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Holomorphic Prioritization of Sets within Decagram of Strategic Decision Making of POSM Using Operational Research (OR): Analytic Hierarchy Process (AHP) Analysis

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***Abstract*—**There is decagram of strategic decisions of operations and production/service management (POSM) within operational research (OR) which must collate, namely: design, inventory, quality, location, process and capacity, layout, scheduling, maintain ace, and supply chain. This paper presents an architectural configuration conceptual framework of a decagram of sets decisions in a form of mathematical complete graph and abelian graph.

Mathematically, a complete graph is undirected (UDG), and directed (DG) a relationship where every pair of vertices is connected, collated, confluent, and holomorphic.

There has not been any study conducted which, however, prioritizes the holomorphic sets which of POMS within OR field of study. The study utilizes OR structured technique known as The Analytic Hierarchy Process (AHP) analysis for organizing, sorting and prioritizing(ranking) the sets within the decagram of POMS according to their attribution (propensity), and provides an analysis how the prioritization has real-world application within the 21st century.

***Keywords*—**AHP analysis, Decagram, Decagon, Holomorphic.

I. Introduction

THERE are ten critical decision areas of operation management which they are: goods and service design, quality, process and capacity design, location, layout design, human resources and job design, supply chain management, inventory, scheduling, and maintenance [2].

In geometry, a decagon is any polygon with ten sides and ten angles. A regular decagon has all sides of equal length. However, ten OM decisions was developed by researchers in Fig. 1 to show how these ten OM are related first and second to see which decision is has the priority.

A. Goods and Service Design (C1)

Design of goods defines much of the transformation process. The factors of cost, quality and human resources must be made during the stage. Operation management of product and services is also different because due to different characteristic and tangible / intangible feature [3].

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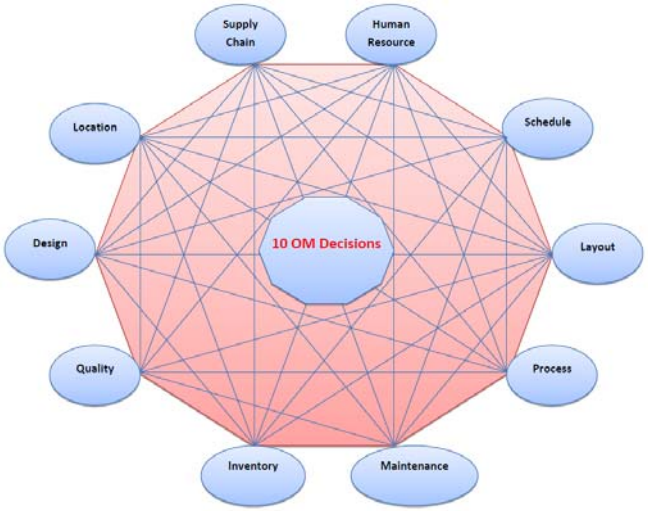

Fig. 1 Decagram of strategic decisions of operations and production/service management (POSM)

B. Quality (C2)

Customer has a very high quality standard nowadays and operation management decision in quality must be clear and strict for its members to understand and comply. It must set a quality, standard and operating procedure to meet customers' high expectation. [3].

C. Process and Capacity Design (C3)

Manufacturing of physical products may have higher importance on process and capacity design than services operation. Operation management (product) should decide what process it, what type of technology and to what extent, human resources, quality and maintenance that determines its basic cost structure. Services operation decision on this area is much simpler and it can determine by customers who directly involved in the process. For example, customer will ask tailor to design specific fashion clothes. Capacity design issue is critical for services because it will try to reduce waiting time and avoid loss of sales due to insufficient capacity. For manufacturing capacity design is based on firm's financial capability, forecast for future and market demand [3].

D. Location (C4)

Location can be an area for operation management to decide and with globalization of business, operation managers

too must think global. For physical goods, location selection can be determined by pools of qualified human resources, technology, raw material, access to market and government policy. For services as it is direct to customers, the location is determined by market accessibility or near to customer as possible [3].

E. Layout Design (C5)

Material flow, process selection technology used, capacity needs, worker's needs, inventory requirement, and capital will influence the decision for layout design. For services such as hotels, beside capacity needs layout also will enhance its attributes and features to the customers [3].

F. Human Resources and Job Design (C6)

Employees are the integral part in the total system design. Operation management must set a policy to set labor standards to ease transition of skills, improvement of knowledge, skills and abilities (KSA), build a balance work and life quality in an effective cost target. For services one extra area operation management should touch, which is customers relationship that they are dealing directly [3].

G. Supply Chain Management (C7)

Supply chain is a networks and decisions that have to take place of what to produce, what material to buy, from where, how is the cost and how is the delivery from supplier to the final end customers in on-time delivery and minimum cost possible. It is more critical in production of goods than services [1], [3].

