Identification and Prioritization of the Effective Factors on Employee Productivity of SMEs of Shiraz Industrial Town Using AHP and TOPSIS Techniques : Case Study In Iran

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Abstract
In today's changing and complicated conditions that rules the economical, social, political, and…. environment, one of the factors that can help the survival of an organization is the issue productivity. As to this in this study we've tried to identify the most influential factors on the human force productivity and then to prioritize these factors. After studying the existing texts and pieces of research regarding productivity and decision making techniques and also interviewing experts and professors, a questionnaire including managerial, social-psychological, cultural, environmental, personal and economical factors was prepared.
After analyzing the first questionnaire, the final criteria were identified and the second questionnaire which included the tables of pair- comparisons of the criteria was prepared and the obtained data was used for ranking the criteria in AHP, SAW, TOPSIS and ELECTRE methods. With regard to the fact that the results obtained from carrying out the above methods didn't correspond to each other in some cases for reaching a general consensus concerning the ranking of criteria the aggregate techniques (Poset) that include average, Borda and Copeland methods were used.
Finally the managerial factors were identified as the most important factors and then personal, cultural, social-psychological and finally environmental factors respectively.
Keywords: "Human Force Productivity, POSET, SAW,ELECTRE, TOPSIS, AHP

Introduction

The word scarcity is closest in meaning to the word finite or economy that is used in contrast to the word infinite or free. Scarcity is the central and fundamental problem of every society. Economical resources are diverse cases of work, capital, land and management that are used in producing goods and services. Since the resources of any society is finite and scarce, all the societies encounter problems such as : what to be produced, how to be produced, for whom to be produced; and how the goods be rationed and preserved during time to make the system grow.

Since the organization is provided with finite resources and facilities and many of these resources are not renewable or their second formation takes a long times or some resources are scarce so that providing these resources needs spending great expenses and also population growth and consequently consumption and production increase intensifies scarcity of the resources everyday, so satisfying infinite needs by depending on such resources and facilities is never possible. As a result the only logical and possible way is obtaining the maximum efficiency and profit from the minimum resources and this issue resides in productivity and noticing it can be to the benefit of both the organization and the society in which the organization exists.

Taking steps to improve and to use the various resources such as work force, capital, materials, energy and information effectively and efficiently is the aim of all the managers of economical organizations and the industrial manufacturing units and service institutes.

As it is in a Hadis from Imam Sadegh:

A person whose last and present days are identical has lost, a person whose present day is better than his last day is envied by others (everybody wishes to be in his shoes) and a person whose present day is worse than his last day is damned and a person who didn't notice any progress in himself as the days are passing moves toward loss and everybody who moves toward loss, death is better for him than life.

1- Statement of the Problem

The activities of every organization are affected by a set of factors. Identifying and examining these factors can effectively help to the betterment of the activities and accomplishing the organizational goals. One of the most

important goals of any organization is raising quality; that in today's competitive conditions the organizations must consider quality improvement along with productivity improvement.

The importance of productivity in raising national welfare is now generally accepted. All the human activities benefit from productivity improvement. This is important since most of the increase in gross national product or GNP is caused by the improvement of the effectiveness and quality the human force rather than utilization of additional work and capital. In another words when productivity increases, the gross national product or GNP increases more rapidly than other input factors.

So change in productivity has a great impact on many economical and social phenomena such as rapid economic growth, raising life level, improvement of the balance of payments, inflation control and even quantity and quality of the leisure time. These changes affect salary level, the relation between cost and price, the required investment and employment. Many countries that can't coordinate with their competitors' productivity level try to compensate for their problems by decreasing their money value. But this causes the real income of the people decrease as the price of import goods raises and the internal inflation increases.

Concerning the fact that productivity depends on many factors and these factors differ from one organization to the other with regard to nature, mission, activity, operations and..., and also the fact that the degree of this effect and significance of these factors is not identical on the productivity of different organizations, so it is not possible for the organizations to get involved in all the effective fields and aspects. Necessarily for reaching the highest level of productivity first it is essential that these factors be identified and prioritized for the organization with regard to their importance according to scientific rules and criteria, then for the improvement of productivity the implementation plans and necessary programs be prepared.

