DETERMINING THE AREA SIZES OF EACH PRODUCT CATEGORY IN A DEPARTMENT STORE USING MULTI-CRITERIA DECISION MAKING METHODOLOGIES

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ABSTRACT

In a department store, customers have the opportunity to reach a wide range of consumer goods from different product categories within a single store area. Store layouts generally show the size and location of each department, any permanent structures, fixture locations, and customer traffic patterns. Determining the area sizes to be allocated to each product category and the layout of these areas in the department store is a strategic planning decision problem. The layout problem has been studied in the literature with different approaches where the sizes of the areas are known. The first purpose of this paper is to determine the area sizes of each product category.

Customers decide to go to a department store for several reasons including the quality of products, services, location, etc. These reasons have been studied in the literature. However, "for which product categories do customers decide to go to a department store" is an open question. The second purpose of this paper is to find the frequency of product categories from the viewpoint of the customers. Therefore, our aim is to obtain the required results in a systematic way with multi-criteria decision making methodologies. For this purpose, we perform the Analytic Network Process (ANP) and the Analytic Hierarchy Process (AHP) from the viewpoints of department managers and customers, respectively.

In the ANP model, several tangible and intangible criteria such as product costs, the demands of customers, sales history, overall inventory, floor space and relationship with suppliers are chosen, and the intersections between them are specified. Pairwise comparisons are made by department store managers. The ANP outcome is the weight of each product category, and these weights are considered the percentage of the area size within the store from the viewpoint of the department stores. In the AHP model, a simple model is constructed to define the customers' preference for each product category. Pairwise comparisons between product categories are made by the customers. Therefore, the outcome of the AHP model is the weight of each product category, and this is the preference of each product category from the viewpoint of the customers. The outcomes show that these weights may be different. This is an expected situation since even if a

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product category is preferred by some as the driver to visit a department store, the footprint of that category in the actual store may be small. The outcome from customers provides feedback to department store managers on which product category should be diversified as well as the area sizes of those categories.

Keywords: department store; space allocation; multi-criteria decision making; Analytical Network Process; Analytical Hierarchy Process; product category; layout

1. Introduction

The retail industry is one of the largest and most diversified operations in the world. The structure of this industry connects manufacturers to consumers by providing products and services from the producer to the customer. Retailers are dynamic in nature and need to keep their strategies competitive and profit-oriented. Product assortment, the collection of goods and/or services a retail store offers to customers, is a factor that affects profitability and has a high priority for retailers as they work with a limited budget, store size and shelf space (Kumar et al. 2017).

Department stores are a kind of retail establishment and provide a wide range of product categories to customers. Many studies have been conducted from different perspectives about department stores in the literature. Gardner et al. (2002) and Park (2012) analyzed the Sampoong department store collapse. Location evaluation of department stores in a major metropolis was studied by Doucet (2003). An accounting technique in a department store was investigated by Walsh and Jeacle (2003). Later on, Wargocki et al. (2004) studied the sensory pollution loads of department stores. Miller (2006) discussed strategic human resource management in department stores. Kernsom (2010) and Sahachaisaeree (2012) studied the importance of windows in department stores. A building-energy load model in department stores was investigated by Chung and Park (2012). While Eckert et al. (2015) analyzed location patterns near department stores, Ratanatamskul and Siritiewsri (2015) studied the development of compact anaerobic treatment of department store wastewater. The creation of a compelling brand meaning by orchestration in a department store in Scandinavia was investigated by Hjelmgren (2016), and investigation of indoor air quality of department store buildings was discussed by Cheng et al. (2017).

In addition to the subjects of these studies, layout is a critical factor driving consumer elaboration and response in retailing. As Behera et al. (2017) mentioned, store location and layout are essential variables that influence shopper conduct and are a basic determinant of the overall image of a store. Well composed store layouts are critical because they impact in-store movement designs, shopping environment, shopping conduct, and operational productivity. This problem has often been studied in the literature (Peters et al., 2004; Bostani and Peters, 2005; Yapicioglu and Smith, 2012a, 2012b; Cil, 2012; Ozcan and Esnaf, 2013; Ballester et al., 2014), and the objective is to maximize revenue or adjacency satisfaction and minimize traffic density or traffic distance. The common assumption in these studies is that the area sizes for product categories are known.

Furthermore, multi-criteria decision making techniques are used for retail stores. Akalin et al. (2013) solved the retail store location selection problem for a clothing store using an Analytical Hierarchy Process (AHP) model with the preferences of the retailers. Eroglu (2013) also used AHP to determine the consumer preferences for product attributes for retailer selection.

As seen in the literature, there has not been much attention paid to the determination of the area sizes of product categories. This study contributes to the literature by filling this gap. The managers whose job it is to work through the decision making process of these area sizes consider certain criteria such as customer needs, depot space, suppliers, etc. In other words, managers have alternatives and conflicting criteria. On the other hand, customers decide to go to a department store for one or more of these product categories. Some product categories may be preferred more than others. Namely, customers are making a comparison among the product categories. Multi-criteria decision making techniques use the general theory of measurement to derive relative properties. The Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP) are two multi-criteria decision making techniques. The AHP has a hierarchical structure and the ANP has a network structure to model a decision problem, but both of these methods can include quantitative and qualitative criteria. The decision model for customers is considered a simple model with paired comparison between product categories. The decision model for the managers is a network model where each criterion influences the others. Therefore, in this study, the ANP and the AHP were chosen to construct the outcomes from the viewpoints of department managers and customers, respectively.

First, several tangible and intangible criteria (product costs, demand of customers, sales history, overall inventory, floor space and relationship with suppliers, etc.) were specified by the department store managers. Interactions among these criteria were also presented (e.g. the demands of customers influences sales history). Then, an ANP model was constructed since ANP is a suitable technique to manage inner and outer dependencies between criteria.

