# Application of cost/benefit analysis for surgical gown and drape selection: A case study

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***Background:*** The selection of medical textiles is an important subject for the health care sector in terms of benefits and costs. The basic cost calculation does not always yield to proper results in product selection; it would even mislead. It is usually a complicated task to give a decision whether to use reusable or single-use products, especially when the patient and surgeons lives are in consideration. The objective of the present paper is to carry out a cost/benefit study to help hospital managers and surgical team in comparing reusable and single-use surgical gowns and drapes.
***Methods:*** A detailed case study was carried out to determine the net benefits and costs associated with reusable and single-use surgical gown and drape use in the University of Gaziantep Hospital. The Analytic hierarchy process (AHP) is used to evaluate qualitative benefit data. The relevant data were determined through the literature research and interviews with the doctors, administrators, and personnel of related departments (such as infection control, cleaning, and others) in the hospital. The benefit/cost ratios of the alternatives have been examined, and a sensitivity analysis has been carried out to measure the impact of changes in costs and benefits.
***Conclusion:*** After the study, it is concluded that, even though cost is relatively higher, single-use gown and drape sets provide the highest benefit rates. Reduction of prices of single-use sets will make them more competitive and attractive in the health care sector.


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Medical textiles are textile products and constructions used for first aid, clinical or hygienic purposes, or for medical and biologic uses.[1] The key priority for surgeons and hospital authorities is for garments and drapes that provide the highest levels of liquid and microbial penetration protection to both patients and operating theater staff. In addition, surgical gowns and drapes consume a considerable amount of expense in hospitals. Surgical gowns are used to prevent direct contact transfer of potentially infective agents from the surgical team to the operating wound and vice versa. Operating gowns prevent dispersal of skin scales if they are made of a suitable material and used in combination with ultra clean air systems. Patient drapes are used to provide a microbiologically clean working area around the wound. If they enclose the wound tightly and are fixed to the skin, they also prevent transfer of the patient's own skin flora into the wound.[2] Surgical gowns and drapes are fabricated from either reusable or single-use materials. These 2 basic types of products each have their own advantages and disadvantages. In addition, within each of these 2 broad categories, there is a considerable variation in design and performance characteristics that reflects the necessary tradeoffs in economy, comfort, and degree of protection required for particular surgical procedures.[2] Therefore, it is important to compare the benefits and costs of different surgical gowns and drapes alternatives to reach an effective decision. Cost/benefit analysis is mainly studied in the areas in which the benefits of the subjects are qualitative such as environment, education, health care, government policies, and others. There is a considerable amount of cost/benefit applications in the medical literature. Some of them are summarized here. Kovacs et al[3] made a comparison of medical or surgical treatment of ovary syndrome by using a conventional cost/benefit analysis. They compared the cost of laparoscopic ovarian cautery with a typical cycle of gonadotropin ovulation induction. Wang et al[4] performed a cost/benefit study to analyze the financial effects of electronic medical record systems in ambulatory primary care settings from the perspective of the health care organization. Udvarhelyi et al[5] summarized the applications of published cost/effectiveness and cost/benefit analyses in the medical literature. Puzniak et al[6] conducted a cost/benefit analysis, over two-and-a-half years at the medical intensive care unit (MICU) at

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Barnes-Jewish Hospital in St. Louis. According to their study, the required gowns added more than $70,000 to an intensive care unit's annual costs but saved the unit over $400,000 in annual hospital costs associated with potential spread of the bacteria.[6]

There are also several studies for the comparison of the benefits of reusable versus single-use gowns.[6,7] Different approaches are used in those studies to determine benefits of reusable versus single-use gowns like random assignment, crossover design, and pre- and postinitiation of a disposable draping system. Some of the studies used personnel masked as gown for assessing the outcome variable. Garibaldi et al[7] used intraoperative wound contamination. They reported that there was only a 10% probability they would have missed a significant difference between single-use and reusable gowns if such a difference truly existed. Several other studies have reported higher infection rates associated with reusable fabrics.[7-9] Moylan et al[9] reported a logistic model using postoperative infection as the dependent variable and 5 predictors: type of gown, wound category, length of operation, gender, and antibiotics. In their models, the use of reusable gowns and drapes was associated with a significantly higher rate of surgical site infections. Bellchambers et al[10] reported a prospective, randomized, masked study that compared reusable gowns and drapes with single-use items in patients undergoing coronary artery bypass surgery. No difference in the rates of sternal or leg wound infections between the groups was noted. There are also a number of studies available in the literature for cost analyses of gowns and drapes. In most of those studies, an attempt was made to demonstrate the economy of use of one product over another. Badner et al,[11] Laufman et al,[12] and Murphy[13] studied the comparisons of per-use costs of gowns. These economic analyses considered 5 cost components: direct costs, drape set-up and changing costs, laundering and reprocessing costs, storage/inventory costs, and disposal costs. For single-use items, direct purchase cost was the most important factor in the total cost; however, for reusable items; the most important factor was the combination of ''number of reuses,'' ''laundering and reprocessing costs,'' and ''number of drapes used per procedure.'' DiGiacomo et al[14] compared the usage of gowns and drapes in 2 hospitals and concluded that reusable scrub suits and gowns would result in cost savings in excess of $100,000 compared with using disposables. Moylan et al[9] and Murphy[13] presented lower costs with the use of disposable gowns and drape systems. Another economic analysis was carried out by an independent market research company for one of the major manufacturers of medical textiles.[15] The research has revealed that, despite different cost and administrative structures in France, Germany, and the United Kingdom, standard single-use surgical gowns compare very favorably with reusable gowns in these countries when all the relevant cost factors were taken into consideration. Single-use surgical drapes were also found to have a competitive cost position in France and Germany but not in the United Kingdom. The study has also taken into consideration the high waste disposal costs of these items, especially in France and Germany. More recently, Lizzi et al[16] et al reported that using disposable drapes is not more expensive than using reusable cotton cloth drapes. The reusable cotton cloth drapes do not provide an adequate security barrier for the operators and may require an additional plastic drape for protection. However, we should draw a preconclusion here that, in most of these studies, not all cost factors were taken into account. Additionally, the unit price of the single-use products are in a decreasing trend in the world market because of technologic advancements in their production. Finally, the distribution of cost-contribution factors is considerably different among the countries. Therefore, it is recognized that more work is still required to assess the impact of currently available single-use and reusable gown and drapes. Many other factors such as health care provider comfort, environmental impact, and different cost factors should be considered in modeling cost/benefits of single and reusable gown and drapes.[17,18] In this study, an attempt is made to carry out a cost/benefit analysis for single-use and reusable gown and drapes along with a case study in a Turkish Hospital. Moreover, this paper also presents a first application of the analytical hierarchical process (AHP) to the present problem.