2- Literature review

In this research for evaluation and extraction of the proper criteria and indexes, extensive library studies have been conducted and different models examined.

One of the studies that can be referred to is an article under the title of "AHP: a new technique for team decision making", in which the AHP technique along with an assumed example has been thoroughly explained. [1]

Another study is an MA thesis entitled as "identification and prioritization of the effective factors on productivity using decision making techniques of MADM in a fuzzy environment" in which the researcher by identifying the effective factors on the productivity of Shiraz Pars Nasouz company has prioritized them. The techniques used in the research are AHP, TOPSIS, ELECTRE and LINMAP[8].

In 2008 several international articles in which the AHP and TOPSIS techniques simultaneously have been used published which some of them are as follows:

"weapon selection using the AHP and TOPSIS methods under fuzzy environment"[9], "evaluation of hazardous waste transportation firms by using a two step fuzzy-AHP and TOPSIS methodology ''[10] and "transshipment site selection using the AHP and TOPSIS approaches under fuzzy environment" [11] and … that in all the above articles the researchers first have drawn the hierarchical tree of their research and then using AHP techniques they've weighted and finally prioritized the present choices in their model using TOPSIS technique.

2-1-Productivity

Some time the following words are used instead of productivity. Although these words are not exact equivalents for the term productivity, but they are used for identifying different aspects of productivity.

A: Efficiency: The ratio of the real obtained output to the standard output (expected value) is called efficiency, or in fact the ratio of the accomplished work to the work that must be done (Abtahi& Kazemi,9:1379)

B: Effectiveness: Effectiveness involves the degree of achieving defined goals. In other words effectiveness shows to what degree the defined goals have been achieved with regard to the conducted efforts. (Abtahi& Kazemi,9:1379)

C: Productivity: Productivity is a concept that shows the relationship between the produced product (offered services) and the effective factors in making that product (services). This relationship most of the times is presented in a simple manner in the form of a model as the **taken ratio to the given ratio**.

So with regard to the above matters:

Productivity= effectiveness + efficiency

Productivity= accomplishment of right works + rightly accomplishing works (Abtahi& Kazemi,10:1379)

Also it can be referred to the definitions proposed by the Productivity Organization of Iran that state: productivity is a logical attitude toward life and work. It's a culture whose aim is to make the activities more wise for a better and more elevated life (the National Organization of Iran Productivity,1373)

2-2-Analytic Hierarchy Process

The Analytic Hierarchy process is proposed by professor. Saati as one the multi-criterion decision making methods. This method has been noted from 1980 by many researchers and many studies have been conducted on it up to now.

The aim of The Analytic Hierarchy Process is forming a hierarchy of the complexity of a problem through the classified degrees from high to low or from the general to specific and economic matters, so that in this manner a more exact precision be achieved according to the perception of the issue.

For carrying out the analytic hierarchy process in the first step the hierarchy tree of the problem which includes goal, criteria and sub-criteria must be drawn.

In the next step the tables of the pair-comparisons of criteria and sub-criteria must be prepared and presented to the participants of this research.

In the third step, the completed tables by participants must be examined with regard to inconsistency rate and the tables which include inconsistency rate of more than .1 be returned to the participants to reconsider their judgment that includes inconsistency**.**

Finally the ideas of the individuals were put together to reach a final ranking of criteria, this stage was done through Team Expert Choice 2000 software.

2-3 Simple Additive Weighted (SAW) Method

The Simple Additive Weighted Model namely SAW is one the simplest methods of multi- index decision making method. By computing the weights of indexes, one can use this method easily. For using this method the following steps is necessary:

1. Quantifying the decision making matrix
2. Linear **out scaling** of the decision making quantities
3. Multiplying the **out scaled** matrix in the weights of indexes
4. Selecting the best choices (A*) using the following criterion

$$A^* = \left\{ A_i \middle| Max \sum_{j=1}^{n} n_{ij} w_j \right\}$$

In other words, in SAW method an choices is selected (A*) that the product of its weighted <u>outscaled</u> quantities ($n_{ij} w_i$) is more than the rest of the choices.[7]

2-4-Techniques for Order-Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS model was proposed by Hwang and Yoon in 1981. This model is one of the best models of multi-index decision making and has many applications. In this method also m choices are examined by n indexes. This technique is fundamentally based upon the concept that the selected choices must have the minimum distance with the positive ideal solution (the best possible state) and the maximum distance with the negative ideal solution (the worst possible state). It is assumed that the desirability of each index is steadily decreasing or increasing.[7]

2-5-Elimiantion et Choice Translating Reality (ELECTRE)

The ELECTRE model was proposed in late 1980 and was noticed as one of the best techniques of MADM. The basis of this concept is the outranking relationships, that is it doesn't necessarily lead in ranking the choices but may eliminate some choices.