In addition to department store managers, the customers' preferences were considered in this study because customers may buy goods from one product category more frequently than goods from any other product category (e.g. outfits may be purchased six times more than cosmetics by a customer). Product categories are determined as the criteria, and then, the AHP is used to evaluate the paired comparisons among the product categories to obtain the order preference of each product category from the customers' perspective.

This paper is organized as follows: the ANP model that was developed to determine the area sizes of each product category from the viewpoint of the department store managers is given in detail in Section 2. Then, the AHP model that was developed to determine the customer preferences of each product category is discussed in Section 3. Finally, the conclusions are given in Section 4.

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2. Multi-criteria decision making model for a department store

In this section, a brief description of the multi-criteria decision making techniques used in this study is given. Also, the model that was developed for product categories in department stores is introduced.

2.1 Methodology

The Analytic Hierarchy Process (AHP) developed by Saaty (1980) is a general theory of measurement to derive relative priorities on absolute scales from paired comparisons within a hierarchic structure (Saaty & Vargas, 2006). Decision makers who use the AHP method structure the problem into a hierarchy with the top level as the overall objective, and the bottom level that includes the action alternatives or the alternatives that would contribute positively or negatively to the main objective through their impact on the criteria in the intermediate levels of the hierarchy (Sagir & Ozturk, 2010). When using the AHP or its generalization on feedback networks, the Analytic Network Process (ANP), to model a problem, one needs a hierarchic or a network structure to represent that problem, as well as pairwise comparisons to establish relationships within the structure. Many decision problems cannot be structured hierarchically because they involve interaction and dependence on higher-level elements. Not only does the importance of the criteria determine the importance of the alternatives, but the alternatives themselves also determine the importance of the criteria (Saaty & Vargas, 2006). The AHP is applicable to individual and group decision settings. In group decision making, the individuals' judgments can be calculated by the geometric mean which is the most common approach used in AHP with group decision making (Lai et al., 2002; Garcia et al., 2006).

The ANP represents a decision making problem as a network of criteria and alternatives grouped in clusters. All of the elements in the network can be related in a possible way, i.e., a network can incorporate feedback and interdependence relationships within and between clusters. This provides a way to more accurately model complex decisions (Sagir & Ozturk, 2010). There are two kinds of influence: outer and inner. In the first, one compares the influence of elements in a cluster on elements in another cluster with respect to a control criterion. In inner influence, one compares the influence of elements in a group to each one in the group. If we think about it carefully, everything may be seen to influence everything including itself according to many criteria. The world is far more interdependent than we know how to deal with using our existing ways of thinking and acting. The ANP is a logical way to deal with dependence.

The fundamental scale of values to represent the intensities of judgments is a 1-9 scale. The scale represents importance as follows: 1 is equal importance, 3 means moderate importance, 5 means strong importance, 7 means very strong importance, 9 means absolute importance, and 2, 4, 6 and 8 are used to express intermediate values. The priorities derived from the pairwise comparison matrices are entered as a part of the columns of a super matrix. The super matrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control criterion. In the ANP, steady-state priorities from a limit super matrix are investigated. To obtain the limit, the matrix is raised to powers. Each power of the matrix captures all of the transitivity of an order that is equal to that power. The limit of these powers, according to Cesaro summability, is equal to the limit of the sum of all of

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the powers of the matrix. All order transitivity is captured by this series of powers of the matrix. The outcome of the ANP is nonlinear and rather complex. The limit may not converge unless the matrix is column-stochastic, that is, each of its columns sums to one. If the sum of the columns is one, then because the principal eigenvalue of a matrix lies between its largest and smallest column sums, it is known that the principal eigenvalue of a stochastic matrix is equal to one (Saaty, 2001).

Let C_h, where $h = 1, \ldots, N$ be a component of a decision network, and it has n_h elements, where $e_{h1}, e_{h2}, \ldots, e_{hn_h}$ is denoted. Thus, the elements for C_1 are $e_{11}, e_{12}, \ldots, e_{1n_1}$, for C_2 are $e_{21}, e_{22}, \ldots, e_{2n_2}$, and finally for C_N are $e_{N1}, e_{N2}, \ldots, e_{Nn_N}$. Given this, the priority vector from the paired comparisons is derived. These comparisons depict the influences of a given set of elements in a component on any element in the system (Sengupta, Gupta & Dutta, 2017). The influence of the elements in the network may be represented in the super matrix, and a typical entry W_{ij} in the super matrix is called a block of the super matrix. Figure 1 shows these matrices (Saaty, 2001; Saaty & Vargas, 2006). Each column of W_{ij} is a principle eigenvector of the influence (importance) of the elements in the ith component of the network on an element in the jth component.

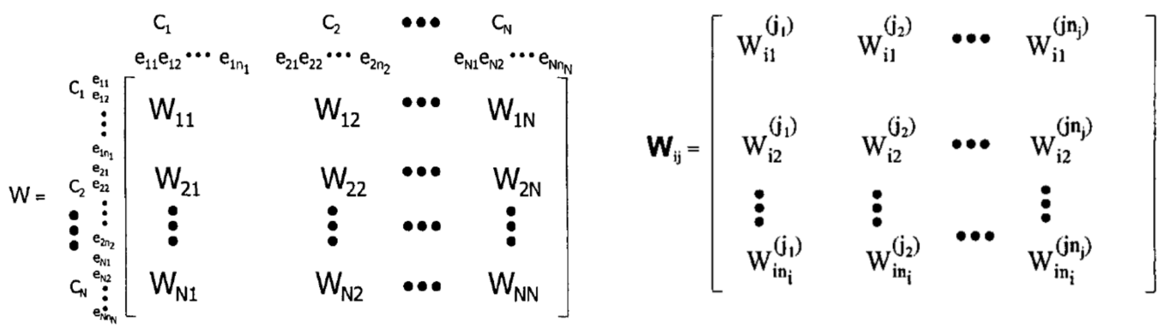

Figure 1 Super matrix of a network and details of a component

Briefly, the ANP has four major steps (Girginer et al., 2007; Meade and Sarkis, 1998; Saaty, 1996):

1. *Model construction and problem structuring*: The problem is modeled as a network.
2. *Pairwise comparison matrices and priority vectors:* Pairwise comparison matrices between criteria and alternatives are conducted by judgments which are made with a 1-9 scale.
3. *Super matrix formation:* An eigenvector for each column block is calculated by the row components with respect to the column components of the pairwise comparison matrix. The blocks in each column of the matrix are weighted, known as the weighted super matrix. The final priorities of all of the elements are determined by normalizing each block of the super matrix (see Fig. 3).
4. *Obtaining weights and selection of best alternatives:* The priority weights of alternatives are computed in the column of alternatives in the normalized super-

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matrix. The alternative with the largest overall priority may be selected as the best option among alternatives or the weights may be used for various purposes.

