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DISCOVERING THOUGHTS AND INVENTING FUTURE

HIGHLIGHTS

TV Manufacturing Organization

Time Implementation Status

Ergonomics: A Categorical Imperative

Total Productive Maintenance

Transocean Rig

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Supplier Selection Using MCDM Method in TV Manufacturing Organization

By Ajit Pal Singh
Adama Science & Technology University

Abstract - The aim of this study was to provide an analytical tool to evaluate and select the best supplier(s)/vendor(s) in fuzzy environment for Television (TV) manufacturing organization. A hierarchy through which decision makers can bring about a comparison among the suppliers was worked out and software for the same was developed. The methodology for selection was based upon multiple criteria decision making/multiple attribute decision making (MCDM/MADM) method using technique for order preference by similarity to ideal solution (TOPSIS). MCDM approach and application of TOPSIS proved to be a powerful technique for rapid, performance evaluation, comparative assessment and selection of supplier(s). Biasness in decision making process was avoided using weights for DM's based on their proficiency in the problem under consideration. The suppliers were evaluated and selected on the basis of criteria/attributes (quality, delivery, price, and suggestion acceptance) and weights were assigned (0.5, 0.3, 0.1, and 0.1) to them. The ranking/selection order of ten suppliers (alternatives) was determined as C4, C5, C10, C7, C2, C6, C1, C8, C9, and C3. Although the study concentrates on TV manufacturing organization, however the methodology can be adopted by any organization if the criteria and alternatives are clearly defined. Results have provided valuable suggestions to suppliers on how to improve each criterion so that they could bridge the gap between actual and aspired performance values in the future. The decision-aiding software was implemented in C language to automate the supplier(s) selection process.

Keywords : supplier(s) selection, decision matrix, MCDM, MADM, TOPSIS, purchasing.

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SUPPLIER SELECTION USING MCDM METHOD IN TV MANUFACTURING ORGANIZATION

Strictly as per the compliance and regulations of:

Supplier Selection Using MCDM Method in TV Manufacturing Organization

Ajit Pal Singh

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I. Introduction

In today's highly competitive environment, it is impossible for an organization to successfully produce low-cost, high-quality products without help/involvement of suppliers. Supplier selection or its evaluation is a common problem for acquiring the necessary raw materials (semi-finished/finished materials) to support the outputs of organizations. Supplier evaluation and selection involve decisions that are critical to the profitability, growth and survival of manufacturing organizations in the increasingly competitive global scenario. Such decisions are often complex, because they require the identification consideration and analysis of many tangible factors.

The decision problem involves tradeoffs between multiple criteria that are often qualitative. In recent years, many methods have gained considerable acceptance for judging different proposals [1, 2, 3].

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II. General Methods of Supplier Selection

Most commonly used methodologies for solving the supplier selection problem are as follows:

- **Total cost approach:** In the total cost approach, the quoted price of each vendor was taken as the starting point and then each constraint being considered as replaced by a cost factor and the business was awarded to the vendor with the lowest unit total cost [12, 17, 25].
- **Multiple attribute utility theory (MAUT):** MAUT is a vendor selection technique most useful in dealing with international vendor selection, as it is capable of handling multiple conflicting attributes inherent in international vendor selection [14, 19, 21].
- **Multi-objective programming:** It is an additional flexibility of multi-objective approach which allows a varying number of vendors into the solution and provides suggested volume allocation by vendor. However, the process of obtaining solution through this method is complex [7, 10, 20].
- **Total cost of ownership (TCO):** TCO is a methodology and philosophy. It looks beyond the price of purchase to include many other purchase-related costs. The TCO models are further classified by usage such as vendor selection and vendor evaluation [6, 9, 15].
- **Analytic hierarchy process (AHP):** It is considered to be a good approach and can be used in a multifactor decision-making environment, especially when subjective and/or qualitative considerations have to be incorporated. It also provides a structured approach or to determines the scores and weights for the different criteria to be used in decision making [5, 11, 13, 16].

Different mathematical, statistical and game theoretical models have been proposed to solve the vendor/supplier selection problem. De Boer et al. (2001), Weber et al. (1991) and many others (see Tahriri, 2008) have reviewed the methodology of supplier/vendor selection.

Weber et al. (1991) had provided a comprehensive review of the criteria that academicians and purchasing managers feel important in the vendor selection decision. Several factors affect a supplier's performance, for example, Stamm & Golhar (1991), and Ellram (1990) had identified, 13 and 18 criteria for supplier selection respectively, however, price, quality, lead-time, technical service and delivery reliability have been considered as the five primary criteria used in the supplier selection problem.

On the other hand Dickson (1966) had identified 23 different criteria in vendor selection process and quality was given an extreme importance.

Present studies, presents a real-life problem from a developing–country. Since MCDM (Hwang & Yoon, 1981) provides an effective framework for supplier comparison based on the evaluation of multiple conflict criteria, therefore, MCDM method in supplier selection has been applied in this paper, which provides decision maker's with a method to systematically analyze the effects of policy decisions on the relevant criteria in supplier selection decisions.

The objective of the study was therefore, (i) to integrate multidimensional issues in an MCDM framework that may help decision makers to develop clear insights and make intelligent decisions, (ii) to assess supplier performance for suitability of approved suppliers.

The procedure covers all the approved suppliers who were supplying raw material and semi-finished/finished components to the manufacturing company except for foreign suppliers/contractors.

The responsibility for implementing the supplier selection procedure lied mainly with Head-Product Planning. Suppliers rating system was evolved in such a way that it was a continuous process. A rating was done on six months supplies by the supplier(s) by considering various aspects, such as quality, delivery, price, and suggestion acceptance.

III. Formulation of MCDM Supplier Selection Model

In most large organizations supplier selection process is done empirically. In this paper, we deal with the problem of supplier selection where buyers order quantities from different suppliers in a multiple sourcing network. The supplier selection, which inherently involves conflicting criteria, has not been dealt with as a multi attribute problem frequently.

In the present study, on supplier selection problem, quality, delivery (time), price, and suggestion acceptance as the four attributes/objectives functions were selected.

The MCDM problem was solved using the multiple attribute decision making (MADM)-technique for order preference by similarity to ideal solution (TOPSIS) technique.

MCDM refers to making decisions in the presence of multiple, usually conflicting, criteria. Problems for multiple criteria decision making are common occurrences in everyday life. The problems of MCDM are widely diverse and share the following common characteristics:

- Each problem has multiple objectives/attributes. A decision maker must generate relevant objectives/attributes for each problem setting.
- Multiple criteria usually conflict with each other.
- Each objective/attribute has a different unit of measurement.

Solutions to these problems are either to design the best alternative or to select the best one among the specified finite alternatives. The problems of MCDM can be broadly classified into two categories viz., Multiple attribute decision making (MADM), and Multiple objective decision making (MODM) [27, 28]. In actual practice this classification is well fitted in two facets of the problem solving viz., MADM is for selection (evaluation) and MODM for design.

The distinguishing feature of the MADM is that there are usually a limited number of predetermined alternatives. The alternatives have associated with them a level of the achievement of the attributes (which may not necessarily be quantifiable) based on which the final decision is to be made. The final selection of the alternative is made with the help of inter- and intra-attribute comparisons. The comparisons may involve explicit or implicit tradeoff.

IV. Formulation of MCDM Supplier Selection Model

Consider a manufacturing organization has 'm' suppliers for evaluation and selection. However, owing to operational and resource constraints, it is unable to consider all ' ' suppliers simultaneously.

Hence, the management is faced with a decision problem. As discussed earlier, MCDM philosophy is broadly classified into two categories: MADM and MODM.

There are three features of MADM method: should have a set of quantifiable objectives; should possess a set of well-defined constraints; and should have a process to obtain some trade off information between the stated and unstated objectives.

The methodology of TOPSIS is a MADM process, which is expressed in matrix form. TOPSIS method evaluates the decision matrix 'D' of a $m \times n$ matrix which contain 'm' number of alternatives associated with 'n' number of criteria (or attributes).

The element x_{ij} of the 'D' matrix indicates the value alternative $i(A_i)$ for the criteria. The structure of a 'D' matrix is shown in Fig. 1.

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$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \cdots \\ A_i \\ \cdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & C_2 & \cdots & C_j & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{ij} & \cdots & x_n \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

Fig.1 : Structure of 'D' matrix.

where: A_i = the i^{th} alternative considered, x_{ij} = the numerical outcome of the i^{th} alternative with respect to the j^{th} criterion

Different researchers have employed MCDM methodology and its various techniques for supplier's selection process [1, 2, 24]. The technique of TOPSIS (of MADM) hitherto, has not been employed for supplier selection as this mainly refers to a selection process where objectives/attributes are conflicts. However, in the present study TOPSIS has been employed for supplier selection process as quality, delivery, price, and suggestion acceptance criteria were also in a sort of conflict in nature. In the present studies suppliers have been ranked/selected according to the weights of the criteria given by the decision maker's of the organization.

a) The TOPSIS model

TOPSIS is a method for cardinal preference to attributes. Hwang and Yoon (1981) developed this technique based upon the concept that the chosen alternative should have the shortest Euclidean distance from the ideal solution and farthest from the negative-ideal solution.

Assuming that each attribute takes the monotonically increasing (or, decreasing) utility; then it is easy to locate the 'ideal' solution which is composed of all best attribute values attainable, and the 'negative-ideal' solution composed of all worst attribute values attainable. One approach is to take an alternative which has the (weighted) minimum Euclidean distance to the ideal solution in a geometrical sense [27]. Dasarathy (1976) used this similarity measure in clustering multidimensional data arrays. This method is simple and yields an indisputable preference order of solution.

b) Algorithm for TOPSIS model

The general structure of the MCDM model is that of a heuristically evolved procedure that can provide support to decision makers. The steps are described below.

Step 1: List the set of suppliers to be evaluated and selected by the organization. Identify all the intrinsic and extrinsic factors that may influence the organization while it is evaluating the suppliers. Generate a matrix 'D' having size $m \times n$. This is known as decision matrix.

Step 2: Obtain the information from the decision maker's or users on the relative importance of criteria. Assign weights to each of the criteria given by the decision maker's, is then accommodated to the decision matrix. It is usually given by a set of (preference) weights, which is normalized to sum 1. In case of n criteria, a set of weights is

$$w = (w_1, w_2, \ldots\ldots, w_j, \ldots\ldots, w_n) \quad (1)$$

$$\sum_{j=1}^{n} w_j = 1 \quad (2)$$

Step 3: Construct the normalized decision matrix: Normalization may be essential to facilitate the computational problems inherent to the presence of different units in decision matrix. The advantage of normalization is that all the criteria are measured in dimensionless units so that inter-attribute comparison is possible.

The normalization procedure does not lead to equal minimum and maximum values for all attributes, so straightforward comparison is therefore difficult. An element r_{ij} of the normalized decision matrix R can be calculated as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}}, \quad R = \begin{bmatrix} r_{11} & r_{12} & r_{ij} & r_{1n} \\ r_{21} & r_{22} & r_{ij} & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & r_{mj} & r_{mn} \end{bmatrix} \quad (3)$$

where: $i = 1,2,\ldots\ldots,m;\ j = 1,2,\ldots\ldots,n$

So that all criteria's have the same unit length of vector.

Step 4: Construct the weighted normalized decision matrix: This matrix 'V' can be calculated by multiplying each column of the matrix R with its associated weight w_j .

Therefore, the weighted normalized decision matrix V is equal to RW :

$$V = \begin{bmatrix} v_{11} & v_{12} & v_{ij} & v_{1n} \\ v_{i1} & v_{i2} & v_{ij} & v_{in} \\ \cdots & \cdots & \cdots & \cdots \\ v_{m1} & v_{m2} & v_{mj} & v_{mn} \end{bmatrix}$$

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & w_j r_{ij} & w_n r_{1n} \\ w_1 r_{i1} & w_2 r_{i2} & w_j r_{ij} & w_n r_{in} \\ \cdots & \cdots & \cdots & \cdots \\ w_1 r_{m1} & w_2 r_{m2} & w_j r_{mj} & w_n r_{mn} \end{bmatrix} \quad (4)$$

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where:

$$W = \begin{bmatrix} w_1 & & & 0 \\ & w_2 & & \\ & & \cdots & \\ 0 & & & w_n \end{bmatrix}$$

Step 5: Determine ideal and negative-ideal solutions from step 4: Let the two artificial alternatives and be defined as:

Ideal solution,

$$A^+ = (\max_i v_{ij} | j \in J), (\min_i v_{ij} | j \in J') | i = 1,2,......,m$$
$$= \{v_1^+, v_2^+, ..., v_j^+, ..., v_n^+\} \quad (5)$$

Negative-ideal solution,

$$A^- = \{(\min_i v_{ij} | j \in J), (\max_i v_{ij} | j \in J') | i = 1,2,......,m\}$$
$$= \{v_1^-, v_2^-, ..., v_j^-, ..., v_n^-\} \quad (6)$$

where:

$$J = \{j = 1,2,.....,n | j \text{ associated with benefit criteria}\}$$

and

$$J' = \{j = 1,2,.....,n | j \text{ associated with cost criteria}\}$$

The ideal solution is a hypothetical solution for which all attribute values correspond to the maximum attribute values (most preferable alternative). The negative-ideal solution is a hypothetical solution for which all attribute values correspond to the minimum attribute values (least preferable alternative).

