

دراسة تشخيصية لسلسلة التوريد لصناعة السجاد:دراسة حالة لشركة سجاد رائدة

دراسة تشخيصية لسلسلة التوريد لصناعة السجاد:

دراسة حالة لشركة سجاد رائدة عالميا

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A Supply Chain Diagnostic Study for Carpet Industry: A Case Study of a Leading Carpet Company

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ملخص البحث

تتطلب بيئة الأعمال التنافسية اليوم ممارسات إدارة سلسلة التوريد (SC) بين شركاء سلسلة التوريد (SC) لضمان القدرة التنافسية وتحسين الأداء التنظيمي وذلك من خلال التنسيق بين الشركاء لتقليل الفاقد في الوقت وخفض التكاليف وتحسين الإنتاجية وزيادة الربحية. يهدف هذا البحث إلى دراسة تشخيصية لسلسلة توريد صناعة السجاد من خلال تقييم مستوى التنسيق والتكامل بين مختلف شركاء سلسلة التوريد ووظائف سلسلة التوريد الداخلية. وتعتمد منهجية البحث على عدة إجراءات. أولاً، تم إجراء مرحلة تمهيدية لتحليل هيكل SC الحالي من حيث تحليل الموردين، وتحليل SC الداخلية، وتحليل العملاء، ووظائف SC، وتحليل ABC. بعد ذلك، تم تصميم استطلاع لتقييم مستوى التنسيق والتكامل بين مختلف شركاء سلسلة الامداد ووظائف سلسلة الامداد الداخلية، مع توضيح نقاط الضعف ومجالات التحسين. تم إجراء دراسة حالة لإحدى الشركات العالمية الرائدة في مجال تصنيع السجاد لإثبات إمكانية تطبيق الإجراءات المقترحة. بالنسبة لأهم النتائج، لقد وجد أنه يجب إجراء تحليل ABC بناءً على الكميات المشتراة، حيث يوصى بأن تكون غالبية العناصر من الفئة C بالإضافة إلى ذلك، يجب إجراء تحليل ABC بناءً على الاستهلاك السنوي للعناصر. سيحدد هذا العناصر سريعة الحركة F والعناصر متوسطة الحركة M والعناصر النادرة الحركة R. النتائج الأخرى هي أن مؤشرات الأداء الرئيسية الحالية تقيس تقييم الموظفين بدلاً من أهداف الشركة، وهناك نقص في التنسيق والتكامل في سلاسل التوريد الداخلية. أيضاً هناك حاجة إلى دورات تدريبية متخصصة لموظفي شركة السجاد حتى يتمكنوا من إجراء جميع التحسينات المطلوبة.

الكلمات المفتاحية/الرئيسية

صناعة السجاد، قطاع التصنيع، ممارسات إدارة سلسلة التوريد، التعاون في سلسلة التوريد

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Abstract

Today's competitive business environment requires collaborative supply chain management (SCM) practices between supply chain (SC) partners to ensure competitiveness and better organizational performance. This research aims at providing procedures to conduct a diagnostic study of carpet supply chain through assessing the level of coordination and integration among different SC partners and the internal SC functions. As a methodology, first, an introductory phase was conducted to analyse the current SC structure in terms of suppliers' analysis, internal SC analysis, customer analysis, SC functions and ABC analysis. Then, a survey was designed to assess the level of coordination and integration among different SC partners and the internal SC functions, while illustrating the weaknesses and areas of improvements. A case study of a world leading carpet manufacturer was conducted to demonstrate the applicability of the proposed procedures. It is found that the ABC analysis should be performed based on purchased quantities, where the majority of the items are recommended to be class C. In addition, the ABC analysis should take place based on items' annual consumption. This will define the fast moving items (F), Medium moving items (M) and Rare moving items (R). Other findings are

that the current KPIs measure the employees' appraisal rather than the company's goals, and there is a lack of coordination and integration in the internal SC. Tailored training courses are needed for the carpet company staff to be able to carry out all needed improvements.

Keywords

Carpet industry, manufacturing sector, supply chain management practices, supply chain collaboration

1. Introduction:

In recent years, business started to face dramatic changes in the global market which requires adaption and implementation of new strategies to cope with the severe competition and challenges (Tidd and Bessant, 2018). Competition has led companies to create close relationships with their upstream and downstream partners. Collaboration between SC partners aims to improve overall SC performance. The adaptation of SC concept facilitates the integration process within an organization and among different organizations throughout the SC (El Shoghari and Abdallah, 2016).

In addition, supply chain management (SCM) enables improvement of performance and efficiency of the business processes through focusing on enhancing the integrated relationship among different partners in the SC (supplier, product or service provider, and customer), while capturing different functional activities in an efficient way of integration (Najjar, 2010). Supply chain management practices (SCMPs) help also in competing and sustaining in the current competitive business environment through identifying processes that are working well and processes that need improvement and thus improving the overall organizational performance (Khalil et al., 2019).

Moreover, designing the relevant supply chain performance measurement system (SCPMS) linked to SC structure in terms of customers, supplier and competitors is essential to provide clear understanding of collaborative relationships (Tyagi et al., 2017). SCPMS allows benchmarking to identify best practices and SC performance improvement opportunities, in order to make plans for improving the performance, implementing them and finally, monitoring and evaluating the results (Elgazzar et al., 2019).

The adaption of SCM, SCMPs and SCPMS proved to have a positive impact on the organizational performance and competitiveness (Abdallah et al., 2014). The effectiveness of the SCPMS in terms of performance improvement depends on the implemented SCM context that captures SCMPs from different dimensions (practices, patterns and attitudes) (Gimenez et al., 2012).