## METHODS

The main purpose of this study is to determine costs and benefits of single-use and reusable gown and drapes. To determine the benefits, first of all, available literature was reviewed and then face-to-face communications were carried out with personnel in the Gaziantep University Hospital (GUH). The AHP approach is carried out to determine cost structure and factors that are necessary to carry out acceptable cost estimation. Because it is not possible to convert most of the benefits into ''cost terms'' for calculating cost/benefit ratios directly, the AHP methodology is employed. The AHP enabled structuring and ranking of benefits based on the information collected from the GUH personnel.

### Cost/benefit analysis

Cost/benefit analysis is a set of procedures for defining and comparing benefits and costs. In this sense, it is a way of organizing and analyzing data as an aid to

thinking. Decisions are made by decision makers, and cost/benefit analysis is properly regarded as an aid to decision making and not the decision itself. The basic concept of cost/benefit analysis comes from economics. The analyst investigates a project or alternative course of action and attempts to quantify all positive and negative aspects into a common currency such as dollars. With positives (benefits) and negatives (costs) in a common currency, their ratio or difference (net benefits) can be calculated to determine whether the benefits outweigh the costs. Only the projects with positive net benefits have benefit/cost ratios greater than one. They are the ones that would be undertaken. If only one project from among several options is to be taken, then the project with the highest benefit/cost ratio would give the highest return for monies expended. Choosing the project with the highest positive net benefit would assure a positive return on investment but not necessarily the highest return. The cost/benefit analysis methodology can be summarized in 6 steps[19]: ''choosing the scenario and alternatives,'' ''assessing the benefits,'' ''quantifying the benefits,'' ''quantifying the costs,'' ''calculating desirability where desirability = (benefit/cost),'' and ''making decisions.''

## AHP

The AHP developed by Saaty[20,21] is a method for ranking decision alternatives and selecting the best one when the decision maker has multiple objectives, or criteria, on which to base the decision. Thus, it answers the question, ''which one?'' A decision maker usually has several alternatives from which to choose when making a decision[22] as in the case of the selection problem of single-use versus reusable gown and drapes discussed in this paper. By applying the AHP methodology, one can identify several qualitative and quantitative criteria, examine the competing and conflicting objectives among them, and assess their relative importance to make tradeoffs and determine priorities among them for making good decisions. The AHP can be used to assess the benefits and costs of surgical gown and drapes and enables us to consider the tradeoffs between them in deciding whether to use single-use or reusable. The application of AHP methodology involves 4 phases, namely,[23] ''structuring the problem and building the AHP model,'' ''collecting data through pair-wise comparisons by expert interviews,'' ''determining normalized priority weights of individual factors,'' and ''analyzing the priority weights and deriving a solution to the problem.'' For more details on the AHP, one can refer to Saaty,[20] Saaty,[21] Baykasoglu and Ozen,[22] and Chin et al.[23] In the second phase of the AHP methodology, pair-wise comparisons are carried out by using a 9-point scale (equal importance [1], weak importance of one over other [3], essential or strong important [5], demonstrated importance [7], absolute importance [9], intermediate values between the 1 adjacent judgments [2,4,6,8]) as suggested by Saaty.[20] When using AHP for cost/benefit analysis, priorities rather than dollars are used as the common currency of comparison. The decision maker proceeds with 2 AHP hierarchies, one for measuring benefit and the other one for measuring cost for the same set of project options similar to references.[19,23,24] The cost priorities are then compared with the benefit priorities to see which option has the highest ratio of cost priority/benefits priority. By analogy to regular cost/benefit analysis using money as the common currency, it is assumed that both benefit and cost priorities are measured in the same commensurable units.[24]

## CASE STUDY

This case study was performed in GUH. The hospital is located on the campus of the University of Gaziantep. The hospital is the biggest one in the southeast region of Turkey. It has 450 beds at the time of this study. There are 37 departments working in the hospital with an approximately 1500 labor force including academic personnel. Approximately 70 operations per day are held by 11 surgical departments in the hospital, which has 13 operation rooms.

