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An Application of the Analytic Hierarchy Process to Determine Benchmarking Criteria for Manufacturing Organisations

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***Abstract*—This paper determines benchmarking criteria from the point of view of the actors who were involved in benchmarking processes within three Libyan Manufacturing Organisations (LMOs). It also describes an application of the Analytic Hierarchy Process (AHP) that can help an organisation to determine its benchmarking criteria. It presents a structured hierarchy for assessing the key capabilities using the AHP. The hierarchy is illustrated using the four main criteria that manufacturing companies consider when carrying out benchmarking. AHP and benchmarking techniques make the implementation and analysis studies more effective, easy and applicable to companies. Further, AHP is used to calculate the relative weights of each criterion, sub-criterion and specific sub-criterion, to prioritise them, and finally to select the important benchmarking criterion within each of the three companies investigated.**

***Index Terms*—Benchmarking; AHP; hierarchy; pairwise comparison; multi-criteria analysis**

I. Introduction

Many developing countries, including Libya, have paid a great deal of attention to national economic and social problems, but less attention has been given to managerial and organisational difficulties which can have a significant impact on the achievement of development strategies. In implementing their economic development strategies, developing countries need new management tools, such as benchmarking (Salem, 2005), but at the same time they are surrounded by a complex environment in terms of increases in organisation size, technological advancement, demand for skilled employees, high inflation and competitive market conditions (Khan et al., 2002; Agnaia, 1996). Therefore, Libyan organisations exist in an environment characterised by continuous change resulting from a variety of factors (e.g. characteristics of the milieu, social, economic and political climate, and market competition) (Salem, 2005).

Abusneina et al. (1993) stated that the industrial organisations in Libya had been characterised by the low amount of actual production or low rate of return on investment. For instance, several decisions in many industrial organisations appeared to have been taken without adequate feasibility research and others had not been revised or updated at different stages of construction (Salem, 2005; Tarbaghia, 1995). This in turn caused high costs of industrial products compared with similar products imported from other countries. Accordingly, many Libyan industrial products were unable to compete with imported products, even in the local market (Abusneina et al., 1993). Further, Bengharbia (1994) indicated that the increasing cost of industrial products is seen as one of the main problems encountered by the industrial sector. The reasons behind this are the high cost of importing raw materials and spare parts; the rise in the cost of manpower as a result of a greater numbers of workers in factories; reduction in actual production and the failure to use cost accounting and budget systems in certain companies.

This paper deals with benchmarking as it applies to the Libyan environment. It discusses the need to gain a deeper understanding of the importance of each criterion by using AHP in determining benchmarking best practice in LMOs. The objectives of this study are, first, to understand and determine the structure of benchmarking rationales in these organisations within their environmental development context. Second, to use the AHP technique for the evaluation of criteria, sub-criteria and specific sub-criteria for a targeted benchmarking implementation.

This study attempts to understand the results of determining benchmarking criteria in manufacturing organisations operating in the Libyan environment. Further, the first motivation for this study is that there are no previous studies that have described an application of AHP to determine benchmarking practices in Libya. Second, the study of three industrial LMOs would contribute to the development of suggestions about benchmarking practices helping to improve industrial organisations in Libya. Also, this study examines whether the AHP methodology and the framework of testing these concepts are transferable into the Libyan setting where decisions are made in very traditional ways.

The study focuses on four main criteria. These are cost control, quality control, sales maximisation and market share. Most organisations seek to benchmark each of these at some stage of their business life. It examines managers' views about the relative importance of the criteria which influence benchmarking judgements and processes. In general, this paper presents the results of managers' judgements about the importance of various benchmarking criteria. However, benchmarking and its effective practices

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in developing countries have remained largely unexplored. In this sense, no previous research has attempted to provide an explanation of the structure of benchmarking practices in LMOs. Consequently, two research questions are developed to investigate the evaluation of benchmarking criteria for an organisation. These research questions are: first, in what sense does AHP examine managers' views in terms of the relative importance criteria and sub-criteria which influence benchmarking judgments and processes? and, second, does the responsibility of managers to settle upon organisational goals cause the firm to be more concerned with some benchmarking criteria and less concerned with others?

These questions are answered in the context of LMOs through empirical fieldwork and analyses of managers' judgements about the importance of various criteria of benchmarking. Further, the paper is concerned decision-making model (AHP) that would help LMOs to determine benchmarking criteria in a more effective way. To that end, AHP is applied to analyse data collected and to understand the phenomenon of benchmarking practice in LMOs.

