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Full Length Research Paper

Analytic hierarchy process for prioritizing production functions: Illustration with pharmaceutical data

Oluseye Ogunyemi[1], Ade Ibiwoye[2]* and Emmanuel Olateju Oyatoye[1]

[1]Department of Business Administration, University of Lagos, Akoka, Lagos, Nigeria.
[2]Department of Actuarial Science and Insurance, University of Lagos, Akoka, Lagos, Nigeria.

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Since the downturn hit the world's economy in 2008, many organizations have been having a tough time remaining in business not to talk of making profit. Consequently, companies now seem to give a relatively high priority to the marketing competencies of their staff even when this may not be the required antidote. Using data from five major pharmaceutical companies in Lagos, Southwest Nigeria, this study applies the Analytic Hierarchy Process (AHP) technique to effectively prioritize the seven functions (7Ms) of manufacturing functions. The outcome of the study reflects the relative importance of the management function over the other functions of manufacturing in the pharmaceutical industry.

Key words: Analytic hierarchy process (AHP), 7Ms of production, prioritization, synthesizing.

INTRODUCTION

In today's highly competitive business world, it is imperative for every manufacturer to constantly appraise the performances of its operations. This is because the only way to remain in business and maintain standard is by accuracy of actions and being of a high level of efficiency and effectiveness. This can hardly be attained without proper planning, supervising, controlling and continuously evaluating the activities of the various functions connected with the process. To do this effectively, managers do not only need the right tools, but they must employ methods like value analysis and value management for decreasing system inputs, and achieving optimality in effectiveness without having negative effect on system outputs.

To be able to compete effectively in a global economy companies need to apply all of their resources, human, capital and the likes, with maximum efficiency and as an integrated whole. However, with the harsh operating environment for manufacturers in Nigeria typified by inadequate power supply, incessant strike actions by employee unions, endemic corruption, and lack of infrastructures, just how easily can these companies realize their objectives? Although Nigeria boasts one of the largest populations and fastest growing economies in Africa, its business environment remains suboptimal (Business Monitor International, 2011). One strategy that companies tend to adopt in the circumstance is to lay emphasis on the marketing function of their operations (Kesic, 2009). They, therefore, give marketing a high priority sometimes to the neglect of other important management functions.

In this study we re-examine the present strategy of giving priority to the marketing function and attempt to prioritize the seven functions (7Ms) according to their importance using Analytic Hierarchy Process (AHP) approach. The choice of AHP is informed by the fact that some of the criteria on which the 7Ms are to be compared are not easily quantifiable numerically as they depend, to a great extent, on the perception of individuals. These are planning, efficiency, capacity, experience, and education. Since AHP is a method that can be used to prioritize both tangible and intangible factors, it offers a better method of investigating the ranking of the seven functions. Specifically, because of the importance of pharmaceutical industry in the health sector and to general well being, our method is applied to the health pharmaceutical industry.

CONTEXTUAL SETTING

The pharmaceutical industry is a very important component

*Corresponding author. E-mail: adeibiwoye@yahoo.com.

component of the health sector. This importance is underscored by the attention that is given to it by government, worldwide. In Nigeria, for instance, government has since 1990 set up a national drug policy that is designed to promote affordable, safe and quality drugs (FMH/WHO, 2002). However, not much dividend has been derived from the policy. The industry in Nigeria seems to be bedevilled by the intractable problem of what Ohabunwa (2011) referred to as unfair trade characterised by fake drugs, smuggled drugs, substandard drugs, look alike, imitation, intellectual property abusers, parallel importation and conniving with custom people. In addition to these problems, Okafor (2011) identifies others as intense competition, low capacity utilization, serious faking and adulteration of original brands and even low buying power of customers.

From the point of regulation two separate bodies are prominent. One is the National Agency for Food and Drugs Administration and Control (NAFDAC) and the other is the Pharmacists Council of Nigeria (PCN). The first regulates pharmaceutical products while PCN regulates the premises and professional practice. The desired outcome is yet to be realized in spite of the multiple regulations as what has been witnessed thus far is poor regulatory environment, lack of effective IP protection and high import duties resulting in low profitability and poor return on investment (Chiejina, 2011). Chiejina therefore submitted that it is no surprise then that patented drug producers and large multinational companies are often discouraged from investing in Nigeria's pharmaceutical market. An investigation conducted by Business Monitor International (2011) shows that domestic companies in Nigeria are mostly engaged in the production of generic medicines, some of which are illegal, while inadequate purchasing capacity in the public and private sectors continue to detract foreign investors.