In carpet industry, the supply chain is long and complicated; hence the implementation of sustainable practices along the entire chain is challenging. The world class supply chain practices show the technical cycle for the carpets as shown in Figure 1, which includes the following phases:

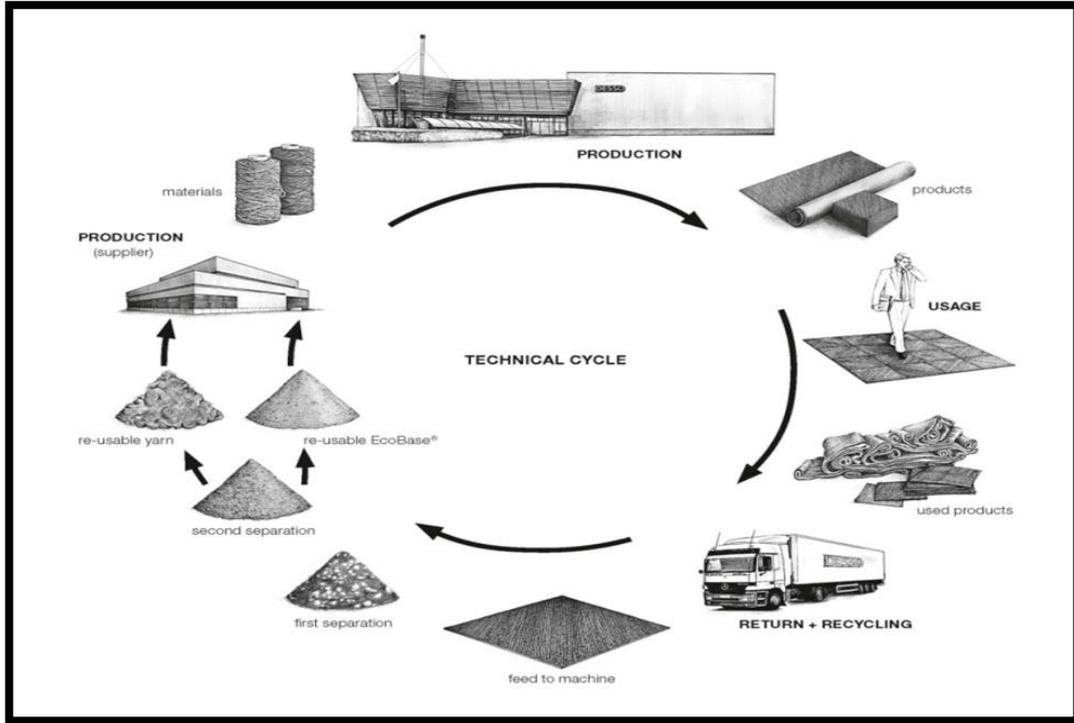


Figure 1- Weaving Supply Chain

- **Raw Materials:** carpet consists of dyed pile yarns. Ninety-seven percent of pile yarns today are made up of synthetic polymers; the rest of the yarns are wool and comprise the more expensive, woven carpet. Synthetics are plastics such as nylon (which is in 66% of all carpet), acrylics (15%), polyester (less than 15%), and polypropylene (less than 5%). These pile yarns are dyed using a variety of organic chemical compounds, or occasionally, organometallic complexes.
- **The Manufacturing Process:** the synthetic yarns arrive at the carpet manufacturer either in staple fiber form or bulk. The staple fibers, which average 7 inches (18 cm) long, are loose, individual strands that arrive in bales. Several bales are blended together into one batch in a hopper. Then, after lubrication, they are spun into long, loose ropes called slivers by a carding machine. Most carpets are dyed after tufting, yet sometimes the yarns are dyed first. The yarn can also be put on forms, and the heated dyes can then be forced under pressure from inside the forms to color the yarn.
- **Tufting the carpet:** to make printed carpet of various designs, white carpet passes under screens in which holes in the desired pattern have been cut. The desired color is squeezeed through the holes in the screen, and the carpet is advanced 36 inches (91 cm) to a different screen that applies a new color in a different design through the screen. Up to eight colors can be applied with this method.

- Finishing the carpet: The ends of the dyed carpet are first sewn together to form a continuous belt. This belt is then rolled under a dispenser that spreads a coating of latex onto the bottom of the carpet. At the same time, a strong secondary backing is also coated with latex. Both of these are then rolled onto a marriage roller, which forms them into a sandwich and seals them together. The carpet is then placed in an oven to cure the latex.
- Quality Control: every piece of carpet that is tufted is inspected to see if any tufts are missing. One person with a single needle tufting gun shoots pile yarn wherever holes are found. Each piece of carpet is then inspected. The manufacturer checks that the piece is of the proper dimensions and that the tuft height is of the desired length. The static shock potential is also tested. Backing fabrics and carpet padding are tested for strength by being pulled in a vise until they break. The primary backing's strength is checked both before and after tufting.

Based on the carpet SC, this research aims at providing procedures to conduct a diagnostic study of carpet supply chain through assessing the level of coordination and integration among different supply chain partners and the internal supply chain functions. A case study of a world leading carpet manufacturer is conducted to demonstrate the applicability of the proposed procedures, while illustrating the areas of improvements. There is a need for a procedure for mapping the key portions of the supply chain for strategic purposes.

This paper is organised as follows: The next section presents a literature review of SCM. Section three demonstrates the research objectives and methodology. In section four, the case study of a world leading company is presented. The roadmap for SC improvement is drawn in section five, while the findings and conclusion come in section six.

2. Literature review:

Increasing attention has been given over years to supply chain (SC) as it aims to increase profitability and minimize costs as well as increasing customer satisfaction. In carpet industry, like other industries, improving SC performance has also become important as it helps companies to target profitable market segments, and to identify areas for service improvement. This section aims to discuss the theory of SC concept, and its applications in carpet industry.

In theory, the concept of SC identified in 1985 as a process for building improved and stronger upstream and downstream business linkages, focused forward improving value for the ultimate customer. These linkages can be achieved through integration and collaboration between SC partners and perform logistics activities (Stonebraker and Liao, 2006). The characteristics of a supply chain must include multiple structures, focus on integration, and goals

of service and profitability, and may also involve collaborative processes and value-adding considerations. Within the SC theory, there are three flows that require proper planning in order to enhance the integration levels between partners, including information flow, capital flow and materials/products flow.

Supply Chain Management (SCM) theory aims generally to enable the integration of all the business processes in terms of planning and control of materials, logistics, services and information stream from original supplier to end user, to add value for costumers and improve SC performance. The term SCM has been used to explain the planning and control of materials and information flows as well as the logistics activities not only internally within a company but also externally between companies (Cooper et al., 1997; Fantazy et al., 2010; OU et al., 2010; Galaskiewicz, 2011). SCM framework is grounded on a paradigm of strategic management theory that emphasizes the development of “collaborative advantage”, as opposed to “competitive advantage”. The framework also draws on the “relational view” of interorganizational competitive advantage (Chen & Paulraj, 2004).