2-6-Prioritizing Strategies

With regard to the different techniques mentioned above different rankings may be obtained for the same problem. In that case for reaching a consensus regarding the different rankings the aggregate methods which include average, Borda and Copeland methods must be used.

3-Methodology

The approach of this research has been based on three basic steps. In the first step for the thorough perception of the concepts and identifying aspects and indexes of the research problem free and manipulated interviews were held with professors and also managers, and the experts of different levels of Pooshak Sharg Jameh Company, and then with regard to the literature review and examining the present condition of the factory, the important criteria and indexes in the improvement of the human force productivity were determined that lead to the identification of 38 criteria in 6 subgroups of managerial, social-psychological, cultural, environmental, personal and economic.

Managerial Factors
1- Capable supervisor
2- Presence of proper conditions for contribution to decision making
3- Training during work
4- The system of promoting employees according to capability Presence of motivational factors and stimuli in work environment
5- Presence of motivational factors and stimuli in work environment
6- Job turnover
7- Degree of control of the employees by the manager and supervisor

Social-psychological factors
1- Good relationship between manager and employees
2- Job security
3- Experiencing the feeling of fairness of the working conditions (indiscrimination,…)
4- Presence of a friendly spirit between employees
5- Job satisfaction
6- Presence of the feeling of attachment to the organization

Cultural Factors
1- Having positive attitude toward organization and work
2- Having work- conscience
3- Presence of the appropriate environment for showing creativity and innovation
4- Presence of the proper conditions for job progress and promotion
5- Presence of the proper conditions for job progress and promotion
6- Commitment to rules and regulations

Environmental Factors
1- Appropriate physical conditions of the working environment (light level, noise, humidity and air conditioning and…)
2- Hygiene and safety of the work
3- Proper work tools
4- Cleanness and freshness of the work environment (order, ….)
5- Ergonomy
6- Playing music during work
7- Raw materials quality
8- Product design
9- Technology and technical knowledge
10- The system of repairing and preserving equipment and machinery

Personal Factors
1- Presence of harmony between personal skills and job
2- Education level
3- Presence of harmony between personal interests and job
4- Having work experience

