# Hierarchy of Shopping Centers in the City of Curitiba, State of Paraná, Brazil

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**Summary**
One of the great challenges of integrated waste management in cities of any size is related to the need for awareness of the major generators of solid waste, such as hotels, hospitals, supermarkets and shopping centers (SCs). Presently, the landfill of Curitiba, State of Paraná, Brazil, is committed to its capacity, with estimates for activities being stopped by the end of 2010. Because of this, the Municipality of Curitiba has published laws, rules and terms of reference for the preparation of the Plan for Solid Waste Management (PSWM) in ventures with high producing potential. This study aimed to rank the SCs in the city of Curitiba, according to its solid waste management. To achieve this objective the following steps were developed: identify the SCs adopted as a case study, develop a questionnaire, technical visits, questionnaire application and classify the studied SCs using the Analytic Hierarchy Process (AHP) method. The evaluation by AHP made it possible to identify the SCs with better solid waste management, among the small-, medium- and large-sized, and conclude that the differential of SCs with the most appropriate waste management is concerned, basically to: containers; the differentiation of waste by the color of the plastic bag, internal transportation and control in the separation of residues..

***Keywords:*** *Solid Waste Management, Shopping Malls; Hierarchy; AHP Method.*

## 1. Introduction

The issue of solid waste in Brazil has been widely discussed, especially since the publication of the results of the National Survey of Basic Sanitation (PNSB) in 2002, by the Brazilian Institute of Geography and Statistics [5]. These findings suggest a need for greater involvement in all stages of solid waste management, from the generator to the definition of public policies in all areas, especially the municipal one.

According to the PNSB, from all waste collected, about 4% are sent to sanitary landfills, 21% are sent to non-treated open air waste deposits, 4% are allocated to separation, composting or incineration, and the remainder, just over 60%, are related to another destinations, for instance, controlled landfills [5].

To improve the efficiency of separation and thus the recycling of urban solid waste, it is essential to develop policies for integrated management of solid waste, which is summarized in the functional steps comprising the generation, packaging, collection, storage, transportation, recovery and final disposal of solid waste. Thus, these steps should be described in detail and presented in a Plan of Solid Waste Management (PSWM).

One of the great challenges of integrated waste management in cities of any size is related to the need for awareness of those establishments that are considered the major generators of solid waste, such as hotels, hospitals, supermarkets and shopping centers (SCs). As such, several municipalities have established specific environmental laws in which are defined the terms small and large generator. For the latter, the legal specifications require that responsibility for all stages of waste management is the generator's itself, and consequently the development of a program for solid waste management, to be prepared and submitted for approval by the supervisory body, in the specific case of Curitiba, the Municipal Secretary of Environment.

Commercial Malls, popularly known as shopping centers (SCs), generate proportionately greater amount of recyclable waste when compared to organic and tailings. In general, the waste generated in these establishments do not receive proper separation, causing part of the waste collected, considered potentially recyclable, to be sent to the landfill.

In light of this observation, and depending on the specific municipal environmental law, the need to implement effective programs for solid waste management for large generators becomes mandatory so it is possible to obtain the expected results with respect to recycling, such as increased life of landfills, by minimizing recyclable

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materials sent to landfills, environmental awareness of employees and customers of SCs in relation to the importance of proper separation of recyclable materials and obtain financial gain by marketing value-added non-contaminated residues.

It is worth noting that pursuant to Article 33 of Municipal Decree 983/2004, large generators, which in [2] and [3] are defined as establishments that generate a volume of waste above 600 liters / week (Article 8 of the Decree) shall prepare and submit for approval of the Municipal Department of the Environment (SMMA) a Program of Solid Waste Management [2], and therefore several SCs are included in this class.

Thus, the importance of this study is in verifying the SCs' procedures for Solid Waste Management (SWM), analyzing their strengths and weaknesses, and whether they agree or not with the relevant legislation, making suggestions for improvements, if this is the case. Greater awareness by the SCs' administrations about these procedures will surely be an example to the local population about the importance of correct SWM for the environment, especially in the separation and final destination stages.