II. Literature Review

A. Benchmarking Practices in LMOs

Since the early 1980s benchmarking has been a widely used and generally accepted business practice (Mcgaughey et al., 2005; Yaisn 2002). It has evolved into total quality management and is a powerful tool for performance analysis (Kirby, 2005). The development of benchmarking is very much associated with Xerox in the USA (Sisson et al., 2003). The first book on the subject was written by the company's head of benchmarking in the 1980s (Camp, 1989).

Owing to a lack of a complete understanding of benchmarking in LMOs (Salem, 2005), it appears that many of them find it difficult to employ the technique effectively. Throughout the fieldwork it appeared that many Libyan organisations face difficulties in quality control and sales maximisation because of lack of productive ability and new technology. This is a result of shortages in raw materials and spare parts caused by some restrictions which the government put on its importation policy because of UN and US sanctions against Libya in 1990s (Salem, 2005; Bait-Emal, 2000). Also, lack of sufficient R&D in both quantity and quality affected sales maximisation and quality in Libyan organisations (Abusneina et al., 1993). Further, there were insufficient resources for management training and a lack of encouragement to carry out benchmarking practice in many Libyan organisations.

B. 2.2 The Selection Model to Determine Benchmarking Criteria

One difficulty LMOs faced when implementing benchmarking was a multicriteria decision one (Salem, 2005; Gzema, 1999). A methodology which can address this problem is the pairwise comparison model in AHP, which Saaty developed in the 1970s (Saaty, 1980). Since that time a wealth of literature has existed to provide a discussion of AHP applications in many research areas, such as accounting and auditing (Hassell et al., 1989; Arrington et al., 1984), electric utility industry, medicine, business (Golden et al., 1989), and education (Bahurmoz, 2003). While AHP has seen limited application in benchmarking, Korpela et al. (1996, p: 226) indicated that AHP had previously been used for benchmarking by Eyrich (1991). His application was for benchmarking computer-integrated manufacturing (CIM) sites, and AHP was basically used for determining the success factors, the corresponding requirements and their importance for a best-of-breed CIM site. Accordingly, Eyrich stated that in considering benchmarking it is important to develop a common understanding of what it means to be the best in order to obtain the maximum result. Eyrich (1991) suggested that AHP is appropriate for use in the benchmarking process because it facilitates consensus and develops hierarchical models to solve problems. Through AHP a firm can identify the sub-goals that are required to achieve the main goal (Cheng et al., 2003). Then it should be possible to identify the specific sub-goals required to achieve organisational objectives.

C. Construction of Model Hierarchy

1) This basic hierarchy can aid in identifying criteria, sub-criteria and specific sub-criteria. However, this hierarchy is based on two major levels:
2) Organisational criteria - the criteria in this level which are used for the evaluation of the various activities are identified as cost and quality control, sales maximisation, and market share. These four criteria which are associated with organisational well beings make up the second level of the hierarchy.

Activities level (level three): these include sets of sub-criteria (labour, material, etc). There are also sets of specific sub-criteria at the low levels of this hierarchy (time, payment, amount used, etc.). All of those are presented in Figure-1

Furthermore, evaluation of all pairwise comparisons (using the Saaty's 9-point scale) is used. Consider for example the evaluation of sub-criteria or specific sub-criteria against the criteria. This involved many pairwise matrices across the hierarchy levels.

D. Pairwise Comparison Matrices

Once the hierarchical structure has been formed, the judgmental process by managers begins across all elements. For each level of the hierarchy, beginning at the top and working down, a comparison matrix for the components is obtained. However, the input matrix of pairwise comparisons shows the extent to which one element is preferred over another by managers in determining the criterion, sub-criterion and specific sub-criterion across all levels shown in the hierarchy within each of the three companies.

In this study, the evaluation model used was that suggested by Saaty (1990, 1995) for determining the criteria sub-criteria and specific sub-criteria to be benchmarked within each of the three companies. The following formula developed by Saaty (1995, 1980) could be applied for this pairwise comparison:

$$AW = \lambda_{max} W$$

Where A is the pairwise comparisons matrix, W is the normalised weight vector and λ_{max} (lambda max) is the