An ever present danger that can not be easily dismissed is that raised by Nsimba (2008) that with the current state of operation in the pharmaceutical industry patients may lose confidence in health care professionals and the modern medicine and the pharmaceutical industry in general. This is probably becoming a prophecy given the droves of senior government officials who seek medical attention overseas annually. Efforts by NAFDAC to correct the anomalies have faced stiff opposition and in consequence the problems facing the pharmaceutical industry have persisted.

LITERATURE REVIEW

A number of optimization techniques have been tried with varied degree of success. They include integer programming, dynamic programming and nonlinear pro-gramming (Taha, 2007). The limitations of some of these techniques gave rise to the development of Analytic Hierarchy Process (AHP) and Multi Attribute Utility Theory (MAUT). Saaty (1986) asserts that the foundation of the Analytic Hierarchy Process (AHP) is a set of axioms that carefully delimits the scope of the problem environment. AHP is based on the well-defined mathematical structure of consistent matrices and their associated right eigenvector's ability to generate true or approximate weights (Merkin, 1979; Saaty, 1980, 1994)

The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair-wise mode. In doing this, the AHP uses a fundamental scale of absolute numbers that has been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes just as well or better than other scales (Saaty, 1994). The AHP is perhaps, the most widely used decision making approach in the world today. Its validity is based on the many hundreds of actual applications in which the AHP results were accepted and used by the cognizant decision makers (Saaty, 1994b).

Bayazit (2005) proposed an AHP model to guide the management of a tractor manufacturing plant in deciding if flexible manufacturing system (FMS) should be implemented in the entire plant. Also, Rostamzadeh and Sofian (2009) sought to prioritize the effective 7Ms in improving system performance with special attention on manufacturing plants. Forman and Gass (2001) reported the use of AHP for R&D decisions at the Xerox Corporation. They reported that users confirmed that intuitive decisions are much more easily overturned than decisions made with AHP because the latter are based on a body of facts and criteria that people have carefully discussed and agreed to.

DATA AND METHODS

The data for this study were collected via a questionnaire administered to employees of five pharmaceutical companies in Lagos. These companies were particularly chosen because of their wealth of experience in drug manufacturing in Nigeria. Their establishments fall into what NAFDAC (2010) referred to as Phase II (1957 to 1980) in the evolution of drug production in Nigeria. The criteria on which the questionnaire was based are: planning, efficiency, capacity, experience, and education. These were based on their relevance to the decision alternatives, the 7Ms. The criteria and the decision alternatives are hierarchically represented in Figure 1.

Five persons at each level of manager, assistant manager, sales representative and medical representative were randomly selected for each of the companies. Furthermore, three other respondents were drawn from each of production, finance, purchasing, warehousing, logistics, inspection, and human capital development units. Thus, a total of 205 respondents were involved. This limited number is due to the fact that pharmaceutical firms engage people with specialised skills.

According to the AHP rules, one of the most important stages of this model is allocating weights to each one of the variables as a pair-wise comparison. The questionnaire used for this study was designed based on the data needed for AHP model, and no other

