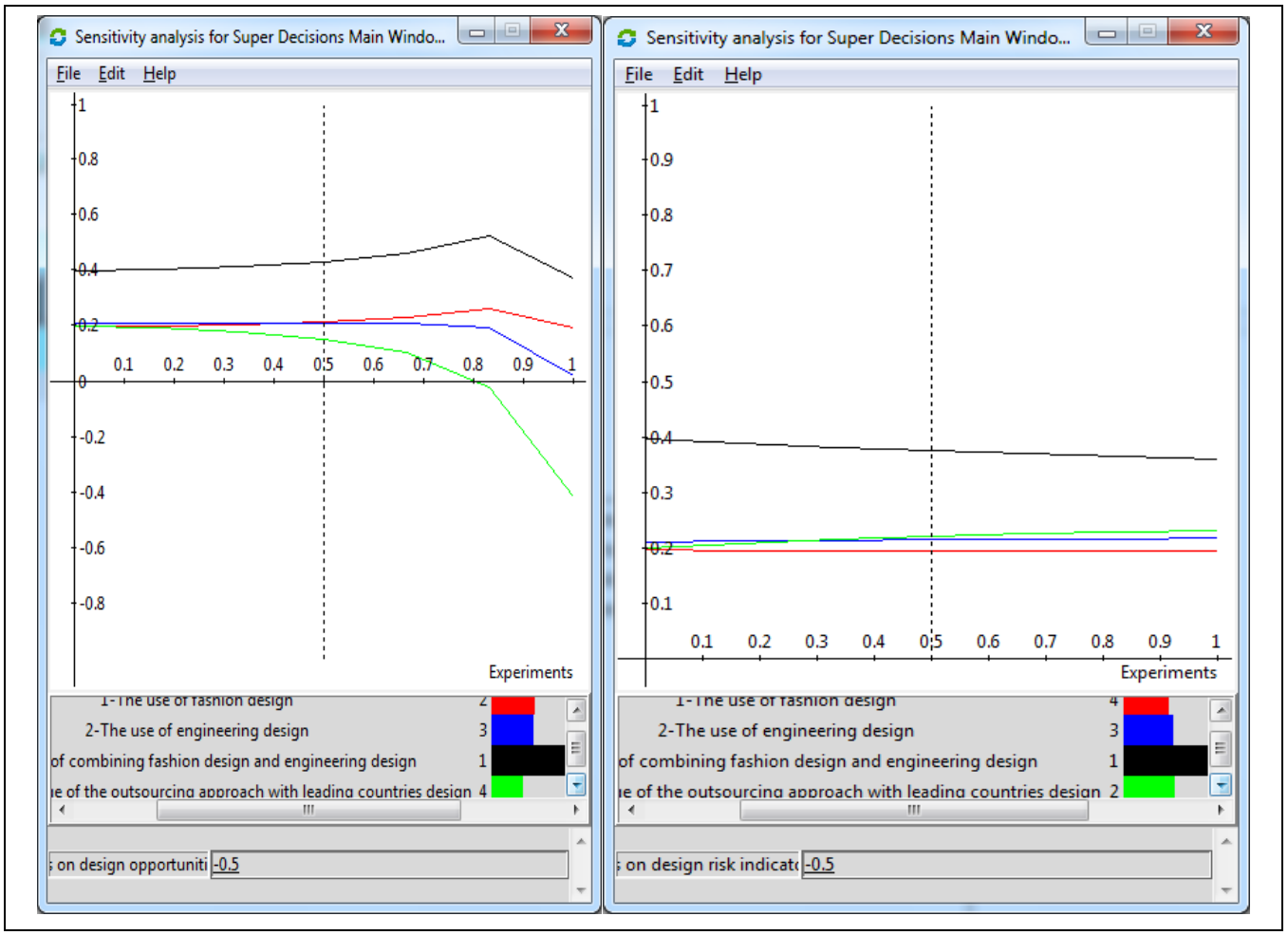

Figure A12 Sensitivity analysis with respect to opportunities and risks