The main objective with this study is to rank the malls of the city of Curitiba in relation to their solid waste management through the Analytic Hierarchy Process (AHP) Method. Through this hierarchy, the SCs can be objectively "scored" by identifying their strengths and weaknesses, making them, either through their own administrations or through the public administration, reach more ambitious levels raising confidence and satisfaction from the whole community.
This work is organized as follows: section 2 describes the AHP method connecting it to the problem analyzed and how the SCs hierarchy in relation to solid waste management was obtained. In Section 3, the results are obtained and discussed, and finally, section 4 provides the conclusions.

## 2. Methodology

For this study, 20 SCs located in Curitiba, which, by request of their administration, will not be identified here. These SCs will henceforth be denoted by the letters CC, followed by the digits 10-20: CC1, CC2,..., CC20. Moreover, the sample size that was adopted for this study was determined considering that it includes most of Curitiba's SCs, with different sizes, from small to large [9].

A questionnaire was created to collect information about the SWM of the 20 SCs that were taken for analysis. The questions were formulated based on literature review and six pre-visits. The questionnaire was developed in order to be applied to the functional area of the administration of each of the SCs studied.

Visits to the 20 SCs were performed between January and May 2009. During the technical visits the questionnaire was applied and observations of interest to the research and photographic records were made. The technical visits and interviews were also aimed at identifying procedures for separation, collection, internal storage and final disposal of each type of waste. At this stage of the visits was also investigated the knowledge that employees and shopkeepers of each SC had in relation to the existence of programs and proper procedures for waste management.
From the replies to the questionnaires and to establish a hierarchy of the SCs studied in terms of environmental characteristics, we applied a multi-criteria analysis method, the Analytic Hierarchy Process (AHP), as proposed by [8]. For such, 46 criteria were identified in relation to solid waste management, as presented in Table 1 (see attachment 1), based on the questionnaires and literature review. Of these 46 criteria, 26 were answered by all 20 SCs analyzed and therefore, only these 26 attributes (criteria) were considered in this work (highlighted with (*) in Table 1).

Defined the criteria, the data about the 20 SCs were organized in order to classify them preliminarily, in ascending order, first by the criterion "number of stores" and, later, by the criteria of "year of development and implementation of the PSWM". The first criterion was chosen based on the Municipal Law 12.382/2007 [4] and the other, based on the Municipal Decree 983/2004 [2]. After this classification, the SCs were divided into three groups, small, medium and large, as in Table 2 (attachment 1). Establishments considered small SCs are those that have less than 40 stores, the medium-sized are those with a number of stores between 40 and 100, and large ones are those with more than 100 stores. Thus, four shopping centers were included in the first group (CC20, CC16, CC18 and CC15), five in the second (CC17, CC19, CC11, CC14, and CC9) and in the third, 11 establishments (CC1, CC8, CC4, CC10, CC6, CC13, CC7, CC5, CC2, CC3 and CC12). This classification was used to rank the SCs in order to apply the AHP method.

After determining the order of SCs according to the "number of stores" and "year of development and implementation of the PSWM", the attributes were compared in pairs (pairwise comparisons), according to the AHP approach. The judgments of decision makers about the importance of one attribute over another, taken subjectively, can be converted into a numerical value, using a scale with values from 1 to 9, where "1" denotes equal importance and "9" denotes a high degree of favoritism [1]. Table 3 (attachment 1) connects the verbal scale (judgment) to numeric one (values).

Using mathematical notation, matrix A, of order n x n, to compare n elements, is given by:
A = [ aij ]

where: $$a_{ij} = \frac{1}{a_{ji}}$$ , where aii = 1, $1 \leq i, j \leq n$

The main diagonal of A is always "1". Reciprocity should be observed through the diagonal, this is, if a1,3 = 5, then a3,1 = 1/5, this is, if criterion 3 is five times less important than the criterion 1, then criterion 3, in its turn, has 1/5 of the importance of criterion 1.