The implementation of SCM provides a set of practices to effectively integrate all SC partners: suppliers, manufacturers, wholesalers, distributors and customers for improving the individual organisation performance as well as the entire SC as whole (Chopra, 2001; Li et al, 2006). This requires changing the structure of organization to integrate internal functions and linking them to the external operations of SC partners (Tutuncu and Kucukusta, 2008) through focusing on the entire SCM in terms of: SC functions, SC strategy and SC collaboration (Frederico and de Souza, 2017).

SCM practices are defined as set of practices to manage integration, coordination and relationships within organization and among SC partners in order to satisfy consumers in effective and profitable manners (Ibrahim and Hamid, 2014). Three dimensions of SCM practices lead to improving supply chain performance. These are strategic supplier partnership, strategic customer relationship, and information sharing (Sukati et al., 2011).

Thus, Shapiro (2001) showed that the SCM combines concepts from different disciplines such as strategic management and theory of the formation of the company, logistics, production and inventory management, accounting management, scientific forecasting, marketing and operation management. This full integrated concept of SCM considers as a key driver of organization performance since it enhances the relationship between SC partners from upstream suppliers to downstream customers (Wisner et al., 2005).

Strategic supplier partnership requires supplier long term and close relationship in order to support the integration between organization and its suppliers through sharing risk and reward for more sustainable SC functions (Toni and Nassimbeni, 1999; Thatte, 2007; Gharakhani et al., 2012). The collaboration

with suppliers proved to have a positive impact on process and product innovation which contributes to successful SCM (Radas and Boz'ic, 2009).

Strategic customer relationship refers to planning, implementing, and evaluating a successful relationship between each provider and recipient in the entire SC to ensure the delivery of the right products and services to customers in terms of right time, right place, and appropriate quantity and quality (Lee, et al, 2007). Customer relationship management leads to customer satisfaction as it allows product differentiation from competitors, helps to sustain loyalty, and improves the value provided to customer (Ruben and Lauri, 1999; Thatte, 2007).

Also, information sharing enables accessing information between SC partners thus enabling to monitor processes, which provide better SC visibility for more effective decision making (Simatupang and Sridharan, 2002).

Previous studies confirmed the impact of SCMPs on improving organizations performance (Ijaz, 2014; Mollel, 2015; Gawankar et al., 2017; Kumar and Kushwaha, 2018). The improvement of different dimensions of SCM practices contribute to better SC performance in terms of improving profitability, customer response and ability to deliver value to the customers, as well as improving the interconnection and interdependence among SC partners (Sukati et al., 2011). Efficiency and effectiveness have been used as key dimensions for measuring supply chain performance. Efficiency indicators are based on cost management, while effectiveness is measured based on the level of reliability achieved (Lee et al., 2007).

Different performance measures have been employed to assess SC performance from different perspectives; price/cost, quality, delivery dependability, and time to market, value- to-customer, product innovation (Vokurka et al., 2002; Duclos et al, 2003; Thatte, 2007). The most broadly applicable SC performance measurement framework is the Supply Chain Operations Reference (SCOR) Model with its standardised comprehensive performance metrics for measuring SC performance from five perspectives: reliability, responsiveness, agility, cost, and asset management. The focus of the SCOR on achieving transactional efficiency and effectiveness through engaging partners from the logistics, production and purchasing functions makes its performance metrics appropriate to achieve cross functional business processes integration within the organisation's structure (Elgazzar, 2013).

As illustrated in the literature, SCMPs plays an essential role in improving SC performance. Supply chain management practices, such as strategic supplier partnership, customer relationship, information sharing can be linked to SC functions within the organization and among the entire SC partners for achieving better SC performance.

Regarding the carpet industry as a second part in this section, Petrovic-Lazarevic et al. (2007) discussed how to enhance supply chain and global

competitiveness in the textiles, clothing, footwear and leather (TCF&L) industry of 12 Australian companies, with a conclusion indicated that an increased strategic and global focus by the supply chain needs to be sustained by adequate information flow, appropriate value-adding processes, with suitable leading technology applications and people-valuing and innovation-fostering company environments.

Helms & Hervani (2006) discussed recycling within the carpet industry using the issues of reverse logistics, with the purpose of understanding recycling framework of this industry. Venkateswarlu et al. (2006) investigated the carpet supply chain in India that consists of exporters, contractors, loom owners, weavers (located in India), importers and retailers (located in foreign countries). Biehl et al. (2007) examined the parameters for a carpet reverse logistics network such as carpet replacement and carpet demand, which requires coordination between internal SC functions and external SC partners.

Parmigiani et al. (2011) discussed the linkages between supply chain capabilities, configuration, and performance in carpet industry, with a focus on social and environmental, technical and relational capabilities. An integrated model of capabilities, stakeholder exposure, and performance was produced in order to improve overall SC performance of carpet industry. Azad et al. (2012) proposed eight factors as better strategies to help carpet industry grow faster, including specialized relationships, knowledge coordinator, knowledge tool, knowledge organization, knowledge processes, knowledge chain, knowledge hardware and Knowledge feasibility study.

Despite the importance of supply chain management practices on supply chain performance, it can be summarized that there is a lack on studies that link supply chain management practices and supply chain performance; particularly in developing countries (Ibrahim and Hamid, 2014). Hence, this research focuses on empirically linking SCM practices and supply chain performance in manufacturing companies through conducting a diagnostic study of an Egyptian world leading carpet manufacturer. The diagnostic study will highlight which SCM practices will be linked to each function to achieve better level of SC performance.

3. Research Objectives and Methodology

Globally, the carpet market size was valued at 51.9 billion US dollars in 2018, where the carpet industry has witnessed a radical change in the last few years due to increasing competition between carpet manufacturers. Thus, carpet companies have invested in improving SC performance from providing optimum pricing, timely delivery and high quality products. This requires to engage stakeholders, coordinate between internal SC functions, and collaborate between external SC partners.

Hence, this research has set the following questions:

1. What are the SC characteristics, structure and strategy of the carpet company?
2. What are the main process and sub-processes of the carpet company's SC?
3. What are the corresponding performance measures for the selected carpet company's processes and sub-processes?

In reference to the research questions, this research as addressed the following objectives:

1. To analyse the current SC structure of the carpet company case study.
2. To examine the integration and coordination between the SC partners.
3. To investigate the current KPIs of the carpet company case study.
4. To propose SC roadmap to fill the gap between world class supply chain practices and the practices at the carpet company case study.

