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Multi-Criteria Decision Analysis of Supply Chain Practices and Firms Performance in Nigeria

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***Abstract*—Companies are facing numerous pressures and challenges in order to be competitive in the market and meet the requirements of their customers which require an improvement in the supply chain practices of the firms to be more effective and efficient for sustainable competitive advantage. This study examines the use of a multi-criteria decision making method using analytic network process (ANP) to estimate the how supply chain activities of the selected manufacturing firms' influences its firm performance in other to enhance the satisfaction of customers. The population of the study is the manufacturing firms quoted in the Nigeria stock exchange. An ANP-based questionnaire was administered to Managers of selected manufacturing firms for pairwise comparison of supply chain factors relative influences and dependencies on their customers. A nonlinear network model was built to capture all the factors of supply chain practices and firms performance into clusters, nodes and dependences for the purpose of estimating various influences supply chain practices on the performance of the various companies studied.. Data collected were analysed using software of Super decision 3.0version. The results revealed factors of supply chain practices that have a great connection with one another and strong relationship indicating that without the implementing the key factors of supply chain there would not be a significant improvement in the performance of the organisation which will also affects the desire of the customers. The ANP model has helped to show the interdependencies and feedback among the various factors of practices of supply chain to augment the level of performance of the firms.**

***Index Terms*—Analytical Network Process, Supply chain, strategic supplier partnership, supply chain integration, outsourcing, customer relationship management.**

1. INTRODUCTION

The supply chain management practices are essential concepts that help numerous companies to integrate and provide quality products and services to their various customers due to the fact that the needs of the customers changes rapidly. But the abilities of the companies to cope with the various challenges encountered in terms of their cost, providing quality products and services to their customers depends solely on the strengths and opportunities the companies have over their competitors' (Lei & Zabinsky, 2011).

The main stakeholders of the manufacturing firms are the end users (customers) in which the companies/firms tries to meet the requirement and demands of their customers ensuring that they provide quality products and rendered quality services to them.

The concept of supply chain management denotes a systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole (Mentzer, et al 2001).

Furthermore, numerous scholars have been able to identify various supply chain management practices used in various organisations/firms for instance, Donlon (1996) identified six supply chain management practices which are outsourcing, supplier partnership, information sharing, cycle time, compression and continuous process flow; Tan, Kannan,&Handfield (1998) recognized three supply chain management practices to be quality, purchasing and customer relationship later Tan, Lyman & Wisner (2002) came up with supply chain integration, information sharing, customer service management, geographical proximity and Just in Time capabilities has their supply chain management practices. Also Lee (2004) acknowledged the supply chain management practices to be five which comprise of outsourcing, strategic supplier partnership, customer relationship information sharing and modularity. The supply chain management practices were categorized into two categories quantitative and qualitative measures. Quantitative measures are cost and resource utilization and qualitative measures are quality, flexibility, visibility, trust and innovativeness (Chan, 2003).

In spite of all these identified supply chain management practices, this study set out to explore the use of one of the multi- criteria decision making method (Analytic Network Process) to model the network relationship among the supply chain managements practices explored by the manufacturing firms in Nigeria and provide alternative strategies how those practices can be used to improve their performances so as to enhance customers satisfaction.

2. LITERATURE REVIEW

2.1. Theoretical Framework

There are several theories associated with supply chain management and firms' performance. In view of this research we are focusing on few of the theories like system theory, theory of constraints.

System Thinking Theory

The theory underpinning the study is system thinking theory, in the early 50's the theory was used to elevate the operations of manufacturing and it further employed the system approaches to build and restructure the internal procedures of business (Rigby, *et al* , 2000). The theory is the trans-disciplinary study of the abstract organisation of phenomena, independent of their substance, type, or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models, which can be used to describe them. It is an approach to problem solving that looks at problems not as isolated challenges but rather in the context of the larger system in which a particular function or process operates. While working with an organizational structure, like a supply chain, the system is the combination of the people, structures, processes and environment that work together to create a desired outcome. Moreover, the theory provides a model of decision-making that helps organizations to adapt to change effectively. Adapting to change helps the organisation to facilitate learning and the theory has a rational used in analyzing the relationship between the parts of a system in other to make a meaningful decision when the situation arises. This theory related to the supply chain management has to do with planning and coordination the production flow from acquiring raw materials and production through distribution to the final customer.

Theory of Constraints

This theory is a management philosophy that supports organisation to constantly accomplish their aims. This theory is based on three key assumption in which organisation can be measured which are operational expense, through put and inventory. These three concepts are the critical requirement for making a sound financial decision in an organisation (Goldratt, 1998).

Theory of constraints is based on the premise that the rate of goal achievement by a goal-oriented system that is the system's throughput is limited by at least one constraint. These theory is relevant to supply chain in order to establish a competitive advantage based on extra ordinarily availability by reducing the damaged caused when the flow of goods is interrupted by shortages and surpluses.