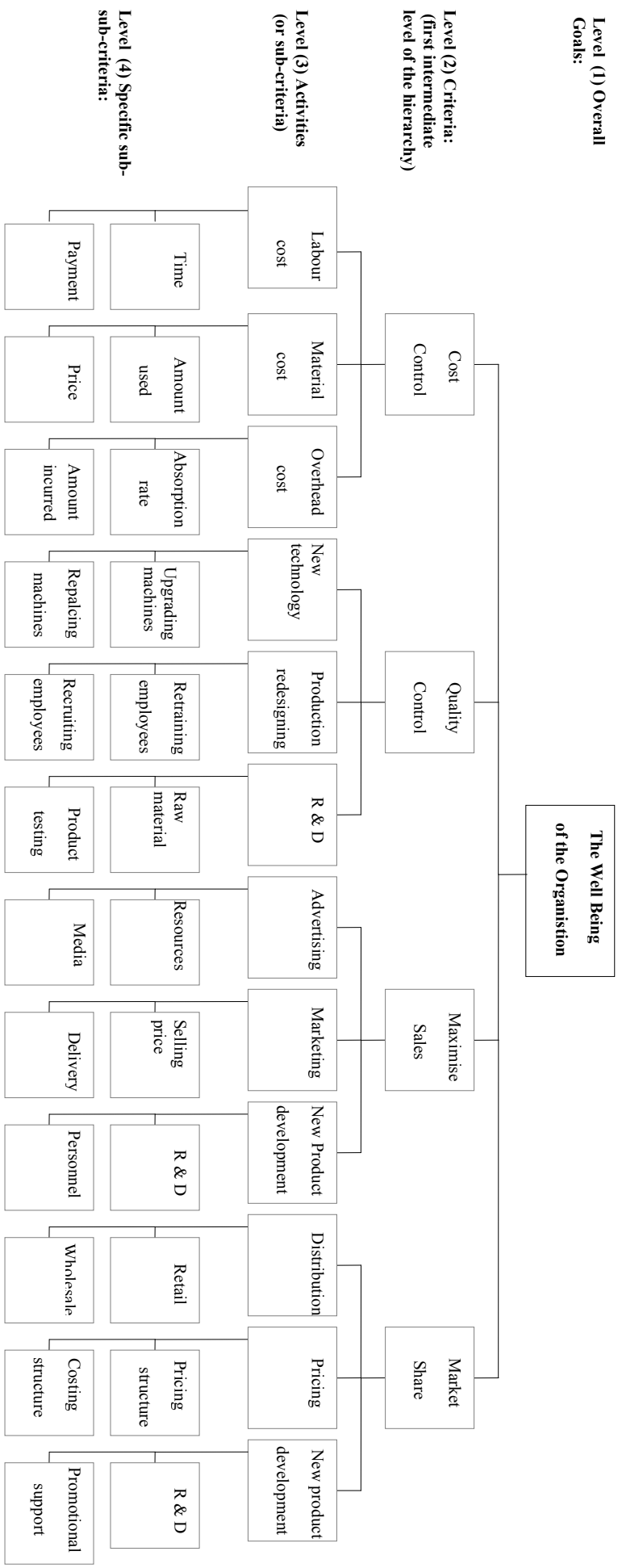

Figure-1. An Analytical Hierarchy of the selection of cost control, quality control, maximise sales and market share for an organisation (Elements within all levels in this hierarchy are developed by the author)

maximum eigenvalue of matrix *A*. The maximum eigenvalue can be used to estimate consistency in a matrix, as reflected in the proportionality of preferences (Saaty 1995, 1980). Specifically, the closer λ_{max} is to the number of elements *n* in the matrix *A*, the more consistent the matrix will be. However, The deviations from consistency are expressed by the following equation and the measure of inconsistency is called the consistency index (CI) (Albayrak et al., 2004; Lee et al., 2002; Saaty, 1995).Consistency index (CI) = $(\lambda_{max} - n) / (n - 1)$

Generally, if the CI is less than 0.10, the consistency of the decision-maker is considered satisfactory. But if CI exceeds 0.10, some revisions of judgement may be required (Lee et al., 2002). In order to control the results of the methods, the consistency ratio (CR) is used to estimate directly the consistency of pairwise comparisons. The CR is computed by dividing the CI by a value obtained from a table of Random Consistency Index (RCI) as shown below (Lee et al., 2002; Saaty, 1980, 1995).

$$CR = CI / RCI = (\lambda_{max} - n) \div (n - 1) / RCI$$

Where: λ_{max} = maximum eigenvalue of the priority matrix, *n* = number of elements in the matrix and RIC = computed for matrices of order *n*. Different-order random matrices are given by Lee et al. (2002) and Saaty (1995, p: 83):

Size of matrix (or *n*)	1	2	3	4	5	6	7	8	9	10
Random Consistency Index	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

III. Research Methods

The population for this study consists three Libyan organisations in different manufacturing areas which have benchmarking experience or were in the process of benchmarking at the time of this study. As a condition of obtaining access for data collection, this study was unable to mention the real name of the organisations under investigation. This is because of sensitivity of data collection from these organisations. Accordingly, the researcher adopted a new name for each of the anonymous organisations to be used in presenting data collected for this study. The letters 'A', 'B' and 'C' are used to refer to these organisations and their activities.