H. Inventory (C8)

Decisions on how and where the inventory level to keep long term customers satisfaction, suppliers, material availability for not to disrupt the production, human resources needed for this purpose and important the holding cost from financial perspective. Goods production are more concern because manufacturer may kept raw material, in progress work order and final goods while services is not critical as it is directly produce and consume simultaneously [3].

I. Scheduling (C9)

Schedules are more formal in goods production with short, medium and long term planning to accommodate customers demand. For services the demand is more direct and volatile and often concern on human resources and KSA availability to meet current customer's needs [3].

J. Maintenance (C10)

Decision must be made regarding the desired level of reliability, stability and systems must be established by management to maintain that reliability and stability [3].

Many scholars had presented the importance of these ten OM decisions [2]. But neither of them had presented which variables of ten OM decisions is the critical one. This study targeted toward specifying and ranking the most critical variables from ten OM decisions.

II. Statement of Problem

The potential benefits of ranking or prioritizing ten OM decisions sometimes are not related by researchers. Prioritizing ten OM decisions by scholars might not be realized.

III. Purpose of Study

The purpose of this research is to Prioritizing ten OM decisions which will guide organizations to focus on the most critical once.

IV. AHP Analysis Steps

The first step in the AHP procedure is to make pair wise comparisons between each criterion. [4]-[7].

The example scale for comparison is in Table I [6].

- Results of the comparison (for each factors pair) were described in term of integer values from 1 (equal value) to 9 (extreme different) where higher number means the chosen factor is considered more important in greater degree than other factor being compared with.

TABLE I
Pair Wise Comparisons

Scale	Degree of preference
1	Equal importance
3	Moderate importance of one factor over another
5	Strong or essential importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Values for inverse comparison

TABLE II
Results of the Comparison

Factor	Factor weighting score			Factor
	More importance than	Equal	Less importance than	
C1	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C2
C2	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C3
C3	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C4
C4	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C5
C5	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C6
C6	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C7
C7	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C8
C8	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C9
C9	9 8 7 6 5 4 3 2	1	2 3 4 5 6 7 8 9	C10
C10	.....			

1. Goods and service design. (C1), 2.Quality.(C2), 3.Process and capacity design. (C3), 4.Location (C4), 5.Layout design (C5), 6.Human Resources and Job Design (C6), 7. Supply Chain Management (C7), 8. Inventory (C8), 9. Scheduling (C9), 10.Maintenance (C10).

Step 1: Pair Wise Comparison

TABLE III
APPLYING PAIR WISE COMPARISON ON 10 OM DECISIONS

#	A	B	C	D	E	F	G	H	I	J	K
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
2	C1	1	4	1	3	3	2	2	6	8	4
3	C2	0.25	1	9	7	7	1	1	1	5	5
4	C3	1	0.11	1	3	2	8	8	6	4	2
5	C4	0.33	0.14	0.14	1	1	2	2	4	6	8
6	C5	0.33	0.14	0.14	1	1	4	4	6	6	8
7	C6	0.5	1	0.13	0.5	0.25	1	1	7	7	7
8	C7	0.5	1	0.13	0.5	0.25	0.25	1	7	7	7
9	C8	0.17	1	0.17	0.25	0.17	0.14	0.14	1	1	1
10	C9	0.13	0.2	0.25	0.17	0.17	0.14	0.14	1	1	1
11	C10	0.25	0.2	0.5	0.13	0.13	0.14	0.14	1	1	1
	Total	4.21	8.59	11.96	16.42	14.84	18.53	19.28	39	45	43

Step 2: Normalization

This step is to normalize the matrix by totaling the numbers in each column. Each entry in the column is then divided by the column sum to yield its normalized score. The sum of each column is 1.

TABLE IV
NORMALIZATION MATRIX

#	A	B	C	D	E	F	G	H	I	J	K	Total	Average
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10		
2	C1	0.25	0.46	0.08	0.18	0.02	0.11	0.1	0.15	0.17	0.09	1.61	0.16
3	C2	0.06	0.11	0.72	0.42	0.46	0.05	0.05	0.01	0.11	0.11	2.05	0.21
4	C3	0.25	0.01	0.08	0.18	0.13	0.43	0.41	0.15	0.09	0.05	1.78	0.18
5	C4	0.08	0.02	0.01	0.06	0.07	0.11	0.1	0.1	0.13	0.18	0.86	0.09
6	C5	0.08	0.02	0.01	0.06	0.07	0.21	0.21	0.15	0.13	0.18	1.12	0.11
7	C6	0.13	0.11	0.01	0.03	0.2	0.05	0.05	0.18	0.15	0.16	1.07	0.11
8	C7	0.13	0.11	0.01	0.03	0.02	0.01	0.05	0.18	0.15	0.16	0.85	0.09
9	C8	0.04	0.11	0.01	0.01	0.01	0.01	0.01	0.01	0.2	0.2	0.61	0.06
10	C9	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.2	0.2	0.52	0.05
11	C10	0.06	0.02	0.04	0.01	0.01	0.01	0.01	0.01	0.2	0.2	0.57	0.06