2.2 ANP model for the department managers

First, the clusters, factors, and alternatives are explained, and the model is given. Then, the outcomes of the ANP model are discussed.

2.2.1 Clusters, factors, and alternatives

Department store managers determine the size of space that will be reserved for each product category in their department stores. Based on this fact, the alternatives and criteria were defined based on the literature and opinions of four department store managers. These managers are responsible for formulating policies and operating procedures for the store, planning and organizing store activities, etc. In order to obtain a wide range of opinions, the selected managers (four) were from different companies or different branches of the same company.

The product categories were determined as the alternatives and five clusters, and ten factors were defined.

1. *Alternatives:* The alternatives are outfits, shoes, bags and accessories, underwear, cosmetics, baby and kid's wear, and sports goods. These were the existing product categories of the department stores that were part of this study.
2. *Budget*: The budget cluster contains the factors cost of product and markups of product (Bahng & Kincade, 2014) and overall inventory (Silver et al., 1998; Bahng & Kincade, 2014). Product costs and markups are the basis for the initial price of stock-keeping units (SKU) and they form a foundation for the calculation of net sales, gross margins, and other profitability measures. Stock is the term used for merchandise that is on the floor, in back rooms and on order (Bahng & Kincade, 2014). Budget was chosen as a cluster since the product categories defined in the alternatives are bought from vendors. Therefore, the cost of the purchasing process is naturally affected by the cost of the products and markups of products. The overall inventory is checked before a decision is made about the quantity to be purchased. The factors in the budget cluster only influence the alternatives.
3. *Product*: The product cluster contains the sales history factor (Bahn & Kincade, 2014). Product and sales history were chosen as a cluster and a factor since sales forecasting is a significant factor involved in making the purchase process efficient. Therefore, sales history is needed for forecasting. Sales history is obtained from the previous sales for each product category, and only influences the alternatives.
4. *Customer*: The customer cluster contains the factors that are the characteristics of target customers and demands of the target customers (Duncan, 1972; Mantrala et al., 2009; Bahng and Kincade, 2014) and the customers' disposable income (Mantrala et al., 2009; Bahng and Kincade, 2014). The characteristics of the target customers (such as age, marriage status, and educational level) influence the sales history and alternatives. For example, the more married couples with children who choose a department store, the higher the amount of baby and kid's wear is sold. The demands of the customers influence the overall inventory, sales

history, and alternatives. The more demand for a product category, the more the inventory will be sold out. If customers' disposable income is high, the area size for the more expensive product categories may be increased in the department store.

5. *Store*: The store cluster has the factors floor space and economic conditions of the store's region (Mantrala et al., 2009, Bahng & Kincade, 2014) and depot space. In pursuance of floor space, the area sizes are determined. If the department store has a large floor space, then a larger area size may be considered for each product category. Floor space influences the alternatives. The economic condition of the store's region also influences floor space, sales history, characteristics of the target customers and alternatives. If the region is home to high-income workers, then the floor space is expected to be bigger, and the amount of products sold larger. Depot space influences the overall inventory and alternatives. The more depot space the department store has, the more inventory is kept.
6. *Suppliers*: The supplier cluster has the factor relationship with suppliers (Duncan, 1972; Wagner et al., 1989; Silva et al., 2002; Kannan & Tan, 2006; Bahng & Kincade, 2014). Relationship with suppliers influences product costs and overall inventory. A good relationship may ensure lower product costs and the ability to purchase fewer products at one purchase, or in other words, less inventory.

The clusters, factors, their related literature and influencing factors that are mentioned above are summarized in Table 1. Also, the ANP model with all of the clusters, factors, alternatives and inner and outer dependencies is shown in Figure 2.

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Table 1
Clusters, factors and related literature of the department store model

Cluster	Factors	Literature	Influences
Budget	Product costs	Bahng and Kincade (2014)	Alternatives
	Markups of product	Bahng and Kincade (2014)	Alternatives
	Overall inventory	Silver et al. (1998) and Bahng and Kincade (2014)	Alternatives
Product	Sales history	Bahng and Kincade (2014)	Alternatives
Customer	Characteristics of target customer	Duncan (1972), Mantrala et al. (2009) and Bahng and Kincade (2014)	Sales history, Alternatives
	Demand of target customer	Duncan (1972), Mantrala et al. (2009) and Bahng and Kincade (2014)	Overall inventory, Sales history, Alternatives
	Customers' disposable income	Mantrala et al. (2009) and Bahng and Kincade (2014)	Sales history, Characteristics of target customers, demand of target customers, Alternatives
Store	Floor space	Mantrala et al. (2009) and Bahng and Kincade (2014)	Alternatives
	Economic condition of the store's region	Mantrala et al. (2009) and Bahng and Kincade (2014)	Floor space, Sales history, Characteristics of target customers, Alternatives
	Depot space	-	Overall inventory and Alternatives
Suppliers	Relationship with suppliers	Silva et al. (2002), Duncan (1972), Kannan and Tan (2006), Wagner et al. (1989) and Bahng and Kincade (2014)	Product costs, Overall inventory