The data for this study was collected using a questionnaire and semi-structured interviews. The semi-structured interviews were conducted with managers to obtain general information about the companies. The questionnaire was distributed personally to 60 participants in the three companies. To secure effective participation, an opportunity to discuss the questionnaire was offered to the participants through the researcher's personal attendance. Accordingly, in some cases completion of the questionnaire could be considered as a semi-structured interview, because the discussion enriched the researcher's knowledge of the respondents' answers, instead of his having to rely solely on what was written in the questionnaire. Ten usable questionnaires were elected from each company.

Pairwise comparisons were made by managers within the three companies at all levels. Questions were designed to elicit judgements about the relative importance of each of the selected criteria in satisfying market demand requirements.

This study used the standard measurement scale developed by Saaty (1980) to determine priorities' weights across all elements for the purpose of benchmarking implementation. The scale ranges from equal to extreme, where one represents equal importance and nine indicates absolute importance. The scale is 1, 3, 5, 7, and 9 with 2, 4, 6, and 8 as intermediate values. Figure-2 shows Saaty's standard scale which respondents use in AHP.

Intensity of Importance	*Definition*	*Explanation*
1	Equal importance	Two activities or items contribute equally to the objective.
3	Weak importance of one over another	Experience and judgement slightly favour one activity or item over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another.
7	Demonstrated importance	An activity or item is strongly favoured and its dominance is demonstrated in practice.
9	Absolute importance	The evidence favouring one item over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent judgements	When compromise is needed.

Figure-2.Election technique response scales which can be used by respondents in AHP

Source: Saaty (1980 1990, 1995)
Sample Responses

_____ Cost Control: Quality Control ___5_____
____7____ Cost Control: Maximise Sales_____

The instrument continues until all 30 pairwise comparisons made by each of the thirty managers in this study are completed (see questionnaire appendix -A). These pairwise comparisons are empirically demonstrated in the

next section.

IV. Results of AHP Application And Discussion

AHP was used in this study as a structured way of building prioritised criteria across four main criteria. This section presents a discussion of managers' responses to questions developed to investigate the evaluation of benchmarking criteria, sub-criteria and specific sub-criteria for an organisation.

As an example, a detailed computational method for one respondent from Company A is available on reqest. This respondent was required to work through thirty paired comparisons of the main criteria. This respondent believed that C_1 (cost control (0.31)) and C_2 (quality control (0.31)) were the most important criteria followed by C_4 (market share (0.24)), and C_3 (sales maximisation (0.14)) when all criteria, sub-criteria and specific sub-criteria were jointly and simultaneously evaluated.

A. Criteria Level Analysis

Various criteria have been identified in the questionnaire (appendix-A) in order to achieve consistency in responses and to reduce ambiguity over the meaning of criteria. The decision hierarchy depicts the four distinct main criteria of the well-being of the organisation in the Libyan context. However, the respondents within the three LMOs were required to work through six paired comparisons of the four benchmarking criteria conditional on the assumption that they were concerned with determining the well-being of the organisation. Consequently, these four criteria were integrated into one set of priorities by considering the relative strength of the well-being of the organisational dimensions, as discussed below.

1) Priorities of benchmarking criteria within the three companies

From the AHP analysis of managers' views about the relative priorities of each criterion to be benchmarked, the evaluation of benchmarking cost and quality control, sales maximisation and market share across respondents within each of Companies A, B and C are given below.

Company A's results are summarised in Table-1. Seven of the ten respondents believed that quality control was the most important criterion in determining the well-being of the organisation. These respondents indicated that their company was spending resources on improving quality, while two respondents rated quality control as the second and third most important criterion. However, one respondent indicated that he believed cost and quality control were equally important when determining benchmarking. Across respondents, the rating of cost control, sales maximisation and market share were second, third and fourth respectively. These three criteria appeared to be less important in determining the well-being of the organisation.

The overall conclusion for Company A is that there was general consensus across respondents' responses that quality control mean ranks is more important than cost control, sales maximisation and market share in benchmarking (Table-1).

TABLE-1: Ranks Given by Respondents to Criteria Tested to Determination of Best Benchmarking*

Explanation	Companies		
	A	B	C
Cost control	2.30	2.50	1.5
Quality control	1.40	1.60	1.4
Maximise sales	2.90	2.50	2.00
Market share	3.10	2.60	3.80

*This table shows the average of the main ranking for the participants' responses within each company.

In Company B the highest weights were given by four respondents to quality control in determining benchmarking (some respondents ranked different criteria as joint first). Across respondents, there was general agreement that quality control is the most important criterion in determining benchmarking. The importance of cost control and sales maximisation is unclear, but it was generally accepted that cost control and sales maximisation are the second and third most important criteria respectively in determining the well-being of the organisation.