Economic Factors
1- Proper paying of cash bonus
2- Paying proper non-pecuniary bonus
3- Presence of the system of paying salary and wage according to performance
4- Facilities
5- Appropriateness of salary and wage level
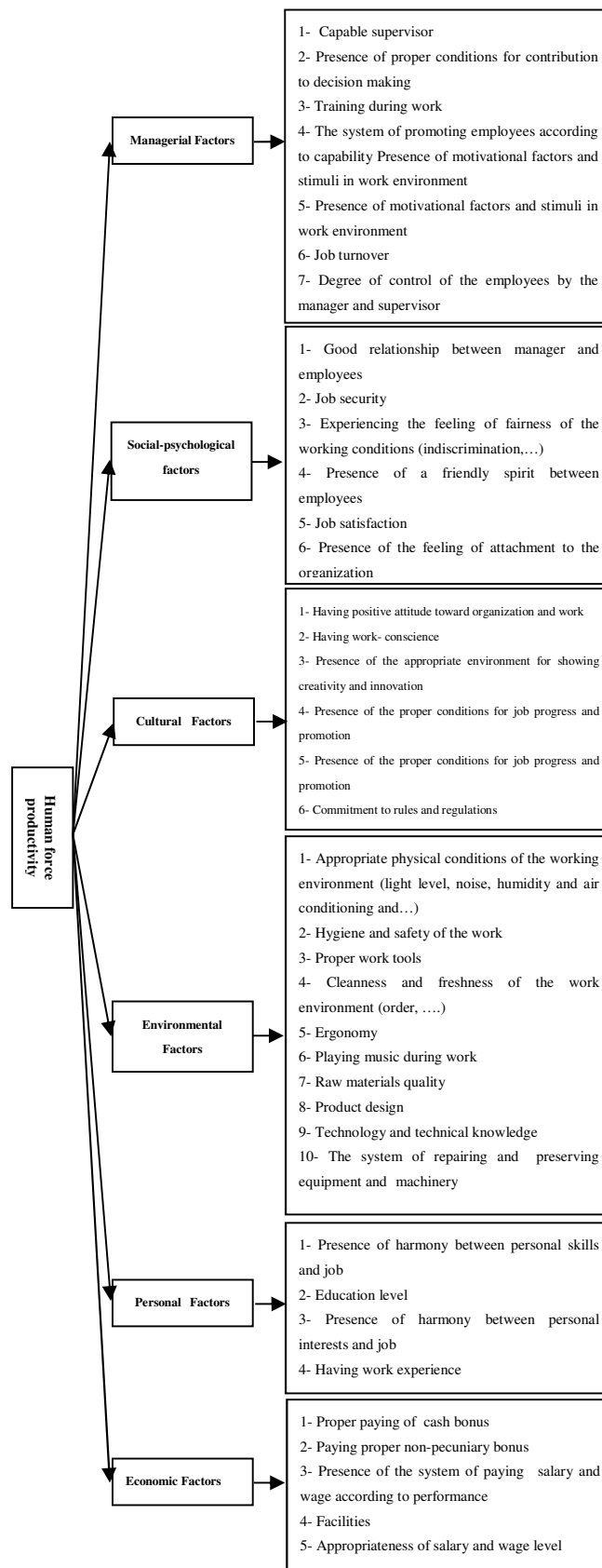
Human force productivity

Figure 1: the hierarchical tree of the primary criteria of the human force productivity
After identifying the most important primary criteria which were 38 criteria by the research team, the subjects were asked to rank the criteria according to the following table.

Table (1) Spectrum of grading the criteria

Effect Level	Very High	High	Middle	Low	Very Low
Point	5	4	3	2	1

Due to some limitations in the company (such as low knowledge of some employees and also the manager's request as to non-random selection of subjects), overall, from the 32 distributed questionnaires 30 of them were gathered.

For putting the ideas together and ranking the final criteria through EXCEL software the arithmetic and geometric mean of the criteria significance was computed and the final criteria was identified as it follows.

The criteria which had the highest importance with regard to the results from the analysis of questionnaire A, namely those cluster of criteria which had a score higher than the of the whole responses to the questionnaire (for the individual participants) were kept and some of the criteria that had a arithmetic and geometric mean lower than the total average were deleted from the process.

After identifying the 21 final criteria we came up with interesting result and that's the fact that none of the criteria from the economic factors gained the adequate conditions for being selected -that in some ways points to the studies by Hawthorne- that is for the human force psychological and motivational factors are much more important than the economic factors and just one factor of "appropriateness of salary & wage level" has the acceptable arithmetic average (that is its average is higher than the total arithmetic mean) but its geometric average is lower than the total geometric average and hasn't the adequate conditions for being selected; and finally from the 38 primary criteria 21 criteria were selected.