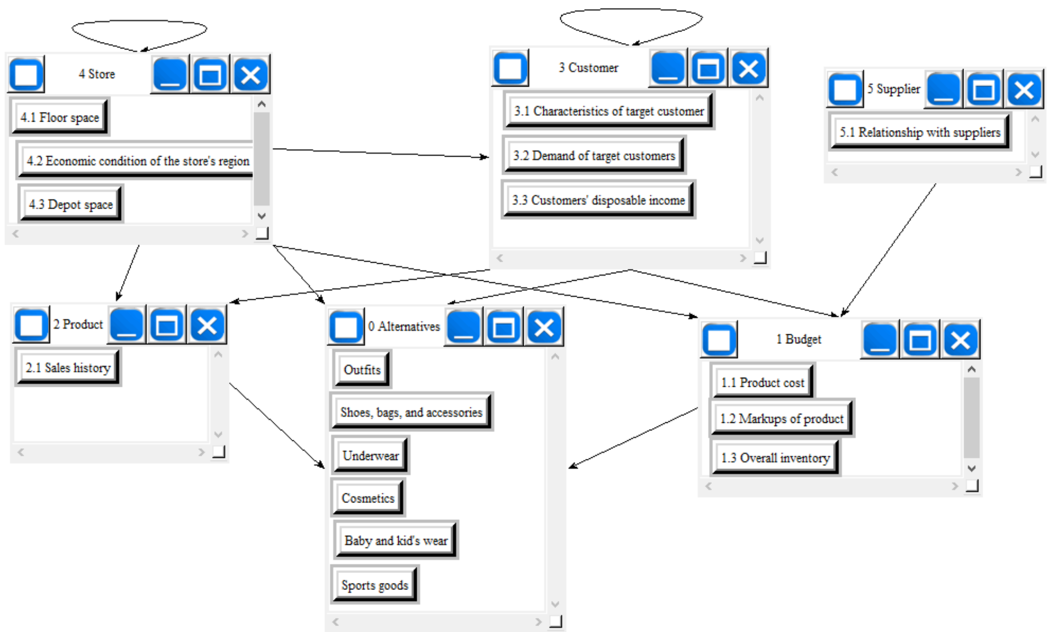

Figure 2 ANP model for the product category of the department store

The relationships of the ANP model are as follows: the budget cluster influences the alternatives cluster. The customer cluster influences the product since all of the factors (characteristic of target customers, demand of target customers, customers' disposable income) affect sales history. Additionally, it influences the budget cluster since the demands of the customers affects the overall inventory. It also influences the alternatives cluster and itself. The product cluster influences the alternative clusters. The store cluster influences the budget since the depot space affects the overall inventory. Also, it influences the customer cluster since the economic conditions of the store's region affects the characteristics of the target customers. Further, it influences the product cluster since the economic condition of the store's region affects the sales history. It also influences the alternatives cluster and itself. The supplier cluster influences the budget cluster since the relationship with suppliers affects the overall inventory and product cost. The relationships are shown in the relation matrix (Fig. 3) where rows and columns represent the factors of the ANP model. "+" means that i^{th} row factor influences the j^{th} column factor. The numbers are taken from Table 1 and the alternatives are shown as 0 (zero).

Factors	1.1	1.2	1.3	2.1	3.1	3.2	3.3	4.1	4.2	4.3	5.1	0
1.1	−	−	−	−	−	−	−	−	−	−	−	+
1.2	−	−	−	−	−	−	−	−	−	−	−	+
1.3	−	−	−	−	−	−	−	−	−	−	−	+
2.1	−	−	−	−	−	−	−	−	−	−	−	+
3.1	−	−	−	+	−	+	+	−	−	−	−	+
3.2	−	−	+	+	+	−	+	−	−	−	−	+
3.3	−	−	−	+	+	+	−	−	−	−	−	+
4.1	−	−	−	−	−	−	−	−	+	+	−	+
4.2	−	−	−	+	+	−	−	+	−	+	−	+
4.3	−	−	+	−	−	−	−	+	+	−	−	+
5.1	+	−	+	−	−	−	−	−	−	−	−	−

1.1 Product costs, 1.2 Markups of product, 1.3 Overall inventory, 2.1 Sales history, 3.1 Characteristics of target customers, 3.2 Demand of target customers, 3.3 Customers' disposable income, 4.1 Floor space, 4.2 Economic condition of the store's region, 4.3 Depot space, 5.1 Relationship with suppliers. 0. Alternatives

Figure 3 Relation matrix of the ANP model

Four department store managers in Turkey performed the paired comparisons among the factors, clusters and the percentage of space given to the product categories (alternatives). A question similar to "With respect to markups of a product, how much space do you give to baby and kid's wear rather than cosmetics?" was asked for each factor during a face-to-face interview. Also, a question similar to "With respect to customers, how much more important are alternatives than budget?" was asked for the related clusters. These judgments are made based on a 1-9 scale that was discussed in Section 2.1, and the geometric mean is calculated.

2.2.2 Outcome of the ANP model

Figure 4 shows a screen view for the paired comparison of factors and priorities that were produced from the judgment and inconsistency of the judgment matrix. Baby and kid's wear should have 38% of the total store area with respect to the markups of product. Likewise, the inconsistency of the matrix is 0.08304. Figure 5 shows a screen view for the paired comparison of clusters and priorities that was produced from the judgment and inconsistency of the judgment matrix. The customer cluster is the most important cluster with a value of 0.54 with respect to customer. This comparison is consistent with a 0.08687 inconsistency ratio.

After each comparison related to each factor was made, the priorities for alternatives and factors were obtained and are shown in Table 2. The product category, which has the biggest percentage of space in the department store, may be different for each factor. "Outfits" should have the biggest percentage of space with respect to eight of the ten factors, while "baby and kid's wear" has the biggest percentage of space with respect to markups of products, and "outfits" and "sports goods" have the biggest percentage of space with respect to customers' disposable income.