Step 3: Consistency Analysis

TABLE V
CONSISTENCY ANALYSIS

#	A	B	C	D	E	F	G	H	I	J	K	Total	Avg.	Consistency Measure
1	Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	1.61	0.16	
2	C1	0.25	0.46	0.08	0.18	0.02	0.11	0.1	0.15	0.17	0.09	2.05	0.21	1.33
3	C2	0.06	0.11	0.72	0.42	0.46	0.05	0.05	0.01	0.11	0.11	1.78	0.18	1.30
4	C3	0.25	0.01	0.08	0.18	0.13	0.43	0.41	0.15	0.09	0.05	0.86	0.09	1.04
5	C4	0.08	0.02	0.01	0.06	0.07	0.11	0.1	0.1	0.13	0.18	1.12	0.11	0.85
6	C5	0.08	0.02	0.01	0.06	0.07	0.21	0.21	0.15	0.13	0.18	1.07	0.11	0.91
7	C6	0.13	0.11	0.01	0.03	0.2	0.05	0.05	0.18	0.15	0.16	0.85	0.09	0.98
8	C7	0.13	0.11	0.01	0.03	0.02	0.01	0.05	0.18	0.15	0.16	0.61	0.06	0.93
9	C8	0.04	0.11	0.01	0.01	0.01	0.01	0.01	0.01	0.2	0.2	0.52	0.05	0.97
10	C9	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.2	0.2	0.57	0.06	0.75
11	C10	0.06	0.02	0.04	0.01	0.01	0.01	0.01	0.01	0.2	0.2	1.61	0.16	0.79
	Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	CI =		-1.1
												RI =		1.49
												C. Ratio		-0.74

Now, calculate the consistency ratio and check its value.

The purpose for doing this is to make sure that the original preference ratings were consistent.

There are 3 steps to arrive at the consistency ratio:

1. Calculate the consistency measure.
2. Calculate the consistency index (CI).
3. Calculate the consistency ratio (CI/RI where RI is a random index).

$$CI = (\lambda \max - n) / (n- 1)$$

$$CR = CI / RI$$

To calculate the consistency measure, we can take advantage of Excel's Matrix multiplication function =MMULT ().

Approximation of the Consistency Index (CI)

1. Multiply each column of the pair wise comparison matrix by the corresponding weight.
2. Divide of sum of the row entries by the corresponding weight.
3. Compute the average of the values from step 2, denote it by λ *max*.
4. The approximate CI = (λ *max – n)/ (*n- 1)

Consistency Ratio (CR):

$$CR = CI / RI$$

- In practice, a CR of 0.1 or below is considered acceptable.
- Any higher value at any level indicates that the judgments warrant re-examination [4].

Consistency Index (CI):

$$CI = (\lambda\ max - n)/ (n- 1)[4].$$

Random Index (RI):

TABLE VI
RANDOM INDEX

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.46	1.49

Notes: n = order of matrix
Random inconsistency indices for n = 10[4].

V. Conclusion

After implementing AHP analysis technique, researchers found that priorities are as this order:

1. Scheduling (C9)
2. Maintenance (C10)
3. Inventory (C8)
4. Supply Chain Management (C7)
5. Human Resources and Job Design (C6)
6. Location (C4)
7. Layout design (C5)
8. Process and capacity design. (C3)
9. Quality. (C2)
10. Goods and service design. (C1)

Founding results were clearly showing that scheduling is most important factor from ten OM decisions. This result was supported by Kathy Schwalbe, in his book which titled Information Technology Project Management. He said that "Perhaps part of the reason that schedule problems are sp common is that time is easily measured and remembered. You can debate scope and cost overruns and make actual numbers appear closer to estimates, but once a project schedule is set, people remember the projected completion date" [8].

References

[1] Chopra, Sunil &Meindle, Peter (2010). Supply Chain Management (4th. Edition).
[2] Heizer, Jay & Render, Barry (2010). Operations Management (10th Edition). Pearson Education, Inc.
[3] http://bizniaga.blogspot.com/2008/07/henzer-10-critical-decision-area-for-om.html Web. 25 Feb. 2014
[4] Bunruamkaew, Khwanruthai (2012). How to do AHP analysis in excel. University of Tsukuba, Graduate School of Life and Environmental Sciences, Division of Spatial Information Science.
[5] Saaty, T.L. (1980). The analytical hierarchy process. MCGraw-Hill, New York.
[6] Saaty, T.L., Vargas, L.G. (1991). Prediction, Projection and forecasting. Kluwer Academic Publishers, Dordrecht, 251 pp.
[7] Hass, R. and Meixner, N. (n.d.). An Illustrated Guide to the Analytic Hierarchy Process. Institute of Marketing and Innovation, University of Natural Resources and Applied Life Sciences, Vienna (Available online) http://www.boku.ac.at/mi/
[8] Kathy Schwalbe, PH.D., PMP (2014). Information Technology Project Management.(7th Edition), Gengage Learning.