In the final step, the final 21 criteria were compared by participants through pair-comparison tables and the obtained data from these tables were used as the criterion of different techniques for prioritizing the higher criteria.
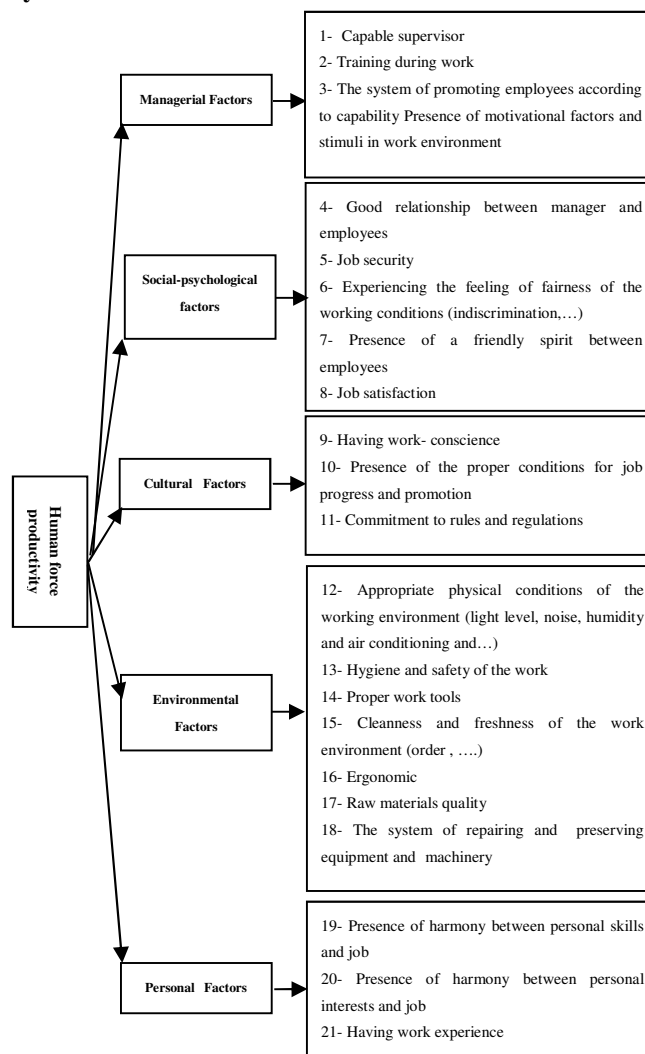
Human Force Productivity

Figure 2: the hierarchical tree of the final criteria of the human force productivity

3-Participants

The participants took part in this study included managers, supervisors, and a number of employees of a jeans manufacturing unit in Shiraz province.

The mentioned manufacturing company totally has 150 personnel and is located in Shiraz special weaving zone that produces 2000 pairs of jeans in every work shift.

5-Data Analysis

Regarding the fact that from the 38 primary criteria 21 were chosen, the second questionnaire with 6 pair-comparison tables was prepared (5 table for the comparison of criteria in their respective subcategory and 1 table also for the pair comparison of the groups) and were distributed among 18 members of the factory and finally 16 completed questionnaires were gathered.

5-1- Running Hierarchical Analysis Technique

After completing the questionnaires, the ideas of different participants will be put together using the Team Expert Choice Software. This software has extensive facilities for obtaining the matrixes of individuals' pair comparisons and then combining different individuals' matrixes together and changing into a single matrix that through the geometric average the individual factors of the participants' matrixes will be obtained.

The trend was in such a way that after completing the second questionnaire by respondents, the pair comparison matrixes of that questionnaire would enter the software one by one and for determining consistency and nonconsistency of the ideas, it was necessary to compute the conflict rate of matrix of ideas of each individual. Finally, 16 of the 18 distributed questionnaires were collected and after entering the last questionnaire data into the software and examining its conflict, the software draw a pulled matrix for each of the 6 matrixes (in which the point of all participants were presented in the form of geometric matrix) and offered us the final ranking of 21 criteria along with their respective weights separately.

Table 2: *final weights of the 21 criteria of human force productivity according to AHP technique*

Factors	Factor Weight	Criteria	Criterion weight in sub-group	Final Weight	Rank
Managerial Factors	0.259	1.Capable supervisor	0.421	0.109	1
		2.Training during work	0.257	0.0666	6
		3.The system of promoting employees according to capability	0.322	0.0834	3
Social-psychological factors	0.255	4.Good relationship between manager and	0.155	.0395	12
		5.Job security	0.275	.0701	4
		6. Experiencing the feeling of fairness of the working conditions (indiscrimination,)	0.27	0.0689	5
		7. Presence of a friendly spirit between employees	0.112	0.0286	14
		8. Job satisfaction	0.188	0.0479	11
Cultural Factors	0.179	9. Having work- conscience	0.518	0.0927	2
		10. Presence of the proper conditions for job progress and promotion	0.189	0.0338	13
		11. Commitment to rules and regulations	0.293	0.524	10
Environmental Factors	0.136	12. Appropriate physical conditions of the working environment	0.116	0.0158	20
		13. Hygiene and safety of the work	0.154	0.0209	17
		14. Proper work tools	0.175	0.0238	16
		15. Cleanness and freshness of the work environment (order, ….)	0.115	0.0156	21
		16. Ergonomic	0.134	0.0182	18
		17. Raw materials quality	0.124	0.0169	19
		18. The system of repairing and preserving equipment and machinery	0.182	0.0248	15
Personal Factors	0.17	19. Presence of harmony between personal ability and job	0.338	0.0575	8
		20. Presence of harmony between personal interests and job	0.342	0.0581	7
		21. Having work experience	0.32	0.0544	9