Next, the relative weights of alternatives with respect to the criteria are computed. The relative weights are obtained by applying a two-step process. First, all elements of each column of matrix A are summed up and, secondly, each element of each column is divided by its corresponding sum of this column. The matrix resulting from this process is called normalized matrix A', with order n x n, and is defined as:

$$A' = a'_{ij}$$

where: $$a'_{ij} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}}$$ for $1 \leq i, j \leq n$

Then the average value of each row of the normalized matrix is calculated to obtain the weight vector W, with order n x 1, or relative weight, or even the eigen vector that is determined by:
W = [wk]

where: $$w_k = \frac{\sum_{j=1}^{n} a'_{ij}}{n}$$ for $1 \leq i, k \leq n$

Thus, for the pairwise comparison between the criteria, the process is repeated for each matrix A. Each line connecting any two elements in the hierarchy has a relative weight associated with it.

Once all the relative weights have been calculated, we need to verify whether they are adequate. For this, a composite weight vector C = [cd], with order n x 1, for each choice of the decision d is determined. This is defined by the aggregation of weights on the hierarchy for each choice of the decision. For this, the relative weight W (vector containing the average normalized sums of the rows of matrix A) is multiplied by matrix A itself, and then these products added up. Therefore,
C = [ cd ], for $1 \leq d \leq n$

where: $$c_d = c_j = w_j \sum_{i=1}^{n} a_{ij}$$ for $1 \leq j \leq n$

After calculating the cd components of the composed weight vector C, these values are divided by their corresponding relative weights, thus obtaining vector D, of order n x 1, and then, the results of these divisions are added up, resulting in scalar DS or simply sum.

$$Sum = DS = \sum \frac{c_j}{w_j}$$

The next step is to calculate the mean value of DS. This is an approximation of the maximum eigenvalue, denoted by λmax:

$$\lambda_{\max} = \frac{DS}{n}$$

Finally, the Consistency Index (CI) is calculated, given by:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

To determine if the values ascribed to matrix A are consistent, the Consistency Ratio (CR) is determined. This is an approximate mathematical indicator, or guide, of the consistencies arising from the pairwise comparison. This rate is a function of the value of λmax and of the "consistency index", which is then compared to similar values if the pairwise comparisons have been simply random (called “random index"). If the relation between the consistency index and the random index (called "consistency ratio") is not greater than 0.1, [8] suggests, generally, that this consistency is quite acceptable for pragmatic purposes. The consistency ratio is determined by:

$$CR = \frac{CI}{RI},$$

where the value of the random index (RI) depends on the order of matrix A, as shown in Table 4 (attachment 1). These values were obtained by performing a large number of simulations developed by Saaty, 1980 [1].

If the consistency ratio presents a value greater than 0.1, it is necessary to change the weights established for each comparison element in matrix A in this criterion and redo the calculations. Otherwise, the weights assigned are appropriate.

## 3. Obtaining and Discussing Results

With the questionnaires applied and filled in, it was possible to rank the SCs studied in relation to their solid waste management. The ranking was done using the AHP method, as presented in Section 2 above. The 26 criteria examined were highlighted with (*) in Table 1, which presents the criteria that have answers to all 20 SCs studied. As already shown in Table 2, these SCs were grouped into small, medium and large ones. It was then applied the AHP method to each of these groups separately, and in the attachment 2 is an example of such application, considering the criterion "number of stores" for small SCs.

Using the calculated values for the criteria for the three groups (small, medium and large), the ranking was determined according to Tables 5 and 6 (attachment 1). The figures presented in the tables refer to the weight vector W of each of the attributes considered.

The values in blue, in Tables 5 and 6 refer to SCs' typical values, considered more appropriate in relation to their solid waste management, while the values in red refer to SCs' differed values of, considered less adequate. It is worth noting that in Table 6 were considered three additional criteria (Year of the PSWM, Knowledge of the PSWM and Training for the PSWM), besides the 26 already analyzed and mentioned above. That is so, because all SCs with more than 100 stores have PSWM and therefore, it was possible to include criteria related to this feature in the hierarchy of these establishments.

In these tables 5 and 6 the results from the sum of the weights assigned to criteria are highlighted in the last line and the highest values refer to those SCs that have better waste management. Thus, malls CC18, CC14 and CC2 were ranked as those with the best programs for waste management among the SCs of small, medium and large sizes, respectively.