2.2. Concepts of Supply Chain Practices

2.2.1 Supply Chain Integration

Supply chain integration is defined as a process of interaction and collaboration in which companies in a supply chain work together in a cooperative manner to achieve mutually acceptable outcomes (Pagell, 2010). However, according to Zhao, *et al* (2008), they viewed supply chain integration concept as the degree to which an organisation strategically collaborates with its partners and manages intra- and inter-organisational processes in order to achieve efficient and effective flows of products, services, information, money and decisions. In this study supply chain integration is being classified into six which are customer integration, technology integration, internal operations, material/service supplier integration, relationship integration and measurement integration.

2.2.2. Strategic Supplier Partnership

The strategic supplier partnership identifies optimum practices that can facilitate supply chain process alignment and integration. In order to further expedite collaboration, it is necessary to implement the latest collaborative information systems that drive efficiencies, performance, and quality throughout a supply chain (Robinson & Malhotra, 2005). Supply chain partnership is defined as a strategic coalition of two or more firms in a supply chain to facilitate joint effort and collaboration in one or more core value creating activities such as research, product development, manufacturing, marketing, sales, and distribution (Maheswari, Kumar & Kumar, 2006; Li, *et al* 2006). The strategic influence and operational capabilities of individual participating

helps to achieve significant benefits for the organisation is major existence of strategic partnership (Stuart, 1997).

However, Griffith, and Harvey, (2001) considered strategic partnership as the ability to coordinate inter-organizational relationships effectively as one of the important resources of the firms. In the course of this study the strategic supply partnership is being measured looking at quality of selecting supplier, solving the problems of suppliers, involving the supplier in new development process and also including the suppliers in the planning and setting of goals and objectives of the organisation.

2.2.3. Information Sharing

In the view of Agarwal and Shankar (2003) information sharing is vital concept to successful partnership, without complete information about the firms business, trade partners cannot work effectively towards achieving the goals of the companies. Also Information sharing is viewed as an access to private data between business partners thus enabling them to monitor the progress of products and orders as they pass through various processes (Simatupang & Sridharan, 2005). The concept information sharing is essential when considering the supply chain management practices. In the course of this study information sharing is being measured by having advance notice to trade partners on any changes that arises, keeping each other informed about what affects their partners, exchanging information on establishing a business unit and sharing of business unit proprietary information with trade policy.

2.2.4. Customer Relationship

According to Spekman, Kamauff, and Myhr, (1998), the success of a firm or company solely depends on the strength of its relationship with supply chain partners which could reduce or increase revenue. According to Tan, Lyman and Wisner (2002), maintaining a long term and good relationship with customers the organisation needs to strategize on how to manage the complaints of their customers and provide adequate solutions to their problems. This study set to measure customer relationship in terms of good communication, conformity, having trust in their customers, commitment and how complaints of customers are being handled.

2.2.5. Outsourcing

Literally, outsourcing means buying materials for external supplier or making strategic use of outside resources to perform activities traditionally handled by internal staff and resources (Baily, *et al*, 2008). Outsourcing is an effective cost-saving strategy when used appropriately in a situation where it is more affordable to purchase a good from companies with comparative advantages than it is to produce the good internally. In this study outsourcing is being measured using this concepts operations reduction cost, service level improvement, core competence prioritization, capital cost reduction, employee based reduction.

2.3. Empirical Review of Supply Chain Management Practices and Firms Performance

There is debate of literature on the various articles on supply chain management practices and firms performance.

Lopes de Sousa Jabbour, et al. *(2011)* empirically investigated the indicators and constructs of supply chain management practices of some Brazillian companies, the study was able to achieve four constructs which are supplier chain integration for production planning and control support, information sharing about the products and targeting strategies, strategic relationship with customer and supplier and support customer order compared with previous studies that had six dimensions of supply chain management practices.

Abuzaid, (2014) investigated supply chain management practices in manufacturing companies in Jordian, how these supply chain practices influences the strategic flexibility of the selected companies listed in the Amman Stock exchange. He was able to identify four supply chain practices which are Strategic partnership with supplier, relationship with customer, information sharing level and quality of information sharing while the strategic flexibility was broken down into three production flexibility, market flexibility, and competitive flexibility. He found that the identified practices have a positive impact on the flexibility with highest relationship with customers and lowest impact on quality of information sharing. The information sharing level, strategic partnership with supplier relationship with customers has the greatest influence on market flexibility, production flexibility and competitive flexibility respectively. In adopting these strategies it enables the companies to have a sustainable competitive advantage.

Mutuerandu and Iravo (2014) conducted a study in Kenya by assessing the level of implementation of supply chain practices in Haco Industries. However, they identified four key dimension of supply chain practices as strategic supplier partnership, Information sharing , customer relationship and training practices in which these factors were used to investigate the level of influence on the performance of the industries. The findings revealed that there is a high level of practical implementation of supply chain practices in Haco industries and

these factors have a positive influence on the performance of the organisation in terms of reducing the lead time lowering the operational cost ,expanding its market share and sales.