5-2-Ranking according to SAW, TOPSIS and ELECTRE Techniques

After entering the data from the ideas of the second questionnaire participants into Expert Choice Software, this software separately gives us the criteria weights obtained from the ideas of participants by which we make the decision matrix for running SAW, TOPSIS and ELECTRE methods. The obtained result from the evaluation of each respondent is regarded as one column of the decision matrix in this relation and with regard to the fact that 16 questionnaires is completed and gathered we will have a decision making matrix with 21 row (the number of criteria) and 16 column (the number of respondents) that will be used as the criterion of the other multi-index decision making techniques.

After running the above technique the following results has been obtained.

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Table 3: *Ranking the 21 criteria of human force productivity according to SAW, ELECTRE and TOPSIS techniques*

Factors	Criteria	SAW	ELECTRE	TOPSIS
Managerial Factors	1.Capable supervisor	1	1	1
	2.Training during work	8	7	3
	3.The system of promoting employees according to capability	3	2	4
Social-psychological factors	4.Good relationship between manager and employees	11	11.5	9
	5.Job security	6	5	7
	6. Experiencing the feeling of fairness of the working conditions (indiscrimination, …)	7	7	8
	7. Presence of a friendly spirit between employees	14	14	14
	8. Job satisfaction	12	9	12
Cultural Factors	9. Having work- conscience	2	3	2
	10. Presence of the proper conditions for job progress and promotion	13	13	13
	11. Commitment to rules and regulations	10	10	11
Environmental Factors	12. Appropriate physical conditions of the working environment	21	20.5	21
	13. Hygiene and safety of the work	15	15	15
	14. Proper work tools	16	17	18
	15. Cleanness and freshness of the work environment (order ,….)	17	19	16
	16. Ergonomic	18	17	17
	17. Raw materials quality	20	20.5	20
	18. The system of repairing and preserving equipment and machinery	19	17	19
Personal Factors	19. Presence of harmony between personal skills and job	9	11.5	10
	20. Presence of harmony between personal interests and job	4	4	6
	21. Having work experience	5	7	5

It's noteworthy that since some criteria gained identical ranks, the arithmetic average of their rank has been used as the rank of all those criteria.

6-Conclusion

As it was noticed in the above tables, the obtained results from running SAW, TOPSIS and ELECTRE techniques didn't lead in a single and identical ranking for 21 selected criteria and confuses us in selecting the higher criteria, as to this we must make use of methods that lead to a sum up for ranking the criteria. These methods which are known as aggregation methods include: rank average method, Borda method, and Copeland method.

In the average method, an average is obtained from the criteria ranks in 4 methods of SAW, TOPSIS and ELECTRE and ranking is done according to that.

The Borda method is according to majority rule, in such a manner that the criterion that has better ranks (more gains) in proportion to the other criteria in different methods has the higher rank in this method.

The Copeland method uses the information from the Borda method, just differing in the point that it also takes into consideration the number of losses of every criterion in proportion to the rest of the criteria and subtracts them from the number of gains and ranks according to the results from the difference of wins and defeats.