The research methodology sets procedures to conduct a diagnostic study of carpet supply chain through tackling a case study on one of the leading carpet companies. The selected company is the largest carpet manufacturer in Egypt and one of the world's largest manufacturers of machine-made carpets. Based in Cairo, this body corporate has manufacturing facilities in three countries and distributes its products in more than 150 countries worldwide. Therefore, the company was selected as it has 31 factories in Egypt, China and USA; more than 30 years' operating in the industry; and it has a sustainable business model from purchasing materials, manufacturing products, and distributing carpets to customers. Also, the company offers a wide variety of popular, award-winning products both in local and export markets; namely woven, tufted, non-woven felt fibres and handmade products. In 2018, the company attained total revenue by 10,405 million EGP by various business segments as follows; 3% for non-woven, 1% for fibres, 17% for tufted, and 79% for woven.

In Egypt, the company has over 80 retail showrooms and more than 40 wholesale stores across the nation, while it has warehouses with total 803,500 m² across 3 continents (USA, China and Egypt). In USA, the company manufactures in the company's plant in Dalton, Georgia, and also markets and distributes products it imports from the company's Egyptian plants. The company sells to mass merchants and big-box retailers as well as to independent retailers, furniture retailers, catalogues and department stores. In China, the company occupies 170,000 m² in the Tianjin industrial zone, 80 kilometers south of Beijing, where the total annual capacity of the plant was 3.3 million m².

In Egypt, there are six locations represent the entire company as follows:

- A carpet company that is based in 10th of Ramadan City, producing three grades (A, B and C) of machine woven carpets and rugs for the Egyptian market, with annual capacity for the company presently reaching 22 million m².

- A company's international facility that is vertically integrated facilities in 10th of Ramadan City encompass the scope of extrusion of synthetic fibers, dyeing and spinning wool as well as the weaving and finishing of products. The majority of the group's diversified products related to home textiles are produced within this facility (carpets, rugs, Axminster, Gobelin, gun-tuft and fibers). The total annual capacity of the plant was 34 million m², and it targets mainly export markets.
- Fiber factory that operates three production plants in 10th of Ramadan City. Since its establishment in 1980, its output has risen sharply to more than 56 million m² of carpeting, up from a capacity of 18 million m² in 2002. In addition, the fiber factory diversified product offerings include, door and kitchen rugs, rubber backed bathroom mats, multilevel textured mats for outdoor applications, car mats, children's rugs and mats, scatter rugs and club rugs. the fiber factory also manufactures three-dimensional advertising floor panels, runners and artificial turf for indoor and outdoor applications.
- Fibers company that is located in 10th of Ramadan facility manufactures polypropylene fibers and polyester yarn. It also manufactures and exports different types of non-woven rugs and carpets and other related polypropylene products. Total annual capacity of the plant was 16 million m².
- A new yarn production facility is that commenced operations in 2012 with an annual capacity of 100 tons daily, increasing control of the supply chain. The new factory produces nylon, which is the primary raw material. With excess capacity, the leading carpet company is not only self-reliant on yarn, but it is also able to export yarn to the US.
- Textiles company is focused on creating the highest quality rugs and carpets with minimal impact on the environment. As a responsible international corporate citizen, the company invests in modern technology and equipment upgrades to optimize output in the production processes.

In the second quarter of 2020, the export revenues dropped due to COVID-19 by 30% reaching 1,146 million EGP, and the local sales value reported a 33% decline to 667 million EGP. However, the leading carpet company has received attention in different new regions such as Saudi Arabia due to entering the market with a competitive pricing strategy; Germany due to growing the online sales representing 50% of sales and shifting a major client from a Turkish supplier to the leading Egyptian carpet company; and Japan due to focusing on product development for the region.

Hence, the company strive to continuous improvement to face ever changing market requirements and challenges, and to manage coordination and collaboration between SC members. In this context, a diagnostic study of the

selected leading company supply Chain has been conducted defining the weaknesses and areas of improvements.

The research procedures are illustrated in three stages as follows:

▪ **Stage 1: An Introductory Phase to Outline the Current SC**

At this stage, the purpose is to analyse the current SC of the selected leading company. Primary data from the case study company has been collected from (i) the company's documentation, (ii) archival records, (iii) in site-direct observation, and (iv) unstructured interviews with top managers to get an overview about the carpet company's SC. By the end of this stage, a detailed analysis of the selected company's SC was drawn in terms of SC structure (Suppliers' analysis, Internal SC analysis, Customer analysis, Current SC functions and Current ABC analysis).

▪ **Stage two: The Selected Company's SC Diagnosis (Survey)**

A survey had been designed to diagnose the company's SC through assessing the level of coordination and integration among different supply chain partners and the internal supply chain functions, while illustrating the weaknesses and areas of improvements.

The survey consisted of 4 main sections:

- a) External SC diagnosis
 - Sourcing strategy
 - Collaboration with suppliers.
 - Information sharing with suppliers.
 - Collaboration with customers.
 - Information sharing with customers.
 - Information sharing quality with trading partners.
- b) Internal SC diagnosis
 - Supply Chain coordination with R & D.
 - Supply Chain coordination with Marketing.
 - Supply Chain coordination with Sales.
- c) Internal SC activities' analysis: SC, procurement, logistics, production, production planning, warehousing, sales, marketing, and R&D.
- d) KPI model at the selected company:
 - First Category covered Cost, Time and Quality.
 - Second category covered Supply chain planning, production, marketing and warehousing.
- e) The Research Sample

Surveys were distributed to employees from different departments, including commercial, customs, engineering, export, planning, procurement, SC, quality, production, transportation, R&D, logistics, and warehousing. The survey took place at both tactical and operational levels. An exploratory approach has followed through with qualitative research process through conducting survey

sample; with a target population of managers, supervisors and employees who represent previous functions.