Overall, while the preferences across respondents were less consistent, quality control appears to be regarded as the most important criterion. This was confirmed by the mean ranks for each criterion mentioned, as shown in Table-1 for Company B.

Despite the conflicting objectives, Company C demonstrates a consensus across respondents regarding cost control and quality control (Table-1 for Company C). Seven of the ten respondents indicated that cost control is relatively the most important criterion. Many of these respondents indicated that economic circumstances influenced the company with respect to the facilities, planning, production redesigning, new technology, etc. and influenced the motivation level of the employees. Economic circumstances have directly or indirectly influenced the effectiveness of the company to benchmark quality control. However, in terms of mean ranks, there is a great deal of variance across respondents' importance rating composition.

Finally, it appears that quality control, sales maximisation and market share are generally regarded as being less important in determining benchmarking than is cost control. The mean ranks confirm that cost control was clearly considered as the most important criterion as shown in Table-1 for Company C.

2) Consistency analysis for criteria level

The consistency of responses across respondents was examined within each of the three companies with respect to the benchmarking criteria. The author found that the principal eigenvalue (λ_{max}) is very close to n (number of elements in the matrix). This is consistent with the Saaty's suggestion (1980, 1995) that the closer the value of computed λ_{max} to n, the more consistent in performing pairwise comparisons of criteria (or elements). In fact, λ_{max} is equal to 4.06, 4.03 and 4.01 within each of the companies A, B and C respectively (Table-5). This consistency is considered satisfactory because the value of the CI and CR was less than 0.10 within each of three companies. This confirms studies by Lee et al. (2002), and Saaty (1980, 1995) who have indicated that the value of CR is acceptable if it less than 0.10.

B. Sub-criteria level analysis

This section describes the derivation of priorities associated with determination of benchmarking sub-criteria. In this sense, there are four sets of sub-criteria with respect to their relation to the main criteria used in this study as shown in Figure-1.

1) Priorities of cost control sub-criteria within the three companies

The analysis of respondents' responses in Company A in determining cost control sub-criteria revealed that the company had no clear consensus across respondents regarding three sub-criteria (labour, material and overhead cost). In fact, five of the respondents believed that material costs were the most important sub-criterion in benchmarking cost control, while five respondents believed labour cost to be the second and third most important when benchmarking cost control. Across respondents, overhead cost appears to be the third most important sub-criterion. The mean ranks indicate that material cost, labour cost and overhead cost were believed to be the most, second and third most important sub-criteria respectively in benchmarking cost control (Table-2 for Company A).

TABLE-2: RANKS GIVEN BY RESPONDENTS TO SUB-CRITERIA TESTED TO DETERMINATION OF COST CONTROL*

Explanation	Companies		
	A	B	C
Labour cost	1.80	1.70	1.70
Material cost	1.60	1.40	1.10
Overhead cost	2.40	2.30	2.10

*This table shows the average of the main ranking for the participants' responses within each company.

Concerning Company B, it appears that there was general consensus over the importance of the material cost when benchmarking cost control. There is little consensus over the importance of labour cost when benchmarking cost control. Of the ten respondents, five believed that labour cost was most important, while five believed it to be second and third most important. Moreover, a majority of the respondents believed that overhead cost is the least important sub-criterion when benchmarking cost control. Overall, the mean ranks confirm that material cost was clearly regarded as the most important sub-criterion compared with labour and overhead cost, as shown in Table-2 for Company B).

This section analysed the respondents' responses in determining cost control sub-criteria in Company C. There appears to be general consensus across respondents regarding the importance of labour, material and overhead cost with respect to the determination of cost control in this company (Table-2 for Company C). Nine of the respondents believed that material cost is the most important sub-criterion when assessing cost control, and eight of the respondents viewed labour cost as being one of the two most important sub-criteria in benchmarking cost control. Further, investigation revealed that the overhead cost was considered by three respondents as the third most important sub-criterion.

2) Priorities of quality control sub-criteria within the three companies

Table-3 for Company A shows that the majority of respondents believed that new technology was the most important sub-criterion in determining quality control, while a few of them evaluated new technology as the second and third most important sub-criterion. Five respondents rated production redesign as the second most important sub-dimension, while three of the ten respondents rated it the most important sub-dimension when determining quality control. With respect to R&D, five respondents rated it as the least important sub-dimension, but five respondents believed it to be the most and second most important sub-dimension when determining quality control. Overall, the results suggest that, in determining quality control, the respondents believe that new technology is considerably more important than production redesign and R&D in benchmarking quality control. This was confirmed by the mean ranks as shown in the Table-3.