Results from running aggregate techniques (average, Borda and Copeland) is presented in.
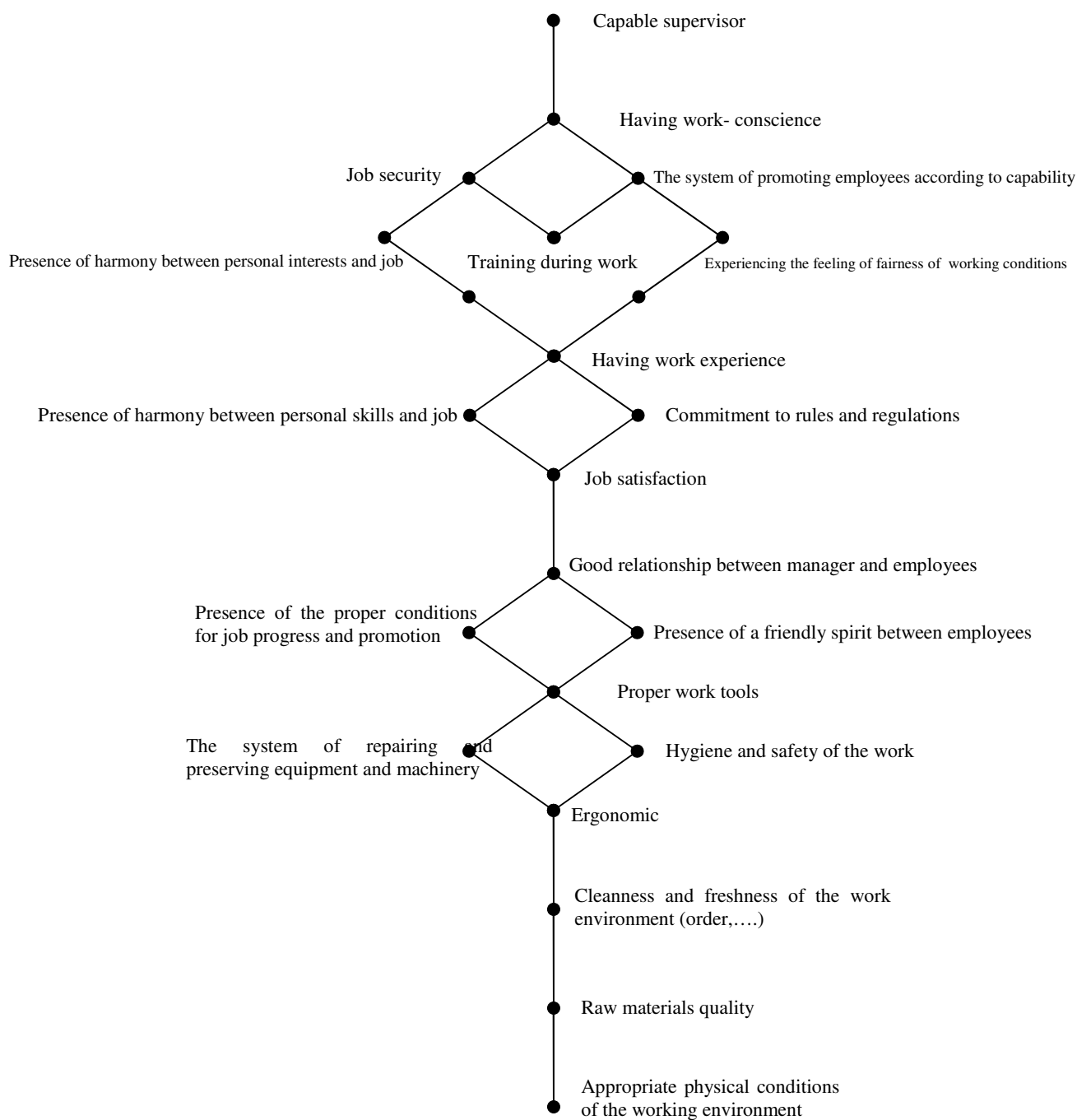
Table 4: *Ranking the 21 criteria of human force productivity according to Average. Borda and Copeland techniques*

Factors	Criteria	Average	Borda	Copeland
Managerial Factors	1.Capable supervisor	1	1	1
	2.Training during work	6	7	5
	3.The system of promoting employees according to capability	3	3	6.5
Social-psychological factors	4.Good relationship between manager and employees	11	11.5	10
	5.Job security	5	5	3
	6. Experiencing the feeling of fairness of the working conditions (indiscrimination, …)	8	7	4
	7. Presence of a friendly spirit between employees	14	14	15
	8. Job satisfaction	12	11.5	6.5
Cultural Factors	9. Having work- conscience	2	2	2
	10. Presence of the proper conditions for job progress and promotion	13	13	17
	11. Commitment to rules and regulations	10	10	8.5
Environmental Factors	12. Appropriate physical conditions of the working environment	21	21	21
	13. Hygiene and safety of the work	15	15	19
	14. Proper work tools	16	16	14
	15. Cleanness and freshness of the work environment (order ,….)	19	18.5	16
	16. Ergonomic	17.5	17	18
	17. Raw materials quality	20	20	20
	18. The system of repairing and preserving equipment and machinery	17.5	18.5	12.5
Personal Factors	19. Presence of harmony between personal skills and job	9	9	8.5
	20. Presence of harmony between personal interests and job	4	4	11
	21. Having work experience	7	7	12.5