According to Afande, Ratemo, and Nyaribo, (2015) reviewed the various factors that determine the supply chain management practices that organisations adopt. They identified six factors which include the size of organisation, capital, the organisation structure, government policy; its position in the supply chain, the industry firms operates in.

The study conducted in textile and apparel industry in Kenya investigating the supply chain practices adopted in the industry on lead time, they identified four supply chain practices as modularity based manufacturing, supply chain integration, supplier chain relationship management and supply chain responsiveness. From their findings it revealed that modularity based manufacturing, supply chain relationship management and supply chain responsiveness ha]s an adverse effect on the lead time while supply chain integration has a positive effect on lead time (Omai, Ngugu & Kiare, 2018).

In view of the researches done in supply chain management practices, this study sets out to use a multi-criteria decision making method named Analytic Network Process to prioritize the supply chain management practices of manufacturing firms in Nigeria and provide alternative strategies for the practices to improve their performance and also enhances customer satisfaction.

2.4. Analytic Network Process

Analytical network process (ANP) is one of the multi-criteria decision making methods used to measure intangible factors which allow for complex interrelationships among decision levels and attributes (Yüksel & Dağdeviren, 2007). ANP is a simplification of the Analytic Hierarchy Process that deals with decision problems that cannot be structured hierarchically because of the dependency and interaction between higher and lower level elements (Saaty, & Özdemir, 2005).

ANP is a comprehensive decision-making method that elucidates the interdependencies; reflects the dependencies as quantitative outcome; and simultaneously provides feedback within and between the clusters of elements (Ravi, Shankar & Tiwari, 2005). ANP is an essential model used to analyse a decision problem through the use of a control hierarchy or network. This network is structured into clusters, elements. For each control criterion, the clusters of the system with their elements are determined. All interactions and feedbacks within the clusters are called inner dependencies whereas interactions and feedbacks between the clusters are called outer dependencies (Saaty, 1999). Inner and outer dependencies are the best way decision-makers can capture and represent the concepts of influencing or being influenced, between clusters and between elements with respect to a specific element. Then pairwise comparisons are made systematically including all the combinations of element/cluster relationships. ANP uses the same fundamental comparison scale (1-9) as the AHP. This comparison scale enables the decision-maker to incorporate experience and knowledge intuitively (Harker & Vargas, 1990) and indicate how many times an element dominates another with respect to the criterion.

3. METHODOLOGY

Research Design

This study is a cross sectional descriptive survey design. The population of the study is the manufacturing firms quoted in the Nigerian stock exchange. There are 12 sectors in which the firms were classified in the Nigerian Stock Exchange. One hundred and seventy eight companies were listed across the various sectors. Stratified random sampling technique was used to select the number of manufacturing considered in this study. Kothari, (2004) stated that since the population of the various manufacturing firms is not of the same group. This type of sampling technique is used to obtain a sample representative while according to Mugenda and Mugenda, (2003) stated that where the population of the study are heterogeneous, a minimum target of 10% is required to represent the sample size of such population. Copies of questionnaire were distributed to the managers of the selected manufacturing firms. The data collected were analysed using the Super decision 3.0 version software.

ANP Methodology

According to Saaty, (2001) the ANP is a connection of two parts, in which the first aspect comprises of a control hierarchy or network of criteria and sub criteria that control the feedback networks while the second aspect consist of the networks of influence that contains the factor s of the problem by grouping them into clusters. Each criterion has a feedback network. A super matrix table was constructed showing the priorities of the factors for each of the network.

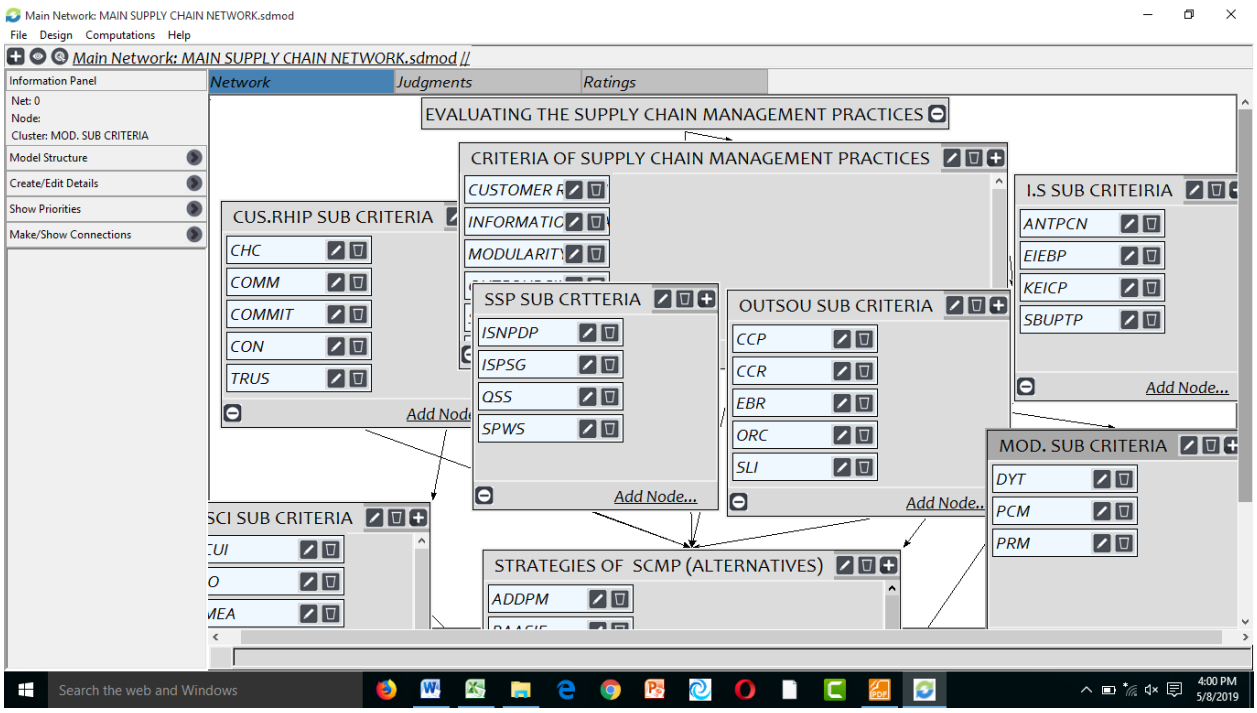
The analytic network process has the following procedure:

i. Model construction: Determine the network of each control criterion. Determine all the criteria which affect decision. Determine the clusters for each network, one cluster is the alternative and combine all relevant criteria into same cluster.
ii. Formulating the interdependencies and performing pairwise comparison between the cluster/elements
iii. Constructing the super matrix: this super matrix is categorized into two: the unweighted and weighted. The unweighted super matrix is derived from the local priority vectors of pairwise comparison matrix obtained from the elements in the super matrix, and then weighted the blocks of the super matrix by the corresponding priorities derived from the clusters to translate it into a column stochastic matrix (weighted super matrix).
iv. Select the best alternative: The final phase is to multiply the weighed super matrix by Itself until the row values coverage to the same values for each column of the matrix, and then yielded the limiting super matrix provided the priorities ranking for the cluster of alternatives.

Therefore, alternatives with the highest value should be chosen.

The Structure of the ANP Proposed Model

The aim of ANP model is to choose an appropriate supply chain management practices of the manufacturing firms selected in which the main goal is evaluating supply chain management practices criteria. It consist of six factors classified under criteria cluster, while 27 sub- criteria and six(6) alternatives strategies of supply chain management practices. The diagram is shown below.



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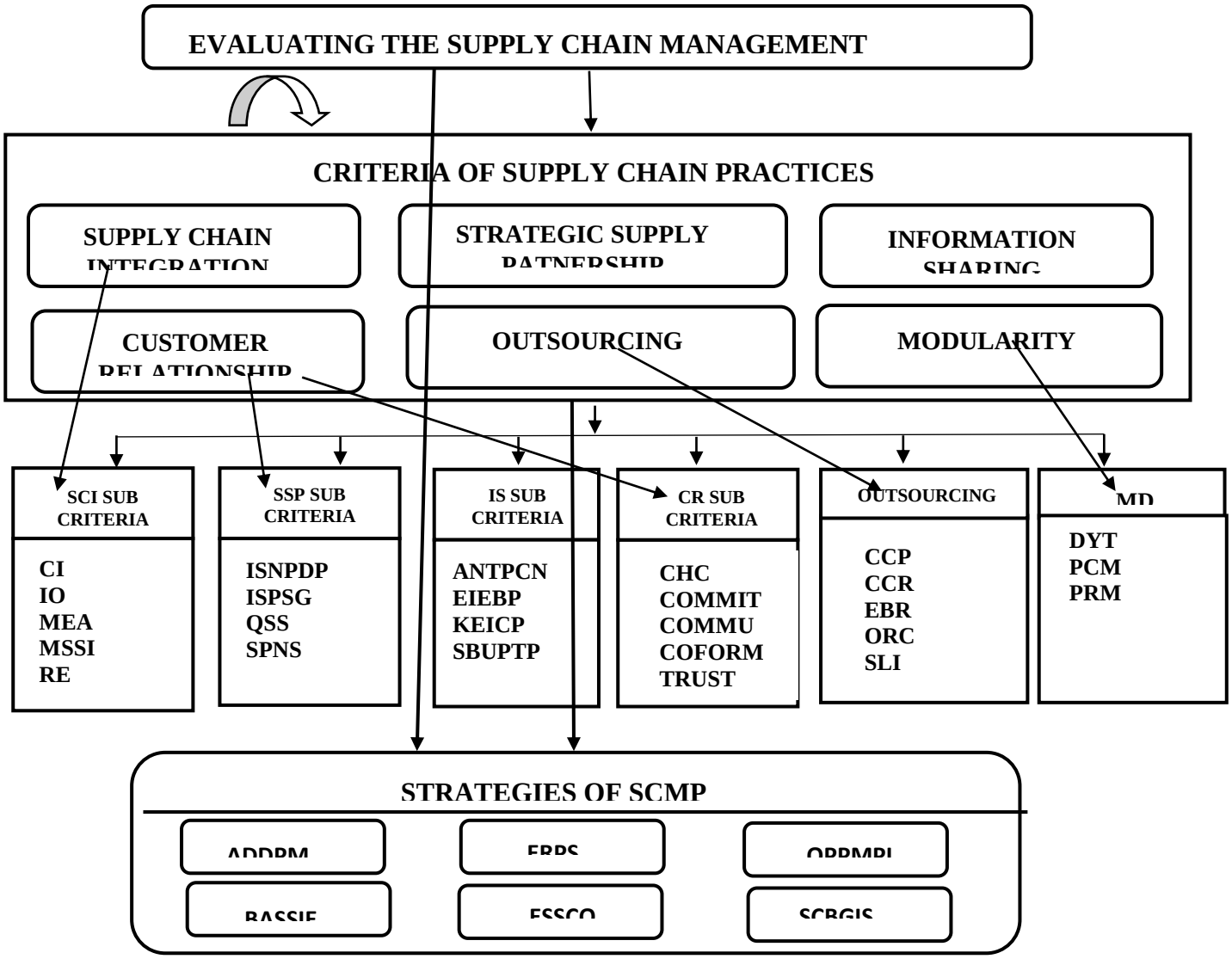