The AHP model

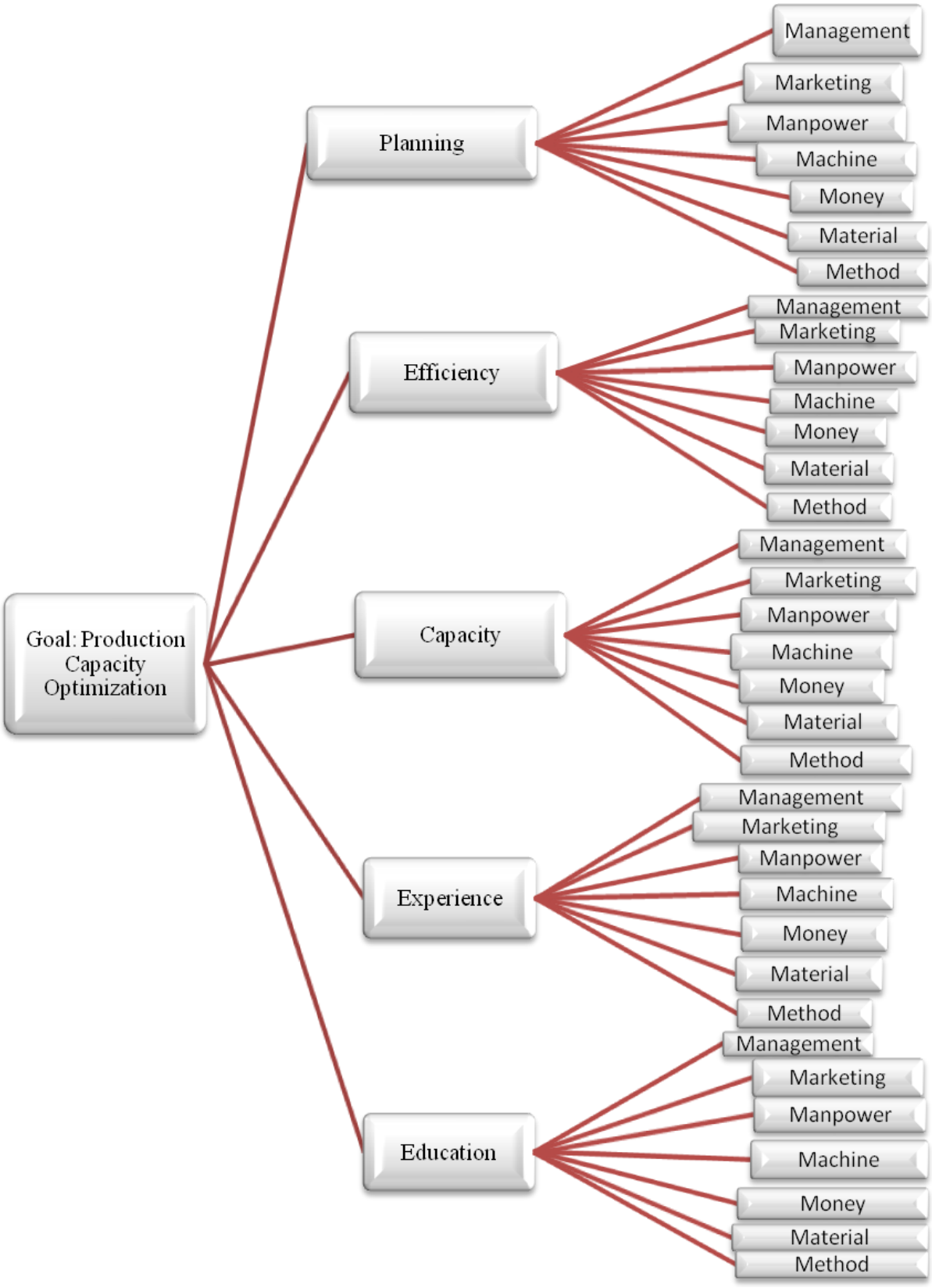

Figure 1. Hierarchical representation of the goal, criteria and decision alternatives.

Table 1. Random indices.

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Adapted from Tsagdis (2008).

Table 2. Pair-wise comparison of criteria with respect to the goal.

Criteria	Planning	Efficiency	Capacity	Experience	Education
Planning	1	3	2	4	4
Efficiency	0.3333	1	3	7	6
Capacity	0.5	0.3333	1	3	4
Experience	0.25	0.1429	0.3333	1	2
Education	0.25	0.1667	0.25	0.5	1
Sum	2.3333	4.6429	6.5833	15.5	17

Source; Obtained from respondent's perception.

demographic questions were asked from the respondents. production capacity optimization in order to effectively prioritise the effective 7Ms involved in production.

Consistent with Anderson (2001), the following procedure was used in synthesizing judgment and determining the consistency ratio. After determining the sum of all columns in the pair-wise comparison matrix, each element of the pair-wise comparison matrix is divided by its column total. The resulting matrix is referred to as the normalized pair-wise comparison matrix. Next we obtain the average of each row in the normalized matrix. This gives the respective priorities – the global priorities when comparison is with respect to the goal, and the local priorities when comparison is with respect to the criteria. Adding all the values in the priority vector to ensure that the sum equals one, the resulting priority vector depicts the relative importance of each criterion in the decision. In synthesizing judgement, the global priority vector is then multiplied with the local priority vectors in order to determine the overall priorities of the decision alternatives.

An important consideration in terms of the quality of the ultimate decision relates to the consistency of judgments that the decision maker demonstrates during the series of pairwise comparison. However, before one becomes too concerned about a lack of consistency in the pair-wise comparisons, we should realise that perfect consistency is very difficult to achieve and that some lack of consistency is expected to exist in almost any set of pair-wise comparison (Anderson, 2001). Saaty suggests 0.1 as an acceptable boundary and believes that if inconsistency ratio is more than 0.1, it is better to revise the decision. We shall retain this provision.