Step 6: Calculate the separation measure: Calculate S_{i^+} and S_{i^-} (where $i = 1$ to m) from ideal and negative-ideal solutions (step 5), respectively. Separation measure is nothing but the n-dimensional Euclidean distance. The separation of each alternative for ideal and negative-ideal solution can be measured by Euclidean distance:

$$S_{i^+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_i^+)^2} \quad i = 1,2,......,m \quad (7)$$

$$S_{i^-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_i^-)^2} \quad i = 1,2,......,m \quad (8)$$

where: S_{i^+} and S_{i^-} are the separation measures of 'i^{th}' alternative from A^+ and A^-, respectively.

Step 7: Calculate the relative closeness to the ideal solution: Determine the relative closeness of A_i with respect to A^+ (ideal solution). This can be measured by the relation:

$$C_{i^+} = S_{i-} \div (S_{i+} + S_{i-}) \;, 0 \langle C_{i^+} \langle 1, \quad i = 1,2,.....,m \quad (9)$$

The S_{i^+} and S_{i^-} values are obtained from step 7. It is clear that $C_{i^+} = 1$ if $A_i = A^+$ and $C_{i^+} = 0$ if $A_i = A^-$. An alternative A_i is closer to A^+ as C_{i^+} approaches to 1.

Step 8: Rank the preference order: Rank the alternatives according to the descending order of C_{i^+}.

c) Criteria employed in evaluation and selection (rating) of suppliers

The suppliers were evaluated based on the following criteria:

(a) *Quality:* A six monthly statement of rejections was generated by computerized system for the rejections during the supplies of the last six months which gave the percentage of rejections for the received material. Head-Quality Assurance allocated marks in the quality column of suppliers rating format.

Quality rating (Quality verification) was done on the basis of inspection stages: Incoming inspection and Inprocess inspection stages.

- Incoming inspection: It is based on quantity delivered versus quantity accepted for a given consignment, it was calculated as follows:

$$q = (Q_1 + 0.8Q_2 + 0.5Q_3)100 \div Q$$

where:

q = quality rating for a particular month,

Q_1 = Quantity accepted,

Q_2 = Quantity accepted under deviation,

Q_3 = Quantity accepted after rework,

Q = Total quantity received.

$$C_1 = (q_1 + q_2 + q_3 + ... + q_N) \div N$$

then, $$QR = Sum(C) \div N$$

where: C = Consignment and N = Number of consignments received in a month.

- Inprocess inspection: In this category, quality rating was determined based on the feedback from assembly shop after the materials have been used up. Information on shop rejection on account of manufacturing defects was provided by the shop to electronic data processing (EDP) every month. To calculate the quality rating the same formula as given above (see Incoming inspection) was applied. where: q = Quality rating for a particular month, Q_1 = Quantity used without problems, Q_2 = Quantity used under deviation, Q_3 = Quantity used after rework in shop, Q = Total quantity used in the month, N = Number of the months. Rating for quality was limited to 0.5 weights given by decision maker's.

(b) *Delivery:* A quarterly statement on receipts was generated for each material supplied by the suppliers during the period and was compared with the delivery schedule given to the suppliers at the start of the quarter. Based on this statement, Head-Planning and Purchase allocated marks in the delivery column of supplier rating format, which were intimated to EDP. Delivery rating was calculated based on scheduled delivery versus actual delivery. In case, purchase required to be postponed or preponed for delivery of consignment from the date specified in purchase order, a request approved by Head-Planning and Purchase was sent to EDP and the amended delivery schedule was taken into consideration for calculating delivery rating. Weights allocated for delivery rating were 0.3 and calculated as follows:

A=If delivery was on the scheduled date or within a week prior to the schedule-0.3

B=If delivery schedule was not met and supplies were delayed, the ratings were as per Table 1.

Table 1 : Delivery rating points.

	Day	Week				
Delays by	1	1	2	3	4	〉4
Points	0.25	0.2	0.15	0.1	0.05	0
Early delivery by	-	-	2	3	4	〉4
Points	-	-	0.25	0.2	0.15	0.1

(c) *Price:* Every six months a comparative statement of each supplier price with the rates of other suppliers was prepared or in case of a single source, comparison with organization norms were made by purchase and planning department and given to its Head who inturn allocated marks in price column in the supplier rating format and sent it to EDP.

Price rating (PR) was calculated based on the ratio of the quoted price over standard price. Until a standard price was worked out, the lowest price quoted was used as a substitute. The maximum price rating was 0.1 weights and calculated as follows:

$$PR = (Standard\ Price)10 \div Quoted\ Price$$

EDP systems worked out the progress to accommodate all these inputs in order to implement the supplier rating system.

(d) *Suggestion acceptance:* To overcome the rejection and improve the quality, various suggestions were given to suppliers by quality assurance/planning and purchase department and a check was kept on implementation of those suggestions and marks were allocated to a particular supplier in the supplier rating format.

Suggestion acceptance was calculated on the basis of suggestions made during supplier's visits, their implementation in the future supplies or in infrastructure changes suggested were checked during future visits. Weights allocated for suggestion acceptance were 0.1.

(e) *Periodicity:* Suppliers rating system was evolved in such a way that it was a continuous on going exercise. It was possible at any point of time to get a rating for any suppliers, based on previous six months performance. The ratings were formally communicated to respective suppliers twice a year (in the month of April and October).

V. Illustrative Example of Supplier Selection in Tv Manufacturing Organization

In this section, an empirical example of supplier selection decision was used to demonstrate that the MCDM (MADM-TOPSIS) is an appropriate model for supplier selection in a TV manufacturing organization.

Step 1: A supplier selection problem consists of five basic elements: alternatives (suppliers), criteria, outcomes, preferences and information (see Table 2).

Table 2 : Decision matrix for supplier selection.

S_j	C_i			
	C_1	C_2	C_3	C_4
	$w_1=0.5$	$w_2=0.3$	$w_3=0.1$	$w_4=0.1$
S_1	48	28	7	8
S_2	49	26	7	7
S_3	33	26	7	8
S_4	48	25	7	7
S_5	46	25	7	8
S_6	47	25	8	8
S_7	47	25	7	8
S_8	47	27	8	7
S_9	39	27	7	8
S_{10}	46	22	6	5

where: S_j :Suppliers/Alternatives, C_i: Criteria/ Attributes, C_1: Quality, C_2: Delivery, C_3: Price, C_4: Suggestion acceptance.

Note that S_j: the set of m suppliers/ alternatives we will choose from to make our decision, $j=1,...,m$; C_i : the set of criteria with which we need to make a good decision, i ; =1,…, n , w_j : the weights a decision maker place on each criterion; f_{ij} : the performance scores of each choice, measured in terms of the criteria. Note that the five elements can evolve over time as situations change. Thus the dynamic change of the ''information'' represented by the evolution of the elements above will be treated in the decision process.

The multiple criteria decision issue focuses mainly on the identification of the evaluation criteria and on the determination of the preference structure (i.e., weights) [4, 26].

Ten suppliers have been evaluated and the main criteria for evaluation and selection that were used are quality, delivery, price and suggestion acceptance. The weights are assigned by decision maker's for each criterion was 0.5, 0.3, 0.1, and 0.1 respectively. (Note: that all criteria's except C_3 are the benefit criteria).

The decision matrix 'D' (see Table 2) was generated for further problem solving. Other criteria which could be added if necessary, together with a suggestion that a computer may be used to simplify calculations. Performance score (f_{ij}) regarding the quality, delivery, price and suggestion acceptance for different suppliers were required to solve the problem. For which, decision matrix was obtained which is shown in Table 2.

Step 2: The weights a decision maker placed on each criterion was as follows. As per Eqs. (1) and (2):

$$w = (0.5, 0.3, 0.1, \text{ and } 0.1) \text{ and } \sum_{j=1}^{4} w_j = 1$$

Step 3: Calculation of the normalized decision matrix. The decision matrix values were provided by the organization and on this basis further calculations for supplier selection were made. As per Table 2 and Eq. (3):

$$R = \begin{bmatrix} 0.3354 & 0.3518 & 0.3108 & 0.3392 \\ 0.3424 & 0.3267 & 0.3108 & 0.2968 \\ 0.2306 & 0.3267 & 0.3108 & 0.3392 \\ 0.3354 & 0.3141 & 0.3108 & 0.2968 \\ 0.3214 & 0.3141 & 0.3108 & 0.3392 \\ 0.3284 & 0.3141 & 0.3552 & 0.3392 \\ 0.3284 & 0.3141 & 0.3108 & 0.3392 \\ 0.3284 & 0.3392 & 0.3552 & 0.2968 \\ 0.2725 & 0.2764 & 0.3108 & 0.3392 \\ 0.3214 & 0.2764 & 0.2664 & 0.2120 \end{bmatrix}$$

$$R = \begin{bmatrix} 0.1677 & 0.1055 & 0.03108 & 0.03392 \\ 0.1712 & 0.0980 & 0.03108 & 0.02968 \\ 0.1153 & 0.0980 & 0.03108 & 0.03392 \\ 0.1677 & 0.0942 & 0.03108 & 0.02968 \\ 0.1607 & 0.0942 & 0.03108 & 0.03392 \\ 0.1642 & 0.0942 & 0.03552 & 0.03392 \\ 0.1642 & 0.0942 & 0.03108 & 0.03392 \\ 0.1642 & 0.10176 & 0.03552 & 0.02968 \\ 0.1362 & 0.08292 & 0.03108 & 0.03392 \\ 0.1607 & 0.08292 & 0.02664 & 0.02120 \end{bmatrix}$$

Step 4: Calculation of the weighted normalized decision matrix 'V': As per eq. (4),

$$V = \begin{bmatrix} 0.1677 & 0.1055 & 0.0310 & 0.0339 \\ 0.1712 & 0.0980 & 0.0310 & 0.0296 \\ 0.1153 & 0.0980 & 0.0310 & 0.0339 \\ 0.1677 & 0.0942 & 0.0310 & 0.0296 \\ 0.1607 & 0.0942 & 0.0310 & 0.0339 \\ 0.1642 & 0.0942 & 0.0355 & 0.0339 \\ 0.1642 & 0.0942 & 0.0310 & 0.0339 \\ 0.1642 & 0.1017 & 0.0355 & 0.0296 \\ 0.1362 & 0.0829 & 0.0310 & 0.0339 \\ 0.1607 & 0.0829 & 0.0266 & 0.0212 \end{bmatrix}$$

Step 5: Determination of ideal and negative-ideal solutions from step 4, as per Eqs. (5) and (6):

$A^+ = 0.1712, 0.0829, 0.0266, 0.0339$ and

$A^- = 0.1153, 0.1055, 0.0355, 0.0212$

Step 6: Calculation of separation measure S_i^+ and S_i^- as per Eqs. (7) and (8):

$$S_{1^+} = \sqrt{(0.1677-0.1712)^2 + (0.1055-0.0829)^2 + (0.0310-0.0266)^2 + (0.0339-0.0339)^2}$$

$$S_{1^+} = 0.0232$$

$$S_{2^+} = \sqrt{(0.1712-0.1712)^2 + (0.0980-0.0829)^2 + (0.0310-0.0266)^2 + (0.0296-0.0339)^2}$$

$$S_{2^+} = 0.0163$$

$$S_{3^+} = \sqrt{(0.1153-0.1712)^2 + (0.0980-0.0829)^2 + (0.0310-0.0266)^2 + (0.0339-0.0339)^2}$$

$$S_{3^+} = 0.0580$$

$$S_{4^+} = \sqrt{(0.1677-0.1712)^2 + (0.0942-0.0829)^2 + (0.0310-0.0266)^2 + (0.0296-0.0339)^2}$$

$$S_{4^+} = 0.0133$$

$$S_{5^+} = \sqrt{(0.1607-0.1712)^2 + (0.0942-0.0829)^2 + (0.0310-0.0266)^2 + (0.0339-0.0339)^2}$$

$$S_{5^+} = 0.0126$$

$$S_{6^+} = \sqrt{(0.1642-0.1712)^2 + (0.0942-0.0829)^2 + (0.0355-0.0266)^2 + (0.0339-0.0339)^2}$$

$$S_{6^+} = 0.0159$$

$$S_{7^+} = \sqrt{\begin{matrix}(0.1642-0.1712)^2+(0.0942-0.0829)^2+\\(0.0310-0.0266)^2+(0.0339-0.0339)^2\end{matrix}}$$

$$S_{7^+} = 0.0140$$

$$S_{8^+} = \sqrt{\begin{matrix}(0.1642-0.1712)^2+(0.1017-0.0829)^2+\\(0.0355-0.0266)^2+(0.0296-0.0339)^2\end{matrix}}$$

$$S_{8^+} = 0.0223$$

$$S_{9^+} = \sqrt{\begin{matrix}(0.1362-0.1712)^2+(0.0829-0.0829)^2+\\(0.0310-0.0266)^2+(0.0339-0.0339)^2\end{matrix}}$$

$$S_{9^+} = 0.0352$$

$$S_{10}^{+} = \sqrt{\begin{matrix}(0.1607-0.1712)^2+(0.0829-0.0829)^2+\\(0.0310-0.0266)^2+(0.0212-0.0339)^2\end{matrix}}$$

$$S_{10^+} = 0.0138$$

$$S_{1^-} = \sqrt{\begin{matrix}(0.1677-0.1153)^2+(0.1055-0.1055)^2+\\(0.0310-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{1^-} = 0.0541$$