In fact, there are two types of sampling strategies including probability and non-probability. The primary difference is that probability sampling involves random sampling, whereas non-probability does not involve random sampling. Probability sampling includes random sampling and allows "an equal and independent chance of being selected". This decreases the likelihood of researcher bias. Due to the randomness of the sample, validity and reliability are increased. In contrast, non-probability sampling includes "a variety of sampling techniques for selecting a sample, which is appropriate when random sampling cannot be done because there is no "complete list of the population". It is suggested that non-probability sampling can increase the possibility of researcher bias and unethical behaviors to occur. Thus, this research has used probability sampling, particularly random sampling strategy. The following equation was used in calculating the sample size "Richard Geiger equation":

$$n = \frac{\left(\frac{z}{d}\right)^2 \times (0.50)^2}{1 + \frac{1}{N} \left[\left(\frac{z}{d}\right)^2 \times (0.50)^2 - 1\right]}$$

Where,

N = sample size; N= Population size; Z = confidence level at 95% (standard value of 1.96); E= error proportion = 08%

With total population of 950 employees working for the Egyptian leading carpet manufacture case, the sample size calculated using sample size calculation equation was actually 273 employees with a 95% confidence level. The questionnaire was distributed to 273 respondents in stated functions of the company, out of which 231 usable responses were received with response rate 84.6%.

▪ Stage three: Proposing a Roadmap for the Company's Future SC

Based on the analysis of the current SC and findings of SC diagnosis, a roadmap is proposed for future SC; to propose SC roadmap to fill the gap between world class supply chain practices and the practices at the carpet company case study.

As a methodological approach, a case study of the leading carpet company has selected to research exploration of a phenomenon within SC carpet context using a variety of data sources in different SC functions and activities. A single case study has chosen as it helps to reveal the decision making for the same SC carpet activities across different managerial levels, which is known as a case analysis.

▪ **The Research Limitations**

This research has certain place limitation which is concerned with the sample selection in the carpet company’s premises in Egypt (only 10th of Ramadan City, Cairo, Egypt), with no regards to other company’s premises and SC functions. In addition, the survey is limited to those managers, supervisors and employees in SC functions including commercial, customs, engineering, export, planning, procurement, SC, quality, production, transportation, R&D, logistics, and warehousing. Other functions in the case study have not been considered such as marketing, reverse logistics, customer service, sales and wholesaling.

4. Current Supply Chain of the Carpet Company Case study

4.1. Supply Chain Partners Analysis

The carpet company has what can be considered a large global supply chain, having domestic and international suppliers and customers. The current supply chain can be considered of three tiers as shown in Figure 2, which are suppliers, internal supply chain and customers.

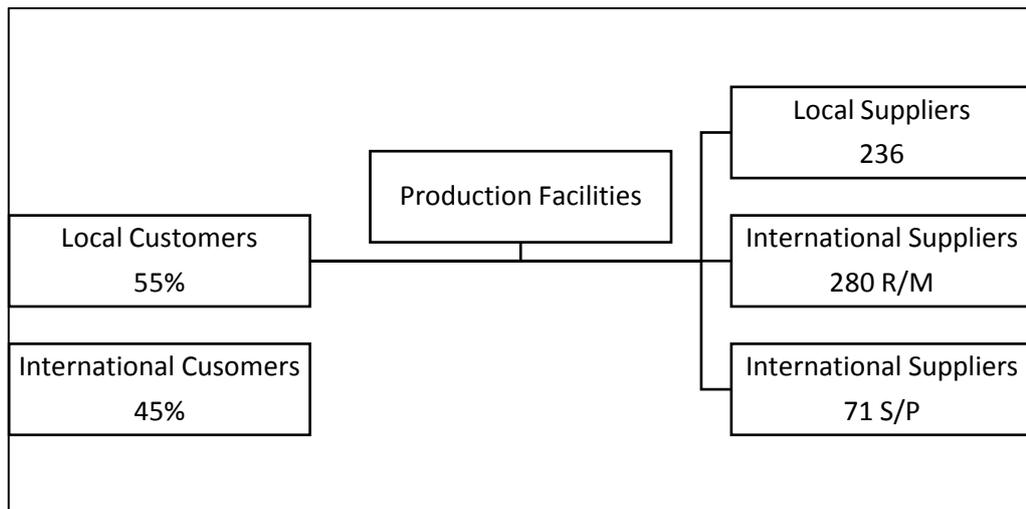


Figure 2- Current Supply Chain Structure of Carpet Company Case Study

Source: developed by the authors

4.1.1. Suppliers’ analysis

The carpet company has a total of 587 suppliers as follows: 236 local suppliers, 280 international suppliers for raw materials (R/M) and 71 international suppliers for spare parts (S/P). Out of the 351 international suppliers, only 57 were active suppliers. The total number of purchased items was 184 items; the number of items purchased from international suppliers was 37 items only.

4.1.2. Internal Supply Chain Analysis

The carpet company's internal supply chain consists of 18 factories for products' manufacturing in addition to one master batch factory, one Yarn factory, one factory for cartoon tubes and one factory for packaging plastics. Six warehouses are available as follows; two at the cartoon tubes and packaging plastics factory, while the other four are serving the carpet, master batch and yarn factories. All those factories and warehouses are at the same facility in the 10th of Ramadan City, Cairo, Egypt.

4.1.3. Customers Analysis

The carpet company has local and export customers, where the local customers represent 55% of the sales. As shown in Figure 2, the local market is covered through retail outlets and authorised distributors. While, the Export market is covered by the direct orders received through international exhibitions. Based on the forecast, the carpet company adopts both Make-to-Stock (MTS) and Make-to-Order (MTO) as stock policies. MTO represents 55% of the exports, while the remaining 45% are fulfilled by MTS. The local market is managed by MTS policy.

4.2 Supply Chain Functions Analysis

Currently, the main SC functions in the selected case study are purchasing and warehousing. In the following sections, an analyses of these functions take place.

- **Purchasing Function**

Purchasing is done through purchasing agents, each agent is purchasing a number of items. The purchasing approval cycle is given in Figure 3.