To estimate consistency ratio each row of the pair-wise comparison matrix is multiplied with the priority vector. This gives a new vector called the weighted sum vector. Dividing the values of the weighted sum vector with the respective values of the priority vector gives rise to a third vector referred to as quotient. We then compute λ_{max} by taking the average of this outcome. The Consistency index (C.I) is then obtained as:

$$C.I = \frac{[\lambda_{max} - n]}{n - 1}$$

where n is the number of items being compared.

The consistency ratio (CR), is then computed as $\frac{CI}{RI}$, where RI, the random index, is the consistency index of a randomly generated pair-wise comparison matrix.

Consistent with Saaty (1980), random index (R.I) 1 to 11 in Table 1 are from the results obtained at Wharton while those from 12 to 15 are from results at Oak Ridge (Saaty 1980, 21).

RESULTS

Pair-wise comparison of criteria relative to the goal

To attain the goal of production optimization, we set up for comparison with the goal, five major criteria, namely: planning, efficiency, capacity, experience and education. The results are shown in Table 2.

Synthesizing relative to the goal

Next we obtain the normalized matrix shown in Table 3 by dividing each entry in Table 2 by its corresponding column sum. The priority vector is obtained by dividing the row sum of the criteria in the normalized matrix by the number of criteria, which is five.

The synthesis of the pair-wise comparison of the decision criteria with respect to the goal reveals that planning has the highest rank priority of 0.3744. This is followed by efficiency which has a priority of 0.3237. In the third place is capacity with a rank priority of 0.1734. Next are experience and education which have respective priorities of 0.0741 and 0.0544. The summation of these priorities equal one.

Estimating the consistency ratio relative to the goal

To estimate the consistency ratio we multiply each row of

Table 3. Normalized matrix and priority vector of criteria

Optimization factor	Planning	Efficiency	Capacity	Experience	Education	Sum	Priority vector
Planning	0.4286	0.6462	0.3038	0.2581	0.2353	1.8719	0.3744
Efficiency	0.1429	0.2154	0.4557	0.4516	0.3529	1.6185	0.3237
Capacity	0.2142	0.0718	0.1519	0.1935	0.2353	0.8668	0.1734
Experience	0.1071	0.0308	0.0506	0.0645	0.1176	0.3707	0.0741
Education	0.1071	0.0359	0.0380	0.0323	0.0588	0.2721	0.0544
Sum							1.0000

Table 4 Estimating the consistency ratio

Weighted sum	Quotient
2.2064	5.8937
1.8141	5.6043
0.9086	5.2407
0.3806	5.1335
0.2824	5.1889
Sum	27.0610
λ_{max}	5.4122

λ_{max} is obtained by dividing the sum of the quotient by the number of criteria, and this gives $\lambda_{max} = 5.4122$.

$$C.I = \frac{5.4122-5}{5-1} = 0.1030$$

$$C.R = \frac{0.1030}{1.12} = 0.092$$

The RI value is 1.12 when n = 5

the pair-wise comparison in Table 2 by the priority vector in Table 3. This gives the weighted sum vector as shown in Table 4. The Quotient is then obtained by dividing the weighted sum vector by its corresponding priority vector.

Planning

Planning involves selecting missions and objectives as well as the actions to achieve them; planning requires decision-making (choosing future course of action from among alternatives). It is one of the major functions of management of any organization (Weihrich et al., 2008). In this case, planning includes managerial plan, marketing plan, a plan of how the finances would be utilized, and a plan as to what quantity of materials would be consumed in order to optimize production. Also included are the level of automation and efficiency of the machines to be used in production as well as planning how information technology and the structure of the organization are to be utilized. The pair-wise comparison of the planning alternatives is shown in Table 5.

Table 5 shows that with regards to planning, the management function is twice preferred to the marketing function, four times more preferred to each of manpower and method, and three times preferred to each of machine and material. The remaining row entries listed in respect of the other functions are the odds ratio against the management function. Similar argument applies to the marketing, money, manpower, machine, method and material columns.

Efficiency

Efficiency is the quality of doing a particular task well and effectively without wasting time, money, or energy; it is the achievement of the ends with the least amount of resources (Weihrich et al., 2008).

In this regard, we refer to managerial efficiency as efficiency in marketing activities, efficiency in expenditure, efficient manpower utilisation, machine efficiency, and efficiency with respect to the method and materials used in the production process.

From Table 6 it is seen that managerial efficiency is six times more preferred than marketing efficiency, five times more preferred to efficiency in expenditure, four times more preferred to each of manpower efficiency and efficiency in methods, three times more preferred than machine efficiency and twice more preferred to efficiency in the use of material. Similar argument applies to the marketing, money, manpower, machine, method and material columns.