$$S_{2^-} = \sqrt{\begin{matrix}(0.1712-0.1153)^2+(0.0980-0.1055)^2+\\(0.0310-0.0355)^2+(0.0296-0.0212)^2\end{matrix}}$$

$$S_{2^-} = 0.0572$$

$$S_{3^-} = \sqrt{\begin{matrix}(0.1153-0.1153)^2+(0.0980-0.1055)^2+\\(0.0310-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{3^-} = 0.0154$$

$$S_{4^-} = \sqrt{\begin{matrix}(0.1677-0.1153)^2+(0.0942-0.1055)^2+\\(0.0310-0.0355)^2+(0.0296-0.0212)^2\end{matrix}}$$

$$S_{4^-} = 0.0544$$

$$S_{5^-} = \sqrt{\begin{matrix}(0.1607-0.1153)^2+(0.0942-0.1055)^2+\\(0.0310-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{5^-} = 0.0486$$

$$S_{6^-} = \sqrt{\begin{matrix}(0.1642-0.1153)^2+(0.0942-0.1055)^2+\\(0.0355-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{6^-} = 0.0517$$

$$S_{7^-} = \sqrt{\begin{matrix}(0.1642-0.1153)^2+(0.0942-0.1055)^2+\\(0.0310-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{7^-} = 0.0519$$

$$S_{8^-} = \sqrt{\begin{matrix}(0.1642-0.1153)^2+(0.1017-0.1055)^2+\\(0.0355-0.0355)^2+(0.0296-0.0212)^2\end{matrix}}$$

$$S_{8^-} = 0.0497$$

$$S_{9^-} = \sqrt{\begin{matrix}(0.1362-0.1153)^2+(0.0829-0.1055)^2+\\(0.0310-0.0355)^2+(0.0339-0.0212)^2\end{matrix}}$$

$$S_{9^-} = 0.0336$$

$$S_{10^-} = \sqrt{\begin{matrix}(0.1607-0.1153)^2+(0.0829-0.1055)^2+\\(0.0266-0.0355)^2+(0.0212+0.0212)^2\end{matrix}}$$

$$S_{10^-} = 0.0514$$

Step 7: Calculation of relative closeness to ideal solution as per Eq. (9). The S_{i^+} and S_{i^-} values were obtained from step 6.

$$C_{1^+} = \frac{0.0541}{0.0232+0.0541} = 0.6998; \quad C_{2^+} = \frac{0.0572}{0.0163+0.0572} = 0.7782$$

$$C_{3^+} = \frac{0.0154}{0.0580+0.0154} = 0.2098; \quad C_{4^+} = \frac{0.0544}{0.0133+0.0544} = 0.8035$$

$$C_{5^+} = \frac{0.0486}{0.0126+0.0486} = 0.7941; \quad C_{6^+} = \frac{0.0517}{0.0159+0.0517} = 0.7647$$

$$C_{7^+} = \frac{0.0519}{0.0140+0.0519} = 0.7875; \quad C_{8^+} = \frac{0.0497}{0.0223+0.0497} = 0.6902$$

$$C_{9^+} = \frac{0.0336}{0.0352+0.0336} = 0.4883; \quad C_{10^+} = \frac{0.0514}{0.0138+0.0514} = 0.7883$$

Step 8: Suppliers (alternatives) were evaluated/ selected (ranked) according to the descending order of C_{i^+} , the preference order is C_4, C_5, C_{10}, C_7, C_2, C_6, C_1, C_8, C_9, C_3 and decision maker's/management can take decision accordingly.

VI. Results

An interactive computer code was generated in C language that runs under the Microsoft Disc Operating System using a Turbo compiler. This program enables the user to rank the various suppliers (alternatives) depending upon their 'relative closeness to ideal solutions' values. The computer code generates first a decision matrix (D) after seeking data for various alternatives from user. Again, it obtains information (weights) for the relative importance of each criterion. Then it calculates the values of the ideal, A^+ and negative ideal solutions A^-, respectively for finding out the separation measures as well as the 'relative closeness to ideal solutions', C_{i^+} where i =1 to 10. The final ranking is thus obtained (by computational and software) and is shown in Table 3.

Table 3 : Final ranking (selection) of the supplier(s).

Rank	Supplier (S_j)	C_{i^+} value	Rank	Supplier (S_j)	C_{i^+} value
1	S_4	0.8035	6	S_6	0.7647
2	S_5	0.7941	7	S_1	0.6998
3	S_{10}	0.7863	8	S_8	0.6902
4	S_7	0.7875	9	S_9	0.4883
5	S_2	0.7782	10	S_3	0.2098

VII. Conclusion

The MCDM (MADM-TOPSIS) model has been described in this paper and applied to a real-life organization. It has helped the organization as follows:

- A systematic and structured approach that focuses on relevant evaluation criteria has made the organization decision makers quantify their subjective perceptions.
- The modeling approach has helped the organization to collate and clarify systematically various types of information.
- The procedure has been used to replace the biased judgments of decision makers.
- The selection of suppliers and the determination of appropriate order quantities to be placed with them are important decisions for many organizations. Such decisions may greatly affect a firm's ability to compete in the market as they frequently account for large portion of a product's production cost and may involve long-term contracts.
- Supplier selection decisions also affect the ability of the organization to effectively implement production strategies, e.g., although price is important, however, delivery reliability and product quality take on increased importance in just-in-time manufacturing systems.
- The approach allows the purchasing manager to generate non-inferior purchasing options and systematically analyze the inherent tradeoffs among the relevant criteria. This is particularly an important feature in that it allows organizations to analyze potential impacts of strategic options.
- The number and specific forms of the objectives were determined in consultation with the purchasing manager. The inclusion of more objectives though would pose no theoretical problems; however, it would increase computational time (i.e., an increased number of non-inferior solutions to be generated) and increased complexity of the output (i.e., more solutions and more tradeoffs to be analyzed) might create implementation problems. The practical implications of these potential problems are another area for future research.
- Organization can provided valuable suggestions to suppliers on how to improve each criterion so that they could bridge the gap between actual and aspired performance values in the future.
- Study carried out in the TV manufacturing organization prove the practical feasibility of the model TOPSIS for the suppliers ranking/selection problem.
- Finally, the model TOPSIS has been used, as a conscious exercise, within the manufacturing organization to make a choice between suppliers on the basis of very relevant criteria, so that capital can be committed to feasible, as well as profitable ventures.

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Executive Manager's Opinion about Just-In-Time Implementation Status in the Middle East Industry

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Abstract - The purpose of this study is to identify and evaluate the scale of implementation of Just-In-Time (JIT) in the different industrial sectors in the Middle East. This study analyzes the empirical data collected by a questionnaire survey distributed to companies in five main industrial sectors in the Middle East, which are: food, construction, chemicals, fabrics and engineering. The following two main hypotheses are formulated and tested: 1- The requirements of JIT application differ according to the type of industrial sector. 2- The elements of JIT application differ according to the type of industrial sector. Descriptive statistics and ANOVA test were used to examine the two hypotheses. This study indicates a reasonable evidence for accepting these main hypotheses. It reveals that there is no standard way to adopt JIT as a production system, where each industrial sector should concentrate in the investment on critical requirements and elements that differ according to the nature and strategy of production followed in that sector.

Keywords : Just-In-Time, questionnaire, types of industrial sectors.

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Keywords : Just-In-Time, questionnaire, types of industrial sectors.

I. Introduction

JIT is a very important and relevant topic to all operations managers today. It aims to meet demand instantaneously, with perfect quality and no waste (Slack et. al, 2004). It has become a major factor of competitiveness in the global environment (Aghazadeh, 2003). JIT systems, which are designed to produce or deliver goods or services as needed and minimize inventories, require major changes in traditional operating practices (Krajewski and Ritzman, 2010). JIT originated in the 1950s at Toyota Motor Company in Japan, through continuous effort to solve manufacturing problems. JIT is often referred as the Toyota production system. Many definitions have been put forward for JIT. Fouad and AlBayati (2002) defined JIT as organizational philosophy that utilizes important procedures to maximize profit through minimizing inventory. Vollmann *et al* (1997) defined JIT as an approach to minimize the waste. Whereas, Wantuch (1989) defined JIT as a production strategy with a new set of values to continuously improve quality and productivity.

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JIT is characterized by reduced inventory, improved quality (Gomes and Mentzer, 1991), reduced lead times, enhanced flexibility, worker empowerment, improved morale, minimum waste (Boyer, 1991) and timely response to customer needs. JIT is based on two principles: elimination of waste; and respect and full utilization of human resources and capabilities. Potential waste is apparent at every stage of the production process (Herod, 2000). The most important kind of waste to eliminate with JIT is the imbalance between customer demand and production. Inventory is generated by overproduction which leads to a waste of money. Operating with internal customers, this imbalance may exist at each stage in production, including the relation between supplier and producer. Waste may also arise during production for a number of other reasons, i.e. waiting, transporting, processing and producing defective goods. He and Hayya (2002) mentioned that after analyzing thirty eight articles published between 1982 and 1990, it is found that, in a total of 44 industrial companies, inventory was reduced by 68%, defect rates reduced from 6% to 0.5%, quality increased by 50%, and space reduced by 46%.

Questionnaires have been used and are still being used by many researchers to assess the JIT implementation benefits. Most of research has examined the effect of JIT philosophy in developed countries. He and Hayya (2002) used statistical analysis methods to examine the empirical data from a questionnaire survey to test the hypothesis that JIT has a positive impact on the quality of food. They used four quality measures. Of these measures used, product quality, following USDA standards, and customer satisfaction score extremely high, with product safety scoring slightly lower. They concluded that most of the responding food companies considered themselves to be among the best quality-food producers. Kristensen et. al. (1999), in their study, used a questionnaire survey run in manufacturing companies in the Nordic companies and East Asian companies, to evaluate to what degree the effects of TQM and JIT are to be expected. They found that JIT companies are very professional and facts-driven. They base their success on high quality of relationships with suppliers, employees and customers. Fouad, (1991) identified and compared the scale of implementation of JIT activities in the UK by entirely British and American owned

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companies. He concluded that the British owned manufacturing companies are showing a high degree of interest in training programs, but they ; and the American owned companies; are still using the formal paper work for selecting their suppliers.

Not much attention has been paid to the study of the implementation of JIT in less developed countries. Amoako-Gyampah and Gargeya (2001) examined the implementation of JIT production systems in Ghana. After He analyzed a survey questionnaire, he found that the Ghanaian manufacturing firms which implemented JIT invested in JIT production in terms of their efforts in employees training, setup time reduction, cellular manufacturing, continuous quality improvement, and supplier partnership.

The Middle East countries are recognized to be from the less developed countries. There is a crucial need to adopt the new technologies in the production management. The industrial sector in the Middle East suffers from many problems that can be cured by intelligent implementation of JIT system. The main four problems are: high inventory levels, high percentages of scrap and rework, high setup and lead times, and a huge shortage in the communication systems with the suppliers.

In this study, a questionnaire survey will be analyzed to evaluate the scale of implementation of JIT in the different types of industry in Middle East from the executive managers point view. It will bring out the critical JIT requirements and JIT elements essential to the successful incubation of JIT according to the type of industry.

II. Research Methodologies

a) The JIT hypothesis

Many researchers wrote about the main components of JIT. Davisom *et al.* (2000) mentioned that JIT depends on the use of superior technology and electronic data interchange, which facilitates the development of technology skills and technologically advanced manufacturing equipment and facilities. Landry *et al.* (1998) used words like "mutual trust" and "partnership" to describe the buyer-supplier relationship in a JIT environment. Pheng and Chuan (2001) and Yui (1997) argued that JIT is an efficient management system to cope with schedule fluctuations. Krieg and Kuhn (2002) considered kanban production control system as one of JIT major operational elements.

After a deep study of the previous researches, the main JIT requirements and JIT elements are summarized in Table 1, and a comprehensive questionnaire is designed to contain them all. The questionnaire will assess the executive manager's opinions about the critical JIT requirements and the critical JIT elements, and how these two JIT components differ according to the type of industrial sector. In this study the following two main JIT hypotheses will be tested:

Hypothesis 1: The requirements of JIT differ according to the type of industrial sector.

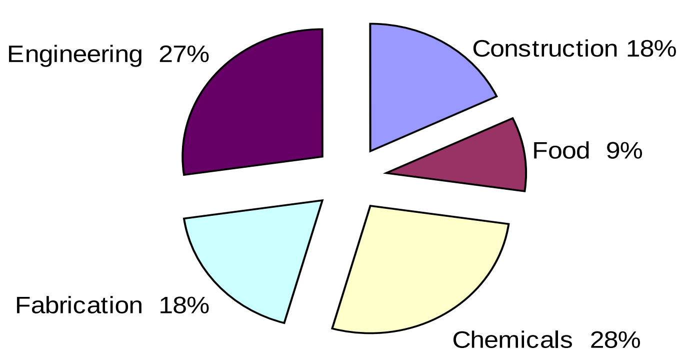
Hypothesis 2 : The elements of JIT differ according to the type of industrial sector

b) The survey questionnaire

Through field interviews and pilot pretests, we modified the JIT requirements and elements in order to accommodate the quality characteristics in the industrial companies included in the study. We targeted the main five types of industrial sectors in the Middle East, which are: the construction, food, chemical, fabric and engineering.