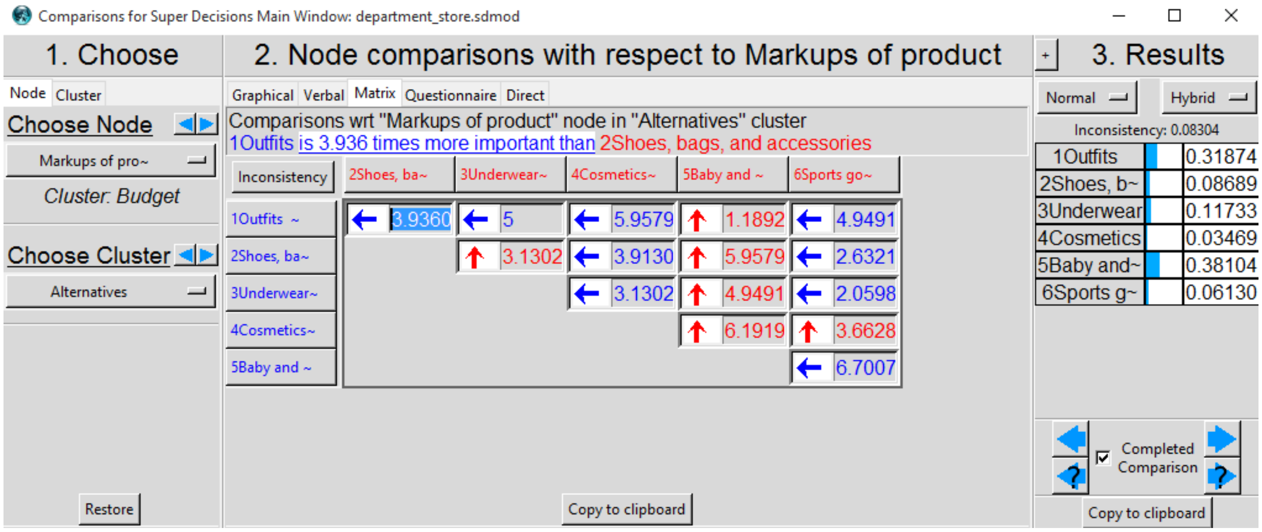

Figure 4 Screen view of paired comparison of factors and priorities produced from the judgment and inconsistency of the judgment matrix

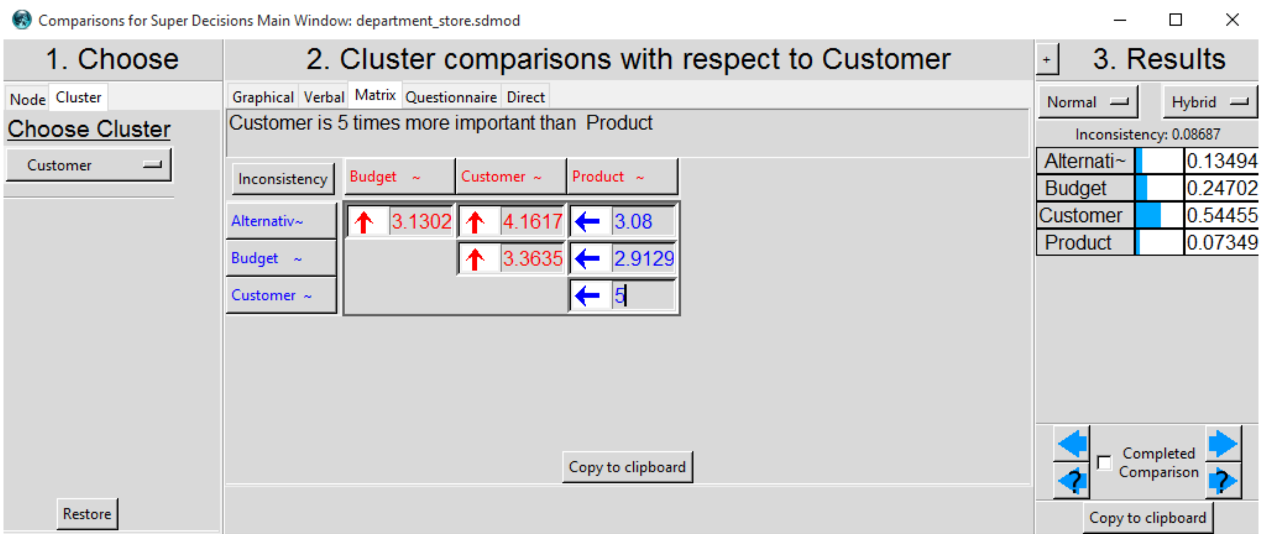

Figure 5 Screen view of the paired comparison of clusters and priorities produced from the judgment and inconsistency of the judgment matrix

Table 2
Priority of alternatives and/or factors related to each factor

Clusters	1.Budget			2.Product	3.Customer			4.Store			5.Suppliers
Alternatives/ Factors	1.1	1.2	1.3	2.1	3.1	3.2	3.3	4.1	4.2	4.3	5.1
Outfits	*0.39*	0.31	*0.34*	*0.40*	*0.37*	*0.44*	*0.22*	*0.60*	*0.39*	*0.44*	-
Shoes, bags and accessories	0.07	0.09	0.09	0.10	0.10	0.11	0.20	0.09	0.11	0.14	-
Underwear	0.09	0.12	0.05	0.03	0.03	0.02	0.06	0.02	0.06	0.04	-
Cosmetics	0.04	0.03	0.03	0.05	0.04	0.08	0.11	0.05	0.05	0.03	-
Baby and kid’s wear	0.31	*0.38*	0.12	0.09	0.07	0.05	0.20	0.06	0.08	0.10	-
Sport goods	0.09	0.06	0.36	0.32	0.38	0.31	*0.21*	0.18	0.31	0.26	-
Characteristic of target customers	-	-	-	-	-		0.25	-	-	-	-
Demand of target customers	-	-	-	-	-		0.75	-	-	-	-
Overall inventory	-	-	-	-	-		-	-	-	-	0.25
Product costs	-	-	-	-	-		-	-	-	-	0.75

1.1 Product costs, 1.2 Markups of product, 1.3 Overall inventory, 2.1 Sales history, 3.1 Characteristics of target customers, 3.2 Demand of target customers, 3.3 Customers’ disposable income, 4.1 Floor space, 4.2 Economic condition of the store’s region, 4.3 Depot space, 5.1 Relationship with suppliers.