Table 5 Pair-wise comparison of decision alternatives relative to planning

Alternative	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	1	2	1	4	3	4	3
Marketing	0.5	1	0.5	2	3	2	2
Money	1	2	1	2	2	2	3
Manpower	0.25	0.5	0.5	1	2	3	2
Machine	0.3333	0.3333	0.5	0.5	1	0.25	1
Method	0.25	0.5	0.5	0.3333	4	1	0.5
Material	0.3333	0.5	0.333	0.5	1	2	1
Sum	3.6667	6.8333	4.3333	10.3333	16	14.25	12.5

Table 6. Pair-wise comparison matrix of decision alternatives with respect to efficiency.

Alternative	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	1	6	5	4	3	4	2
Marketing	0.1667	1	1	3	3	3	2
Money	0.2	1	1	2	2	2	2
Manpower	0.25	0.3333	0.5	1	2	3	3
Machine	0.3333	0.3333	0.5	0.5	1	1	1
Method	0.25	0.3333	0.5	0.3333	1	1	0.5
Material	0.5	0.5	0.5	0.3333	1	2	1
Sum	2.7000	9.4999	9	11.1666	13	16	11.5

Table 7. Pair-wise comparison matrix of alternatives with respect to capacity.

Alternative	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	1	2	2	0.25	5	4	5
Marketing	0.5	1	1	0.3333	4	4	3
Money	0.5	1	1	0.2	2	1	2
Manpower	4	3	5	1	4	2	3
Machine	0.2	0.25	0.5	0.25	1	1	2
Method	0.25	0.25	1	0.5	1	1	2
Material	0.2	0.3333	0.5	0.3333	0.5	0.5	1
Sum	6.65	7.8333	11	2.8666	17.5	13.5	18

Capacity

Capacity incorporates the concept of rate of conversion within an operational setting. It is often difficult to get a realistic measure of capacity because of the day-to-day variations that are encountered. Employees are sometimes absent or late, equipment breakdowns occur, facility downtime is needed for maintenance and repair, machine setups are required for product changeovers and vacation must be scheduled. Adam and Ebert (1978) argued that since all these uncertainties and varia-tions cause true capacity to change from time to time, they must be considered in any estimate of capacity.

Table 7 indicates that respondents regard manpower utilization to be the most preferred with respect to capacity Thus, manpower function is four times more preferred than the management and machine functions, three times more preferred to marketing and material functions, five times more preferred to financial function, and twice preferred to the method function. Similar argument applies to the marketing, money, manpower, machine, method and material columns.

Experience

Experience is the knowledge or skill gained from doing a job or activity. The experiences of those handling the affairs of each of the decision alternatives are worthy of consideration if optimality in production capacity is desirable. Experience and judgement are the bases for

Table 8. Pair-wise comparison matrix of alternatives with respect to experience

Alternative	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	1	2	2	4	3	3	4
Marketing	0.5	1	0.3333	0.3333	0.25	0.5	0.5
Money	0.5	3	1	2	2	3	4
Manpower	0.25	3	0.5	1	4	3	3
Machine	0.3333	4	0.5	0.25	1	1	2
Method	0.3333	2	0.3333	0.3333	1	1	2
Material	0.25	2	0.25	0.3333	0.5	0.5	1
Sum	3.1666	17	4.9166	8.2499	11.75	12	16.5

Table 9. Pair-wise comparison matrix of alternatives with respect to education

Alternative	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	1	3	3	3	5	5	4
Marketing	0.3333	1	2	1	2	3	3
Money	0.3333	0.5	1	0.5	1	0.5	1
Manpower	0.3333	1	2	1	3	3	3
Machine	0.2	0.5	1	0.3333	1	0.3333	2
Method	0.2	0.3333	2	0.3333	3	1	2
Material	0.25	0.3333	1	0.3333	0.5	0.5	1
Sum	2.6499	6.6666	12	6.4999	15.5	13.3333	16

Table 10. Priorities of decision alternatives with respect to planning

Management	Marketing	Money	Manpower	Machine	Method	Material
0.2702	0.1542	0.2136	0.1213	0.0662	0.0927	0.0817

determining how good a plan is in aggregate planning (Adam (Jr.) and Ebert, 1978).From Table 8, it is observed that respondents reported that managerial experience is more crucial than all the other alternatives. Specifically, managerial experience is regarded as being twice more preferred to marketing and finance, three times more preferred to machine and method and four times more preferred than manpower and material. Again, similar argument applies to the marketing, money, manpower, machine, method and material columns.