A pretest questionnaire, based on the JIT requirements and JIT elements listed in Table 1 , was then sent to the selected companies. The pretest results indicated that although some large plants were willing to share information with us, small companies were defensive about their proprietary quality and safety data. The numbers of companies in all five industry types that felt comfortable with the points presented in the questionnaire are described in Figure 1.

Figure 1 : Types of industrial sectors used in the questionnaire



The survey questionnaire was designed to reflect the pilot pretest, and the JIT requirements and JIT elements were thus fine-tuned. According to He and Hayya (2002), minimizing cost, establishing trust and providing reward are the three key considerations for a usable questionnaire. To minimize cost associated with manager's time, only the questions essential to the study was asked, which led to a two-page questionnaire. To establish trust a covering letter explaining the purpose of the study and assuring confidentiality is included with the questionnaire. Finally the reward was an offer to present academic service and a promise to share the survey results.

Table 1 : Summary of JIT elements and requirements

		Survey Question	Symbol
JIT requirements	Inventory level	Minimization of inventory levels	Q1
	Cultural change	Top management plays a pivotal role in spreading JIT understanding for the different levels of management	Q2
	Employee empowerment	Management support and understanding and employee empowerment	Q3
	Training	On-job training	Q4
	Communication systems	The use of integrated data interchange tools inside the company	Q5
		High degree of communication with the supplier	Q6
	Continuous improvement	Clear goals for continuous improvement	Q7
	Strategic planning	Strategic plans to implement JIT	Q8
		Let near benefits to gain JIT benefits	Q9
JIT elements	Supplier evaluation	Price	Q10
		Quality	Q11
		Small lot sizes	Q12
		Geographical location	Q13
		Technical design capabilities	Q14
		Mutual relations with suppliers	Q15
	Supplier relationship	Single sourcing of fabricated parts, components and materials	Q16
		Long term employment and contracts	Q17
		Healthy profits to suppliers	Q18
		Quick payment of invoices	Q19
		Precise product specifications	Q20
		Designs that matches the suppliers technologies	Q21
		Precise forecasting	Q22
		Reasonable changes in lot sizes	Q23
		Enough time for planning when lot size changes	Q24
	Quality control	Achieving zero defects	Q25
		Operators test and inspect their own work	Q26
		Authorizing operators to stop production line when a quality problem arises	Q27
		Training operators on machines condition monitoring	Q28
		Operators do their own rework	Q29
	Preventive maintenance	The company have a preventive maintenance programs	Q30
	Time utilization	Engineers and operators strive to reduce set up time to the minimum value	Q31
		Operators responsible for preparing and set up their own machines	Q32
		Engineers and operators strive to reduce production lead times	Q33
	Multifunctional workforce	The company have many multifunctional workforce	Q34

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III. Statistical Analyses

The survey questionnaire consists of 34 various questions, 9 of these questions cover JIT requirements and the rest questions cover JIT elements. A five-point Likert scale is used as follows: number 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree. The analysis, using SPSS, utilizes descriptive statistics and ANOVA test.

a) Hypothesis 1: The requirements of JIT differ according to the type of industrial sector

Table 2 shows the statistical data of the survey results for the five types of industrial sectors. The mean and standard deviation were calculated for each JIT requirement and the variability in mean response to the different JIT requirements according to the type of industrial sector is tested using ANOVA test, where F-test values for the different JIT requirements are listed.

Table 2 : Statistical values for executive managers' responses to JIT requirements

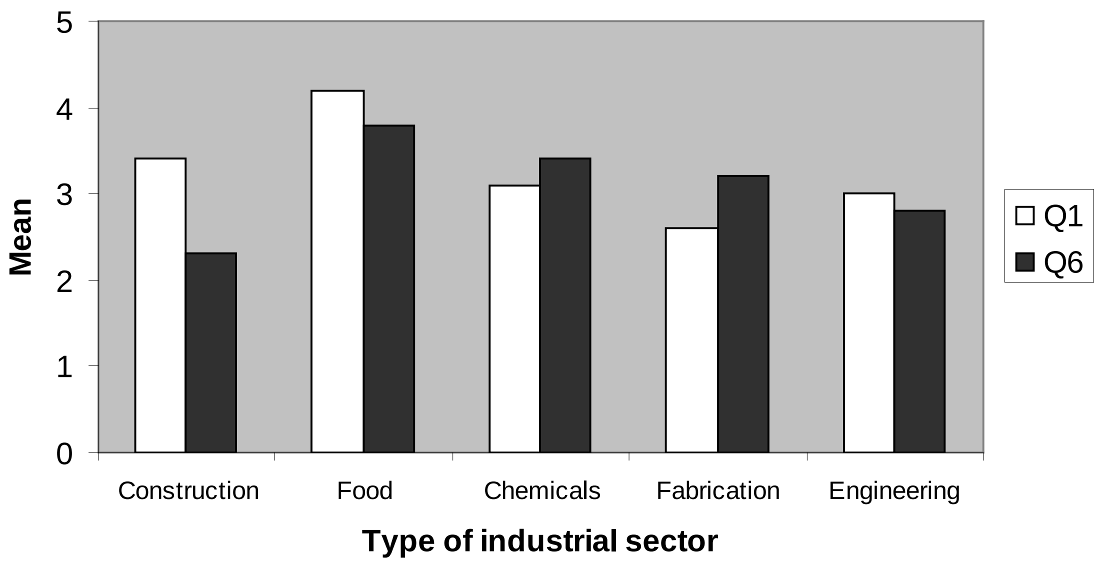
Symbol	Construction		Food		Chemicals		Fabrication		Engineering		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F- test
Q1	3.4	0.84	4.2	0.44	3.1	0.83	2.6	0.51	3.0	1.03	*3.37
Q2	2.0	0.47	2.4	0.54	2.6	0.61	2.2	0.63	2.2	0.86	1.78
Q3	4.2	0.63	3.8	0.44	3.9	0.79	3.3	1.05	3.6	0.81	1.76
Q4	4.1	0.73	4.4	0.54	4.2	0.67	3.6	0.84	4.1	0.74	1.44
Q5	3.1	0.73	4.2	1.09	3.4	0.74	3.6	0.84	3.7	1.16	1.39
Q6	2.3	0.94	3.8	0.44	3.4	0.63	3.2	0.63	2.8	0.41	**7.39
Q7	3.9	0.73	4.2	0.83	4.2	0.77	3.9	0.73	3.7	0.79	0.83
Q8	1.8	0.63	2.2	0.83	2.2	0.86	2.0	0.47	2.0	0.79	0.49
Q9	1.6	0.51	1.8	0.83	1.8	0.94	1.5	0.52	1.4	0.50	0.79

Table 2 shows that the mean value of JIT requirements (Q3, Q4, Q5 and Q7) which are: Top management plays a pivotal role in spreading JIT understanding for the different levels of management (Q3), The relations between management and workforce are mutual and both parties accepts criticism (Q4), Management encourages continuous training programs for all employees (Q5), and Companies objectives towards improving production lines and continuous improvements (Q7), exceed the central value of 2.5, indicating that all the executive managers irrespective of the type of industrial sector felt positive towards these requirements. Whereas, they all felt negative towards three of JIT requirements (Q2, Q8 and Q9) which are: Top management plays a pivotal role in spreading JIT understanding for the different levels of management (Q2),, The company is moving towards implementing JIT through a strategic planning process (Q8),, The company realizes that implementing JIT will not bring a return on investment in a short period of time (Q9),, which have mean scores around the central value of 2.5. As noted from the F-test values, there is no significant difference in the opinions of the executive managers concerning the preceding JIT requirements.

Figure 2 shows the mean response for the other requirements (Q1 and Q6) which are:

Company strives for reducing inventory levels to the minimum (Q1),, The communications tools between company and suppliers are excellent (Q6), which shows significant differences (see the F-values) in the opinions of the executive managers concerning these two elements revealing that the implementation of JIT depends on the type of industrial sector.

Figure 2 : Mean values for the executive managers' responses to Q1 and Q6



For Q1, the food and construction sectors emphasized on the fact that inventory level minimization have to be of the most critical items in the requirements of JIT, therefore the critical actions towards JIT in these two sectors is to get zero inventory level since the raw materials and the finished products have special physical properties that they are susceptible to fast damage. Whereas, the other three sectors: chemicals, fabrications and engineering, may invest first in other JIT requirements since their raw materials and finished products can sustain storage in the inventory without damage. Also, the low inventory level needs frequent set up times which is reasonable at industrial sectors which have normally low setup times as the food and construction sectors.

On the other hand, the food, chemicals and fabrication sectors emphasize the fact that high investment should be put in achieving high technological communication tools (Q6) with the suppliers; this is may due to the awareness of the managers about the importance of the communication tools with the suppliers in reducing the costs associated with high lead times and deteriorated quality.

Previous results demonstrate that, JIT requirements differ according to the type of industrial sector, which verifies *hypothesis 1.* Thereby, the application of JIT production is not standard for all industrial sectors.

b) Hypothesis 2: The elements of JIT differ according to the type of industrial sector

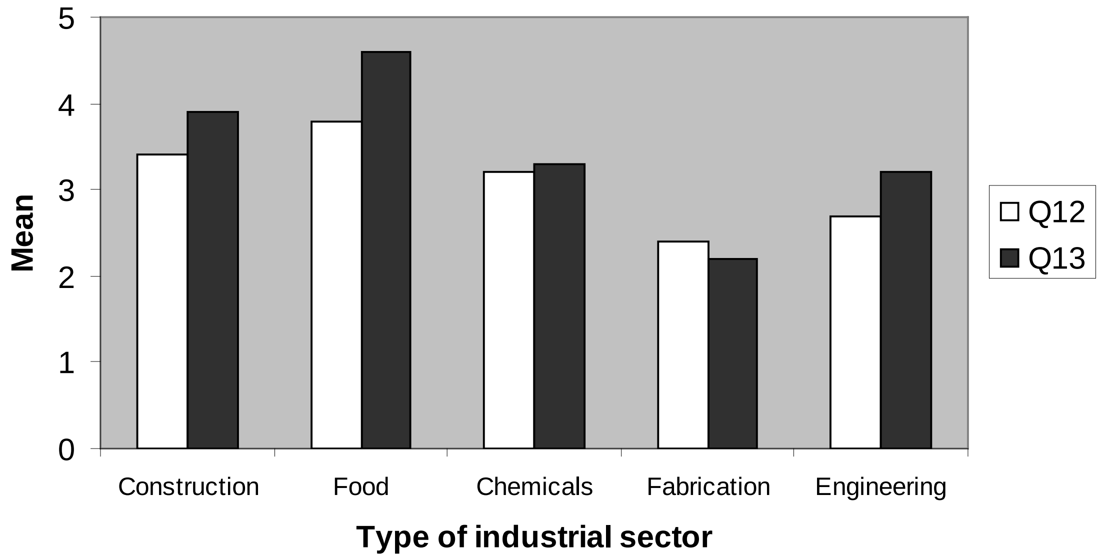
Table 3 shows the statistical data of the survey results for the five types of industrial sectors. The mean and standard deviation were calculated for each JIT element and the variability in mean response to the different JIT elements according to the type of industrial sector is tested using ANOVA test, where F-test values for the different JIT elements are listed. The executive managers responses towards the different elements of JIT are described in Table 3, is described in the following paragraphs.

Table 3 : Statistical values for the executive managers' responses to JIT elements

Symbol	Construction		Food		Chemicals		Fabrication		Engineering		F- test
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Q10	4.2	0.63	4.0	0.70	3.8	0.77	3.9	0.73	3.8	0.77	0.57
Q11	3.5	0.70	4.2	0.44	4.2	0.94	3.6	0.84	4.1	0.91	1.75
Q12	3.4	0.56	3.8	0.83	3.2	0.56	2.4	0.69	2.7	1.22	*2.99
Q13	3.9	0.73	4.6	0.54	3.3	0.81	2.2	0.63	3.2	0.94	**9.67
Q14	4.0	0.81	4.2	0.44	4.2	0.79	4.0	0.81	4.2	0.79	0.35
Q15	4.0	0.81	4.2	0.44	3.6	0.72	3.8	0.42	4.2	0.77	1.04
Q16	1.9	0.73	2.0	1.00	2.8	1.08	2.7	0.67	2.8	0.94	2.34
Q17	1.9	0.56	1.8	0.44	2.4	1.06	2.6	0.96	2.4	0.91	1.37
Q18	3.7	0.67	3.8	0.44	3.6	0.81	3.6	0.69	3.4	0.82	0.43
Q19	4.0	0.52	4.2	0.54	3.8	0.94	4.0	0.82	4.0	0.74	0.15
Q20	3.5	0.52	4.2	0.44	4.1	0.99	3.8	0.78	4.3	0.61	2.24
Q21	3.8	1.03	3.8	0.44	3.9	0.88	4.0	0.66	4.1	0.83	0.31
Q22	3.6	0.84	4.0	0.00	3.7	0.79	3.3	0.82	4.0	0.88	1.92
Q23	3.3	0.48	3.8	0.44	3.8	0.67	3.4	0.51	3.7	0.79	1.42
Q24	3.8	1.03	3.6	0.54	3.8	0.74	3.8	0.42	3.7	0.88	0.13
Q25	3.8	1.25	3.6	0.54	3.4	0.73	2.8	0.63	3.3	0.97	0.97
Q26	3.5	0.84	3.6	0.54	3.5	0.63	3.0	0.66	3.0	0.96	1.23
Q27	2.4	0.84	3.0	0.70	2.2	0.67	2.4	0.51	2.6	0.91	1.04
Q28	4.0	0.47	4.0	0.70	4.0	0.65	4.2	0.91	3.8	0.67	0.51
Q29	2.9	0.56	3.4	0.54	3.0	0.37	3.2	0.78	3.4	0.83	1.96
Q30	3.6	0.96	4.2	0.44	3.7	0.88	3.5	0.84	3.4	0.98	0.85
Q31	3.4	0.51	4.0	0.00	3.5	0.83	3.3	0.67	3.3	0.81	1.01
Q32	4.0	0.94	4.2	0.44	4.1	0.63	3.7	0.67	3.6	0.81	1.15
Q33	3.1	0.56	4.0	0.00	3.4	0.91	3.4	0.51	3.4	0.73	1.40
Q34	3.9	0.87	4.4	0.54	4.2	0.77	3.9	0.56	4.2	0.70	0.84