After each judgment related to customer and store clusters was determined, the priorities for the clusters were obtained and are shown in Table 3. The “customer” cluster has the largest priority with respect to both the customer and store clusters.

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Table 3
Priority of clusters related to clusters

Cluster	Inconsistency		Priority
Customer	0.087	Alternative	0.13
		Budget	0.25
		Customer	0.54
		Product	0.08
Store	0.067	Alternatives	0.14
		Budget	0.18
		Customer	0.35
		Product	0.10
		Store	0.23

From all of the judgments that were given during the ANP comparisons, the weights of the factors were obtained as normalized by cluster and limiting, which are shown in Table 4. Furthermore, the unweighted, weighted and limit matrices are given in the Appendix. The most important factor is the overall inventory using the limiting weights. Then, the factors were put in order as product costs, characteristic of target customer, sales history, demand of target customers and floor space. If all of the clusters are evaluated on their own, the overall inventory is more important than product costs for budget, and characteristics of the target customer is more important than the demands of the target customer.

Table 4
Weight of factors

Cluster	Factors	Normalized by cluster	Limiting
Budget	Product costs	0.38	0.075
	Markups of Product	0	0
	Overall inventory	0.62	0.123
Product	Sales history	1	0.049
Customer	Characteristics of target customer	0.55	0.059
	Demand of target customer	0.45	0.048
	Customers' disposable income	0	0
Store	Floor space	1	0.028
	Economic condition of the store's region	0	0
	Depot Space	0	0
Suppliers	Relationship with suppliers	0	0

The outcome of the ANP for the alternatives is shown in Table 5. In the view of the department store managers, "outfits" has the largest percentage space among the product categories with 37% of total store space. "Baby and kid's wear" and "sports goods" follow outfits with 22% and 21%, respectively. Thereafter, "shoes, bags and accessories", "underwear" and "cosmetics" come after "baby and kid's wear" and "sports goods" with 10%, 7% and 4%, respectively. Therefore, the obtained order of importance is "outfits", "baby and kid's wear", "sports goods", "shoes, bags and accessories", "underwear" and "cosmetics".

Table 5
Outcome of the ANP model

Alternatives	Normalized by cluster	Limiting
Outfits	0.37	0.228
Shoes, bags and accessories	0.10	0.059
Underwear	0.07	0.045
Cosmetics	0.04	0.025
Baby and kid's wear	0.22	0.133
Sports goods	0.21	0.127

2.2.3 AHP model for customers

Flemming (1989) stated that in strategic planning, team planning should be given the highest importance. The plan enables the organization to gain a broad understanding and commitment to the strategic plan by including those who are affected. In this study, those who are affected are the customers. The customers decide to go to a department store for some specific product categories. Here, a simple AHP model is developed to determine how often the product categories are preferred in a department store by the customers. In this part of the study, we did not develop an ANP model as in the previous section since only the product categories are evaluated to determine the customers' preferred percentages.

The criteria determined for the model are the product categories, and there are no alternatives here. With this model, the aim is to prioritize each product category. In Figure 6, the proposed AHP model is shown.

The customers were asked to scale the product categories with each other to obtain the percentage of preference for each product category (criteria) in Turkey. A question similar to "How often do you go to a department store for baby and kid's wear rather than cosmetics?" was asked. The judgment was made with a 1-9 scale.

To determine the number of experts in a group, Saaty and Sagir Ozdemir (2014) indicated that "the most important aspect is the point at which the weighted sum of errors is least". This point is reached somewhere between six and eight experts, and the nearest whole number is seven. Therefore, seven customers who came into the store during a one hour timeframe on a weekday were randomly selected. The geometric mean was calculated for each of the paired comparisons. The screen view on the paired comparison of the criteria and priorities produced from the judgment and inconsistency of the judgment matrix is shown in Figure 7. The comparison was consistent with a 0.09778 inconsistency ratio.