After obtaining the ranking of criteria through every 3 methods of average, Borda and Copeland , now its time to put the results from these 3 methods together and gain a single ranking for the criteria, which technique is termed aggregate method. For merging the 3 above methods the average of rank of each criterion must be computed and with regard to the aggregate table the hierarchical tree of the criteria is drawn. The results from computation of average is presented in the following table.

Table 5: *criteria ranks according to aggregate method*

Row	Criteria Title	Rank
1	Capable supervisor	1
2	Training during work	6
3	The system of promoting employees according to capability	3.5
4	Good relationship between manager and employees	12
5	Job security	3.5
6	Experiencing the feeling of fairness of the working conditions (indiscrimination,…)	6
7	Presence of a friendly spirit between employees	13.5
8	Job satisfaction	11
9	Having work- conscience	2
10	Presence of the proper conditions for job progress and promotion	13.5
11	Commitment to rules and regulations	9.5
12	Appropriate physical conditions of the working environment	21
13	Hygiene and safety of the work	16.5
14	Proper work tools	15
15	Cleanness and freshness of the work environment (order,….)	19
16	Ergonomic	18
17	Raw materials quality	20
18	The system of repairing and preserving equipment and machinery	16.5
19	Presence of harmony between personal skills and job	9.5
20	Presence of harmony between personal interests and job	6
21	Having work experience	8

Capable supervisor

Having work- conscience

Job security

The system of promoting employees according to capability

Presence of harmony between personal interests and job

Training during work

Experiencing the feeling of fairness of working conditions

Having work experience

Presence of harmony between personal skills and job

Commitment to rules and regulations

Job satisfaction

Good relationship between manager and employees

Presence of the proper conditions for job progress and promotion

Presence of a friendly spirit between employees

Proper work tools

The system of repairing and preserving equipment and machinery

Hygiene and safety of the work

Ergonomic

Cleanness and freshness of the work environment (order,….)

Raw materials quality

Appropriate physical conditions of the working environment

Concerning the results from the aggregate method, the factors can be ranked according to their importance in such a way that the average of the rank of criteria of each of the 5 effective factors on human force productivity were computed and the results from prioritizing the factors respectively were as it follows.

As it is shown in table…. , the managerial factor has the highest importance or priority and then personal, cultural, social-psychological factors and finally stands environmental factors that has the lowest level of importance.

Table 6: *Ranking the effective factors on human force productivity*

Factors	Criteria	Criteria Rank	Average of Sub-Criteria Rank	factor Rank
Managerial Factors	1.Capable supervisor	1	**3.5**	**1**
	2.Training during work	6		
	3.The system of promoting employees according to capability	3.5		
Social-psychological factors	4.Good relationship between manager and employees	12	**9.2**	**4**
	5.Job security	3.5		
	6. Experiencing the feeling of fairness of the working conditions (indiscrimination, …)	6		
	7. Presence of a friendly spirit between employees	13.5		
	8. Job satisfaction	11		
Cultural Factors	9. Having work- conscience	2	**8.33**	**3**
	10. Presence of the proper conditions for job progress and promotion	13.5		
	11. Commitment to rules and regulations	9.5		
Environmental Factors	12. Appropriate physical conditions of the working environment	21	**18**	**5**
	13. Hygiene and safety of the work	16.5		
	14. Proper work tools	15		
	15. Cleanness and freshness of the work environment (order ,….)	19		
	16. Ergonomic	18		
	17. Raw materials quality	20		
	18. The system of repairing and preserving equipment and machinery	16.5		
Personal Factors	19. Presence of harmony between personal skills and job	9.5	**7.83**	**2**
	20. Presence of harmony between personal interests and job	6		
	21. Having work experience	8		

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