TABLE-3: RANKS GIVEN BY RESPONDENTS TO SUB-CRITERIA TESTED TO DETERMINATION OF QUALITY CONTROL*

Explanation	Companies		
	A	B	C
New technology	1.50	2.20	1.50
R & D	2.30	1.60	1.90
Production redesigning	1.80	2.10	2.20

*This table shows the average of the main ranking for the participants' responses within each company.

Table-3 also summarises the priority weights produced by the ten respondents in Company B. These results show that there was general agreement among respondents that R&D was the most important sub-criterion when benchmarking quality control. Across respondents, the mean ranks suggest that R&D was clearly regarded as the most important. New technology seems to be rather more preferred by the majority of the respondents - more than production redesign in benchmarking quality control. This result is consistent with Tsipouri's suggestion (2001) that academic thinking and empirical evidence converge, indicating that there is a correlation between R&D and levels of development quality. Thus, it can be argued that the higher the privately performed R&D in the company, the higher the contribution to improve quality when bringing new technology in.

In relation to the above discussion, the researcher's investigations to determine priorities of quality control sub-criteria (new technology, production redesigning and R&D) in Company C revealed that there was little consensus across respondents regarding the three sub-criteria. It is difficult to generalise about respondents' responses and, in the case of determining R&D and production redesign, there is no consensus across respondents concerning these two sub-criteria. Overall, a majority of the respondents believed that new technology was the most important criterion by assigning high weights, while the remaining respondents rated it as the second most important sub-criterion. This was confirmed by mean ranks for new technology (Table-3 for Company C).

3) Consistency analysis for sub-criteria level

The findings were examined through three consistency measurements to provide the level of consistency across respondents' responses with respect to determine

benchmarking sub-criteria of labour, material and overhead cost. Concerning this, the findings shown in Table-6 for consistency regarding λ_{max}, CI and CR indicate satisfactory consistency across respondents' responses in determining cost control sub-criteria within each of the three companies. Specifically, the value of λ_{max} (e. g., 3.04 for Companies A and B and 3.01 for Company C) is very close to *n*. Also, the value of CI and CR is less than 0.10 (e.g., CI= 0.02, CR= 0.04 for Companies A and B, CI= 0.01, C.R= 0.01 for Company C).

The findings in Table-5 also present a high level of consistency of participants' responses in determining quality control sub-criteria within each of the three companies. There are a strong consistency of λ_{max} (e. g., λ_{max} = 3.02, 3.05 and 3.01 for Companies A, B and C respectively) to *n*. This result is consistent with the Saaty's (1994) suggestion that the deviation of the principal eigenvalue from *n* is considered to be the departure from consistency level. Also, the overall consistency of respondents' judgements by means of CI and CR is considered satisfactory (e.g., CI= 0.01 and CR= 0.02 for Company A, CI= 0.03 and CR= 0.05 for Company B, CI= 0.01 and CR= 0.01 for Company C).

C. Specific Sub-Criteria Level Analysis

The study analysed the results of twelve paired comparisons across the twenty-four specific sub-criteria within each of the three companies under the determination of sub-criteria (e.g., labour, material and overhead cost). The result of all the paired comparisons of specific sub-criteria made by thirty respondents across Companies A, B and C is presented, along with a detailed discussion of paired comparisons for amount used and price with respect to material cost.

The detailed discussion of the specific sub-criteria (e. g., amount used and price with respect to material cost) is followed for all twenty-four specific sub-criteria used in this study.

1) Priorities of material cost specific sub-criteria (amount used and price) within the three companies

The judgement over materials costs in Company A is presented in Table-4. With respect to amount used there was general agreement among respondents that this element is much more important than price. This was confirmed by seven of the ten respondents who indicated that they believed that the amount used was the most important specific sub-criterion when benchmarking materials costs. Overall, the mean ranks confirm that amount used was regarded as the most important specific sub-criterion.

TABLE-4: RANKS GIVEN BY RESPONDENTS TO SPECIFIC SUB-CRITERIA TESTED TO DETERMINATION OF SUB-CRITERIA (LABOUR, MATERIAL AND OVERHEAD COST)*

Explanation	Companies		
	A	B	C
Time	1.40	1.30	1.10
Payment	1.30	1.60	1.20
Amount used	1.30	1.60	1.10
Price	1.60	1.30	1.60
Absorption rate	1.40	1.70	1.30
Amount incurred	1.50	1.40	1.20

*This table shows the average of the main ranking for the participants' responses within each company.

Table-4 summarises the results of the priority weights for each of the ten respondents for amount used and price in the determination of materials costs in Company B. The results show that there is a general agreement among respondents regarding the importance of the amount used and price specific sub-criteria. However, seven of the ten respondents indicated that they believed price was the most important, while the remaining three respondents ranked price as the least important specific sub-criterion. Evaluation of amount used revealed that this specific sub-dimension was regarded as slightly less important than price. Indeed, six of the ten respondents viewed the amount used as the least important, while the remaining respondents believed it to be the most important specific sub-dimension in benchmarking material cost. This was confirmed by mean ranks for price as shown in Table-4.