### Benefits of using gown and drape

The benefits of using surgical gown and drape that are considered in this study can be listed as follows: ''increased dependability and reliability,'' ''reduced risk of infection,'' ''increased comfort,'' ''minimized waste disposal,'' and ''environmental impact.'' To realize and compare the benefits for different types of gown and drapes, the factors and decision criteria related to these benefits need to be determined. We reviewed the literature, EN 13795 European standard requirements, and publications of Association of the Nonwoven Fabrics Industry and carried out personal interviews with the personnel from the GUH to determine the factors and decision criteria for comparison. It should be noted that 3 decision criteria, namely, ''protection and safety,'' ''functionality,'' and ''environmental issues,'' are used in this study to compare the benefits of single-use and reusable gown and drapes. Subcriteria of the ''protection and safety'' are determined as ''barrier effectiveness,'' ''infection benefit,'' and ''sterilization ability,'' whereas the decision criteria ''functionality'' includes 4 subcriteria: ''comfort,'' ''quality maintenance,'' ''fabric properties,'' and ''ready availability.'' ''Waste disposal'' and ''effect on resources'' are considered within the ''environmental

issues.'' Detailed explanations of the criteria and factors that are used in this study are given in Yilankirkan.[17]

## Cost of using gown and drape

Price is the dominant factor in sales of surgical apparel. It should be considered whether most surgeons know this or not. Does a lower price mean less protection against microbial penetration and place patients at greater risk of developing surgical site infections?[25] To provide detailed information on the total life cycle costs of single-use and reusable surgical gowns and drapes, a cost comparison analysis is carried out. Most of the cost factors that are involved in the purchase and use of single-use and reusable surgical gowns and drapes tried to be taken into account from purchasing to final disposal. The economic analysis considered 6 cost contribution elements: direct purchase cost, labor cost (including laundry, sterilization department, transport from/to operation room, warehouse/transport, waste disposal), laundry cost (including energy needed for washing and drying, cost of supplies like stain remover, detergents, chemical whiteners, softeners, and water), sterilization cost (including costs of energy and supplies such as chemicals), waste disposal cost and overhead cost (including depreciation, maintenance, purchasing, warehousing, and others). The data for the economic analysis are gathered through personal face-to-face interviews with hospital managers, purchasing commission members, laundry managers, sterilization department managers, financial department managers, and operating theater staff and also published information from health care authorities and publications and press releases from surgical gown and drape manufacturers. Cost contribution elements are explained as follows.

**Direct purchase cost.** The procurement of both single-use and reusable gowns are made by going to a bid managed by a purchasing team. Although reusable gowns were sewed by the hospital tailor previously, it is presently cheaper to buy ready-made gowns. Single-use gowns vary in type and price. These are selected because of the opinions of the doctors in the purchasing team. For example, the products used by cardiovascular surgery are very expensive in comparison with others. Gamma-sterilized imported products are preferred. For single-use items, direct purchase cost was the most important factor for total cost, whereas factors that had an impact on costs of reusable items included the number of reuses, laundering, and reprocessing cost.

**Labor cost.** Labor cost is considered in 5 parts, separately for single-use and reusable gowns. The usage of reusable gowns needs personnel work for washing, sterilizing, and transporting from/to operating room, whereas single-use gowns need warehouse transportation and waste disposal. Personnel deliver the reusable gowns and drapes from the operation room to laundry, and laundry personnel receive them and sort, wash, finish, press, control, and bundle gowns and drapes. Damaged ones are repaired or disposed after quality check. It is usually preferred not to repair because it is said that repaired ones are not performable. Sterilization personnel sterilize gowns and drapes received from laundry. Next, sterilization and/or operation room personnel transport gowns and drapes to operation room. Warehouse personnel receive single-use gowns and drapes and unload the pallets and put them on the shelves, and other personnel transport them to operation room shelves. Operation room personnel place medical waste bags with used gowns and drapes and send them to the disposal area.

**Laundry cost.** Laundry cost is considered in 3 parts such that energy for washing and drying; supplies including stain remover, chemical whitener, and softener; and water is considered in cost. There is no laundry cost for single-use gowns. There are 11 personnel working in the laundry. Five 40-kg capacity washing machines, four 40-kg capacity washing machines, and one 80-kg capacity drying machines, an iron, and a steam generator are placed in laundry. Gowns and drapes are not ironed. Washing machines work with an automated dosage system, but a person is needed to control and place in the machine. Washing and drying machines work 5 times during the morning and 4 times at night, 7 days a week. One cycle is 1.5 hours. Iron works 12 hours a day, 6 days in a week. Steam generator works 24 hours with liquid petrol gas and consumes 4 tones in 10 days. Laundry department operates to wash 3 to 3.5 tones per day.

**Sterilization cost.** Sterilization cost is considered in 2 sections as energy and supplies, including chemicals, disinfectants, indicators, and others. Sterilization cost is calculated for reusable gowns only. Sterilization personnel sterilize gowns and drapes received from laundry. There are 3 washing machines, 3 steam autoclaves, and 2 ethylene oxide sterilization machines in the sterilization department. Typically, 3 machines make 8 cycles per day. Six personnel work 1 hour for 1 cycle of ethylene oxide sterilization and 2 hours for 1 cycle of steam autoclave sterilization.

**Waste disposal cost.** Because reusable gowns that have completed their life cycles are being used by hospital cleaning services as floor wipe, waste disposal cost is considered for single use gowns only. Operating room personnel place bags with used gowns and drapes into disposal containers (typically 1 or 2 times per day). It is assumed that 20- to 30-kg single-use gowns are disposed per day. Medical waste is collected by municipality periodically twice a week.

