

Environmental Performance Assessment (EPA) by using computerized system

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Abstract

The performance evaluation is an important element of the ISO 14000 process ISO 14001:2004 referred to the environmental performance (EP), as the measurable results of an organization's management of its environmental aspect. An efficient environmental system enables management to set and meet environmental standards and to assess whether the organization's environmental objectives are being achieved, it allow to concentrate their focus on significant gaps in environmental performance.. The (CA- EPA) computer aided Environmental Performance Assessment system, is modified from the CA-360° TPM system to appropriate the Environmental Performance Assessment (EPA). In this work environmental performance objectives are included in the database of the system. By using (CA- EPA) the (state company of leather Industries) was selected as application domain for assessment its Environmental performance.

The results showed that The Performance level of maintenance &-employees choice are 40% of the target level, where, the objectives (goals identifying), environmental instruction applications & laws & orders show the strong points, their Performance level is 80%. The E.Performance level of the other factors are 60%. The total Environmental Performance level is 62% and the summation of total points is 3.14 from the target value 5 and the total gaps from the target value are 38.8 %.

Keywords: Environmental Performance Assessment (EPA), ISO 14001:2004, Environmental performance objectives, pair- comparison technique, Environmental performance gap., target level.

تقييم الأداء البيئي باستخدام نظام حاسوبي

الخلاصة

تقييم الاداء من العناصر المهمة وفق ISO 14000 .ISO 14001:2004 اوضحت ان الاداء البيئي هو نتائج يمكن قياسها نتيجة تطبيق نظام الادارة البيئية المعتمد في المنظمة وفق السياسات البيئية والاهداف المرجوة. النظام البيئي الكفوء يساعد الادارة لوضع معايير بيئية لمعرفة فيما اذا كانت المنظمة قد حققت هذه الاهداف ، وللتركيز على فجوات الاداء البيئي . ان النظام المعان بالحاسوب لتقييم الاداء البيئي CA- EPA قد تم تحديثه من النظام الاساسي CA-360° TPM لكي يوائم متطلبات تقييم الاثر البيئي. وفي هذا العمل تم اعتماد معايير الاداء البيئي في قاعدة بيانات النظام . لقد تم اجراء التطبيق العملي لهذا البحث في الشركة العامة للصناعات الجلدية، وقد اظهرت النتائج نقاط ضعف في مستوى الصيانة وفي اختيار العاملين حيث كانت نسبة الاداء البيئي 40% من الاداء البيئي المستهدف ، في حين اوضحت النتائج نقاط قوية في تحديد الاهداف ، تطبيق التعليمات البيئية و تطبيق اللوائح والقوانين حيث كانت نسبة الاداء البيئي 80% . اما الاداء البيئي للمعايير الاخرى هي 60%. وقد تم ايجاد نسبة الاداء البيئي ككل و هي 62% ومجموع النقاط هي (3.1) من المستهدف (5) ، وان فجوة الاداء البيئي هي 38.8 %.

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Introduction

Organizations of all kinds are increasingly concerned with achieving and demonstrating sound environmental performance by controlling the impacts of their activities, products and services with their environmental policy and objectives. Many organizations have undertaken environmental "review" or "audits" to assess their environmental performance (EP) [1], [2].

The performance evaluation is an important element of the ISO 14000 process [3], [4]. ISO 14001:2004 referred to the environmental performance (EP), as the measurable results of an organization's management of its environmental aspect [1]. They based on its policy, objectives and targets. [2], [5], [6].

where the environmental aspects the element of an organization activities, products or services that can interact with the environment [1].

environmental performance assessment, help organization to know the guidance of their environmental performance [4]. efficient environmental system enables management to set and meet environmental standards and to assess whether the organization's environmental objectives are being achieved. It allow to concentrate their focus on significant gaps in environmental performance [5].