Education

Education is the level of formal, informal and on-the-job training that an employee of an organization has gone through.

Table 9 shows that managerial education is far more important than other alternatives.

Synthesizing the criteria and determining the normalized matrix

In synthesizing, each cell in the pair-wise comparison matrix was divided by its respective column sum. In doing this we obtained the normalized matrix for each of the criteria. A combined table of normalized matrix with respect to the criteria is as presented in Table 15.

The computation of the row sum of each of the normalized matrix and dividing it by the number of decision alternatives gives the priority vector for each of the criteria. The results for the various criteria are presented in Tables 10 to 14.

With respect to planning, Table 10 reveals that synthesizing the pair-wise comparison of the decision alter-natives indicates that management has the highest rank with a priority of 0.2702. Money ranks second with a priority of 0.2136. Marketing and Manpower follow with respective priorities of 0.1542 and 0.121, Fifth and sixth ranks go to method and material functions with respective priorities of 0.0927 and 0.0817., Machine ranks in the seventh position with a priority of 0.0662.

As shown in Table 11 the priorities of decision alternatives with respect to efficiency indicates that management has the highest priority of 0.367, marketing has the second highest priority of 0.163, and finance occupies the third highest priority of 0.132. Manpower ranks fourth with a priority of 0.125, while the fifth, sixth and seventh

Table 11. Priorities with respect to efficiency

Management	Marketing	Money	Manpower	Machine	Method	Material
0.367	0.163	0.132	0.125	0.069	0.057	0.087

Table 12. Priorities with respect to capacity

Management	Marketing	Money	Manpower	Machine	Method	Material
0.2192	0.1574	0.0947	0.3330	0.0624	0.0825	0.0508

Table 13. Priorities with respect to experience

Management	Marketing	Money	Manpower	Machine	Method	Material
0.2961	0.0597	0.2061	0.1787	0.1089	0.0887	0.0618

Table 14. Priorities of decision alternatives with respect to education

Management	Marketing	Money	Manpower	Machine	Method	Material
0.3552	0.1625	0.0751	0.1718	0.0714	0.1053	0.0587

rankings go to material, machine and method with respective priorities of 0.087, 0.069, and 0.057.

From Table 12, the rank priority of the decision alternatives with respect to capacity are in the following order: manpower, 0.3330; management, 0.2192; marketing, 0.1574; money, 0.0947; method, 0.0825; machine, 0.0624, and material, 0.0508.

In Table 13, management has the highest priority of 0.2961; money has the second highest priority of 0.2061, while manpower is in the third place with a priority of 0.1787. Machine occupies the fourth place with a rank priority of 0.1089 while fifth place is taken by method with a priority of.0887. Material and marketing are in the sixth and seventh positions with priority rankings of 0.0618 and 0.0597, respectively

In Table 14, management has the highest priority of 0.3552; manpower has the second highest priority of 0.1718, while marketing is in the third place with a priority of 0.1625. Method occupies the fourth place with a rank priority of 0.1053 while the fifth place is taken by Money with a priority of 0.0751. Machine and material are in the sixth and seventh positions with priority rankings of 0.0714 and 0.0587, respectively

Estimating the consistency ratio relative to the criteria

Following the same procedure as we did while estimating the consistency ratio relative to the goal, the λmax's are as presented below, and the consistency ratios are presented in Table 16

$\lambda max_{planning}$ = 7.5935
$\lambda max_{efficiency}$ = 7.6934
$\lambda max_{capacity}$ = 7.6416
$\lambda max_{experience}$ = 7.6678
$\lambda max_{education}$ = 7.3863

Recall that the consistency ratio with respect to the goal has been estimated to be 0.092. The pair-wise comparison for the different factors is acceptable since each of them has a consistency ratio that is less than 0.10.

Eigenvectors

The eigenvectors are the priorities of the various priorities of the decision alternatives with respect to all the criteria under which the alternatives have been compared

Determining final priority rankings

The final priority ranking of the decision alternatives is determined by multiplying the eigenvectors in Table 17 by the priorities of criteria with respect to the goal (global priority) obtained in Table 3.

Table 15. Normalized matrix of decision alternatives with respect to the criteria.