Analyzing the results obtained for the small-sized SCs (Table 5), it can be noticed that CC18 and CC16 are those which have, respectively, the highest and lowest grade for the management of waste. Despite being the only one of four sites in this group that has a food court, which could result in a value for the sum of the weights that could placed it in a lower rank (higher waste generation), CC18 had the highest value (7.277 ) for the management of solid waste. This can be explained by the separation control held by employees and internal transport carried out with carts and not manually. On the other hand, CC16 showed lowest value (5.655) for the management of solid waste because the waste is placed in open drums at the storage area and, moreover, the disposal of solid waste generated by shopkeepers is held directly in the storage area.

Analyzing the results obtained for the medium-sized SCs (Table 5) one can see that CC14 and CC11 are those which have respectively the highest and lowest grade for the management of waste in this group (medium-sized). CC14 showed a highest value (6.685) for solid waste management, because, besides being the only mall that has a selective collection containers in the circulation area, it is also the only one in which the packaging of recyclable materials in the containers is accomplished by different colors of the plastic bags, while the other four use only the black plastic bag. Another criterion that contributes to the increase in value of the weights of CC14 was the storage of recyclable materials by type, in specific containers for selective collection. The criteria that have "contributed negatively" to the determination of CC11 as the one that has the lowest (3.948) value for the solid waste management were the outsourcing of waste management, the existence of cinema and outdoor area, and it is also the only establishment in this group for which it was not possible to identify the final destination of its waste.

Analyzing the results obtained for the large SCs (Table 6), one can observe that the values of the sum of the weights for all 11 SCs in this group are very close, this is, there is no significant difference between them. However, it is observed that CC2 and CC4 are those which have, respectively, the highest (2.757) and lowest (1.940) grade, and CC2 is the only SC that has containers for selective collection in the circulation area, with four compartments each.

## 4. Conclusions

This study aimed especially to rank the SCs in the city of Curitiba, State of Paraná, according to their solid waste management. It was possible to identify the existence of Plans or Programs for Solid Waste Management in several of the SCs studied.

As one of the conclusions we have that the most of the SCs deal with the solid waste issue as amateurs and there is little knowledge about the topic and the relevant legislation, and also, there is lack of managerial accountability in dealing with waste, as [7] also concluded in his research.

The AHP method was applied to determine the ranking of the 20 SCs studied in relation to solid waste management. This method allowed determining the SCs with the best and the worst solid waste management, according to their size. It was concluded that among the large ones, all 11 SCs have a performance with respect to waste management rather close, but despite this fact, CC2 showed the best waste management. For the medium-sized SCs, CC14 showed the best performance, and among the small ones, CC18 was the one that showed the best ranking.

CC14 showed such performance because it is the only mall that has containers for selective collection at the circulation area, and also because it is the only one in which packaging of recyclable materials is made with plastic bags with different colors. CC2, because it is the only one that has containers for selective collection in the circulation area with four compartments each, and CC18, because of the separation control carried out by the employees and the internal transportation with carts, not manually. Therefore, one can conclude that the difference these SCs show is related basically to: containers; the differentiation of waste by the color of the plastic bag, internal transportation and control when separating waste. It is important to mention that a differentiation, however small, can improve or worsen the performance of waste management and hence, the place of the SC at a satisfactory level in the hierarchy.

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Table 1. The 46 Criteria for Solid Waste Management identified in the Analyzed SCs (where (*) = 26 criteria that were used)