2- Environmental performance objectives and targets:

To meet the requirements under the performance standards, asset of guidance notes corresponding to the performance standards offers helpful more results oriented and emphasize the results of employee behavior (to which

decreasing the amount of unnecessary waste, competitive cost bases for guidance

on the requirements contained in the performance standards [6].

According to ISO 14032:1999, The company's environmental performance criteria are based on their objectives and targets [7]. targets should be measurable environmental performance indicators for measuring performance [8].

According to ISO 14001:2004, the overall environmental goal, consistent with the environmental policy, that an organization sets itself to achieve, and the environmental target are the detailed performance requirements, applicable to the organization or parts thereof, that arises from the environmental objectives and that to be set and met in order to achieve those objectives. The objectives and targets shall be measurable, where practicable [1], [9], [10].

3-Environmental performance objectives of WHO & ILO

The WHO "world health organization" & ILO "international labor organization" establish environmental performance objectives within the environmental management system

These objectives consist human factors management factors, operation factors, and organization factors, as shown in table (1) [11].

4-pair-comparison technique

Usually each of objectives is not of equal importance, thus it is appropriate to assign a weighting factor to each objective, as follow [12]:

a- An objective tree can be used to give a reliable assignment of weighting factors to each criterion as shown in Figure (1).

b- The highest level, overall objective is given value (1.0).

c- At each lower level the objectives are given weights relative to each other.

d- Use pair comparison technique, each objective is listed and compared to every other objective, as shown in figure (2).

The total number of the possible combinations is

$$N = n(n-1)/2 \dots\dots\dots (1)$$

Where:

N = total number of combinations

n = number of objectives

e- The objective that is considered the more important of the two is given a (1), and the less important is given a (0).

f- In the figure (1), there is a hierarchy of objectives at multi-levels. The highest level, overall objectives is given a value of (1.0). At each lower level, the objectives are given weights relative to each other. Each box in the tree is with the number of the objective. The weight (w_i) for each objective can be calculated as follow:

$$w_i = m_i / N \dots\dots\dots (2)$$

Where:

w_i = weight of each objective

m_i = Row summation of each objective

g-The constraints of pair- comparison technique are:

$$\left. \sum_{i=1}^{i=n} m_i = N \right\} \dots\dots\dots (3)$$

$$\sum_{i=1}^{i=n} w_i = 1.0$$

h- The “true weight”, given in the right side of each box is calculated as a fraction of the “true weight “of the objective above it. Using this method to assign weighting factors for sub-objectives by comparing sub-objectives in small groups. The true weights of all of the sub-objectives add up to unity.

i- Calculate the true weight of the sub-objectives, which is shown in figure (3), by using the following steps [13]:

w_{inL} = the weight of the left sub-objectives (in the left box)

$$\sum_{i=1}^{i=n} w_{inL} = 1.0 \dots\dots\dots(4)$$

Step -1: use pair-comparison technique to determine the weight of left sub-objectives in the left box (w_{inL})

Step-2: Calculate the weight of the right sub-objective (true weight) (w_{inR})

$$w_{inR} = w_{inL} * w_{iR} \dots\dots\dots(5)$$

$$\sum_{i=1}^{i=n} w_{inR} = w_{iR} \dots\dots\dots(6)$$

Where

w_{inR} = The true weight of the sub-objectives (in the right box)

w_{iR} = The true weight of the objective above (in the right box)

j- Ranking the performance objectives and sub-objectives according to their weights.

5- (CA-EPA) system:

(CA-EPA) system mean computer aided Environmental Performance Assessment system, the basic of this system is CA-360° TPM system which is previously designed by the researcher [13].

The information of the database of this system is changed to appropriate the Environmental Performance Assessment (EPA), where the environmental Performance objectives are entered as shown in the table (2). Also the information of the windows of the system are changed .

6- Practical Application The practical application of CA-EPA system has been applied in an industrial organization, the ((the state company of leather Industries) .