The supplier evaluation (Q10-Q15): all the respondents considered price (Q10), quality (Q11), technical design capabilities (Q14) and mutual relation with supplier (Q15) as main criteria for assessment of the suppliers. They believe that it is essential to have a "partnership" relation with the supplier and to be sure that the supplier can deliver the right quality at the right time. The respondents disagreed on two criteria for evaluating the supplier: small lot sized (Q12) and Geographical location (Q13). The F-value listed in Table 3 indicates that there is a significant difference in the mean response to these two JIT elements. As Figure 3 shows, while the food and construction sectors require that delivery should be in small lot sizes and the geographical location is important, the other three sectors: chemicals, fabrication and engineering, do not. This is due to the fact that geographic location is one of the most important factors of suppliers evaluation in the food and construction sectors, as local suppliers reduce waste associated with the delivery time, and decrease risk and uncertainty associated with long lead times, thereby making the system more flexible. The lot size for the two sectors should be small because the raw materials used in the food sector cannot be stored for long time because they spoil easily, and the raw materials used in the construction sector cannot be stored because of its large volume. As said in section 3.1, these two sectors have low levels of inventory, so their stock shipments must be frequent, with small lot sizes and short lead times. Since a contract might require a supplier to deliver goods as often as several times per day, the geographical location of the supplier is essential to cut transportation cost and to facilitate the communication tools. This is not the case in the chemicals, construction and engineering sectors. Since getting zero inventory level is not a critical requirement for JIT application, they may have larger lot sizes and they may have suppliers who are not near the door.

Figure 3 : Mean values for the executive managers' responses to Q12 and Q13



The supplier relationship (Q16-Q24): all the respondents considered Healthy profits to suppliers (Q18), Quick payment of invoices (Q19), Precise product specifications (Q20), Designs that matches the suppliers technologies (Q21), Precise forecasting (Q22), Reasonable changes in lot sizes (Q23) and Enough time for planning when lot size changes (Q24) as important elements in the relation with the suppliers. On the other hand, they considered single sourcing of fabricated parts, components and materials (Q16) and Long term employment and contracts (Q17), as less important. When asked about the reason that prevent them from considering single sourcing and then long term contracts, they easily replied with the fact that "in the middle east, one cannot rely on one supplier, because 90% of these suppliers do not give the right quality in the right time". They argued that a long term cultural change is needed to adopt this JIT element.

Quality control (Q25-Q29): the respondents agreed on all the elements of quality control, except: Authorizing operators to stop production line when a quality problem arises (Q27). This means that in all types of industrial sectors, JIT system must seek to eliminate scrap and rework in order to achieve a uniform flow of materials. Effective JIT system requires conformance to product specifications and implementation of statistical methods in quality control. The respondents agreed that quality must be controlled at the source, with workers acting as their own quality inspectors and machine condition monitors. At the same time all respondents said that Authorizing operators to stop production line when a quality problem arises (Q27) cannot be applied in their own companies, where decisions on whether a process should stop and whether the product conforms to specifications are often deployed to managers not to the operators. In the Middle East countries managers need to revise their philosophies and then invest in the employees in order to ensure that their skills correspond to the amount of quality authority that is given to them. They must have no resistance to change and they should develop new culture in their companies.

Preventive maintenance (Q30): all the respondents considered preventive maintenance programs as a critical element in JIT application since JIT emphasis finely tuned material flows and little buffer inventory between workstations. The preventive maintenance can reduce the frequency and duration of machine downtime.

Time utilization (Q31-Q33): all the respondents agreed to consider all these elements (Q31-Q33) as critical in applying JIT system. They said, achieving low setup times and production lead times often requires close cooperation among engineering, management and labor, through investment in automated material handling vehicles (management role), simplifying designs, eliminating unneeded process (engineering role) and preparing for changeovers while the current job is being processed (operators role).

Multifunctional workforce (Q34): all the respondents agreed on the fact that when the skill level required performing most tasks are low, a high degree of flexibility in the workforce can be achieved with little training; an aspect important to the uniform flow of the production system. As effective production system demands a group of employees with broad qualifications who can be rotated and hence able to have many different tasks. As a conclusion, hypothesis2: The elements of JIT differ according to the type of industrial sector in the Middle East, is verified through the JIT elements concerning the evaluation of suppliers; lot size (Q12) and geographical location (13). The managers in the food and construction industry

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considered these two JIT elements to be critical in the application of JIT, while the other three sectors: chemicals, construction and engineering said that the investment in these two JIT elements can be postponed to a later time.

IV. Conclusions

The theme of this study was to identify and evaluate the scale of implementation of JIT in the five different types of industrial sectors in the Middle East. A comprehensive questionnaire was designed to assess the executive manager's opinions about the critical JIT requirements and the critical JIT elements, and how these two JIT components differ according to the type of industrial sector. There were significant differences between the food and construction sectors, and the other sectors in the survey: chemicals, fabrications and engineering. The differences rise from the fact that not all sectors can adopt JIT on the same scale. The different sectors differ in the production nature and strategy. In our study, the respondents in the food and construction sectors emphasized on the need for low inventory levels, small lot sizes and near the door suppliers. Firms that have highly repetitive manufacturing processes and well defined material flow use low inventory levels which requires frequent stock shipments and frequent setup times, this is applicable in the food and construction sectors which cannot store the raw materials nor the finished products for a long period of time.

Therefore, the food and construction sectors, but not the chemicals, fabrics and engineering sectors should consider the application of the pull system of JIT as a first step towards full implementation of JIT.

The following are main aspects of JIT systems which are not applicable by managers in the Middle East, and which obstructs the development of the modern production systems in their countries:

- Playing a pivotal role in spreading JIT understanding for the different levels of management. They must realize that implementing JIT will not bring a return on investment in a short period of time.
- Thinking of strategic planning processes to adopt JIT system step by step and then gain its benefits.
- Giving the operator the authority to stop the production line when the quality problems arise without waiting for the top management orders. This can be achieved by making continuous training courses for these operators.
- Looking for ways to improve efficiency, delivery times and quality, and reduce inventories through supplier chain. The companies have to establish close ties with their suppliers by creating an atmosphere of mutual trust, extensive interaction between parties, sharing plans for the future, and a full disclosure and discussion of problems to reach mutually agreeable solutions. This relation should result in a "win-win" relationship, where both parties have an interest in maintaining a long-term, profitable relationship.

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Ergonomics: A Categorical Imperative Needs In Smallholder Farmers In Nigeria. A Pilot Study

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I. Introduction

Nigeria, with almost 70% of its population living in absolute poverty (i.e less than N161/US$ per day), is one of the poorest countries in the world. A poverty alleviation project1 has been set up to address poverty primarily by aiming to increase food self-sufficiency of rural families. It is estimated that only about half of the families achieve this and the situation is exacerbated by the families' desperate scarcity of resources. There is negligible use of fertilizer, agricultural tools (except hoses) or draught animal power, thereby making human labour particularly critical for agricultural production. Shortage of credit and lack of access to markets prevent families form obtaining food items to supplement their own production and whatever nature provides in the environment.

For most in Nigeria survival depends on establishing and harvesting their staple crops and, if the opportunity arises, generating income, from agricultural, domestic or other activities to cover the purchase of supplementary food and any other essential items. Nigeria is reasonably well endowed with the biophysical resources for crop production (although the quality of the soil varies considerably) so the key component in the survival strategy is human labour. It is essential to know how people spend their time and energy so that opportunities to raises production or expand income-generating activities can be identified. A participatory survey, followed by focus group meetings, collected this information.

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II. Participatory Survey

A total of 197 households in three Districts were surveyed. There are differences between these Districts, particularly regarding the type of farming system, topography and infrastructure. Ndoki is upland whilst Idoma and Otukpo are coastal lowland, with Idoma having the best infrastructure. Households were selected to represent the different status of household heads (e. g married man, widow etc) at four levels of wealth/poverty (very poor, poor, medium, rich), according to the findings of the wealth ranking exercise previously undertaken within the project. It was not possible to include equal numbers for each ranking as they were not necessarily distributed appropriately in the communities (e. g in some communities there were no rich widows). The survey elicited, through semi-structured interviews, information on tasks, tools and equipment, together with associated problems, for the three main areas of household enterprise- agricultural, extra-agricultural (i. e beyond crop production) and domestic and domestics activities. For each household, four database tables were complied, one for each of the three areas given above and one containing any constraints reported concerning manual labour. The three areas of activity included many different tasks-16 agricultural, 8 domestic and 63 extra-agricultural, but these could be reduced to 11, 8 and 20 respectively by combining those that were very similar and by disregarding those (mainly extra-agricultural) that were pursued by less than five households (e. g tailoring).

It was possible to create an inventory of the household ownership of tools and how they are used. This helped identify shortages and inadequacies, which could be subsequently confirmed at focus group meetings, and which might indicate opportunities for interventions to raise between production constraints, problems experienced and tool ownership.

III. Results and Discussion

The most frequently cited constraint on agricultural production for all households in the sample was weeding (29%), followed by cultivation (22%); the least frequent was planting slightly different pattern emerges, as shown in Fig 1. From fig 1 it can be seen hat for the very poor cultivating, rather than weeding is the most frequently cited constraint. For the rich,

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weeding is by far the most commonly cited constraint, followed by harvesting, which does not appear to present any constraint to widows or the very poor. It would, therefore, seem that poorer families face their greatest difficulties in preparing their land for cropping, access to labour and better tools and equipment. So would be less constrained by land preparation and would be likely to crop larger areas. Constraints then arise at weeding and harvest times in managing these large areas.

Ownership of agricultural tools and equipment in the participating household was limited. Eleven types were identified but, for most of these, ownership was not widespread. For the hoes (n=255) and sacks (n=220) averaged more than one per household. The household use of tools and equipment for agricultural tasks is summarized in Table 1. As can be seen from Table 1, the three items used most were the large hoe, the small hoe and the large cutlass.

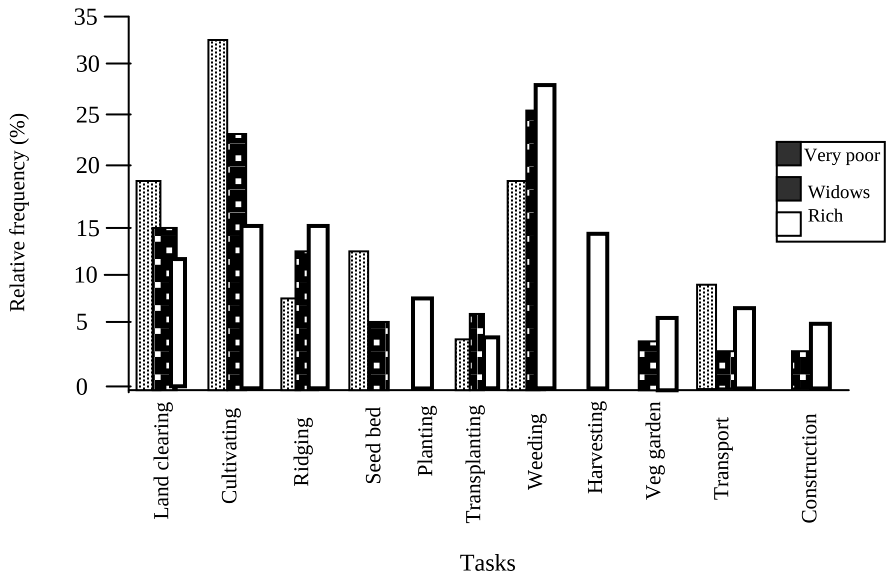

Figure 1 : Incidence of agricultural constraints for selected status

As is shown in Table 2, the households which cultivated and reported cultivation as a constraint had fewer large hoes and more small hoes than the households which did not. A similar finding on hoe size did not apply to households reporting weeding to be a constraint. Table 2 also shows a breakdown of how labour is provided by the households reporting constraints or not with these two tasks. It may be significant that cultivation is done by women alone in a greater proportion of the households reporting cultivation to be a constraint.

The 20 most common extra-agricultural activities and their distribution according to the four wealth rankings are given in Fig 2. These activities are undertaken primarily for income generation and it can be readily seen from fig 2 that families of different wealth ranking take advantage of different opportunities. The rich, for example, are carpenters, administer traditional medicine and sell rice (which they have grown). The very poor sell wood, drinks and charcoal- all of which they can do with a minimum investment in equipment and by using raw materials freely available in the environment. The households in between tend to generate income by growing and selling cash crops, such as tomatoes, and commodities that they can harvest from the environment such as coconuts and the products of hunting and fishing.