| Area | Criteria |
|---|---|
| **General** | Opened |
| | Number of stores * |
| | Estimate of visits |
| | Existence of cinemas * |
| | Existence of food court * |
| | Number of employees |
| **PSWM** | SW Management * |
| | Year of elaboration and implementation |
| | Operation |
| | Change |
| | Previous |
| | Knowledge by employees and shopkeepers |
| | Training of employees and shopkeepers |
| **Selective Collection** | Selective Collection is Performed * |
| | Control in separation * |
| | Specific separation area |
| **Containers** | Circulation area * |
| | Food court * |
| | Outdoors area * |
| **Packaging** | Of wastes in containers * |
| | Of recyclable materials in containers * |
| | Of residues from storage * |
| | Of recyclable materials at storage * |
| **Storekeepers** | Common * |
| | Food court * |
| | Cinema* |
| **Transportation** | Internal * |
| **Hazardous Solid Waste** | Quantity of light bulbs |
| | Volume of oil |
| | Final destination of light bulbs |
| | Final destination of used cooking oil |
| | Health service waste * |
| **Storage** | Specific area * |
| | Area for each type of waste * |
| | For light bulbs * |
| | For oil |
| **Final destination** | Controlling the amount of SW generated * |
| | Amount of residues |
| | Amount of recyclable materials |
| | Waste collection * |
| | Collection of recyclable materials |
| | Of residues * |
| | Of recyclable materials * |
| **Amount Collected** | Amount collected with the sale of recyclable materials* |
| **ISO 14001:2004** | Has |
| | Intends to have |

Table 2. SCs Analyzed and Classified according to the "Number of Stores" and "Year of Development and Implementation of the PSWM", where "N" = None

| SIZE | SC | Nº of Stores | Year |
|---|---|---|---|
| **Small** | **20** | 16 | N |
| | **16** | 22 | N |
| | **18** | 27 | N |
| | **15** | 30 | N |
| **Medium-sized** | **17** | 40 | N |
| | **19** | 40 | N |
| | **11** | 60 | 2008 |
| | **14** | 65 | N |
| | **9** | 70 | 2007 |
| **Large** | **1** | 115 | 1998 |
| | **8** | 120 | 2007 |
| | **4** | 150 | 2007 |
| | **10** | 200 | 2003 |
| | **6** | 210 | 2004 |
| | **13** | 260 | 2005 |
| | **7** | 276 | 2008 |
| | **5** | 300 | 2006 |
| | **2** | 300 | 2008 |
| | **3** | 320 | 2004 |
| | **12** | 350 | 2008 |

Table 3. Pairwise Comparison of the Judgment of Elements X and Y

| Judgment | Values |
|---|---|
| X IS EQUALLY PREFERABLE AS Y | 1 |
| X IS EQUALLY TO MODERATLEY PREFERABLE THAN Y | 2 |
| X IS MODERATELY PREFERABLE THAN Y | 3 |
| X IS MODERATELY TO STRONGLY PREFERABLE THAN Y | 4 |
| X IS STRONGLY PREFERABLE THAN Y | 5 |
| X IS STRONGLY TO VERY STRONGLY PREFERABLE THAN Y | 6 |
| X IS VERY STRONGLY PREFERABLE THAN Y | 7 |
| X IS VERY STRONGLY TO EXTREMELY PREFERABLE THAN Y | 8 |
| X IS EXTREMELY PREFERABLE THAN Y | 9 |

Source: [6].

Table 4. Values of the Random Indices (RI) for matrices with order 1 to 11

| **N** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **...** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RI** | 0,00 | 0,00 | 0,58 | 0,90 | 1,12 | 1,2 | 1,32 | 1,41 | 1,45 | 1,49 | 1,51 | ... |