The environmental performance objectives are rated by The scale degree (5). The weight of the main objectives are calculated by using pair- comparison technique Then ranking the main objectives .

The weights of the sub objectives are calculated by using pair- comparison technique. The CA-EPA system represents these weights as shown in the fig.(4), then ranking the main objectives and the sub objectives according to their weights. The rater entered the degrees for each sub objectives, as shown in the fig.(5).

Then the system calculate the point, the target value, the percentage of the performance level & the percentage of the performance gap level for each Environmental Performance sub objectives as shown in the fig. (6).

The system show the target value graph and the current Environmental Performance level graph, it also shows the performance gap graph as shown in the figure (6) .

The system also calculate the total points and the percentage of the total Environmental Performance level

As shown in the figure (6).

7. Results & Discussion

The results are shown in the tables (3) , (4) where the management factors are of the highest weight (0.33) , then the organization factors (0.27) & operation factors (0.13), employees factors (0.13)& other factors (external factors) are (0.13).

The Performance level at maintenance level&-employees choice are 40% of the target level which they show the weak points, and must took corrective action to improve these points. where the objectives (goals identifying) , environmental instruction applications& laws &orders show the strong points, their Performance level is 80%. The other all factors are 60% and their gaps from the target value are 40%. the total Environmental Performance level is 62% and the summation of total points is 3.14 and the total gaps from the target value are 38.8 %. There for the

company must improve their Environmental Performance.

Conclusion:

Environmental Performance should be periodically measured to maintain and improve environmental management system. Enhancement and strengthen the environmental management system, by setting Environmental Performance objectives and targets to correct and Environmental Performance level and take the appropriate corrective actions prove compliance to the environmental management system.

(CA-EPA) system computer aided Environmental Performance Assessment system, has the ability to measure and evaluate Environmental Performance level, Environmental Performance gap of each Environmental Performance objective and of all organization.

Gap analysis of Environmental Performance objectives from the target provides specific details and recommendation to the organization for the improvement and take corrective actions to strength the weak points.

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Table (1): Environmental Performance objectives

<i>Environmental Performance objectives</i>
1) Employees factors: 1-employees choice 2-skills & knowledge 3- impulse &principles 4-stimulants
2) Management factors: 1-Policy & direction 2-planning approaches 3- monitoring &supervision
3) Operation factors: 1-maintainance level 2- information of health &safety 3- use of raw materials, water& power 4- TQM applications 5-environmental instruction applications
4) Organization factors: 1-the objectives 2-the organization 3- technological level 4-organization cultures 5- research &development
5) Other factors(External factors): 1- laws &orders 2-cooperation with local management 3- cooperation with other institutions

Table (2): Environmental Performance objectives database

<i>Environmental Performance objectives</i>	Weight of criteria	D₁	D₂	-----	D_n	Points = w * D
Employees factors: 1-employees choice 2-skills & knowledge 3- impulse &principles 4-stimulants						
Management factors: 1-Policy & direction 2-planning approaches 3- monitoring &supervision						
Operation factors: 1-maintainance level 2- information of health &safety 3- use of raw materials, water & power 4- TQM applications 5-environmental instruction applications						
Organization factors: 1-the objectives 2-the organization 3- technological level 4-organization cultures 5- research &development						
Other factors: 2- laws &orders 2-cooperation with local management 3- cooperation with other institutions						

Table (3): the final results of the total environmental performance of the company

Total Environmental Performance Gap	Total points	total Environmental Performance Assessment
37.24%	3.14	62.76%