In determining material cost specific sub-criteria, a high degree of consensus emerges across respondents regarding these two specific sub-criteria. Specifically, all respondents agreed that amount used was one of the most important specific sub-criteria. There was little consensus over the relative importance of price. Four respondents considered price to be the most important specific sub-dimension, but six of the ten respondents disagreed, ranking price as the second most important specific sub-dimension in benchmarking material cost. Overall, mean ranks give more priority to amount used than price as exhibited in Table-4 for Company C.

2) Consistency Analysis for Specific sub-criteria

From the above discussion about priorities of benchmarking specific sub-criteria to determine benchmarking sub-criteria, and from the results of consistent matrices shown in Table-5, it appears that there is almost perfect consistency across respondents' responses within each of the three companies. Specifically, the value of λ_{max} is equal to 2 which is exactly the same number of elements (*n*) in each specific sub-criteria matrix across all three companies. The overall consistency of judgements across respondents concerning CI and CR is generally considered satisfactory in determining benchmarking specific sub-criteria with respect to sub-criteria of cost and quality control, sales maximisation and market share. In fact, the values of CI and CR equal to zero for each specific sub-criterion across the three companies.

TABLE-6 FOR CONSISTENCY: THE RESULTS OF THREE CONSISTENCY MEASUREMENTS (λMAX, C.I AND C.R) FOR PRIORITIES OF (CRITERIA, SUB-CRITERIA AND SPECIFIC SUB-CRITERIA)(1) IN DETERMINING THE WELL-BEING OF THE ORGANISATION

Explanation	I. Companies								
	A			B			C		
	λ_{max}	C.I	C.R	λ_{max}	C.I	C.R	λ_{max}	C.I	C.R
All main criteria	4.06	.02	.03	4.03	.01	.01	4.01	.01	.01
All sub-criteria of cost control	3.04	.02	.04	3.04	.02	.04	3.01	.01	.01
All sub-criteria of quality control	3.02	.01	.02	3.05	.03	0.5	3.01	.01	.01
All sub-criteria of maximise sales	3.06	.03	.06	3.05	.02	0.05	3.03	.02	.03
All sub-criteria of market share	3.03	.01	.03	3.04	.02	.04	3.02	.01	.02
All specific sub-criteria of cost control	2.00	.00	.00	2.00	.00	.00	2.00	.00	.00
All specific sub-criteria of quality control	2.00	.00	.00	2.00	.00	.00	2.00	.00	.00
All specific sub-criteria of maximise sales	2.00	.00	.00	.2.00	.00	.00	2.00	.00	.00
All specific sub-criteria of market share	2.00	.00	.00	2.00	.00	.00	2.00	.00	.00

λ_{max} (Lamda) = principle eigenvalue, C.I = consistency index, C.R = consistency ratio.

(1) There are four tables analysing the participants' responses in determining the benchmarking criteria and sub-criteria using the three consistency measurements (λ_{max} , C.I and C.R). Also, there are twelve tables analysing the participants' responses in determining the benchmarking specific sub-criteria criteria using the same three consistency measurements. All these tables are available on request.

This table reports total average of priorities of four main criteria, twelve sub-criteria and four specific sub-criteria. Also, it reports the result of λ_{max} , C.I and C.R for compared priorities of each two specific sub-criteria in determining benchmarking sub-criteria. The results of the three consistency measurements are similar across the specific sub-criteria used in this study. For example the principal eigenvalue is equal to n ($\lambda_{max} = n = 2$, within each matrix of specific sub-criteria). At this point, CI and RC equal to zero for all specific sub-criteria within the three companies.

V. CONCLUSIONS

This study used Saaty's Analytic Hierarchy Process as a procedure for modelling individuals' importance ratings for four main criteria and their sub-criteria and specific sub-criteria as a function of various multiple attributes. The findings in Companies A and B indicated that a majority of the respondents in these two companies had launched a more structured procedure to quality control. Meanwhile, cost control was seen as the most important criterion to be benchmarked in Company C. This is related to the economic circumstances that influenced many LMOs in general and Company C in particular with respect to facilities, production redesigning, new technology, which affected the success of various activities of this company.