**Overhead cost.** Overhead cost is considered in 3 parts as depreciation; maintenance; and facility overhead of purchasing, warehousing, laundry, and sterilization departments. Depreciation cost is calculated for the laundry and sterilization equipment and for the hospital building. Maintenance cost is calculated for laundry and sterilization equipment.

## AHP MODEL FOR SELECTıON OF GOWN AND DRAPE

The AHP is used to formulate a hierarchical model to assess relative importance and priority of criteria, subcriteria, and decision factors for the selection of gown and drapes.

### Structuring the selection of gown and drape problem

This phase involves decomposition of the gown and drape selection problem into a multilevel hierarchical structure in which each level represents a set of meaningful and relevant criteria. A typical AHP model includes goal, criteria, and alternatives. The gown and drape selection problem is represented as a series of hierarchies for benefits and costs as shown in Fig 1a and 1b. Figure 1a describes benefits hierarchy, whereas Fig 1b describes the costs hierarchy. Each of the benefits and costs hierarchies consists of 4 levels, including the goal, decision criteria, subcriteria, and alternatives (single-use gown and drape set or reusable gown and drape set). Level 1 occupies the goal of selecting which type of gown and drape. Based on this goal, relevant decision factors are placed in level 2. In level 3, the subcriteria that define each of the decision factors considered in level 2 are included. Finally, alternatives of single-use or reusable are placed in level 4.

### Measurement and data collection

The measurement and data collection phase involves collection of data to determine the relative importance of criteria or subcriteria used in different levels of the hierarchies as shown in Fig 1. The 9-point scale as suggested by Saaty[20] is used to determine relative importance of criteria. To determine relative importance of criteria, a questionnaire is developed and is used during the face-to-face interviews with the related personnel in GUH. Ten representative evaluators are selected, namely, a professor, the head of the pediatric department, 3 assistant professors from the department of cardiology and cardiovascular surgery, 2 assistant professors from the general surgery department, a doctor from gynecology, a doctor from the department of pulmonary diseases, a doctor from the department of plastic surgery, and an associate professor from department of oncology. Saaty[21] recommended that people who are going to make the pair-wise judgments should know about the subject. Each of these evaluators also has experience in using single-use and reusable gowns and drapes, and some of them are in the purchasing team of the hospital. Each of these evaluators was asked to evaluate carefully and assign relative importance values using the 9-point scaling system in a pair-wise fashion with respect to the criteria of one level of hierarchy given the criterion at the next higher level. This process was continued to all levels of the entire hierarchy. As shown in the benefits hierarchy in Fig 1, there are 3 decision criteria considered for the selection of gowns and drapes. Therefore, the dimension of pair-wise comparison matrix in the present problem is $3 \times 3$.

### Determining normalized weights

The third phase of the AHP model is the determination of normalized weights. The pair-wise comparison judgment matrices are translated into the largest eigenvalue problems that can be solved to determine the normalized and unique priority vectors of weights to success factors, benefits or costs, and alternatives used in each level of the hierarchy.[24] These calculations are performed by employing the Expert Choice.[26] The pair-wise comparison matrices collected from the evaluators feed into the software, and the normalized priority weights for each criterion are determined as shown in Fig 1c. The overall consistency of the pair-wise comparison matrices at all levels is well within the acceptable ratio of 0.10 as recommended by Saaty.[21] Based on the examination of the results, ''protection and safety'' outweighs other criteria, implying that it is of paramount importance for the selection of gown and drape. ''Functionality'' and ''environmental ıssues'' are found to be the next important factors. At level 3, ''barrier effectiveness'' is found to be the most important subcriteria, ''sterilizibility'' is the second most important, and ''ınfection benefit'' is the next important criterion. ''Comfort'' is essential because it is found to be the most important decision factor with respect to ''functionality.'' ''Quality maintenance'' and ''fabric properties'' have similarly weights, and ''ready availability'' is the next most important criterion. In case of ''environmental ıssues,'' the most important criterion is ''waste disposal.'' It carries relatively higher weight than ''effect on resources.'' Similarly, the priority weights of the 2 alternatives considered at the level 4 indicates that ''single-use gown and drape set'' has a higher weight.