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Table 1: Supply Chain Management Practices

SUPPLY CHAIN INTEGRATION CRITERIA(SCI)	
CUI- customer integration	IO- Internal Operations
M.S.S.I- Material/ Service Supplier Integration	RE- Relationship integration
MEA- measurement integration	TECH- Technology
STRATEGIC SUPPLY PARTNERSHIP CRITERIA (SSP)	
QSS- Quality of Selecting Suppliers	SPWS- Solving Problems with supplier
ISNPDP- Involvement of key supplier in the new development process	ISPSG- Inclusion of supplier in planning and setting
INFORMATION SHARING CRITERIA (IS)	
ANTPCN- advance notice to trade partners on changing needs	KEICP- Keeping each other informed about the changes that affect partners
EIEBP- Exchanging information on establishing of business plan	SBUPTP- Sharing of Business unit proprietary information with trade policy
CUSTOMER RELATIONSHIP CRITERIA (CUS. RHIP)	
COMM- Communication	CON- Conformity
TRUS- Trust	COMMIT- Commitment
CHC- Customer handling Complain	
OUTSOURCING CRITERIA (OUT)	
ORC- Operations reduction cost	SLI- Service level improvement
CCP- Core competence prioritization	EBR-Employee based reduction
CCR- Capital cost reduction	
MODULARITY CRITERIA (MOD)	
PRM – Product modularity	PCM- process modularity
DYT- Dynamic teaming	
STRATEGIES OF SCMP	
ADDPM - Adopt a demand driven planning and business model	SCBGIS - Aligning supply chain with business goals by integrating sales and operations planning with corporate business planning
BAASIE - Build an adaptive and agile supply chain with planning and integrated execution	ESSCO - Embedded sustainability into supply chain operations
OPPM - Optimize product design and management for supply, manufacturing and sustainability to accelerate profitable innovation.	ERPS - Ensuring a reliable and predictable supply

4. RESULTS

This study explored the use of super decision software to analyse the data derived from the selected manufacturing firms. The geometric mean of the data obtained from the questionnaire distributed into the software to obtain a stable limiting super matrix, weighted matrix and unweighted matrix.

Table 4.1 shows the pairwise comparison of the six main criteria with respect to the main goal in evaluating the supply chain management practices of manufacturing firms. Strategic supply partnership (SSP) was given the greatest priority among the six criteria while the modularity criteria was given the least priority. The inconsistency is 0.04 which is less than 0.1 as stated by Saaty.

Table 4.1: Comparison Matrix of criteria with respect to the goal: supply chain management practices

GOAL	CUS RE	INFO SH	MOD	OUT	SCI	SSP	Normalised	idealized
CUS RE	1.0000	0.5167	1.7188	1.8384	0.8586	0.7505	0.1542	0.5836
INFO SH	1.9354	1.000	1.7188	2.5759	1.4507	0.4911	0.2119	0.8022
MOD	0.5818	0.5818	1.000	0.5164	0.3165	0.5188	0.0879	0.3326
OUT	0.5440	0.3882	1.9365	1.000	0.9029	0.3505	0.1110	0.4203
SCI	1.1647	0.6893	3.1596	1.1075	1.000	0.6466	0.1708	0.6466
SSP	1.3324	2.0362	1.9275	2.8531	1.5466	1.0000	0.2642	1.0000

Inconsistency = 0.0402			

The table 4.2 displayed the comparison of the sub criteria of customer relationship factor. The criteria named trust was given highest preferences with priority 0.2438 compared with other criteria in the table followed by communication, commitment and conformity has the same level of preference and customer handling complain was given the least.