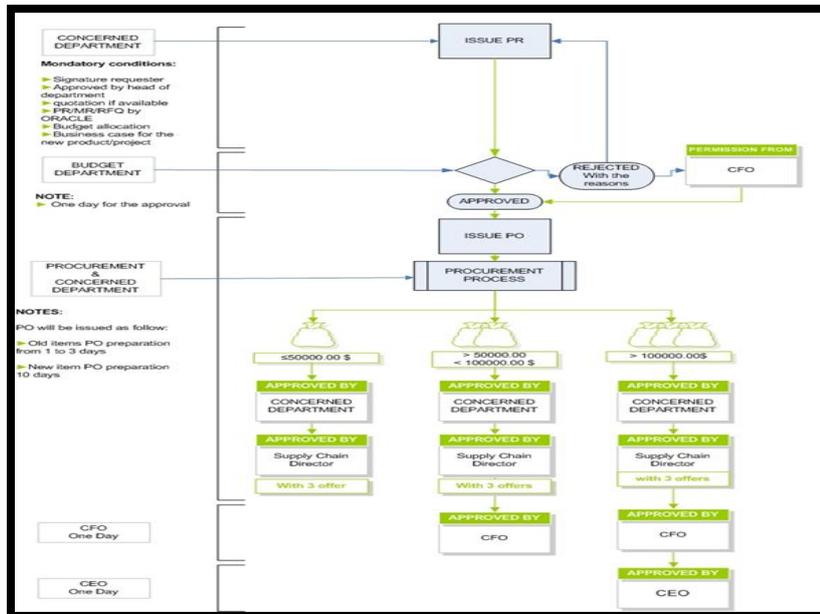


Figure 3 – Purchasing Approval Cycle

دراسة تشخيصية لسلسلة التوريد لصناعة السجاد: دراسة حالة لشركة سجاد رائدة

Source: developed by the authors

In the approval cycle, it is shown that; (1) it is not clear how the purchasing process is initiated; and (2) what are the policies followed to trigger the purchase process. Purchasing process is a reactive purchasing in which three offers must be supplied with the Purchase Order (PO). This imply that there are no long term agreements with the supplier. It is obvious that the approval of the Chief Financial Officer (CFO) and Chief Executive Officer (CEO) is also conditioned with three offer submitted to them with the PO. Analysing the purchasing processes, it is also notable that 18 vendors supply a single item with supply percentage less than 20% of the items as shown in Figure 4.

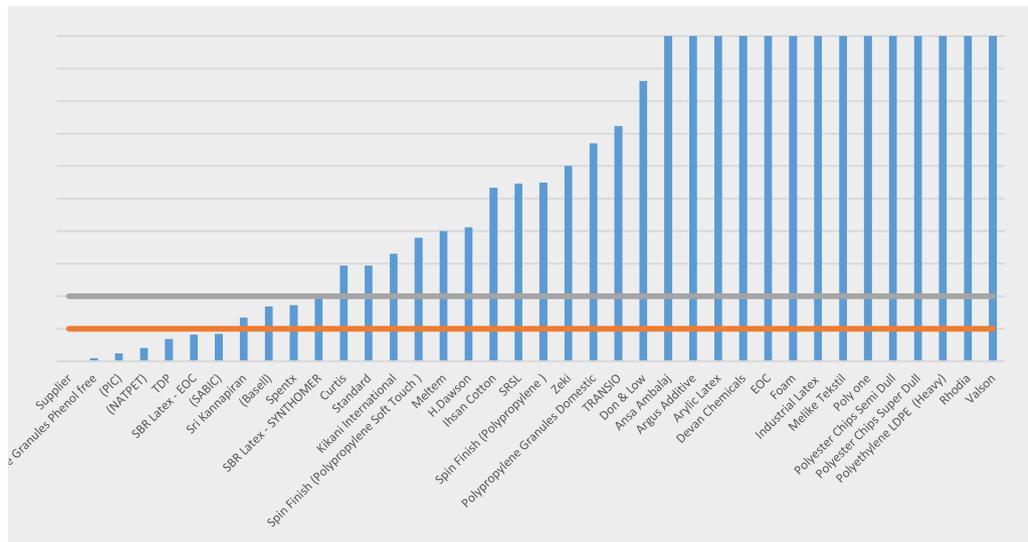


Figure 4. Suppliers for Single Item (Supply %)

Source: developed by the authors

It is clear that from the 19 suppliers supplying more than one item as shown in Figure 5, there are 11 out of them supply less than 15% of the item quantity, and only one vendor supplies more than 75% of an item's quantity.

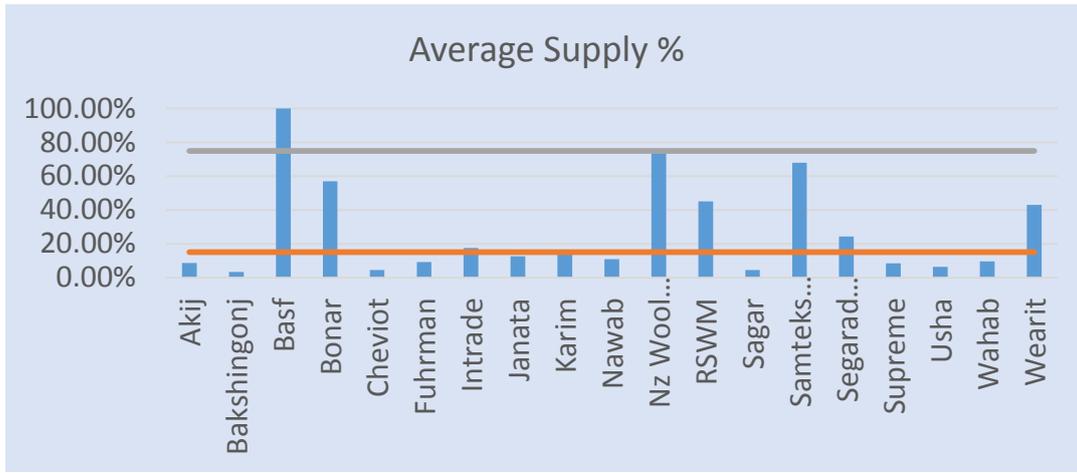


Figure 5: Supply Percentage for Supplying More than One Item
Source: developed by the authors

- **Warehousing Function**

Currently, the carpet company has six warehouses, one for cartoon tubes, one for plastics used for packaging and the other four for raw materials, finished goods and spare parts. This requires to analyse the current ABC applied in warehouses (ABC analysis helps classify products based on how often they are moved and the warehouse storage bins according to how easy they are to reach).

Based on the analysis of SC structure and the relationship with suppliers and customers; ABC analysis was conducted to propose best items classification from both quantities and consumption perspectives. The ABC analysis made to determine the most important items (A class items), average important items (B class items) and least important items (C class items). The current analysis summary is given in Table 1. The analysis shows that A class contains the highest percentage by 66%, the difference between the B and C class is only 2% that is very low, the analysis is made for 184 items, while the purchased items contained only 37 items. In addition, the most quantities purchased are only four items that represent about 78.84% of total purchased quantities.