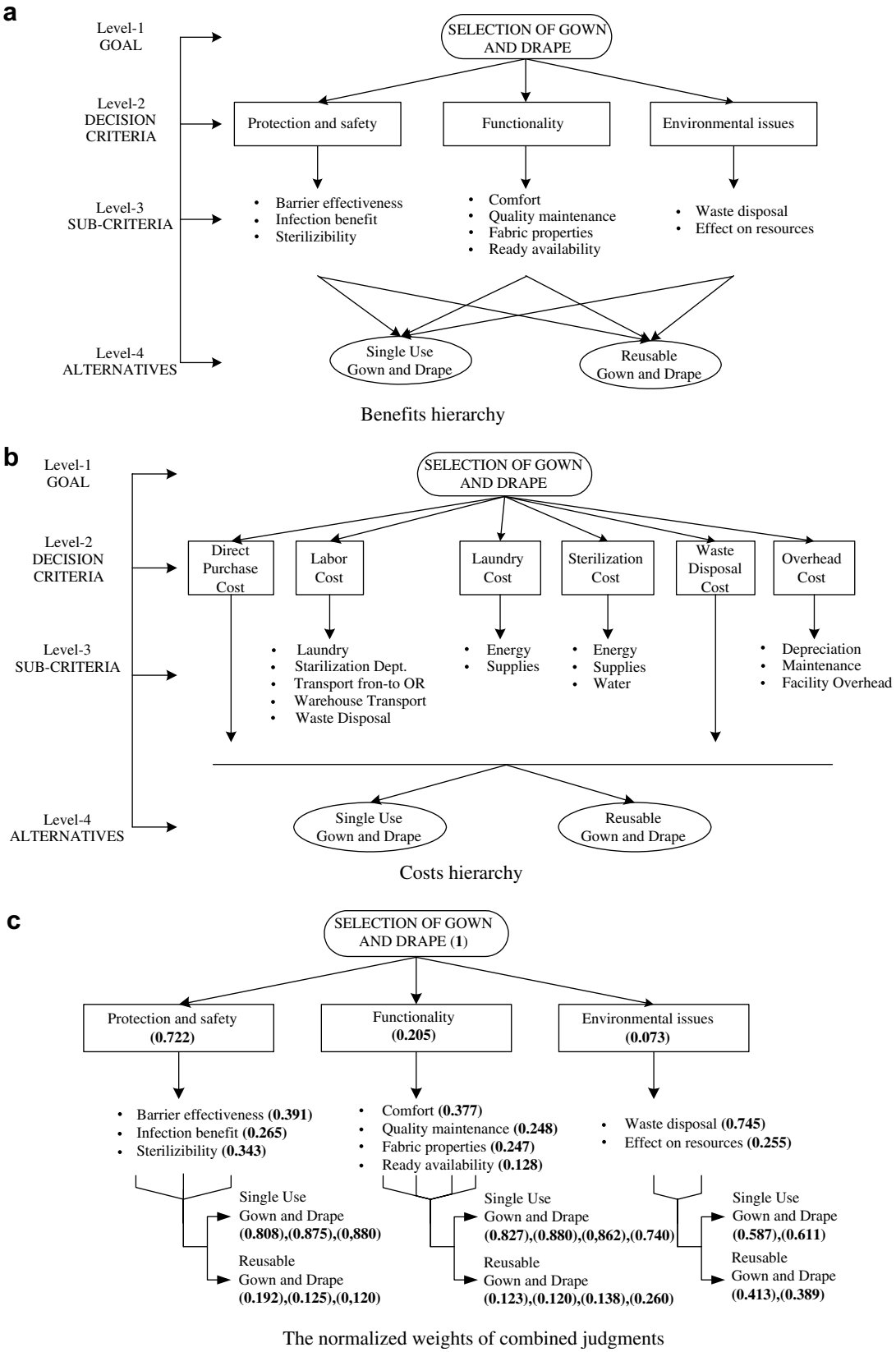


**Fig 1.** Hierarchies used for the selection of "gown and drapes."

**Table 1.** Local priority weights for alternatives

| Decision criteria | Subcriteria | Alternatives | Priority |
|---|---|---|---|
| Percent protection and safety | | | 69.7 |
| Protection and safety | Percent Barrier effectiveness | | 28.7 |
| Protection and safety | Barrier effectiveness | Single-use gown | 0.232 |
| | | Reusable gown | 0.055 |
| Protection and safety | Percent infection benefit | | 17.9 |
| Protection and safety | Infection benefit | Single-use gown | 0.157 |
| | | Reusable gown | 0.022 |
| Protection and safety | Percent sterilizibility | | 23.1 |
| Protection and safety | Sterilizibility | Single-use gown | 0.203 |
| | | Reusable gown | 0.028 |
| Percent functionality | | | 20.3 |
| Functionality | Percent comfort | | 7.6 |
| Functionality | Comfort | Single-use gown | 0.063 |
| | | Reusable gown | 0.013 |
| Functionality | Percent quality maintenance | | 4.8 |
| Functionality | quality maintenance | Single-use gown | 0.042 |
| | | Reusable gown | 0.006 |
| Functionality | Percent fabric properties | | 4.9 |
| Functionality | Fabric properties | Single-use gown | 0.042 |
| | | Reusable gown | 0.007 |
| Functionality | Percent ready availability | | 3.0 |
| Functionality | Ready availability | Single-use gown | 0.022 |
| | | Reusable gown | 0.008 |
| Percent environmental issues | | | 10.0 |
| Environmental issues | Percent waste disposal | | 7.5 |
| Environmental issues | Waste disposal | Single-use gown | 0.044 |
| | | Reusable gown | 0.031 |
| Environmental issues | Percent effect on resources | | 2.5 |
| Environmental issues | Effect on resources | Single-use gown | 0.015 |
| | | Reusable gown | 0.010 |

## Synthesis: Finding Solution to the Problem

The last phase in the AHP is to determine combined priority weights that are obtained by multiplying the local priority weights along all successive levels in the hierarchy. The local priority weights of the each criterion are shown in Table 1. Based on the local priority weights, selecting single-use gowns and drapes is the most preferred choice for each decision criteria. This is also true when considering overall priority weights. The combined priority weight for single-use gowns and drapes and reusable ones are calculated as 0.821 and 0.179, respectively. The consistency ratio of the synthesis is 0.08, which is within the acceptable ratio of 0.10. Based on the AHP results for the benefits, single-use gown and drape is a much better option.

## Calculation of costs

The price of single-use sets differs depending on the fabric type and import-export status. Because there are several types of single-use sets, cost calculations are made by considering reusable, medium-priced single-use and high-priced single-use sets. Because the single-use sets are mainly used in the cardiovascular surgery department in the GUH, the gown drape set for cardiovascular surgery is considered in cost calculations. Cost contribution elements for reusable and single-use sets are shown in Tables 2and 3. The computation of the cost contribution elements is briefly explained below (The data for computing cost elements are collected from hospital accounting department and market).