Planning	Management	Marketing	Money	Manpower	Machine	Method	Material	Experience	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	0.2727	0.2927	0.2308	0.3871	0.1875	0.2807	0.2400	Management	0.3158	0.1176	0.4068	0.4849	0.2553	0.2500	0.2424
Marketing	0.1364	0.1463	0.1154	0.1935	0.1875	0.1404	0.1600	Marketing	0.1579	0.0588	0.0678	0.0404	0.0213	0.0417	0.0303
Money	0.2727	0.2927	0.2308	0.1935	0.1250	0.1404	0.2400	Money	0.1579	0.1765	0.2034	0.2424	0.1702	0.2500	0.2424
Manpower	0.0682	0.0732	0.1154	0.0968	0.1250	0.2105	0.1600	Manpower	0.0789	0.1765	0.1017	0.1212	0.3404	0.2500	0.1818
Machine	0.0909	0.0488	0.1154	0.0484	0.0625	0.0175	0.0800	Machine	0.1053	0.2353	0.1017	0.0303	0.0851	0.0833	0.1212
Method	0.0682	0.0732	0.1154	0.0323	0.2500	0.0702	0.0400	Method	0.1053	0.1176	0.0678	0.0404	0.0851	0.0833	0.1212
Material	0.0909	0.0732	0.0769	0.0484	0.0625	0.1404	0.08	Material	0.0789	0.1176	0.0508	0.0404	0.0426	0.0417	0.0606

Efficiency	Management	Marketing	Money	Manpower	Machine	Method	Material	Capacity	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	0.3704	0.6316	0.556	0.358	0.231	0.250	0.174	Management	0.1504	0.2553	0.1818	0.0872	0.2857	0.2963	0.2778
Marketing	0.0617	0.1053	0.111	0.269	0.231	0.188	0.174	Marketing	0.0752	0.1277	0.0909	0.1163	0.2286	0.2963	0.1667
Money	0.0741	0.1053	0.111	0.179	0.154	0.125	0.174	Money	0.0752	0.1277	0.0909	0.0698	0.1143	0.0741	0.1111
Manpower	0.0926	0.0351	0.056	0.090	0.154	0.188	0.261	Manpower	0.6015	0.3830	0.4545	0.3488	0.2286	0.1481	0.1667
Machine	0.1235	0.0351	0.056	0.045	0.077	0.063	0.087	Machine	0.0301	0.0319	0.0455	0.0872	0.0571	0.0741	0.1111
Method	0.0926	0.0351	0.056	0.030	0.077	0.063	0.043	Method	0.0376	0.0319	0.0909	0.1744	0.0571	0.0741	0.1111
Material	0.1852	0.0526	0.056	0.030	0.077	0.125	0.087	Material	0.0301	0.0425	0.0455	0.1163	0.0286	0.0370	0.0556

Education	Management	Marketing	Money	Manpower	Machine	Method	Material
Management	0.3774	0.4500	0.2500	0.4615	0.3226	0.3750	0.2500
Marketing	0.1258	0.1500	0.1667	0.1538	0.1290	0.2250	0.1875
Money	0.1258	0.0750	0.0833	0.0769	0.0645	0.0375	0.0625
Manpower	0.1258	0.1500	0.1667	0.1538	0.1935	0.2250	0.1875
Machine	0.0755	0.0750	0.0833	0.0513	0.0645	0.0250	0.1250
Method	0.0755	0.0500	0.1667	0.0513	0.1935	0.0750	0.1250
Material	0.0943	0.0500	0.0833	0.0513	0.0323	0.0375	0.0625

The final ranking displayed in Table 18 reveals that managerial function ranks highest, followed by manpower. The visual display of the rankings in Figure 2 clearly distinguishes the importance of the management function. This result for the pharmaceutical industry should not be surprising since it is a high-risk sector that requires a highly alert management and specialized skilled person-nel. Money and marketing functions closely follow manpower in the ranking.

This order is not out of place since money is required to procure the needed raw materials and component parts of machines, while marketing of products is required to get the products to various distributors (pharmacy and medicine stores). Method of transformation ranks fifth, while material and machine hold sixth and seventh positions, respectively.

The outcome of the study has shown the relative importance of management, with a priority of 0.3005, over other functions of manufacturing. This is quite reasonable as management function is believed to coordinate all other functions in the manufacturing process. Manpower had a priority of 0.1661. Money and marketing had priorities 0.1558 and 0.1530, respectively. Method used in the manufacturing process had a priority of 0.08,

Table 16. Consistency ratios.

Consistency measure	Criteria				
	Planning	Efficiency	Capacity	Experience	Education
C. I.	0.098922	0.1156	0.1069	0.1113	0.0644
C. R.	0.0749	0.0875	0.0810	0.0843	0.0488

Table 17. Eigenvectors.