Table 1. Current ABC Analysis of Purchased Items

Class	No of items in the class	Items %	Quantity %
A	10	5.4%	66%
B	38	20.6%	18%
C	136	74.0%	16%

Source: Developed by the authors.

4.3 Analysis of Supply Chain Partners' Coordination

The diagnosis of the case supply chain is based on conducted unstructured interviews and survey. The survey focused on the integration at the external and internal supply chain respectively.

4.3.1 External Supply Chain Coordination Analysis

The given survey response covering the main supply chain practices and coordination schemes with suppliers and customers. These practices cover the following areas that are investigated as follows:

- Sourcing strategy.
- Collaboration with suppliers.
- Information sharing with the suppliers.
- Collaboration with customers.
- Information sharing with customers.
- Information sharing quality with trading partners.

- **Sourcing Strategy**

Supply chain sourcing strategy is about the strategy in selecting suppliers. The carpet company seems to have a good strategy in this area as a result of the survey responses. The company tries to minimize the number of suppliers to build long term coordination with them. In the meanwhile, the company is focusing on the quality of suppliers and their cost. The equal weighing between suppliers' cost and quality may be revised in scope of revised supply chain strategy in the future.

- **Collaboration with Suppliers**

In the collaboration with suppliers, the survey shows that the overall performance of the carpet company at this stage is about 70%. The main deficiency in this area is the number of official collaboration agreements signed with the suppliers. The degree of implementation of this particular area is about 40%, yet it can be easily improved by taking corrective actions on the short to medium term. The other area where deficiency in collaboration is reported is in the inclusion of the organization's key suppliers in its planning and goal setting activities. This area scored about 60%. Lacking of official agreement with suppliers may indicate that the deficiency in collaboration with the suppliers on planning level may be deeper. However, it is an area of improvement will facilitate and smoothen the flow of materials from suppliers to the carpet company.

- **Information Sharing with the Suppliers**

The information sharing with the suppliers is poorly implemented. The survey shows that the overall score is less than 50%. No single item of this area has

scored higher than 60%. It could be deduced that the information shared is the traditional information shared by procurement agents with suppliers. The improvement in this area can be done on medium term with the signing of the official agreements with the suppliers as the type of information shared and the mechanism of sharing this information can be determined. The question here will be: are the current purchasing agents qualified to carry out such coordination activities with the suppliers? However, evaluating (and raising if needed) the current skills and knowledge of the procurement personnel is essential before making any improvement in this area.

- **Collaboration with Customers**

Although, the coordination with customers is more important due to the ever changing market dynamics and competition, yet it can be considered weak at the carpet company. The survey shows that the score of this item is 40% only, which is an indication of lack of procedures and awareness for this particular area. Also, this indicates the weak interaction and follow-up with customers; and this may cause a strategic threat to the carpet company on the long term, causing losing of customers. Setting a procedure for measuring customers' satisfaction is required in order to explore the current and future needs of customers.

- **Information Sharing with Customers**

Although, the coordination with customers at the carpet company is weak, where the information sharing with customers can be considered. This may be due to the good personal level of communication between sales force and customers. This will need to be institutionalised. The information flow seems to be unidirectional from the carpet company to its customers. The flow of information from customers to the carpet company is less than average (about 40%). Such information is essential for forecasting activities as well as for medium and long term planning. Formal agreement with customers had to be in action to empower the information sharing maximising its benefit to the whole supply chain.

- **Information Sharing Quality with Trading Partners**

As expected from the previous coordination areas, the overall information sharing activities with business partners is average. The score is about 60% indicating that there is a good margin of improvement in this area. Adopting the supply chain concepts and paradigms, embedding them in the operating procedures of the carpet company will affect the change. It is notable that the accuracy of information shared between the carpet company and its business partners is highly questionable, which may cause wrongful decisions. On the other hand, the carpet company had to rely on such information (information reliability is about 60%).

4.3.2 Internal Supply Chain Coordination Analysis

At the carpet company, the supply chain department perform four main functions namely: procurement, logistics, warehousing and planning. In this analysis, a focus is made on the coordination between supply chain functions at the carpet company and the following functions:

- Supply Chain coordination with R & D
- Supply Chain coordination with Marketing
- Supply Chain coordination with Sales

■ Supply Chain Coordination with R&D

It is obvious that the coordination between the supply chain functions and the R & D function is not satisfactory in all its contexts. The Sales and Operations Planning (SOP) defining such coordination must be designed and implemented, which will empower the supply chain activities boosting its performance.

■ Supply Chain Coordination with Marketing

The survey score given according to the questionnaire response is 24%. This is a very low level of coordination; which raises the following issues:

- Adequacy of the current SOPs at the carpet company (or even its presence).
- Knowledge and skill of the carpet company personnel.
- Awareness of the middle and top managements about the concepts of Supply Chain Management.

■ Supply Chain Coordination with Sales

Although, the coordination with sales is better than that with R&D and Marketing, it is totally an unacceptable level of coordination. The sales access to inventory information (with its different types) is good (80% satisfactory). The sales conveying information about customers' orders to the supply chain function at the carpet company is very low. This may cause elevated supply chain costs, low level of utilization and poor planning decisions. This also raises the question about the level of knowledge of the carpet company personnel about supply chain concepts.

4.3.3 Internal Supply Chain Activities Analysis

The poor internal supply chain coordination found by overall score 33.3%. The analysis is based on the responses received the conducted survey. The survey was aimed to know how the most important internal supply chain activities are carried out at the carpet company. The responses of the survey are given in Table 3. It can be easily spotted from the responses on the survey that the responsibility is widely dispersed for the activities between various functions.

It is found that the sales function is involved in SC planning, which is totally out of the scope of the sales. The sales should provide the supply chain function with forecasts, prospective customer orders and current ordering rate. In turn, the supply chain set the required planning with coordination of procurement and production. In addition, the analysis shows that the role of logistics function is only about setting the shipping date, while the procurement and manufacturing lead times are only available by the supply chain function. The role of sales should be limited to coordinating with the customers. Sales should not do any monitoring activities on the customer order as it has no empowerment over other functions to initiate corrective actions if needed. This should be transferred to supply chain function, and sales would be informed with the outcome of the process regularly to take actions with the customer, if needed.