Table 4.2: Pairwise comparison of customer relationship sub criteria with respect to customer relationship

CUSTOMER RELATION SHIP	CHC	COMMIT	COMMU	CONFORM	TRUS	Normalized	Idealized
CHC	1.0000	1.3797	0.6776	0.6118	0.8900	0.1765	0.7240
COMMIT	0.7248	1.0000	1.2458	1.1441	0.7137	0.1870	0.7670
COMMU	1.4758	0.8027	1.0000	1.3797	0.7137	0.2045	0.8388
CONFORM	1.6345	0.8740	0.7248	1.0000	0.7248	0.1882	0.7719
TRUS	1.1236	1.4011	1.4011	1.3797	1.0000	0.2438	1
Inconsistency = 0.02865							

The able 4.3 presented the evaluation of the sub criteria for information sharing factor, it was stated that sharing the proprietary information with trade policy among business units has the greatest priority of 0.3664 while keeping each other informed about changes that affect others has the least priority of 0.0941 which indicate that among the information sharing criteria sharing proprietary information of trade policy is approximately four times preferred to keeping each informed about changes that affect the partners.

Table 4.3: Comparison Matrix of information sharing sub criteria

INFORMATION SHARING	ANTPCN	EIEBP	KEICP	SBUPTP	Normalized	Idealized
ANTPCN	1.0000	0.5253	5.1563	0.5818	0.2585	0.7057
EIEBP	1.9037	1.0000	1.7187	0.7247	0.2810	0.7671
KEICP	0.1939	0.5818	1.0000	0.2567	0.0941	0.2567
SBUPTP	1.7188	1.3799	3.8951	1.0000	0.3664	1
Inconsistency	0.1016					

The table 4.4 shows the comparison of the factors used in measuring modularity, it is seen in the table that product modularity was given the highest priority with 0.4494 compared with Dynamic teaming factor with priority of approximately 0.1187 which is approximately four times preferable than others with consistency ratio 0.007 less than 0.10 percent as prescribed by Saaty.

Table 4.4: comparison matrix of modularity sub criteria

MODULARITY	DYT	PCM	PRM	Normalized	Idealized
DYT	1	3.3226	1.0515	0.431827	0.9609
PCM	0.300969	1	0.2415	0.118767	0.2643
PRM	0.951022	4.140787	1	0.449406	1
Inconsistency	0.00781				

The table 4.5 illustrated the comparison of outsourcing sub criteria, the factor that has the greatest priority was prioritization of core competency with 0.3138 followed by employee based reduction with 0.2311 and operations reduction cost was considered to be given the least priority of 0.1157indicating that core competency prioritization is four times desirable than operations reduction cost factor.

Table 4.5: Comparison matrix of Outsourcing criteria

OUTSOURCING	CCP	CCR	EBR	ORC	SLI	Normalized	Idealized
CCP	1.0000	0.8027	2.7131	3.3227	1.7188	0.3138	1
CCR	1.2458	1.0000	0.4911	2.6673	1	0.2108	0.6718
EBR	0.3686	2.0362	1.0000	1.2457	2.6673	0.2311	0.7363
ORC	0.3010	0.3749	0.8028	1.0000	1.2267	0.1157	0.3687
SLI	0.5818	1	0.3749	0.8152	1	0.1286	0.4098
Inconsistency	0.1041						

The table 4.6 showed the comparison of the various factors of supply chain integration. The relationship integration has the highest preference with priority of 0.2783, followed customer integration with 0.1967, while internal operations integration has the least preference of priority 0.0805.

Table 4.6: Comparison matrix of supply chain integration criteria

SUPPLY CHAIN INTEGRATION	CI	IO	MEA	MSSI	RE	TECH	Normalized	Idealized
CI	1.0000	2.8529	2.1084	1.1076	0.7892	1.1076	0.1967	0.7067
IO	0.3505	1.0000	0.3807	0.4597	0.6444	0.3942	0.0805	0.2894
MEA	0.4743	2.6267	1.0000	0.6128	0.3749	0.5253	0.1114	0.4002
MSSI	0.9029	2.1753	1.6319	1.0000	0.2294	0.8027	0.1406	0.5052
RE	1.2671	1.5518	2.6674	4.3592	1.000	1.0696	0.2784	1
TECH	0.9029	2.5368	1.9037	1.2458	0.9349	1.0000	0.1923	0.6908
Inconsistency	0.0565							

The table 4.7 displayed the comparison of sub criteria of strategic supply partnership. From the table, it is observed that solving problems with suppliers (SPWS) has the greatest preference compared with other factors and the given priority was 0.2905while the least given preference was quality of selecting suppliers with priority 0.2076.