Table(4):the final results of the environmental performance of the company

<i>Environmental Performance objectives</i>	<i>Weight of criteria</i>	<i>Rated degree</i>	<i>point</i>	<i>Target value</i>	<i>E. performance level%</i>	<i>E .performance gapl%</i>
O₁ - Management factors:						
1-Policy & directions	0.1089	3	0.3267	0.5445	60.0%	40.0%
2-planning approaches	0.1089	3	0.3267	0.5445	60.0%	40.0%
3- monitoring &supervision	0.1089	3	0.3267	0.5445	60.0%	40.0%
O₂ - Organization factors:						
1-- research &development	0.108	3	0.324	0.54	60.0%	40.0%
2-the organization cultures	0.054	3	0.162	0.27	60.0%	40.0%
3- organization	0.054	3	0.162	0.27	60.0%	40.0%
4- the objectives (goals identifying)	0.027	4	0.108	0.135	80.0%	20.0%
5- technological level	0.027	3	0.081	0.135	60.0%	40.0%
O₃ - Operation factors:						
1- TQM applications	0.039	3	0.117	0.195	60.0%	40.0%
2 environmental instruction applications	0.039	4	0.156	0.195	80.0%	20.0%
3- use of raw materials, water& power	0.026	3	0.078	0.13	60.0%	40.0%
4 - information of health &safety	0.013	3	0.039	0.065	60.0%	40.0%
5- maintenance level	0.013	2	0.026	0.065	40.0%	60.0%
O₄ - Employees factors:						
1-skills & knowledge	0.0429	3	0.1287	0.2145	60.0%	40.0%
2 stimulants(motivation)	0.0429	3	0.1287	0.2145	60.0%	40.0%
3- impulse &principles	0.0221	4	0.0884	0.1105	80.0%	20.0%
4 -employees choice	0.0221	2	0.0442	0.1105	40.0%	60.0%
O₅ - Other factors:						
1-laws &orders	0.0429	4	0.1698	0.2145	80.0%	20.0%
2-cooperation with local management	0.0429	5	0.2145	0.2145	100.0%	00.0%
3- cooperation with other institutions	0.0429	3	0.1287	0.2145	60.0%	40.0%