- *Direct purchase cost* is calculated by dividing purchase cost with number of use.
- *Labor cost* of reusable sets for laundry, sterilization department, waste disposal, and transportation is calculated by multiplying the number of persons with working time and hourly salaries and dividing the result by number of gowns and drapes processed.
- *Laundry cost* (for energy) is calculated by multiplying the total energy used (kilowatts per hour) with the cost per kilowatts per hour and percent allocated to gowns and drapes. Cost for supplies is calculated by multiplying monthly supplies cost with percent allocated to gowns and drapes. Cost for water is calculated by multiplying total liter used with cost per liter and percent allocated to gowns and drapes.
- *Sterilization cost* (for energy) is calculated by multiplying the total energy used (kilowatts per hour) with the cost per kilowatts per hour and percent

**Table 2.** Cost contribution elements for reusable gown and drape set

| | | Re-usable gown/drape set | | |
|---|---|---|---|---|
| **Cost contribution elements** | | **Costing details** | **Cost (YTL)** | **Cost Percent** |
| Gown/Drape Set | | 158.58 YTL/set, direct purchase. 30 uses | 5.286 | 43.89 |
| Labour Cost | Laundry | 1 person x 5.208YTL/h/person x 30min per 25 set | 0.104 | 13.66 |
| | Sterilisation Dept. | (1 person x 5.814 YTL/h/person x 5 min/10sets per cycle) + (1 person x 5.814 YTL/h/person x 15 min) | 1.498 | |
| | Transport from/to Operation Room | 1 person x 5.208YTL/h/person x 5 min/10 sets per cycle | 0.043 | |
| | Warehouse/Transport | N/A | 0.000 | |
| | Waste Disposal | N/A | 0.000 | |
| Laundry Cost | Energy (washing & drying) | 0,020 YTL for washing eqp + 0,017 YTL for drying eqp + 0,3226 YTL for LPG | 0.360 | 6.80 |
| | Supplies (Stain Remover, Detergents, Chemical Whitener, Softeners) | 0,1+0,23+0,07+0,006 YTL/set | 0.410 | |
| | Water | 0,052 YTL/set | 0.050 | |
| Sterilisation Cost | Energy | 1.152 YTL for eqp + 0,75 YTL for LPG. cost per each set | 1.902 | 29.91 |
| | Supplies (Chemicals…etc) | 1.70 YTL/set | 1.700 | |
| Waste Disposal | | 0 | 0.000 | 0.00 |
| Overhead | Depreciation | Calculated based on 10 year economic life, 365 days run, runs 20 hours per day and 9 cycles per day and 25 sets per each cycle (for building economic life has been takes an 50 years) | 0.013 | 5.74 |
| | Maintenance | Calculated based on the service agreement cost and the historical spare parts usage and repair data | 0.011 | |
| | Purchasing, Warehousing, Laundry and Sterilisation Dept. Facility Overhead | Calculation based on the estimated share of the gown/drape sets on overall overhead expenses of the depts | 0.667 | |
| | | Total | 12.044 | 100 |

allocated to gowns and drapes. Cost for supplies is calculated by multiplying monthly supplies cost with percent allocated to gowns and drapes.

- *Waste disposal cost* is calculated by multiplying the kilograms of waste per day with the cost per kilogram and dividing the result by the number of gowns and drapes processed.
- *Overhead cost for depreciation* is calculated by multiplying the annual equipment and building cost depreciation in New Turkish Lira with percent allocated to gowns and drapes.
- *Overhead cost for maintenance* is calculated by multiplying annual laundry maintenance costs in New Turkish Lira with percent allocated to gowns and drapes.
- *Facility overhead cost* is based on the estimated share of the gown/drape sets on overall expenses of the departments.

As can be seen in Tables 2 and 3, the direct purchase cost has the highest percent for all 3 alternatives. Whereas the direct purchase cost for single-use gown and drape set covers almost all of the cost, it is approximately half for the reusable set. As far as the reusable sets are concerned, the second highest cost contribution element is the sterilization cost. Because the direct purchase cost already includes the sterilization cost in single-use gown and drape set's price, it is taken as ''zero.'' Another cost element for reusable sets is labor cost, which covers a considerable percent. As for the single-use sets, there is only a small percent that is for warehouse transport and waste disposal cost. The fourth cost element is laundry cost for reusable sets, whereas it is zero for single-use sets. The last cost element is overhead cost, which is composed of depreciation, maintenance, and facility overhead for reusable sets, whereas it is only facility overhead for single-use gown and drape set. Waste disposal cost is taken as ''zero'' for reusable sets. However, waste disposal is the second important cost element for the single-use sets. A summary of major cost contribution elements is given in Table 4.

The next step is deriving the cost priorities to be able to determine benefit/cost ratios. Cost priorities are derived according to a normalization procedure. For example, weight of single-use gown can be calculated as follows: weight for single use set = 115.563/(12.044 + 115.563) = 0.906.