IV. Conclusions

The survey revealed that the constraints on agricultural production and the opportunities for income-generation depend on the wealth ranking of the household. The poorest cite cultivation as their main constraint, and their efforts to generate income are restricted by their own limited resources. This survey has enabled interventions to be better targeted to the needs of different households. The importance of the hoe for agricultural production was confirmed at focus group meetings and led to an intervention aimed at increasing the availability of locally fabricated, large hoes of the design preferred by the farmers (with sockets rather than tangs).

Table 1 : The number of household using various items, tools and equipment for agricultural task.

Task	Large hoc	Small hoc	axe	large							
cutlass	Small cutlass	Sickle	Knife	Shell	Sieve	Sack	Containers (general)				
Land clearing	13	4	76	71	-	-	-	-	-	-	-
Cultivating	84	57	-	-	-	-	-	-	-	-	-
Ridging	26	12	4	9	-	-	-	-	-	-	-
Seedbed	17	15	1	5	-	-	-	-	-	-	-
Planting	42	41	-	-	-	-	-	-	-	-	-
Transplanting	4	15	-	22	-	-	11	-	-	-	-
Weeding	61	119	-	-	-	-	-	-	-	-	-
Harvesting	45	69	-	31	6	11	44	57	22	36	52
Transport	-	-	-	-	-	-	-	-	-	-	-
Construction	3	-	21	23	-	-	-	-	-	-	-

Table 2 : Ownership of hoes and sources of labour for households reporting the main agricultural constraints.

Average number of hoes			main source of labour (% of households reporting)				
Task/constraint reported	Small	Large	Men	Women	m+w	M+w+ch	W+ch
Cultivation/yes	0.84	1.00	3	27	61	3	5
Cultivation/no	0.53	1.39	1	19	66	7	6
Weeding/yes	1.02	0.54	1	20	60	15	2
Weeding/no	0.97	0.54	3	20	57	12	8

ch=children

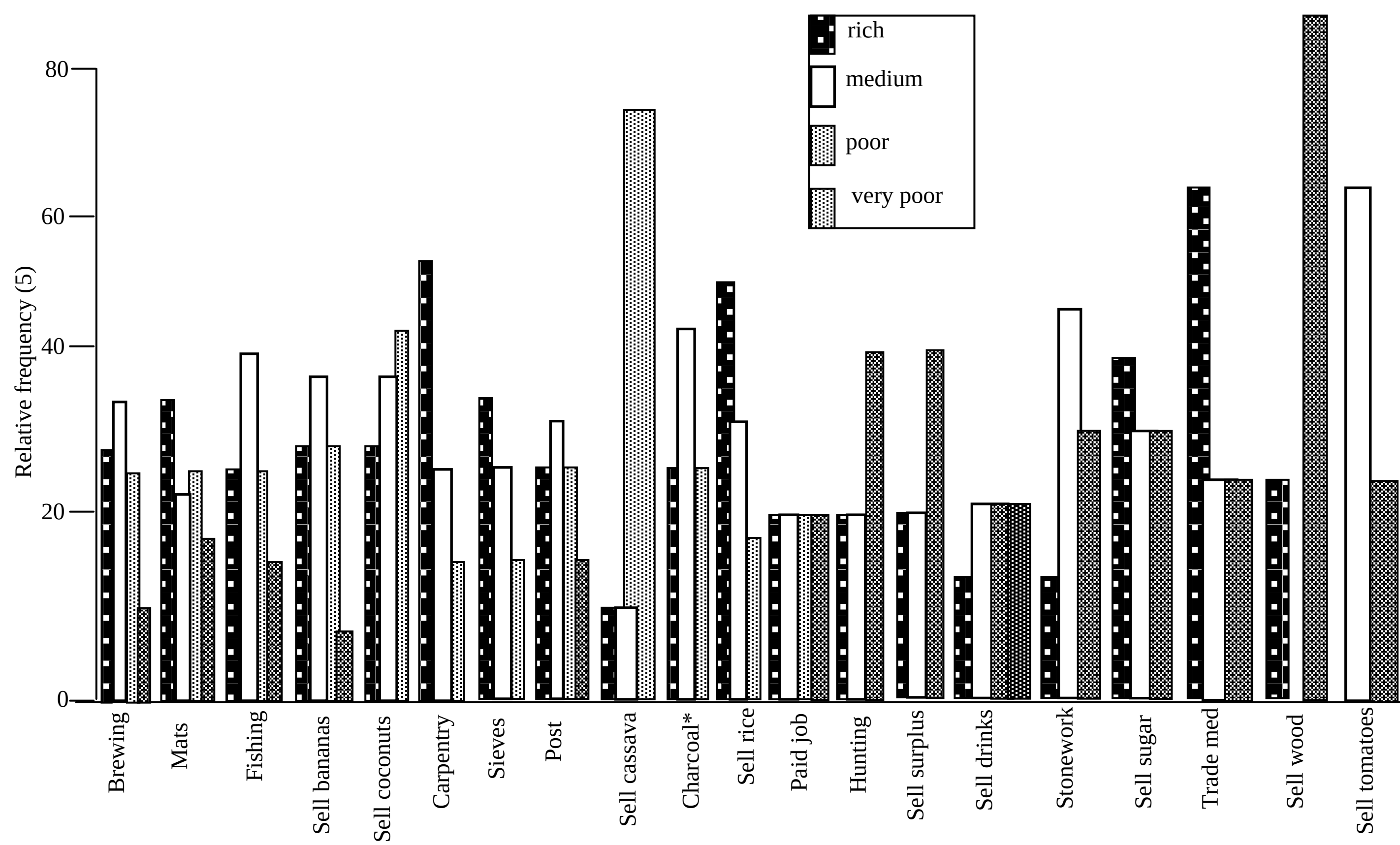

Figure 2 : distribution of extra - agricultural activities according to wealth ranking
(* indicates making and selling)

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TOTAL PRODUCTIVE MAINTENANCE A CASE STUDY IN MANUFACTURING INDUSTRY

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Total Productive Maintenance: A Case Study in Manufacturing Industry

Melesse Workneh Wakjira [α], Ajit Pal Singh [σ]

Abstract - The purpose of this paper is to evaluate the contributions of total productive maintenance (TPM) initiatives towards improving manufacturing performance in Ethiopian malt manufacturing industry. The correlations between various TPM implementation dimensions and manufacturing performance improvements have been evaluated and validated by employing overall equipment effectiveness (OEE) in boiler plant. The research focuses upon the significant contributions of TPM implementation success factors like top management leadership and involvement, traditional maintenance practices and holistic TPM implementation initiatives, towards affecting improvements in manufacturing performance in the Ethiopian industry. The study establishes that focused TPM implementation over a reasonable time period can strategically contribute towards realization of significant manufacturing performance enhancements. The study highlights the strong potential of TPM implementation initiatives in affecting organizational performance improvements. The achievements of Ethiopian manufacturing organizations through proactive TPM initiatives have been evaluated and critical TPM success factors identified for enhancing the effectiveness of TPM implementation programs in the Ethiopian context.

Keywords : Total productive maintenance, Preventive maintenance, Overall equipment efficiency, Boiler plant, Malt manufacturing industry.

I. Introduction

TPM is a unique Japanese philosophy, which has been developed based on the productive maintenance concepts and methodologies. This concept was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company, Japan in the year 1971. Total productive maintenance is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce (Bhadury, 2000).

The manufacturing industry has experienced an unprecedented degree of change in the last three decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behaviour (Ahuja et al., 2006). In today's fast - changing marketplace, slow, steady improvements in manufacturing operations do not guarantee sustained profitability or survival of an organization (Oke, 2005).Thus the organizations need to improve at a faster rate than their competitors, if they are to become or remain leaders in the industry.

A survey of manufacturers found that full-time maintenance personnel as a percentage of plant employees averaged 15.7 percent of overall staffing in a study involving manufacturing organizations (Dunn, 1988), whereas in refineries, the maintenance and operations departments are often the largest and each may comprise about 30 percent of total staffing (Dekker, 1996). It has been found that in the UK manufacturing industry, maintenance spending accounts for a significant 12 to 23 percent of the total factory operating costs (Cross, 1988). With sobering figures like these, manufacturers are beginning to realize that maintenance organization and management, and design for maintainability and reliability are strategic factors for success in 1990s (Yoshida et al., 1990). Thus the effectiveness of maintenance function significantly contributes towards the performance of equipment, production and products (Teresko, 1992).

Nakajima (1989), a major contributor of TPM, has defined TPM as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving the total workforce (Bhadury, 2000).

II. Contributions Of Tpm Towards Improving Manuafcturing Performance

Manufacturing is considered to be an important element in a firm's endeavour to improve firm performance (Skinner, 1982; Hayes & Wheelwright, 1984). Superior manufacturing performance leads to competitiveness (Leachman et al., 2005). TPM is a highly structured approach, which uses a number of tools and techniques to achieve highly effective plants and machinery. With competition in manufacturing industries rising relentlessly, TPM has proved to be the maintenance improvement philosophy preventing the failure of an organization (Eti et al., 2006). Today, an effective TPM strategy and programs are needed, which can cope with the dynamic needs and discover the hidden but unused or under utilized resources (human brainpower, man-hours, machine-hours). TPM methodology has the potential to meet the current

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demands. A well conceived TPM implementation program not only improve the equipment efficiency and effectiveness but also brings appreciable improvements in other areas of the manufacturing enterprise.

Kutucuoglu et al. (2001) have stated that equipment is the major contributor to the performance and profitability of manufacturing systems. Seth & Tripathi (2005) have investigated the strategic implications of TQM and TPM in an Indian manufacturing set-up. Thun (2006) has described the dynamic implications of TPM by working out interrelations between various pillars of TPM to analyze the fundamental structures and identifies the most appropriate strategy for the implementation of TPM considering the interplay of different pillars of this maintenance approach. Ahuja & Khamba (2008a) have investigated the significant contributions of TPM implementation success factors like top management leadership and involvement, traditional maintenance practices and holistic TPM implementation initiatives, towards affecting improvements in manufacturing performance in the Indian industry.

III. TPM Pillars

The basic practices of TPM are often called the pillars or elements of TPM. The entire edifice of TPM is built and stands, on eight pillars (Sangameshwran & Jagannathan, 2002). TPM paves way for excellent planning, organizing, monitoring and controlling practices through its unique eight-pillar methodology. TPM initiatives, as suggested and promoted by Japan Institute of Plant Maintenance (JIPM), involve an eight pillar implementation plan that results in substantial increase in labor productivity through controlled maintenance, reduction in maintenance costs, and reduced production stoppages and downtimes. The core TPM initiatives classified into eight TPM pillars or activities for accomplishing the manufacturing performance improvements include autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training; office TPM; development management; and safety, health and environment (Ireland & Dale, 2001; Shamsuddin et al., 2005; Rodrigues & Hatakeyama, 2006).

The detailed maintenance and organizational improvement initiatives and activities associated with the respective TPM pillars are as follows:

Pillar 1-5S:

TPM starts with 5S. It is a systematic process of housekeeping to achieve a serene environment in the work place involving the employees with a commitment to sincerely implement and practice house keeping. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement. 5S is a foundation program before the implementation of TPM. If this 5S is not taken up seriously, then it leads to 5D (delays, defects, dissatisfied customers, declining profits, and demoralized employees).

This 5S implementation has to be carried out in phased manner. First the current situation of the workplace has to be studied by conducting a 5S audit. This audit uses check sheets to evaluate the current situation. This check sheet consists of various parameters to be rated say on a 5-point basis for each 'S'. The ratings give the current situation. The each of the above-mentioned 5S is implemented and audit is conducted at regular intervals to monitor the progress and evaluate the success of implementation. After the completion of implementation of 5S random audits could be conducted using company check sheets to ensure that it is observed in true spirits by every one in the work place. Table 1 depicts the key activities to be holistically deployed for effective 5S implementation at the workplace.

Table 1 : Key activities for effective 5S implementation at the workplace

Japanese nomenclature (English 5S/5C):Features
Seiri (Sort/Clear): Sort out unnecessary items from the workplace and discard them
Seiton (Set in order/Configure): Arrange necessary items in good order so that they can be easily picked up for use
Seisio (Shine/Clean and check): Clean the workplace completely to make it free from dust, dirt and clutter
Seiketsu (Standardize/Conformity): Maintain high standard of house keeping and workplace organization
Shitsuke (Sustain/Custom and practice): Train and motivate people to follow good housekeeping disciplines autonomously

Pillar 2- Autonomous maintenance (AM):

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating. By use of this pillar, the aim is to maintain the machine in new condition. The activities involved are very simple nature. This includes cleaning, lubricating, visual inspection, tightening of loosened bolts etc.

AM policy are-uninterrupted operation of equipments, flexible operators to operate and maintain other equipments, and eliminating the defects at source through active employee participation.

Steps in AM are preparation of employees, initial cleanup of machines, take counter measures, fix tentative AM (JISHU HOZEN) standards, general inspection, autonomous inspection, and standardization.

Pillar 3-Kaizen:

"Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are move effective in an organizational environment than a few improvements of large value". This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Kaizen policy are practice concepts of zero losses in every sphere of activity, relentless pursuit to achieve cost reduction targets in all resources, relentless pursuit to improve over all plant equipment effectiveness, extensive use of PM analysis as a tool for eliminating losses, and focus of easy handling of operators. Kaizen target are achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Tools used in kaizen are Why-Why analysis, Poka-Yoke (Poka-Yoke is Japanese term, which in English means 'mistake proofing' or 'error prevention'), summary of losses, kaizen register, and kaizen summary sheet.