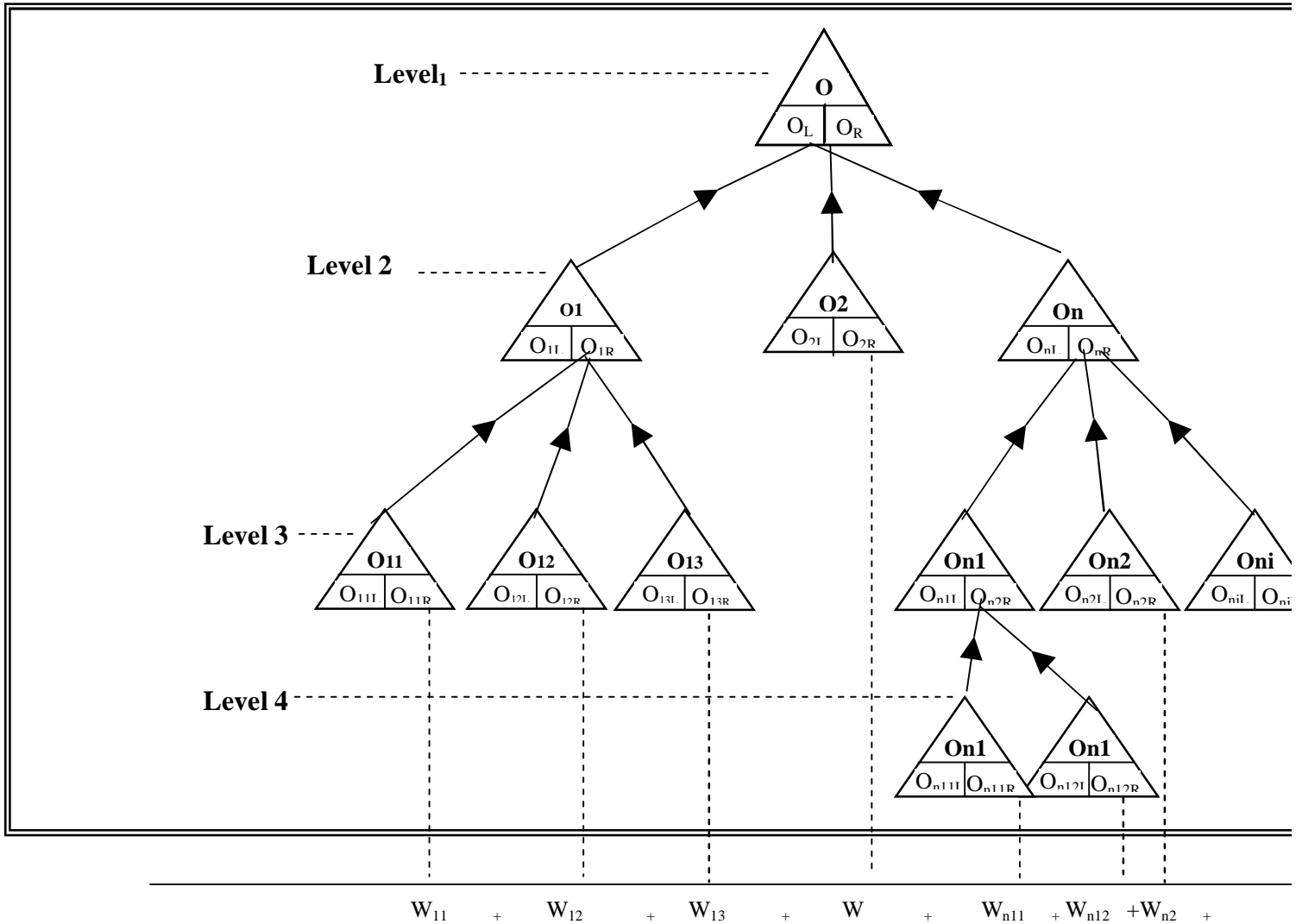


Figure (1): Objective tree for establishing weighting factors [12]

Environmental Performance objectives	O_1	O_2	O_3	O_4	--	O_i	Row summation (m_i)	Objective weight (w_i)
O_1							m_1	w_1
O_2							m_2	w_2
O_3							----	----
O_4							----	----
----							----	----
O_i							m_i	w_i
							$\sum m_i = N$	$\sum w_i = 1.0$