To calculate the benefit/cost ratio, the benefit priority values (as determined by AHP) of each alternative is divided by the normalized cost weights of respective alternative. The normalized weights for costs

**Table. 3.** Cost contribution elements for single-use gown and drape set

| | | | Single-use gown/drape set | | | |
|---|---|---|---|---|---|---|
| **Cost contribution elements** | | **Costing details** | **Cost (YTL) high quality** | **Cost (YTL) medium quality** | **Cost % high quality** | **Cost % medium quality** |
| Gown/Drape Set | | Direct Purchase cost per set | 115 | 52 | 99.51 | 98.93 |
| Labour Cost | Laundry | 0 | 0.000 | | 0.11 | 0.25 |
| | Sterilisation Dept. | 0 | 0.000 | | | |
| | Transport from/to Operation Room | N/A | 0.000 | | | |
| | Warehouse/Transport | 5.208YTL/h/person x 5 min/10 set | 0.043 | | | |
| | Waste Disposal | 5.208YTL/h/person x 10 min/10 set | 0.087 | | | |
| Laundry Cost | Energy (washing & drying) | 0 | 0.000 | | 0.00 | 0.00 |
| | Supplies (Stain Remover, Detergents, Chemical Whitener, Softeners) | 0 | 0.000 | | | |
| | Water | 0 | 0.000 | | | |
| Sterilisation Cost | Energy | 0 | 0.000 | | 0.00 | 0.00 |
| | Supplies (Chemicals…etc) | 0 | 0.000 | | | |
| Waste Disposal | | 60 kg/dayx0.40 YTL/kg/70 set | 0.340 | | 0.29 | 0.65 |
| Overhead | Depreciation | 0 | 0.000 | | 0.08 | 0.18 |
| | Maintenance | 0 | 0.000 | | | |
| | Purchasing, Warehousing, Laundry and Sterilisation Dept. Facility Overhead | Calculation based on the estimated share of the gown/drape sets on overall overhead expenses of the warehouse and purchasing dept. | 0.093 | | | |
| | | Total | 115,563 | 52,563 | 100 | 100 |

and benefits are given for both high-priced and medium-priced sets in Table 5.

## COST BENEFIT ANALYSIS

The main steps of the cost/benefit analysis, which is carried out in this study, are presented below in stepwise fashion.

Step 1: Choosing the scenario and alternatives: the selection of surgical gowns and drapes is the objective. Single-use and reusable gowns and drapes are the alternatives.
Step 2: Assessing the benefits: the benefits of using gown and drapes are examined under 3 headings as ''protection and safety,'' ''functionality,'' and ''environmental issues.''
Step 3: Quantifying the benefits: according to the AHP results, benefit priority for reusable gowns and drapes is determined as 0.179, and benefit priority for single-use gowns and drapes is determined as 0.821.
Step 4: Quantifying the costs: weights for cost are determined and given in Table 5.
Step 5: Calculating the desirability where desirability is equal to ''benefit divided by cost.'' Benefit/cost ratios for reusable and high-priced ''single-use'' gown and drape sets as well as benefit/cost ratios for reusable and medium priced ''single-use'' gown and drape sets are given in Table 5. As can be seen from Table 5, if medium-priced ''single-use'' set, which is considered *the best choice*, shifts from reusable to single use.
Step 6: Making decisions: According to the desirability (benefit/cost ratios), reusable set is the best choice for the selection of gown and drape selection problem if we consider high-priced single-use set. If we consider the medium-priced single-use set then the best alternative is to use single-use set.

Because the benefit/cost ratio of ''high-priced single-use set'' is 0.906, which is smaller than 1, it is possible that this situation may cause the decision maker to have an impression that the cost of single-use product is higher than its benefits. This situation may mislead the decision maker that the single-use products are not feasible to use. However, this situation does not necessarily represent whether or not single-use products are feasible. This case is similar for the reusable set when comparing with medium-priced single-use set. Therefore, as suggested by Wedley et al,[19] a magnitude adjustment is necessary in those circumstances in which the ratio exceeds ''1.'' It should be noted that the ratio exceeds ''1'' when the weight factor for benefits is above 53% for both of the alternatives (medium-priced and high-priced sets). Benefit/cost analysis is basically looking at the problem from 2 perspectives: benefits and costs. Because perspectives are often

**Table 4.** Summary of major cost contribution elements in percentages

| | Reusable gowns and drapes | High-price single use gowns and drapes | Medium-price single use gowns and drapes |
|---|---|---|---|
| Percent overhead cost | 5.74 | 0.08 | 0.18 |
| Percent waste disposal cost | 0.00 | 0.29 | 0.65 |
| Percent sterilization cost | 29.91 | 0.00 | 0.00 |
| Percent laundry cost | 6.80 | 0.00 | 0.00 |
| Percent labor cost | 13.66 | 0.11 | 0.25 |
| Percent direct purchase cost | 43.89 | 99.51 | 98.93 |

**Table 5.** Weights for cost and benefits as well as benefit/cost ratios

| Alternatives | Cost | Benefit weight | Cost weight | Benefit/cost ratio |
|---|---|---|---|---|
| High priced | | | | |
| Reusable gown and drape set | 12.044 | 0.179 | 0.094 | 1.904 |
| Single-use gown and drape set | 115.563 | 0.821 | 0.906 | 0.906 |
| Medium priced | | | | |
| Reusable gown and drape set | 12.044 | 0.179 | 0.186 | 0.962 |
| Single-use gown and drape set | 115.563 | 0.821 | 0.814 | 1.010 |

elements in an AHP hierarchy, there is no reason why they cannot be introduced as a level in the structuring process.[19] As long as this level is introduced directly below the goal, then the related hierarchies could be analyzed directly as a combined entity or indirectly as benefit/cost ratios of the synthesized priorities that originate from the benefit and cost nodes. Because the composite benefit and cost priorities have been hierarchically weighted by the importance of benefits versus costs, they will be in commensurate terms.[19] Figure 2 presents a combined hierarchy for benefits and costs by considering the high-priced set for the case of multiplied weights.