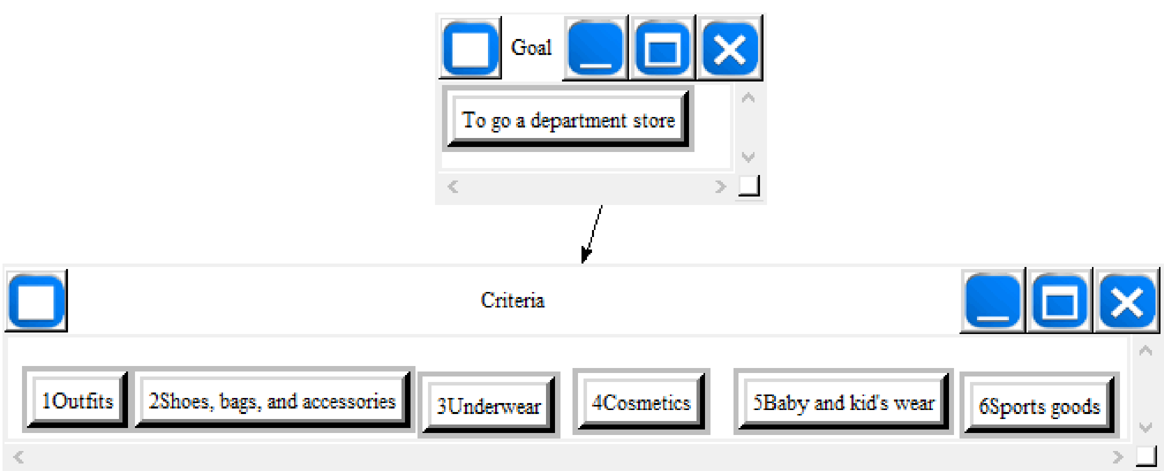

Figure 6 AHP model

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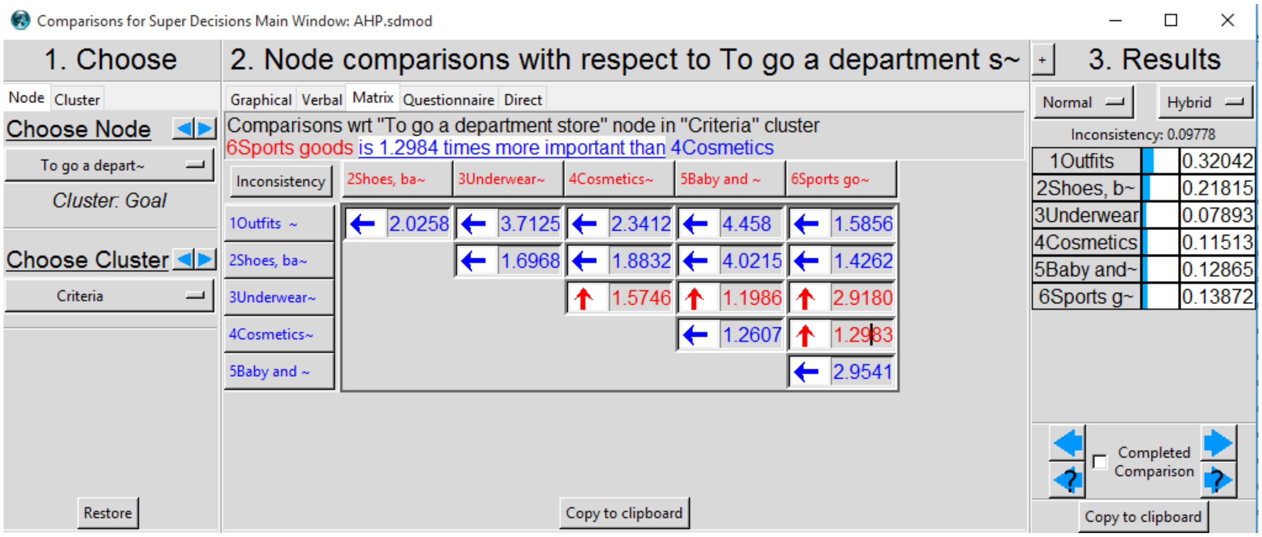

Figure 7 Screen view of the paired comparison of criteria and priorities produced from the judgment and inconsistency of the judgment matrix

Table 6
Outcomes of AHP model and ANP models

Alternatives	**Weights from AHP**	**Weights from ANP**
Outfits	0.32	0.37
Shoes, bags, and accessories	0.22	0.10
Underwear	0.07	0.07
Cosmetics	0.12	0.04
Baby and kid’s wear	0.13	0.22
Sports goods	0.14	0.21

The outcomes of the AHP model are summarized in Table 6, and the outcomes of the ANP model are also included to compare the results of both of the models. In both models, “outfits” was the most preferred product group, while the ranking of the other product groups differed. According to the customers, “outfits” had the biggest preference with 32%, and “shoes, bags, and accessories” followed with 22% among the product categories. Next, “sports goods”, “baby and kid’s wear”, and “cosmetics” followed with 14%, 13% and 12%, respectively. Finally, “underwear” had a priority of 7%. Therefore, the order of priority according to the department store managers is “outfits”, “shoes, bags and accessories”, “sports goods”, “baby and kid’s wear”, “cosmetics”, and “underwear” while the order according to the customers is “outfits”, “baby and kid’s wear”, “sports goods”, “shoes, bags and accessories”, “underwear” and “cosmetics”.

3. Conclusions and further suggestions

In this study, we discussed decision problems related to department stores which offer a wide range of customer goods in different product categories. Determination of the area sizes of the product categories is a decision problem from the viewpoint of the department store managers. The improvement of the organization and management of the stores is crucial for them. We chose the ANP, which represents a decision making problem as a network of criteria and alternatives, grouped in clusters. All of the elements in the network can be related. First, the product categories were defined as "outfits", "shoes, bags, and accessories", "underwear", "cosmetics", "baby and kid's wear" and "sports goods". These were the existing product categories of the department stores that were in the study. Then, we performed a literature review to determine the criteria that may affect the decision about area sizes and discussed them with the department store managers. Budget, product, customer, store, and suppliers were defined as the clusters in the decision problem. We also specified the factors within each cluster and defined the intersections. Next, pairwise comparisons were made with the department store managers during face-to-face interviews. The area sizes of the product categories were obtained and ranked as "outfits", "baby and kid's wear", "sports goods", "shoes, bags and accessories", "underwear" and "cosmetics" with 37%, 22%, 21%, 10%, 7% and 4% of the total store space, respectively. We also determined the preferences for the product categories of the department store customers. We constructed a simple AHP model, and the customers made pairwise comparisons. The preference of product categories were obtained and ranked as "outfits", "shoes, bags and accessories", "sports goods", "baby and kid's wear", "cosmetics", and "underwear" which had 32%, 22%, 14%, 13%, 12% and 7% preference to go to a department store, respectively.

The department store managers ranked "outfits" as the highest area size, and the customers ranked "outfits" as their first preference for going to a department store. This was an expected result since "outfits" contains sub-categories such as tops, dresses, jeans, jackets, suits, etc. Consequently, the customers had more needs in the "outfits" product category. The department store managers' ranked "cosmetics" as the least area size, while customers ranked this as fifth in preference. This result was compatible because cosmetic products are smaller than other products. Therefore, a wide variety of cosmetics products can be placed in one area. The department store managers ranked "baby and kid's wear" as the second largest area size, while customers ranked this category fourth. This area size was acceptable since the "baby and kid's wear" product category has a variety of product sizes that change from month to month for babies and from age to age for kids. If the customers ranked this fourth, the area size seems appropriate.