Fig.(2) :pair comparison technique

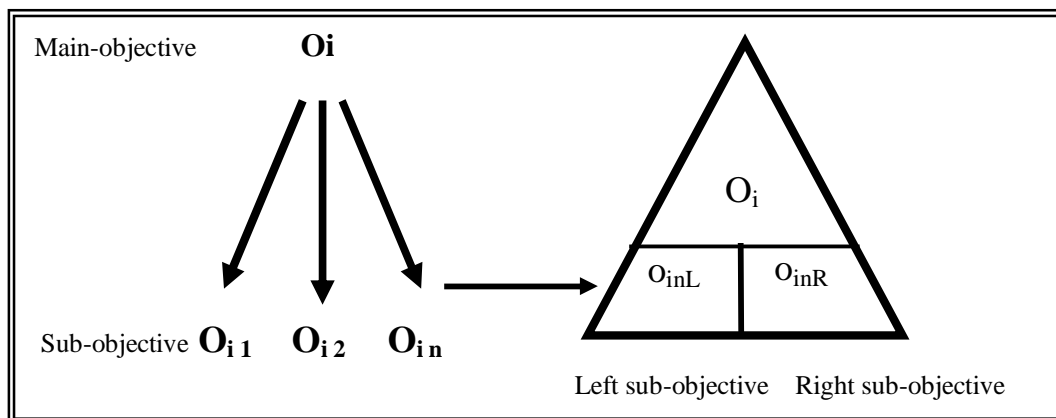
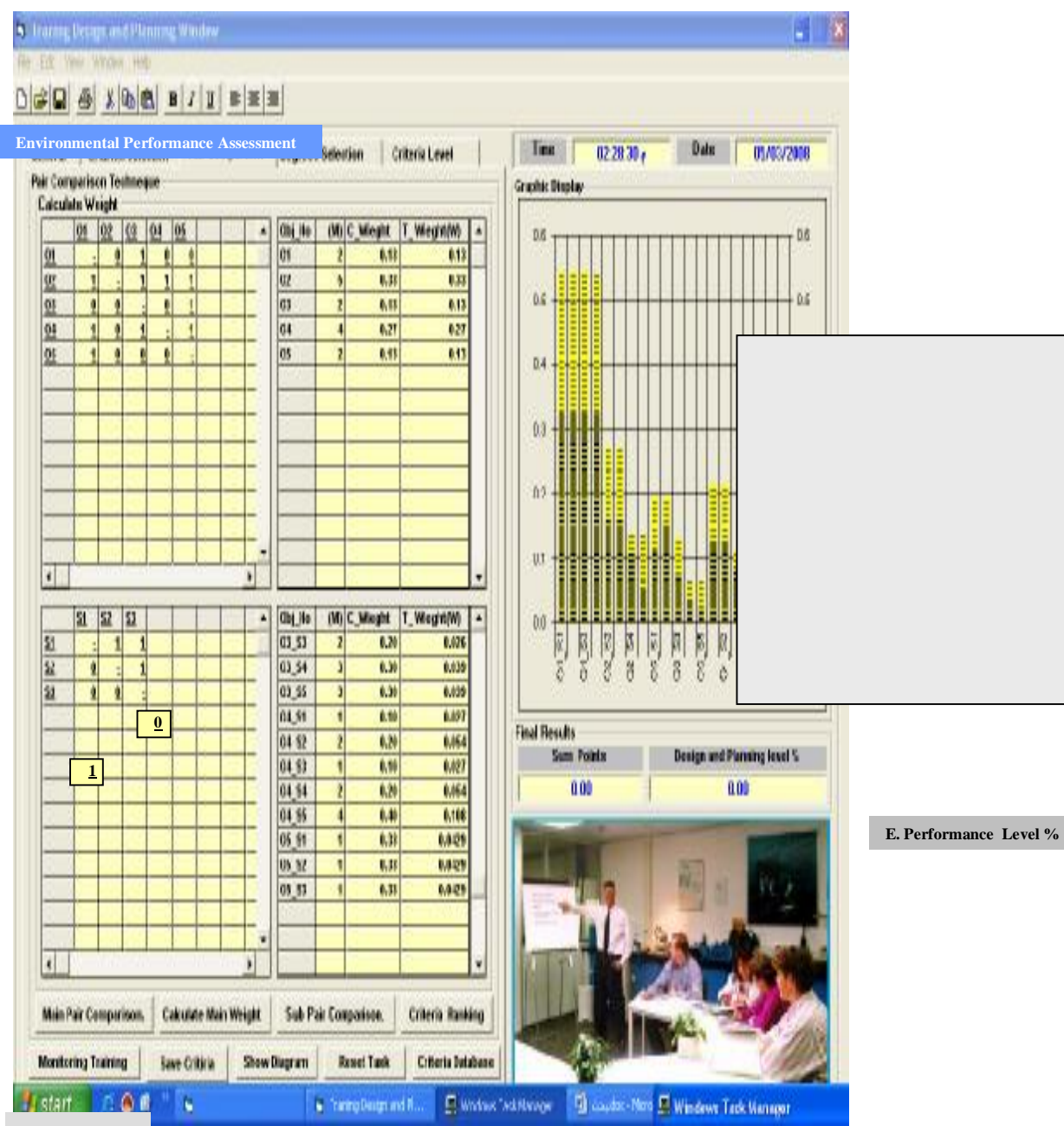