The effect of these new weights is to multiply the original benefit priorities by 0.55 and cost priorities by 0.45. Because multiplication by a constant is a permissible transformation of a ratio scale, the magnitude adjustments maintain the original ratios between alternatives. However, the sum of the benefit priorities at the bottom of the hierarchy (0.452 and 0.098) now sum to 0.55, which is the relative importance of benefits, whereas the cost priorities (0.043 and 0.407) sum to 0.45. Now, being in a common priority currency, they can be compared without misleading implications.

Considering the high-priced set, the resulting benefit/cost ratios are as follows: reusable gown and drape set = 2.327; single use gown and drape set = 1.108.

Considering the medium-priced set, the resulting benefit/cost ratios are as follows: reusable gown and drape set = 1.176; single use gown and drape set = 1.233.

Reusable set is still the best option when considering the high-priced single-use set, and single-use set is the best option in case of considering medium-priced single-use set. However, now, all alternatives have ratios that correctly indicate that the benefits exceed the costs.

## SENSITIVITY ANALYSIS

The following factors would have a direct impact on benefit weights (priorities): doctors' judgments in the pair-wise comparisons, professions of doctors, surgery experience of doctors, and others. Moreover, attitude of hospital in which the case study is performed (whether it is public or private), the attitude of the hospital administrators, amount of gowns and drape consumption, whether gown and drapes are repaired or not, the skill of the purchasing department, whether the laundry is owned or outsourced, whether the products are import or local made, and the labor cost rates can affect the life-cycle costs of surgical gowns and drapes. A sensitivity analysis on benefit weights (priority) is achieved by keeping cost weights fixed to observe the change on the benefit/cost ratios and vice versa. It should be noted that an increase on benefit weight (priority) of a reusable gown drape set means either an increase in the actual cost of the reusable gown and drape set or a decrease on the actual price of single-use set. The same situation is also valid for the cost weights (priority). The sensitivity analysis is carried out by considering both medium-priced single-use and high-priced single-use gown and drape sets. It has been recognized that the benefit/cost ratio of the reusable gown drape set is always higher than the high-priced single-use gown and drape set, if the costs are fixed. This means that, even though the benefits get the highest score, the reusable products always dominate. If the medium-priced single-use set is considered in comparison with the reusable set at constant cost priorities, the reusable gown and drape set gains advantage. We should note that the benefit/cost ratio for these alternatives is also very close to each other. A small change (increase) in the benefit priorities of reusable gown and drape set makes it more favorable in comparison with medium-priced single-use gown and drape set. It should also be noted that high-priced single-use set can become a favorable choice, if the benefit priorities are kept constant within the sensitivity analysis. This presents that, if the actual cost of high-priced single-use ''gown and drape'' set is reduced by some technologic advancements, the product can become

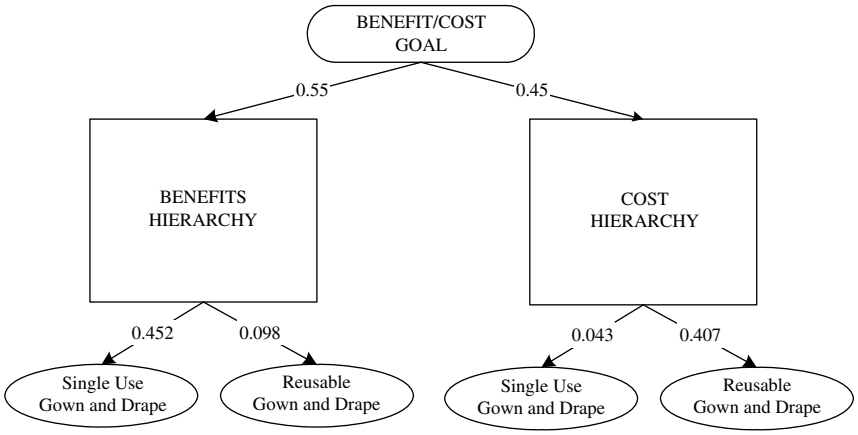


**Fig 2.** Combined benefit and cost hierarchies for high-priced, single-use set versus reusable set.

more competitive. If the same analysis is performed for medium-priced single-use ''gown and drape'' set by keeping their benefit priorities constant, the medium-priced single-use ''gown and drape'' set gains more advantage against the reusable sets. The detailed information on the sensitivity analysis is not presented here because of the space limitation; however, this information as well as the comparative figures of the costs/benefits can be found in Yilankirkan.[17]

## CONCLUSION

Gowns and drapes can be made as wovens or nonwovens. Wovens are called *reusables*, and *nonwovens* are called single-use or disposables. In this paper, a case study was carried out to evaluate cost and benefits of gowns and drapes, which are used in considerable amounts at the GUH. It was aimed to form a basis for making effective selection decisions between these 2 products. The literature was reviewed, and interviews were made with the doctors, finance personnel, and the administrators of the hospital to determine the benefits and costs associated with gown and drape use. The benefits considered in this study include increased dependability and reliability, reduced risk of infection, increased comfort, and minimized waste disposal and environmental impact. The AHP was used as the main instrument in developing the benefit/cost analysis model. The AHP is especially useful in converting qualitative benefits data into quantitative data. A sensitivity analysis was also carried out to observe when different alternatives can be better options. It seems that single-use products are very strong in terms of benefits, but their costs are still expensive to replace reusable products. If the cost of single-use products is reduced by some technologic advancement in their production as well as in their distribution, it seems that they will gain a very competitive position in the gown and drape market. This will probably lead to better infection control in the hospitals.

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