**Source:** Saaty (1980, *apud* [1])

Table 5. Grouped values for in Small- and Medium-sized SCs

| Size (number of stores) | Small (up to 40) | | | | Medium (between 40 and 100) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SC** | **20** | **16** | **18** | **15** | **17** | **19** | **11** | **14** | **9** |
| **Number of stores** | 0,481 | 0,263 | 0,150 | 0,107 | 0,405 | 0,405 | 0,088 | 0,061 | 0,042 |
| **Existence of cinemas** | 0,250 | 0,250 | 0,250 | 0,250 | 0,243 | 0,243 | **0,027*** | 0,243 | 0,243 |
| **Existence of food court** | 0,321 | 0,321 | **0,036** | 0,321 | 0,692 | 0,077 | 0,077 | 0,077 | 0,077 |
| **SW Management** | 0,250 | 0,250 | 0,250 | 0,250 | 0,238 | 0,238 | **0,048*** | 0,238 | 0,238 |
| **Selective Collection** | 0,083 | 0,083 | 0,083 | 0,750 | 0,048 | 0,048 | 0,429 | 0,429 | 0,048 |
| **Separation control** | 0,045 | 0,165 | **0,625** | 0,165 | 0,118 | 0,075 | 0,319 | 0,319 | 0,168 |
| **Containers in circulation area** | 0,073 | 0,073 | 0,392 | 0,462 | 0,111 | 0,111 | 0,111 | **0,556** | 0,111 |
| **Containers in the food court** | 0,299 | 0,299 | 0,218 | 0,183 | 0,480 | 0,102 | 0,158 | 0,102 | 0,158 |
| **Outside containers** | 0,308 | 0,308 | 0,308 | 0,077 | 0,243 | 0,243 | **0,027*** | 0,243 | 0,243 |
| **Packaging of waste in containers** | 0,250 | 0,250 | 0,250 | 0,250 | 0,200 | 0,200 | 0,200 | 0,200 | 0,200 |
| **Packaging of recyclable materials in containers** | 0,250 | 0,250 | 0,250 | 0,250 | 0,077 | 0,077 | 0,077 | **0,692** | 0,077 |
| **Packaging of waste at storage** | 0,308 | **0,077*** | 0,308 | 0,308 | 0,555 | 0,137 | 0,036 | 0,137 | 0,137 |
| **Packaging of recyclable materials at storage** | 0,286 | 0,143 | 0,286 | 0,286 | 0,059 | 0,199 | 0,105 | **0,578** | 0,059 |
| **Solid waste from shopkeepers of the food court** | 0,321 | 0,321 | **0,036** | 0,321 | 0,485 | 0,056 | 0,201 | 0,201 | 0,056 |
| **Solid waste from ordinary shopkeepers** | 0,395 | **0,092*** | 0,395 | 0,118 | 0,059 | 0,059 | 0,294 | 0,294 | 0,294 |
| **Solid waste from cinemas** | 0,250 | 0,250 | 0,250 | 0,250 | 0,243 | 0,243 | **0,027*** | 0,243 | 0,243 |
| **Internal transportation** | 0,165 | 0,165 | **0,625** | 0,045 | 0,048 | 0,238 | 0,238 | 0,238 | 0,238 |
| **Health service waste** | 0,250 | 0,250 | 0,250 | 0,250 | 0,243 | 0,027 | 0,243 | 0,243 | 0,243 |
| **Specific area for storage** | 0,250 | 0,250 | 0,250 | 0,250 | 0,200 | 0,200 | 0,200 | 0,200 | 0,200 |
| **Storage area for each type of solid waste** | 0,250 | 0,250 | 0,250 | 0,250 | 0,034 | 0,034 | 0,310 | 0,310 | 0,310 |
| **Storing of light bulbs** | 0,250 | 0,250 | 0,250 | 0,250 | 0,581 | 0,148 | 0,044 | 0,148 | 0,079 |
| **Control of the amount of waste generated** | 0,250 | 0,250 | 0,250 | 0,250 | 0,200 | 0,200 | 0,200 | 0,200 | 0,200 |
| **Collection of residues** | 0,083 | 0,083 | 0,417 | 0,417 | 0,200 | 0,200 | 0,200 | 0,200 | 0,200 |
| **Final destination of residues** | 0,250 | 0,250 | 0,250 | 0,250 | 0,243 | 0,243 | **0,027*** | 0,243 | 0,243 |
| **Final destination of the recyclable materials** | 0,077 | 0,262 | 0,399 | 0,262 | 0,120 | 0,440 | 0,055 | 0,199 | 0,186 |
| **Amount Collected** | 0,250 | 0,250 | 0,250 | 0,250 | 0,090 | 0,414 | 0,207 | 0,090 | 0,199 |
| **Sum** | **6,246** | **5,655** | 7,277 | **6,821** | **6,216** | **4,658** | **3,948** | **6,685** | **4,493** |

Key: Values in bold and underlined: differentiated values of the SCs considered more appropriate, Values in bold and with an asterisk: differentiated values of the SCs considered less appropriate.