Alternative	Planning	Efficiency	Capacity	Experience	Education
Management	0.2702	0.367	0.2192	0.2961	0.3552
Marketing	0.1542	0.163	0.1574	0.0597	0.1625
Money	0.2136	0.132	0.0947	0.2061	0.0751
Manpower	0.1213	0.125	0.3330	0.1787	0.1718
Machine	0.0662	0.069	0.0624	0.1089	0.0714
Method	0.0927	0.057	0.0825	0.0887	0.1053
Material	0.0817	0.087	0.0508	0.0618	0.0587

Table 18. Final priority ranking of alternatives

Alternative	Weights	Rank
Management	0.3005	1
Marketing	0.1530	4
Money	0.1558	3
Manpower	0.1661	2
Machine	0.0691	7
Method	0.0800	5
Material	0.0755	6

while material and machine had priorities 0.0755 and 0.0691, respectively. This would guide the manufacturers of pharmaceutical products desirous of optimality in the production capacity.

Conclusion

This study has established that for optimal production in the pharmaceutical industry, a good management team must be in place. This is understandable because issues of ethics and good governance which are management dependent are very crucial in this industry. Already the

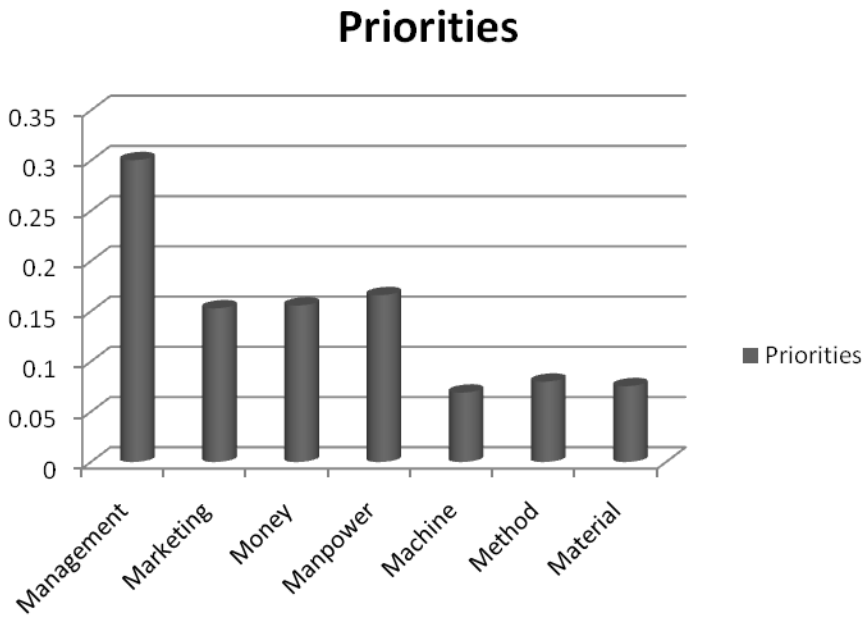

Figure 2. Graphical representation of the priorities of the alternatives.

lack of it is reflected in the preponderance of fake drugs which have been established as posing threats not only to society but also to individuals in terms of the side effects and to the public in terms of trade relations, economic implications and global pandemics (Nsimba, 2008). In developing countries regulatory weaknesses in governance of the pharmaceutical system have been known to negatively impact health outcomes (Garuba et al., 2009). Further, it is the management function that effectively coordinates all other functions involved in the manufacturing process. The management of a pharmaceutical firm is saddled with the responsibility of making strategic decisions like backward integration or outsourcing of some of the other functions, hence pharmaceutical companies cannot take the risk of not having a strong and efficient management team in place.

This is particularly true because drug manufacturing is a high-risk venture that requires a high level of managerial efficiency in respect of the various managerial functions at every stage of the process of drug production. In this industry, it is better to produce little quantity with no defects than to produce large quantities with some defects. Optimizing in this context therefore refers to the effectiveness of the use of resources of a pharmaceutical firm and not the quantity of the product manufactured.

If a company manufactures defective drugs no amount of marketing effort would be able to save that company. Besides the risk of product liability the news spreads fast and in no time the company could be consumed and put out of operation. The issue of the company involved in the sale of contaminated teething drugs resulting in the death of some children in Nigeria is a case in point (Dada, 2008). A strong management can provide the fortress to prevent the production of defective drugs and thereby ensure the survival of a pharmaceutical company. The results obtained for this study can be replicated for other industries where some other function may shoot up as the most important.

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