The analysis helps retailers increase their income per square foot and appropriately evaluate the good qualities and shortcomings in their retail strategy. Note that, as the selected customers may vary, so may the outcomes of the AHP. In this paper, the customers were randomly chosen, and it was shown that the preferences for both store management and the customers can be achieved by the AHP multi-criteria decision making methodology. Store managers may choose the customers who shop the most to use the AHP model.

In future research, AHP and ANP models with fuzzy set theory could be constructed, and the outcomes from crisp numbers and fuzzy numbers could be compared and discussed. The differences and/or similarities will be demonstrated.

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APPENDIX

Unweighted matrix of the ANP model

Super Decisions Main Window: department_store.sdmod: Unweighted Super Matrix

	1Outfits	2Shoes,~	3Underw~	4Cosmet~	5Baby a~	6Sports~	Markups~	Overall~	Product~
1Outfits	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.31875	0.34698	0.39271
2Shoes,~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.08689	0.08934	0.06806
3Underw~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.11733	0.05173	0.09449
4Cosmet~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03469	0.03338	0.04006
5Baby a~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.38105	0.11575	0.31155
6Sports~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06130	0.36282	0.09313
Markups~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Overall~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Product~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Charact~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Custome~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Demand ~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Sales h~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Depot s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Economi~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Floor s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Relatio~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Super Decisions Main Window: department_store.sdmod: Unweighted Super Ma...

Charact~	Custome~	Demand ~	Sales h~	Depot s~	Economi~	Floor s~	Relatio~
0.37300	0.21760	0.43584	0.40497	0.43832	0.39426	0.59901	0.00000
0.09863	0.19821	0.10399	0.09692	0.13699	0.11290	0.08654	0.00000
0.03170	0.06435	0.02259	0.03186	0.04176	0.05774	0.02440	0.00000
0.04170	0.10504	0.07981	0.04920	0.02664	0.04717	0.05024	0.00000
0.07376	0.20161	0.05079	0.09241	0.09727	0.08075	0.05822	0.00000
0.38120	0.21318	0.30698	0.32464	0.25901	0.30718	0.18158	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	1.00000	0.00000	1.00000	0.00000	0.00000	0.25000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.75000
0.00000	0.25000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.75000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.00000	1.00000	1.00000	0.00000	0.00000	1.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Weighted matrix of the ANP model

Super Decisions Main Window: department_store.sdmod: Weighted Super Matrix

	1Outfits	2Shoes,~	3Underw~	4Cosmet~	5Baby a~	6Sports~	Markups~	Overall~	Product~
1Outfits	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.31875	0.34698	0.39271
2Shoes,~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.08689	0.08934	0.06806
3Underw~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.11733	0.05173	0.09449
4Cosmet~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03469	0.03338	0.04006
5Baby a~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.38105	0.11575	0.31155
6Sports~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06130	0.36282	0.09313
Markups~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Overall~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Product~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Charact~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Custome~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Demand ~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Sales h~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Depot s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Economi~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Floor s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Relatio~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Super Decisions Main Window: department_store.sdmod: Weighted Super Matrix

Product~	Charact~	Custome~	Demand ~	Sales h~	Depot s~	Economi~	Floor s~	Relatio~
0.39271	0.24148	0.03900	0.12913	0.40497	0.19399	0.06886	0.59901	0.00000
0.06806	0.06385	0.03552	0.03081	0.09692	0.06063	0.01972	0.08654	0.00000
0.09449	0.02052	0.01153	0.00669	0.03186	0.01848	0.01008	0.02440	0.00000
0.04006	0.02700	0.01882	0.02364	0.04920	0.01179	0.00824	0.05024	0.00000
0.31155	0.04775	0.03613	0.01505	0.09241	0.04305	0.01410	0.05822	0.00000
0.09313	0.24679	0.03820	0.09095	0.32464	0.11463	0.05365	0.18158	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.54237	0.00000	0.55743	0.00000	0.00000	0.25000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.75000
0.00000	0.00000	0.18080	0.00000	0.00000	0.00000	0.42764	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.54239	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.35259	0.09760	0.16136	0.00000	0.00000	0.11824	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.27948	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Limiting the matrix of the ANP model

Super Decisions Main Window: department_store.sdmod: Limit Matrix

	1Outfits	2Shoes,~	3Underw~	4Cosmet~	5Baby a~	6Sports~	Markups~	Overall~	Product~
1Outfits	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.31875	0.34698	0.39271
2Shoes,~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.08689	0.08934	0.06806
3Underw~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.11733	0.05173	0.09449
4Cosmet~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03469	0.03338	0.04006
5Baby a~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.38105	0.11575	0.31155
6Sports~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06130	0.36282	0.09313
Markups~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Overall~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Product~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Charact~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Custome~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Demand ~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Sales h~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Depot s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Economi~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Floor s~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Relatio~	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Super Decisions Main Window: department_store.sdmod: Limit Matrix

Charact~	Custome~	Demand ~	Sales h~	Depot s~	Economi~	Floor s~	Relatio~
0.28410	0.15689	0.22461	0.40497	0.24875	0.22695	0.59901	0.19064
0.07247	0.05038	0.05570	0.09692	0.07090	0.04923	0.08654	0.03669
0.02348	0.01854	0.02341	0.03186	0.03038	0.01733	0.02440	0.04190
0.03279	0.02586	0.02916	0.04920	0.01952	0.02381	0.05024	0.01919
0.05940	0.04853	0.05443	0.09241	0.06907	0.03829	0.05822	0.13130
0.26709	0.14106	0.19963	0.32464	0.20346	0.15043	0.18158	0.08028
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.12981	0.31834	0.00000	0.35792	0.00000	0.00000	0.12500
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.37500
0.00000	0.07978	0.00000	0.00000	0.00000	0.21640	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.23934	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.26068	0.10982	0.09471	0.00000	0.00000	0.13613	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.14143	0.00000	0.00000
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000