Table 6. Grouped values for Large SCs

| **Size (number of stores)** | **Large (100 +)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SC** | **1** | **8** | **4** | **10** | **6** | **13** | **7** | **5** | **2** | **3** | **12** |
| **Number of stores** | 0,106 | 0,085 | 0,097 | 0,080 | 0,091 | 0,072 | 0,089 | 0,095 | 0,106 | 0,102 | 0,077 |
| **Existence of cinemas** | 0,326 | 0,036 | 0,036 | 0,036 | 0,036 | 0,036 | 0,036 | 0,036 | 0,036 | 0,326 | 0,057 |
| **Existence of food court** | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 |
| **SW Management** | 0,030 | 0,030 | 0,030 | 0,030 | 0,321 | 0,140 | 0,036 | 0,036 | 0,036 | 0,036 | 0,274 |
| **Year of the PSWM *** | 0,003 | 0,003 | 0,003 | 0,003 | 0,029 | 0,013 | 0,003 | 0,003 | 0,003 | 0,003 | 0,025 |
| **Knowledge of the PSWM *** | 0,046 | 0,155 | 0,023 | 0,155 | 0,155 | 0,155 | 0,046 | 0,015 | 0,046 | 0,046 | 0,155 |
| **Training for the PSWM *** | 0,004 | 0,014 | 0,002 | 0,014 | 0,014 | 0,014 | 0,004 | 0,001 | 0,004 | 0,004 | 0,014 |
| **Selective Collection** | 0,176 | 0,020 | 0,020 | 0,020 | 0,176 | 0,176 | 0,020 | 0,176 | 0,176 | 0,020 | 0,020 |
| **Separation control** | 0,021 | 0,197 | 0,029 | 0,114 | 0,114 | 0,063 | 0,114 | 0,114 | 0,071 | 0,047 | 0,114 |
| **Containers in circulation area** | 0,100 | 0,093 | 0,023 | 0,023 | 0,023 | 0,231 | 0,023 | 0,100 | **0,262** | 0,100 | 0,023 |
| **Containers in the food court** | 0,048 | 0,143 | 0,048 | 0,143 | 0,048 | 0,143 | 0,048 | 0,048 | 0,143 | 0,143 | 0,048 |
| **Outside containers** | 0,013 | 0,130 | 0,130 | 0,013 | 0,130 | 0,034 | 0,130 | 0,130 | 0,034 | 0,130 | 0,130 |
| **Packaging of waste in containers** | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 |
| **Packaging of recyclable materials in containers** | 0,017 | 0,153 | 0,153 | 0,017 | 0,153 | 0,017 | 0,153 | 0,153 | 0,153 | 0,017 | 0,017 |
| **Packaging of waste at storage** | 0,022 | 0,127 | 0,054 | 0,127 | 0,022 | 0,127 | 0,127 | 0,127 | 0,127 | 0,127 | 0,013 |
| **Packaging of recyclable materials at storage** | 0,038 | 0,119 | 0,023 | 0,119 | 0,178 | 0,070 | 0,119 | 0,119 | 0,119 | 0,015 | 0,079 |
| **Solid waste from shopkeepers of the food court** | 0,069 | 0,045 | 0,141 | 0,247 | 0,028 | 0,018 | 0,247 | 0,028 | 0,028 | 0,028 | 0,122 |
| **Solid waste from ordinary shopkeepers** | 0,069 | 0,045 | 0,141 | 0,247 | 0,028 | 0,018 | 0,247 | 0,028 | 0,028 | 0,028 | 0,122 |
| **Solid waste from cinemas** | 0,213 | 0,041 | 0,081 | 0,081 | 0,081 | 0,038 | 0,078 | 0,018 | 0,078 | 0,213 | 0,078 |
| **Internal transportation** | 0,063 | 0,063 | 0,128 | 0,063 | 0,307 | 0,063 | 0,063 | 0,063 | 0,063 | 0,063 | 0,063 |
| **Health service waste** | 0,176 | 0,020 | 0,020 | 0,020 | 0,020 | 0,176 | 0,176 | 0,176 | 0,044 | 0,158 | 0,018 |
| **Specific area for storage** | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 |
| **Storage area for each type of solid waste** | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 | 0,091 |
| **Storing of light bulbs** | 0,045 | 0,106 | 0,024 | 0,025 | 0,197 | 0,013 | 0,092 | 0,197 | 0,159 | 0,016 | 0,128 |
| **Control of the** | 0,015 | 0,134 | 0,015 | 0,134 | 0,015 | 0,134 | 0,134 | 0,134 | 0,134 | 0,015 | 0,134 |