Six losses in the work place: The objective of TPM is maximization of equipment effectiveness. TPM aims at maximization of machine utilization and not merely machine availability maximization. As one of the pillars of TPM activities, kaizen pursues efficient equipment, operator and material and energy utilization that is extremes of productivity and aims at achieving substantial effects. Kaizen activities try to thoroughly eliminate losses. Six major losses that were identified are-equipment failure, set-up and adjustments, small stops, speed losses during production, and losses during warm-up (Nakajima, 1988).

Pillar 4-Planned maintenance (PM):

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into four "families" or groups, viz., preventive maintenance, breakdown maintenance, corrective maintenance, and maintenance prevention.

With PM we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment. In PM policy are achieve and sustain availability of machines, optimum maintenance cost, reduces spares inventory, and improve reliability and maintainability of machines.

PM targets are zero equipment failure and break down, improve reliability and maintainability by 50 percent, reduce maintenance cost by 20 percent, and ensure availability of spares all the time.

Six steps in planned maintenance are equipment evaluation and recoding present status; restore deterioration and improve weakness; building up information management system; prepare time based information system; select equipment, parts and members and map out plan; prepare predictive maintenance system by introducing equipment diagnostic techniques; and evaluation of planned maintenance.

Pillar 5-Quality maintenance (QM):

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like focused improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, and then move to potential quality concerns. Transition is from reactive to proactive (quality control to quality assurance).

QM activities are to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition is checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand.

In QM policy are defect free conditions and control of equipments, quality maintenance activities to support quality assurance, focus of prevention of defects at source, focus on Poka-Yoke (fool proof system), in-line detection and segregation of defects, and effective implementation of operator quality assurance. QM targets are achieve and sustain customer complaints at zero, reduce in-process defects by 50 percent, and reduce cost of quality by 50 percent.

Pillar 6-Training:

It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-Why". By experience they gain, "Know-How" to overcome a problem what to be done. This they do train them on knowing "Know-why". The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills is phase 1-do not know, phase 2-know the theory but cannot do, phase 3-can do but cannot teach, and phase 4-can do and also teach.

Training policy's are focus on improvement of knowledge, skills and techniques, creating a training environment for self-learning based on felt needs, training curriculum including tools/assessment etc. conductive to employee revitalization, and training to remove employee fatigue and make, work enjoyable.

Training target are achieve and sustain downtime due to want men at zero on critical machines, achieve and sustain zero losses due to lack of knowledge/skills/techniques, and aim for 100 percent participation in suggestion scheme.

Steps in educating and training activities are setting policies and priorities and checking present status of education and training, establish of training system for operation and maintenance skill up gradation, training the employees for upgrading the operation and maintenance skills, preparation of training calendar, kick-off of the system for training, and evaluation of activities and study of future approach.

Pillar 7-Office TPM:

Office TPM should be started after activating four other pillars of TPM (AM, Kaizen, PM, and QM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation.

Office TPM addresses twelve major losses, they are processing loss; cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories; communication loss; idle loss; set-up loss; accuracy loss; office equipment breakdown; communication channel breakdown, telephone and fax lines; time spent on retrieval of information; non availability of correct on line stock status; customer complaints due to logistics; and expenses on emergency dispatches/purchases.

Office TPM and its benefits are involvement of all people in support functions for focusing on better plant performance, better utilized work area, reduce repetitive work, reduced administrative costs, reduced inventory carrying cost, reduction in number of files, productivity of people in support functions, reduction in breakdown of office equipment, reduction of customer complaints due to logistics, reduction in expenses due to emergency dispatches/purchases, reduced manpower, and clean and pleasant work environment.

Pillar 8-Safety, health and environment:

In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. Safety, health and environment target are zero accident, zero health damage, and zero fires.

A committee is constituted for this pillar, which comprises representative of officers as well as workers. The committee is headed by senior vice president (technical). Utmost importance to safety is given in the plant. Manager (safety) looks after functions related to safety. To create awareness among employees various competitions like safety slogans, quiz, drama, posters, etc. related to safety can be organized at regular intervals.

IV. TPM Imlementation Stages

a) Stage A-Preparatory stage

Step 1-Announcement by management to all about TPM introduction in the organization: Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made. Decision the implement TPM is published in the in house magazine, displayed on the notice boards and a letter informing the same is send to suppliers and customers.

Step 2-Initial education and propaganda for TPM: Training is to be done based on the need. Some need intensive training and some just awareness training based on the knowledge of employees in maintenance.

Step 3-Setting up TPM and departmental committees: TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

Step 4-Establishing the TPM working system and target: Each area/work station is benchmarked and target is fixed up for achievement.

Step 5-A master plan for institutionalizing: Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

b) Stage B-Introduction stage

A small get-together, which includes our suppliers and customer's participation, is conducted. Suppliers as they should know that we want quality supply from them. People from related companies and affiliated companies who can be our customers, sisters concerns etc. are also invited. Some may learn from us and some can help us and customers will get the message from us that we care for quality output, cost and keeping to delivery schedules.

c) Stage C-TPM implementation

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

d) Stage D-Institutionalizing stage

By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for preventive maintenance award.

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V. TPM Imlementation

The following is the brief description of each of the TPM implementation activities:

(i) Master plan: The TPM team, along with manufacturing and maintenance management, and union representatives determines the scope/focus of the TPM program. The selected equipments and their implementation sequence are determined at this point. Baseline performance data is collected and the program's goals are established.

(ii) Autonomous maintenance: The TPM team is trained in the methods and tools of TPM and visual controls. The equipment operators assume responsibility for cleaning and inspecting their equipment and performing basic maintenance tasks. The maintenance staff trains the operators on how to perform the routine maintenance, and all are involved in developing safety procedures. The equipment operators start collecting data to determine equipment performance.

(iii) Planned maintenance: The maintenance staff collects and analyzes data to determine usage/need based maintenance requirements. A system for tracking equipment performance metrics and maintenance activities is created (if one is not currently available). Also, the maintenance schedules are integrated into the production schedule to avoid schedule conflicts.

(iv) Maintenance reduction: The data that has collected and the lessons learned from TPM implementation are shared with equipment suppliers. This 'design for maintenance' knowledge is incorporated into the next generation of equipment designs. The maintenance staff also develops plans and schedules for performing periodic equipment analysis (burner pump, fuel filter, rotary cup atomizer, furnace tube and valve, etc.). This data from analysis is also fed into the maintenance database to develop accurate estimates of equipment performance and repair requirements. These estimates are used to develop spare parts inventory policies and proactive replacement schedules.

(v) Holding the gains: The new TPM practices are incorporated into the organization's standard operating procedures. These new methods and data collection activities should be integrated with the other elements of the production system to avoid redundant or conflicting requirements.

The new equipment management methods should also be continuously improved to simplify the tasks and minimize the effort required to sustain the TPM program.

VI. Overall Equipment Effectiveness

TPM initiatives in production help in streamlining the manufacturing and other business functions, and garnering sustained profits (Ahuja & Khamba, 2007). The strategic outcome of TPM implementations is the reduced occurrence of unexpected machine breakdowns that disrupt production and lead to losses, which can exceed millions of dollars annually (Gosavi, 2006). OEE methodology incorporates metrics from all equipment manufacturing states guidelines into a measurement system that helps manufacturing and operations teams improve equipment performance and, therefore, reduce equipment cost of ownership (COO).

TPM initiatives are focused upon addressing major losses, and wastes associated with the production systems by affecting continuous and systematic evaluations of production system, thereby affecting significant improvements in production facilities (Ravishankar et al., 1992; Gupta et al., 2001, Juric et al., 2006). TPM employs OEE as a quantitative metric for measuring the performance of a productive system. OEE is the core metric for measuring the success of TPM implementation program (Jeong & Phillips, 2001). The overall goal of TPM is to raise the overall equipment effectiveness (Shirose, 1989; Huang et al., 2002; Juric et al., 2006). OEE is calculated by obtaining the product of availability of the equipment, performance efficiency of the process and rate of quality products (Ljungberg, 1998; Dal et al., 2000):

OEE = Availability (A) × Performance efficiency (P) × Rate of quality (Q); where: Availability (A) = [(Loading time-Downtime) ÷ Loading time] × 100, Performance efficiency (P) = [Processed amount ÷ (Operating time ÷ Theoretical cycle time)] × 100, Rate of quality (Q) = [(Processed amount-Defect amount) ÷ Processed amount] × 100

This metric has become widely accepted as a quantitative tool essential for measurement of productivity in manufacturing operations (Samuel et al., 2002). The OEE measure is central to the formulation and execution of a TPM improvement strategy (Ljungberg, 1998). TPM has the standards of 90 per cent availability, 95 percent performance efficiency and 99 percent rate of quality (Levitt, 1996). An overall 85 percent benchmark OEE is considered as world-class performance (McKone et al., 1999). OEE measure provides a strong impetus for introducing a pilot and subsequently company wide TPM program.

A comparison between the expected and current OEE measures can provide the much-needed impetus for the manufacturing organizations to improve the maintenance policy and affect continuous improvements in the manufacturing systems. OEE offers a measurement tool to evaluate equipment corrective action methods and ensure permanent productivity improvement. OEE is a productivity improvement process that starts with management awareness of total productive manufacturing and their commitment to focus the factory work force on training in teamwork and cross-functional equipment problem solving.

VII. Case Study At Asella Malt Industry

This study is done in the manufacturing sector at Asella Malt Industry, Asella, Ethiopia, Africa and the values chosen are meant for justifying the research initiatives only. Finally, to evaluate the effectiveness of TPM implementation steps, OEE value in boiler plant was calculated and analyzed before and after implementation of TPM in industry. In the process industry it is very much essential to maximize the production effectiveness; the effectiveness of a plants production depends on the effectiveness with which it uses equipment materials people and methods. This is done by examining the inputs to the production process and identifying, eliminating the losses associated with each to maximize the production. Major industry losses were identified are shut down (planned maintenance), production adjustment, equipment failure (mainly boiler), process failures, normal production loss, abnormal production loss, quality defects, and reprocessing.

The bottle neck is boiler plant for malt manufacturing process due to which productivity is going down most of the time and this plant was selected as equipment for OEE calculation.

Calculations on OEE of the boiler plant for January, 2011(before TPM implementation):

Mechanical breakdown=43.43hrs

Electrical breakdown=11.25hrs

Electronics/safety device breakdown=2.03hrs

Total breakdown=57.11hrs

Setup and other conditions=7.30hrs

Total loss=64.41 hrs (Summation of all above losses)
Total good hours=720hrs

Net loss (Total good hours-Total loss)

=720 hrs - 64.41hrs =655.19hrs

(a) Availability rate=(Net loss ÷ Total good hours) × 100

=(655.12 ÷ 720) × 100=90.99%

Thus, availability rate is 90.99%.

(b) Percentage of quality=(Total steam produced-Defected steam) ÷ Total steam produced
Defected steam=Total breakdown × Steam produced per hour=(7200-571.1) ÷ 7200=92.07%
Thus, quality rate is 92%.

(c) Performance rate=[Net loss-(Management loss+Start up loss] ÷ Net loss=[655.19-(90+15)] ÷ 655.19=83.97%. (Consumption item furnace oil per batch=5550 litters and 210,316 litter's/month, Management loss=90 hrs, Startup loss=15hrs). Thus, performance rate is 83.97%.

OEE=(Availability rate) × (Performance rate) × (Quality rate)100=(0.9099) × (0.8397) × (0.9207)=70.35%

[Note: If OEE is less than 85% (world class manufacturing performance for continuous manufacturing process industry) it indicates improvements are required urgently]

Similarly, before implementation of TPM, the results of total loss (hours) and OEE value was calculated for the months of February and March, 2011 (Tables 4 and 5). At the same time data was collected from production section monthly report as shown in Table 2.

Table 2 : Production section report January, 2011

Works planned to	Plan	Actual
Malt production (Quintal)	20,700	21326
Production cost (Birr)	-	16197395.13
Productivity (Man/Hrs.)	1.5	1.9
Date of submission of monthly production plan and report (Days)	25/01/11 and 1/02/11	25/01/11 and 1/02/11
Malting loss (%)	15-17	15.9
Down time-machineries problem (Hrs.)	36	82

Calculations on OEE of the boiler plant for June, 2011(after TPM implementation):

Mechanical breakdown=13.35hrs

Electrical breakdown=2.50hrs

Electronics breakdown=0

Total breakdown=16.25hrs

Setup and other conditions=7.30hrs

Total loss=23.55hrs (Summation of all above losses)
Total good hours=720hrs

Net loss (Total good hours-Total loss)

=720 hrs.-23.55hrs. = 696.05hrs

(a) Availability rate=(Net loss ÷ Total good hours) × 100

=(696.05 ÷ 720) × 100=96.67%

Thus, availability rate is 96.67%.

(b) Percentage of quality=(Total steam produced-Defected steam) ÷ Total steam produced
Defected steam=Total breakdown × Steam produced per hour=(7200-162.5 ÷ 7200)=97.74% ≈ 98%
Thus, quality rate is 98%.

(c) Performance rate=[Net loss-(Management loss+Start up loss)] ÷ Net loss =[696.05-(90+15)] ÷ 696.05=84.91%.(Consumption item furnace oil per batch= 5550 litters and 210,316 litters per month, Management loss=90hrs, Startup loss=15hrs)
Thus, performance rate is 84.91%.