Figure (3): The relation between objective and sub- objectives



E. Performance Level %

Fig.(4): the pair –comparison window

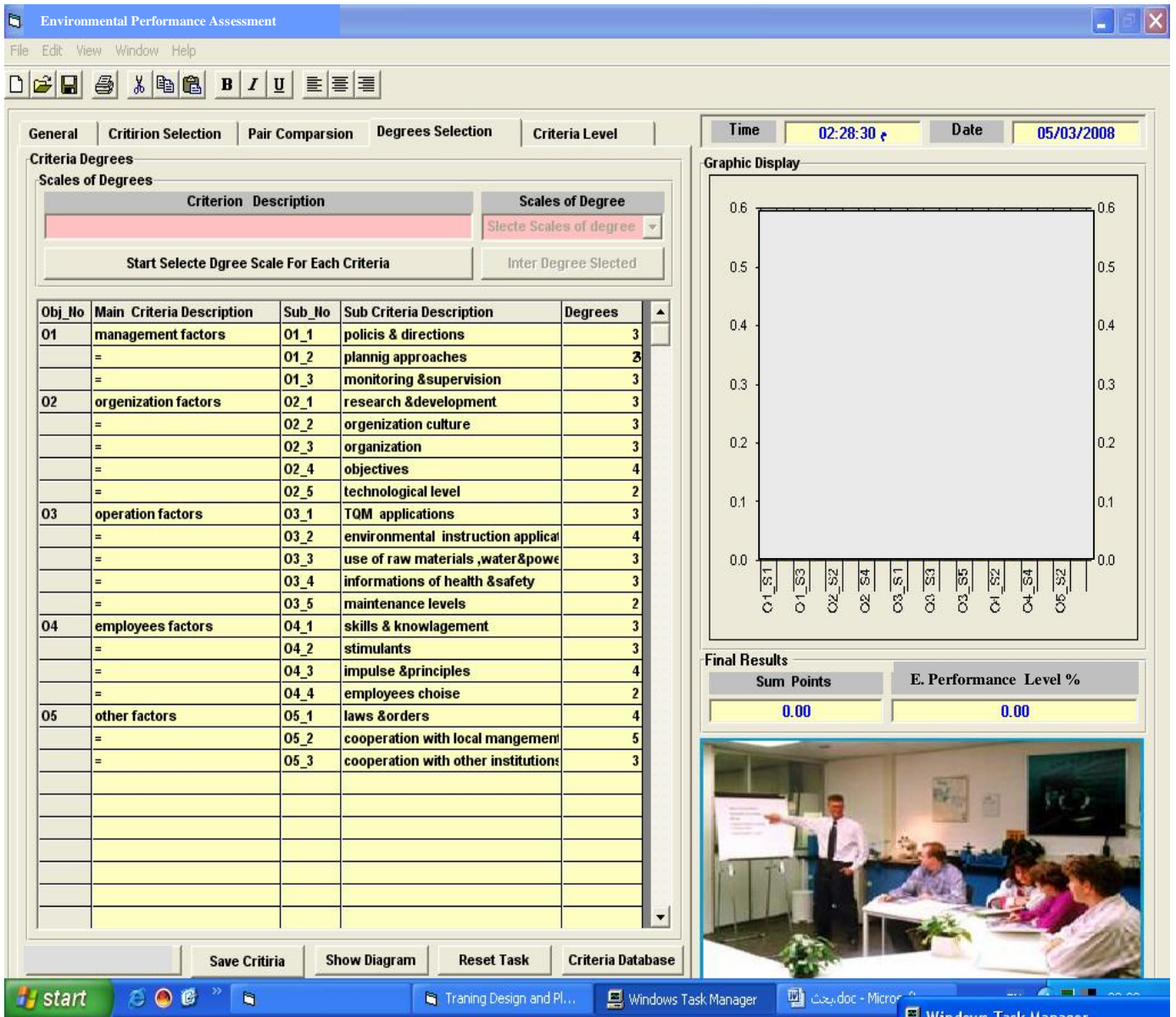