(to be continued)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **amount of waste generated** | | | | | | | | | | | |
| **Collection of residues** | 0,103 | 0,103 | 0,103 | 0,103 | 0,103 | 0,103 | 0,034 | 0,103 | 0,103 | 0,034 | 0,103 |
| **Final destination of residues** | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,067 | 0,333 |
| **Final destination of the recyclable materials** | 0,028 | 0,134 | 0,134 | 0,134 | 0,016 | 0,072 | 0,134 | 0,134 | 0,134 | 0,052 | 0,028 |
| **Amount Collected** | 0,109 | 0,052 | 0,052 | 0,025 | 0,014 | 0,109 | 0,025 | 0,025 | 0,239 | 0,239 | 0,109 |
| **Sum** | **2,272** | **2,478** | **1,940** | **2,404** | **2,730** | **2,465** | **2,607** | **2,489** | **2,757** | **2,391** | **2,648** |

Key: FC: Food Court; SW: Solid waste; FD: Final Destination; HSW: Health service waste; Storg.: Storage; Packg.: Packaging; Cont.: Container; SC: Selective Collection; Res.: Residues; Recycl.: Recyclable materials: Train.: Training; Knowl.: Knowledge; PSWM: Plan for Solid Waste Management; Shpk.: shopkeepers, and Blue: differentiated values of the SC considered more appropriate.

## Example of application of the AHP method, considering the criterion "number of stores" for small SCs.

**Matrix A**

The greater the number of stores, worse is the judgment

| **Number of Stores** | **CC** | **20** | **16** | **18** | **15** |
|---|---|---|---|---|---|
| **16** | **20** | 1.00 | 2.20 | 3.20 | 3.80 |
| **22** | **16** | 0.45 | 1.00 | 2.00 | 2.60 |
| **27** | **18** | 0.31 | 0.50 | 1.00 | 1.60 |
| **30** | **15** | 0.26 | 0.38 | 0.63 | 1.00 |
| | **Sum** | 2.03 | 4.08 | 6.83 | 9.00 |

**Matrix A'**

| **Number os Stores** | **CC** | **20** | **16** | **18** | **15** | **Sum** |
|---|---|---|---|---|---|---|
| **16** | **20** | 0.493 | 0.539 | 0.469 | 0.422 | 1.922 |
| **22** | **16** | 0.224 | 0.245 | 0.293 | 0.289 | 1.051 |
| **27** | **18** | 0.154 | 0.122 | 0.147 | 0.178 | 0.601 |
| **30** | **15** | 0.130 | 0.094 | 0.092 | 0.111 | 0.426 |

| | | |
|---|---|---|
| **Vector of weight W** | 1.922 | 0.481 |
| | 1.051 | 0.263 |
| | 0.601 | 0.150 |
| | 0.426 | 0.107 |

| | | | | | | | | | | | **Sum** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Matrix C** | 0.481 | 1.00 | 2.20 | 3.20 | 3.80 | | 0.481 | 0.578 | 0.481 | 0.405 | 1.944 |
| | 0.263 | 0.45 | 1.00 | 2.00 | 2.60 | | 0.218 | 0.263 | 0.300 | 0.277 | 1.059 |
| | 0.150 | 0.31 | 0.50 | 1.00 | 1.60 | | 0.150 | 0.131 | 0.150 | 0.171 | 0.602 |
| | 0.107 | 0.26 | 0.38 | 0.63 | 1.00 | | 0.126 | 0.101 | 0.094 | 0.107 | 0.428 |

| | |
|---|---|
| **Vector D** | 4.045 |
| | 4.030 |
| | 4.011 |
| | 4.014 |
| **Sum** | 16.100 |
| **Lambda max.** | 4.025 |
| **CI** | 0.008 |