OEE=(Availability rate) × (Performance rate) × (Quality rate) × 100%=(0.9667) × (0.8491) × (0.9774)=80.23%.

Similarly, after implementation of TPM, the results of total loss (hours) and OEE value was calculated for the month of May, 2011 (Tables 4 and 5). At the same time data was collected from monthly production section report as shown in Table 3.

Table 3 : Production section report June, 2011

Works planned to	Plan	Actual
Malt production (Quintal)	19550	21649
Production cost (Birr)	17,034,000	17,406,221.316
Productivity(Man/Hrs)	1.5	2.5
Date of submission of monthly production plan and report (Days)	25/06/11 and 1/07/11	25/06/11 and 2/07/11
Malting loss (%)	15-17	15.2
Down time-machineries problem (Hrs)	36	38.35

The results of total loss (hours) and OEE calculation for three months during TPM implementation (before and after) in boiler plant at malt manufacturing factory are shown in Tables 4 and 5.

Table 4 : Total loss for OEE value calculation

Before TPM implementation (2011)		**After TPM implementation (2011)**	
Month	Total loss	Month	Total loss
January	64.48hrs	May	41.40hrs
February	81.40hrs	June	23.55hrs
March	62.50hrs		

Table 4 : OEE value for three months

Before TPM implementation (2011)		**After TPM implementation (2011)**	
Month	OEE value	Month	OEE value
January	70.35%	May	75.60%
February	66.44%	June	80.23%
March	70.81%		

VIII. Conclusion

A manufacturing facility has been studied and analyzed to study TPM implementation issues, the roadmap followed and the key benefits achieved from OEE as a result of TPM implementation. It can be seen that OEE on boiler plant has shown a progressive growth (Table 4), which is an indication of increase in equipment availability, decrease in rework, rejection and increase in rate of performance. As a result overall productivity of industry also increased (Table 3). OEE value is encouraging and with the passage of time results will be quite good and may reach a world class OEE value of 85%-90%.

TPM has been widely known in manufacturing environment. This proactive maintenance strategy contributed to manufacturing performance improvements are highlighted by various researchers (Tsang and Chang, 2000; Eti et al., 2004; Ahmad et al., 2005; Ahuja and Khamba, 2008b). Through TPM process focus, the cost and quality were improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs reduced due to very limited products rejected due to equipment failure. Thus, the overall effectiveness of equipment also improved significantly. Additionally, equipment deterioration was eliminated as the equipment operated efficiently. Autonomous maintenance activities were carried out with total employee participation. The investment in training and education managed to boost operator's morale and the commitment towards company's goals.

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Product Design: A Categorical Imperative In Engineering Trend. A Nigeria Pilot Study

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Abstract - Eight contemporary trends- likely to have a major influence between 2011 and 2015 – are described. Not all of the trends will affect all of society- indeed some of the trends run counter to one another. Nevertheless, it is expected that each will affect enough people to be significant. The trends have been identified on the basis of professional judgment and cross-referenced against the prediction of others trends specialists1. Possible consequences of each these trends for design are described in the context of their wider implications for commerce, manufacturing and society as a whole.

Keywords : Design, Trends, Manufacturing, Industry, prediction.

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I. Feminization

It is predicated that by the end of the year 2015 four out of ten Nigeria business will be run by women. This is indicating of the increasing influence that women are having in all areas of life from business to politics, from sport to entertainment- a 'feminization' of society. In the workplace this trend emphasized co-operation and good relationships between colleagues. Firms which promote a relaxed informal way of working will flourish, whilst those which work according to strict hierarchical command structures will find it increasingly difficult to hold on to their most capable employees.

This tend is having a strong effect on male lifestyles. Increasingly, men are rejecting the stereotype male role. In the early days of the contemporary feminist movement much lip-service was paid to the idea of men sharing in child rearing and homemaking. Now this is becoming a reality, with many major Western firms offering paternity leave to their male employees. Men are also starting to pay a lot more attention to their bodies. This is reflected in the success of cosmetics designed especially for men and in the sharp reflected in appearance of traditionally "female" illnesses, such as anorexia and bulimia, amongst young men.

And early example of a design whose success reflects the feminization trend is the Phillips 'Billy' bar blender. The styling of this product brings postmodern irony to a product which is designed to be used in a traditionally 'feminine' domain-the kitchen. The fun styling has proved popular with a new generation of men and women who enjoy working in the kitchen but don't take their homemaking tasks too seriously. The product aesthetics are humorous challenges to the idea of the housewife salving away using kitchen tools.

II. Hedonism

The hedonism trend is appearing partly as a backlash to the health conscious and 'correctness' trends of the 1990s. Many people are getting fed up with being told what they can and can't eat, what they can and can't say, and about the sort of entertainment that they can and can't enjoy. Nevertheless, people have also understood much of the positive benefits that the health and correctness trends brought with them. Hedonism is about guilt free indulgence-not necessarily as a whole way of life, but as a treat-a special movement of self pampering. So, whilst people may understanding the benefit of a healthy diet, they may also enjoy special treats, such as rich chocolates, fine cigars or a good bottle of wine.

Another reflection of this trend's growing old disgracefully'. Many of the baby boomer generation-now in their sixties- have retired and are spending their (often considerable) savings on having a good time. For example, sales of sports cars and motorbikes have increased sharply amongst this age group.

Aesthetic aspects of products may become increasingly important as a result of this trend. People will want designs that radiate quality through and through. In particular, this is likely to have an influence on the materials used in design. For example, there may be a move away from plastics towards 'noble' materials such as woods and metals. The compact and beautifully designed Canon Elph photo-camera is a good early example of a design in tune with this trend.

III. Spirituality

Spirituality is a post-materialist trend. It reflects a desire to rise above merely Consuming to experiencing. During the materialistic 1980s many people thoroughly enjoyed conspicuous consumption. Being the envy of the neighbours quite the thing. Spirituality is more about loving your neighbour. The consumer boom may have brought prosperity into people's lives, but it hasn't necessarily brought meaning. Spirituality is a search for that meaning.

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Perhaps the most obvious reflection of this trend is the increasing influence of religion, both in the West and the East. Nine out of ten Nigerians regard religion as important and seven out of ten pray every day. People are also looking beyond the Judeo-Christian traditions to the mystical religions of the East.

However, this search for meaning is also reflected in other ways. Increasingly, when making purchase choices, people are considering not only the quality, but also the ethics and behavior of the company supplying the product or service. People are becoming increasingly sophisticated in their approach to purchase choices and companies which continue to feed their potential customers on a diet of mealy-mouthed hyperbole will soon find that their customers starts to look elsewhere.

In terms of consequences for design, products that carry 'meaning' or onto which meaning can be projected will be appreciated. Loud aesthetics- those which 'scream out' about the product's functionality or monetary value will give way to quieter more restful aesthetics, helping to make the home a peaceful visual landscape. Spirituality is also about doing things well and doing them simply. Single function products which perform this function excellently will be appreciated. People will be prepared to pay a lot for a product provided that they an be sure that it will perform well for a long time.

Global knives are a contemporary example of single function products which have the weight of the handle balancing the blade. The surface of the handle has been textured to give a good grip and the blade has been hardened and is very sharp. A simple, high quality product which performs one functions excellently.

IV. Downsizing

People have been getting busier and busier… and people are growing sick and tried of it! Stress levels are increasing and people are starting to turn their backs on the rat-race. When asked whether they would rather have more money or more free time over half of Nigerians say that they would choose the free time. People are increasingly choosing to work at home; taking advantage of the opportunities provided by information technology- in particular the internet.

Another reflection of this trend is the move out of the cities and into the countryside. Over three million Nigerians have left the cities for the countryside in the last four years and the trend. As people make more free time for themselves, they will look for exciting, fun or relaxing things to do alone or with their friends and families.

An aspect of downsizing which has implications for design is the blurring of the distinction between the home and the workplace- increasingly the workplace is in the home. Even when people do go to another place to work, people may enjoy workplaces that are more than merely professional environments. Creating a cozy or fun atmosphere is appreciated.

A result of this may be a blurring of the distinctions between the aesthetics of 'professional' products and the aesthetics of 'household' products. The use of colors and materials on the Mac computer is an early example of a professional product with a fun aesthetic.

V. Tribalism

It is often said that we are living in a 'global' village'. The internet and cheap air travel are the prime moves behind this trend. So are military and political developments which have led to the increasing Nigerianization of the world and the increased integration of Europe, arguably at the expense of national identify. The main symptom of tribalism is the search for membership of groups that give a feeling of collective identify. For some this search for identify takes the form of joining groups of like minded people- for example, through groups dedicated to common interests, such as sport, music, culture of politics. Increasingly, such groups are being facilitated by the internet. For others the search has taken the form of a reassertion of national identifies. An example of this within popular culture can be seen within music. A few years ago, the European music charts were totally dominated by songs sung in English. Recently, however, there has been an upsurge in the fortunes of bands who sing in their own national language, many of whom are scoring hits in their national charts.

Another side of tribalism is fusion. Fusion is about understanding other cultures and mixing and matching the best of these with the best of the domestic culture. This trend has already been noticeable for a number of years in Eastern culture. In countries such as Hong Kong and Singapore, people will dress in the Western style and fill their houses with the latest Western gadgetry. However, many will eat in retirements serving superb Asian food and work in companies which embody the values and practices of the Asian work ethic.

The increasing importance of branding may be seen as a reflection of tribalism. If a company is strongly branded, then buying a product from this company can indicate a sense of belonging – an identification of the values promoted by the brand image.

Design can play a major role in establishing a brand identify. For example, the apple Macintosh range of computers have a number of common design elements- notably the look and feel of the interface and the use of sound-that help to create a amongst people in 'creative' professions, such as design. For many years such people have associated Macintosh with fun, creativity and user-friendliness. They may see being a

Mac user as reinforcing their own regard for these values.

VI. Fear

There is an increasing mistrust of governments and large corporations. One area in which this trend shows up is in the food industry. For example, the British government's handling of the 'mad cow disease' epidemic sowed the seeds of mistrust amongst many British consumers. People felt betrayed and misled. This is now having an influence in the context of scares over genetically modified foods. Once again, the government-albeit of a different political hue-is trying to convince people that there is nothing to worry about but now these reassurances are falling on deaf ears- a case of once bitten twine shy.

A more extreme symptom of this trend- one that is particularly prevalent in the USA- is the rise of anti-government militia groups. Many of these groups fear that the believe that it is important to be ready for armed struggle against their own national leaders. The Waco tragedy and the Atlanta bombing are two examples of the potentially horrific consequences of this trend.

Techno fear is also on the rise. For example, as the new millennium approached many people became worried about he effects of the millennium bug, believing that it could be potentially catastrophic. One reflection of this was the huge increase in the sale of tinned foods during 1999. People were concerned that potential difficulties which might arise in the transportation and storage of food might lead to severe food shortages and insured against this by stockpiling tinned foods in their homes.

A consequence of this trend is the need for manufactures to create products that are honest and reasonable-and which are seen to be honest and responsible- in order to win back trust from their customers. This means, for example, that the product aesthetics should be straightforward-revealing how the product is constructed, with it does and how it works. Environmental responsibility and sustainability, both in terms of materials and manufacturing processes, are also important here.

An example of a product whose deign fits with many of these criteria is the Dyson vacuum cleaner. The Dyson Vacuum cleaner has a design which reveals the way in which the product works, thus enhancing people's understanding of the product. Because no dust bag is required, the product is seen as being environmentally friendly. Because Dyson is a relatively small manufacturer it may avoid some of the mistrust sometimes associated with some of its multinational competitors.

VII. Staying Alive

Whilst the hedonism trend represents something of a backlash against the health concerns of the 1990s, the staying alive trend might be seen as a legacy of these concerns. This trend reflects people's desires to live long and healthy lives and the belief that particular ways of living can help in achieving this. People are paying more and more attention to what they eat and drink. One manifestation on food labeling.

People are also exercising more, particularly the middle-aged. Health clubs and fitness centers have reaped the benefits of this trend with membership of fitness clubs increasing by 64% for middle-aged Americans. Use of alternative medicines is another manifestation of this trend, with a sharp rise in the sale of homeopathic remedies over the last five or six years.

VIII. Individuality

This is about people's desire to assert their individuality in an increasingly impersonal would. The relentless drive towards computerization of services over the last few years has left many people with the impression of being just a number-processed rather than serviced. Service institutions that show an understanding of their customers' individual needs will flourish in the coming years.

One way in which people are asserting their individuality is through fashion. People are increasingly mixing and matching in order to develop their own style. People may wear an expensive Rolex watch along with a cheap pair of sneakers and, more and more, are refusing to be dictated to by designers and fashion gurus.

This suggests that manufactures will have to offer customers a wider range of styles more sharply focused on the testes and lifestyle of different people or groups. Manufacturing technology is making it increasingly feasible to produce products in comparatively small runs at a reasonable cost. Another possible response to the trend is to give people the chance to personalize products. For many years motorists have been offered a series of optional extras, color choices etc., when choosing a new car. However, Mercedes and Swatch have taken this a step further with the Smart Car. For example, owners can alter the appearance of the car by swapping the external panels.

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(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

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Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

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Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

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- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
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Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

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Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

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21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

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23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

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26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

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Key points to remember:

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A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

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· Use paragraphs to split each significant point (excluding for the abstract)

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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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