Table 4.7: Comparison matrix of strategic supply partnership criteria

Strategic Supply Partnership	ISNPDP	ISPSG	QSS	SPWS	Normalized	Idealized
ISNPDP	1.0000	0.6776	2.4085	0.8027	0.2727	0.9388
SPSG	1.4758	1.0000	0.6444	0.7247	0.2292	0.7890
QSS	0.4152	1.551831	1.0000	0.7148	0.2076	0.7148
SPWS	1.2458	1.379881	1.399	1.0000	0.2905	1
Inconsistency	0.0967					

The table 4.8 showed the inner dependency among the supply chain management practices factors with respect to each other using a pairwise comparison

1. Inner dependency of criteria with respect to Customer Relationship						
CUS	IS	MOD	OUT	SSP	SCI	Weight
IS	1.0000	7.9050	0.5301	1.3371	0.5276	0.1922
MOD	0.1265	1.0000	0.3330	0.2000	0.1100	0.0419
OUT	1.8866	3.0030	1.0000	3.0000	1.0000	0.2803
SSP	0.7479	5.0000	0.3333	1.0000	0.2183	0.1213

SCI	1.8952	9.0909	1.0000	4.5812	1.0000	0.3643
Inconsistency	0.0760					
2. Inner dependency of criteria with respect to information sharing						
IS	CUS	MOD	OUT	SSP	SCI	Weight
CUS	1.000	5.000	7.000	1.000	3.000	0.3879
MOD	0.200	1.000	3.000	0.954	0.954	0.1392
OUT	0.143	0.333	1.000	0.200	0.143	0.0409
SSP	1.000	1.048	5.000	1.000	3.559	0.2860
SCI	0.333	1.049	7.003	0.281	1.000	0.1460
Inconsistency	0.0889					
3. Inner dependency of criteria with respect to modularity						
MOD	CUS	IS	OUT	SSP	SCI	weight
CUS	1.0000	1.0000	0.3333	0.3355	0.2604	0.0888
IS	1.0000	1.0000	2.0229	0.6354	0.2954	0.1509
OUT	3.0000	0.4943	1.0000	0.4472	0.3864	0.1400
SSP	2.9802	1.5738	2.2363	1.0000	0.7837	0.2580
SCI	3.8407	3.3852	2.5878	1.2760	1.0000	0.3623
Inconsistency	0.0582					
4. Inner dependency of criteria with respect to outsourcing						
OUTSOURCING	CUS	IS	MOD	SSP	SCI	weight
CUS	1.0000	0.5252	0.7816	0.1110	0.1111	0.0582
IS	1.9039	1.0000	3.0000	1.0000	1.0000	0.2276
MOD	1.2794	0.3333	1.0000	0.2000	0.3330	0.0744
SSP	9.0090	1.0000	5.0000	1.0000	1.0835	0.3389
SCI	9.0009	1.0000	3.0030	0.9229	1.0000	0.3009
Inconsistency	0.0620					
5. Inner dependency of criteria with respect to strategic supply partnership						
Strategic supply partnership	CUS	IS	MOD	OUT	SCI	Weight
CUS	1.0000	1.0000	7.0000	7.0028	1.0000	0.3028
IS	1.0000	1.0000	5.0000	3.0000	0.2000	0.1796

MOD	0.1429	0.2000	1.0000	1.0000	0.1111	0.0427
OUT	0.1428	0.3333	1.0000	1.0000	0.2797	0.0603
SCI	1.0000	5.0000	9.0000	3.5750	1.0000	0.4146
Inconsistency	0.0767					
6. Inner dependency of criteria with respect to supply chain integration						
Supply chain Integration	CUS	IS	MOD	OUT	SSP	weight
CUS	1.0000	3.0000	5.0000	1.0000	1.0000	0.2601
IS	0.3333	1.0000	4.0028	0.7427	0.1428	0.1013
MOD	0.2000	0.2498	1.0000	0.4453	0.1428	0.0468
OUT	1.0000	1.3464	2.2457	1.0000	0.2003	0.1364
SSP	1.0000	7.0028	7.0028	4.9919	1.0000	0.4554
Inconsistency	0.0768					

So the priority weight of the inner dependency for the criteria of supply chain practices is shown in the table 9.

Table 9: Inner dependency matrix of the supply chain management practices (factors)

CRITERIA	CUS	IS	MOD	OUT	SSP	SCI
Customer relationship	0.0000	0.3897	0.0888	0.0582	0.3028	0.2601
Information sharing	0.1922	0.0000	0.1509	0.2276	0.1796	0.1013
Modularity	0.0419	0.1392	0.0000	0.0744	0.0427	0.0468
Outsourcing	0.2803	0.0409	0.1400	0.0000	0.0603	0.1364
Strategic supply partnership	0.1213	0.2860	0.2580	0.3389	0.0000	0.4554
Supply chain integration	0.3643	0.1460	0.3623	0.3009	0.4146	0.0000

The supply chain management practices (factors) priorities is being computed considering the inner dependency of each of the criterion as shown in table 10 below. After the computation of the inner dependency of each of the criterion of supply chain management practices with the initial priority vector derived, it can be seen that the priority vector of the each of the criterion has changed. For instance, the Customer relationship priority vector has changed from 0.1542 to 0.2211, information sharing priority vector reduced from 0.2119 to 0.1330, modularity changes from 0.0879 to 0.0630, outsourcing criteria changed from 0.1110 to 0.1033; strategic supply chain partnership changed from 0.2642 to 0.2174 and supply chain integration increased from 0.1708 to 0.2603. Comparing these priority vectors it is seen that supply chain integration has the greatest preference with 0.2603 while the modularity factor has the least preference with the priority weight of 0.0630.