Fig.(5): The entered degree window

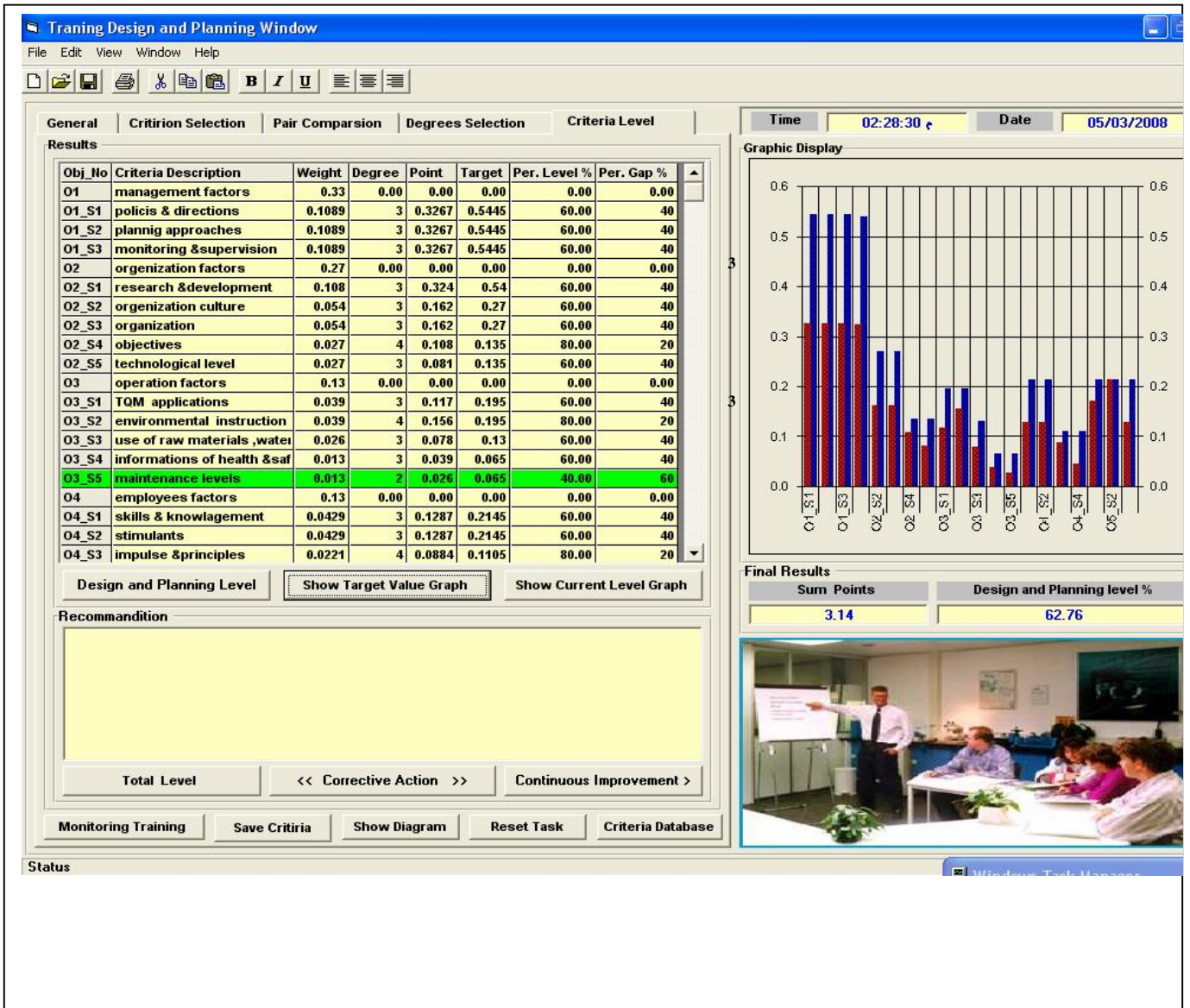


Fig. (6): The window which represents the graphs & the total results