Across respondents, therefore, a general conclusion can be drawn. A majority of the respondents indicated that the unavailability of enough raw materials caused these companies to be more concerned with some benchmarking criteria and less concerned with others. Obviously, the judgements of respondents over the relative importance of cost and quality control, sales maximisation and market share with respect to determination of benchmarking criteria, sub-criteria and specific sub-criteria indicated valuable findings across the three companies. These findings suggest that cost control and quality control are the dominant criteria, while sales maximisation or market share seem less important.

This study did not aim to address the question of why respondents believed some criteria to be more important than others. It is hoped that further research may establish whether respondents were correct in their beliefs. Therefore, while the findings here are unique to the ten respondents in each company who participated in this study, they nonetheless provided a basis from which investigated questions over how and why subjects form their beliefs may be produced.

The study reveals that AHP is useful as a procedure for modelling preferences and relations between benchmarking criteria in benchmarking organisations. In particular, this study has highlighted useful insights into the relationships among managers' priorities, and selection criteria in processing benchmarking implementation. The AHP was considered suitable in this study for guidance in the analysis of the data, and it enabled the researcher to understand the phenomenon of benchmarking implementation at a deeper level of meaning and consequence in LMOs. It presents results obtained from the paramorphic model under AHP for the three companies. Further, the AHP analysis for this study has been obtained not in absolute terms but only relative to the actors (organisational participants) from organisations, their objectives and other criteria included in the hierarchy.

Based on the previous conclusion, this study contributes to the knowledge and understanding of the nature of benchmarking implementation in LMOs. It also contributes to the notion that a decision support system such as AHP can be a viable approach to determining benchmarking criteria as well as improving the quality of LMOs' decisions toward benchmarking implementation. This study indicates that AHP and its framework of testing benchmarking implementation is transferable into LMOs where decisions are made in very traditional practices. Beyond this, the study demonstrated that the AHP model can create opportunities for managers in LMOs to interact, to justify and modify their personal judgments in carrying out benchmarking practice.

APPENDIX

The pairwise comparison criteria

1- Comparison of the importance of characteristics with

respect to determination of THE WELL BEING OF YOUR ORGANISATION (BENCHMARKING BEST PRACTICE)
_____ Cost Control: Quality Control _____
_____ Cost Control: Maximise Sales_____
_____ Cost Control: Market Share _____
_____ Quality Control: Market Share_____
_____ Quality Control: Maximise Sales_____
_____ Market Share: Maximise Sales_____

2- Comparison of the importance of characteristics with respect to determination of COST CONTROL
_____ Labour Cost: Material Cost _____
_____ Labour Cost: Overhead Cost _____
_____ Material Cost: Overhead Cost _____

3- Comparison of the importance of characteristics with respect to determination of QUALITY CONTROL
_____ Developed Devices: Production Redesigning _____
_____ Developed Devices: Research and Development _____
_____ Production Redesigning: Research and Development _____

4- Comparison of the importance of characteristics with respect to determination of MAXIMISE SALES
_____ Marketing: Advertising _____
_____ Marketing: New Product Development (Quality) _____
_____ Advertising: New Product Development (Quality) _____

5- Comparison of the importance of characteristics with respect to determination of MARKET SHARE
_____ New Product Development (Quality): Pricing _____
_____ New Product Development (Quality): Distribution_____
_____ Pricing: Distribution _____

6- Comparison of the importance of characteristics with respect to determination of LABOUR COST
_____ Time: Payment_____

7- Comparison of the importance of characteristics with respect to determination of MATERIAL COST
_____ Amount Used: Price _____

8- Comparison of the importance of characteristics with respect to determination of OVERHEAD COST
_____ Absorption Rate: Amount Incurred _____

9- Comparison of the importance of characteristics with respect to determination of DEVELOPED DEVICES
_____ Upgrading the Machines: Replacing the Machines _____

10- Comparison of the importance of characteristics with respect to determination of PRODUCTION REDESIGNING
_____ Recruiting New Employees: Retraining the Employees _____

11- Comparison of the importance of characteristics with respect to determination of RESEARCH AND DEVELOPMENT
_____ Raw Material: Product Testing _____

12- Comparison of the importance of characteristics with respect to determination of ADVERTISING
_____ Resources: Media _____

13- Comparison of the importance of characteristics with respect to determination of MARKETING
_____ Delivery: Selling Price _____

14- Comparison of the importance of characteristics with respect to determination of NEW PRODUCT DEVELOPMENT (QUALITY)
_____ Research and Development: Personnel _____

15- Comparison of the importance of characteristics with respect to determination of DISTRIBUTION
_____ Retail: Wholesale _____

16- Comparison of the importance of characteristics with respect to determination of PRICING
_____ Pricing Structure: Costing Structure _____

17- Comparison of the importance of characteristics with respect to determination of NEW PRODUCT DEVELOPMENT(QUALITY)
_____ Research and Development: Promotional Support _____

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