Table 10: Interdependency matrix of the criteria of Supply chain management practices

	CUS	IS	MOD	OUT	SSP	SCI		Priority vector	New priority vector
CUS	0.0000	0.3897	0.0888	0.0582	0.3028	0.2601		0.1542	0.2211
IS	0.1922	0.0000	0.1509	0.2276	0.1796	0.1013		0.2119	0.1330
MOD	0.0419	0.1392	0.0000	0.0744	0.0427	0.0468		0.0879	0.0630
OUT	0.2803	0.0409	0.1400	0.0000	0.0603	0.1364	*	0.1110	0.1033
SSP	0.1213	0.2860	0.2580	0.3389	0.0000	0.4554		0.2642	0.2174
SCI	0.3643	0.1460	0.3623	0.3009	0.4146	0.0000		0.1708	0.2603

The table 11 shows the synthesis priorities of the alternatives strategies for supply chain management practices of manufacturing firms. It is shown in the table that adopting a demand driven planning and business operating based model on real time demand insight and shaping (ADDPM) has the greatest preferences with priority of 0.2479 followed by optimizing the product design and management for supply, manufacturing and sustainability to accelerate profitable innovation (OPPMPI) for various companies with priority of 0.2055, followed by building an adaptive and agile supply chain with rapid planning and integrated execution with priority of 0.1706, followed by ensuring a reliable and predictable supply with priority 0.1640 , embedded sustainability into the operation of supply chain operation of priority 0.1224 followed by and the least preference was given to aligning the supply chain with business goals and integrating sales and operations planning with corporate business planning(SCBGIS) with priority 0.0897. Based on the analysis, it is advisable to all the manufacturing firms to make use of the suggested best alternative strategy of supply chain management practices in order to improve their organisation performance and as well enhances the customer satisfaction.

Table 11: Overall Synthesized Priorities for the Supply Chain Management Practices Alternatives Strategies

SCMP (alternatives)	Ideals	Normalised	Raw
ADDPM**	1.0000	0.2479	0.0503
BAASIE	0.6879	0.1706	0.0346
ERPS	0.6614	0.1640	0.0333
ESSCO	0.4935	0.1224	0.0248
OPPMPI	0.8287	0.2055	0.0417
SCBGIS	0.3617	0.0897	0.0182

5. CONCLUSION AND RECOMMENDATIONS

The managers of the manufacturing firms has been able to prioritize the criteria of the supply chain management practices in order of importance for stakeholders of manufacturing firms to abide by in order to improve their performance effectively and efficiently to better enhance the satisfaction of their customers. The result of multi criteria decision making method used in this study ANP showed the inner dependency among the criteria and priority vector were derived. It is shown that among six criteria of supply management practices identified, the supply chain integration criteria has the greatest preference indicating that managers of the various companies have a social relationship that guides their interaction in order to have an effective overall of system approach in their supply chain management followed by customer relationship criteria specifying that having a good relationship and putting trust in your customers can enhances their performance, the third criteria of supply chain management practices that was given preference to was strategic supply partnership demonstrating to managers that solving the problems of their suppliers at the

right time is very vital followed information sharing criteria indicating that managers are of the opinion that it essential to share proprietary information of business unit with trade policy followed by outsourcing criteria which showed that managers believed that prioritization of the core competence of their suppliers needs to considered. The sixth criteria that has the least preference was Modularity criteria which showed that managers believed that designing a product based on well interface may fosters the organizations of complex process design operation more efficiently by decomposing the complex system to simpler subsystem. The ranking of the alternatives strategies of supply chain management practices it is shown that adopting a demand driven planning and business operating based model on real time demand insight and shaping (ADDPM) has the greatest preferences with priority of 0.2479 followed by optimizing the product design and management for supply, manufacturing and sustainability to accelerate profitable innovation (OPPMPI) for various companies with priority of 0.2055, followed by building an adaptive and agile supply chain with rapid planning and integrated execution with priority of 0.1706, followed by ensuring a reliable and predictable supply with priority 0.1640 , embedded sustainability into the operation of supply chain operation of priority 0.1224 followed by and the least preference was given to aligning the supply chain with business goals and integrating sales and operations planning with corporate business planning(SCBGIS) with priority 0.0897. Based on the analysis, it is advisable to all the manufacturing firms to make use of the suggested best alternative strategy of supply chain management practices in order to improve their organisation performance and as well enhances the customer satisfaction.

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