It is worth mentioning that there are two key supply chain activities which currently are not performed at the carpet company. The missing of formal long term forecasting is implying that the strategic plans at the carpet company may be subjective plans. This may threaten the business sustainability. The methodologies adopted in formulating the competitive strategy at the carpet company, and in turn the supply chain strategy, should be revised. On the tactical planning level, performing Material Requirement Plans (MRP) is not conducted by the company, especially in MTO production. This may cause elevated costs and poor machinery utilization.

In addition, the Key Performance Indicators (KPI) measurement is performed by only three functions at the carpet company, namely supply chain, procurement and costing. This implies that there is a lack of the KPI model at the carpet company. In the next section further analysis of KPI measurement at the carpet company is conducted to find out whether it is reflecting the organizational goals or not.

Table 3. Internal Supply Chain Activities

Activity	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	R & D	Others
Long Term Forecast										N/A
Medium Term Forecast	√	√			√		√			
Short Term Forecast	√	√			√		√			
Setting Inventory Policies	√					√				

Table 3. Internal Supply Chain Activities

Activity	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	R & D	Others
Determining re-order quantity					√		√			
Determining safety stock	√	√								Costing
Determining stocking locations	√					√				
Receiving customers' orders			√				√			
Documenting customers' orders			√				√			
Setting delivery date for customers' orders			√				√			
Follow customer order in production				√	√		√			
Assembling customers' orders				√	√		√			
Follow customer order in shipping			√				√			
Setting production schedules				√	√					
Shipping customers' orders			√				√			
Determining MTS quantities							√			
Determining planned built-up inventory (products)		√			√		√			
Preparing capacity planning					√					
Preparing MRP										N/A
Setting the purchasing plan	√	√								
Issuing PO	√	√								
Follow PO execution	√	√								
Suppliers selection	√	√								

Table 3. Internal Supply Chain Activities

Activity	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	R & D	Others
Suppliers accreditation	√	√								
Suppliers performance evaluation	√	√								
Collecting customers' requirements in new products								√	√	
Designing new products							√		√	
Preparing BOM of new products							√		√	
Documenting new design data										
Measuring departmental KPIs	√	√								Costing

4.4 Analysis of Current KPI Model at the Carpet Company

The current KPIs at the carpet company are investigated by the conducted survey and summarized as shown in Table 4. The response of the questionnaire represents about 50 KPIs used in measuring the performance of supply chain activities. The KPIs were divided into two main categories. The first category denotes the overall performance to supply chain strategy, while the second category represents the functional performance to the supply chain strategy.

The following are the main analysis on the response of the questionnaire:

- The KPIs are used mainly to assess personnel performance and to be used in incentive schemes. This justifies the high number of current KPIs (about 50 KPIs).
- The KPIs are not measuring the organizations' performance.
- The same KPI can be used by more than one function. Sometimes, the same KPI can be used by four functions. For example, it is found that a warehouse order cycle time is used as a KPI by supply chain, procurement, logistics and sales.
- The number of KPIs is high in some functions such as sales (23 KPI). This implies the complexity of the process: measuring the performance of the staff to calculate their compensation than measuring the

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performance of the functions and how it participates in achieving the supply chain strategies.

Table 4. Supply Chain Functions KPIs Used at the Carpet Company

	KPI	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	Others
Cost and Finance	Inventory Turnover ratio (Sales/Average inventory)	√	√							
	Inventory Cost									Costing / Finance
	Cost of goods sold									Costing / Finance
	Supply chain cost per unit sold									Non N/A
	On hand inventory Value						√			Costing
	transportation Cost			√						
	Production Cost									Costing
	cash to cash conversion cycle									Finance
	Storage Space Utilization	√					√	√		
Supply Chain (Marketing)	No. of customers complaints							√		
	Customers' orders growth rate							√		
	Order cancelation %							√		
	Units Per Transaction							√		
	% of split shipments			√						
	Units per Transaction							√		

Table 4. Supply Chain Functions KPIs Used at the Carpet Company

	KPI	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	Others
Supply Chain	Forecast accuracy		√			√		√		
	Manufacturing Schedule Adherence				√	√				
	Ratio of demand variability to order variability									N/A
	No. of Suppliers per item	√	√							
	No. of items per supplier	√	√							
Production	Equipment utilization									N/A
	Labour utilization									N/A
	OEE				√			√		
	Flexibility in schedules				√	√		√		
	Asset utilization rate									Costing

	KPI	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	Others
Quality	Supplier quality variability	√	√							Quality
	Order rejection %	√	√				√			
	% defective in production				√			√		
	2nd grade %				√			√		
	Scrap Qty							√		Stock controller

	KPI	Supply Chain	Procurement	Logistics	Production	Production Planning	warehousing	Sales	marketing	Others
Time	Warehouse order cycle time	√	√	√				√		
	On time order %							√	√	
	Order flow time							√	√	
	Supplier time variability	√	√							
	Average product cycle time							√		
	Machinery down time				√	√		√		
Supply Chain (Procurement & Warehousing)	Inventory Accuracy	√	√			√	√			
	No of out of stock	√	√					√		
	Item fill rate							√	√	
	Full orders %							√	√	
	Backorders rate									Costing / Finance
	Obsolete inventory						√			Costing
	Raw material Safety time	√	√							
	Goods safety time	√	√							
	Transient Inventory	√	√				√			Costing
	Average fill rate			√			√	√		
	Supplier quantity variability	√	√							
	Average purchase quantity	√	√							
	WIP				√			√		
Perfect order metric (time x Qty x Quality x Invoicing)		√	√				√			

5 Discussion and Findings

The previous section provided a full analysis and diagnosis of the selected company's SC in terms of assessing the current SC structure, SC functions,

ABC analysis, internal and external SC coordination analysis and the corresponding performance measures. The following findings about the SC practices at the carpet company are reached including: (1) the internal SC needs more coordination and integration; (2) improving the external SC coordination and integration is required; (3) supply Chain activities need to be well defined; and (4) the KPIs should be used as measures of the company's goals achievement, not only as employees' appraisal.

Based on this, the following section will propose a roadmap to better manage the selected company's SC through suggesting procedures to the overall SC performance. This will consider more integration and coordination in SCM practices and linking SC KPIs to SC functions, while raising human skills.

5.1 Proposed ABC Analysis

5.1.1 Proposed ABC Analysis based on Quantities

It is proposed to perform the ABC analysis based on purchased quantities. As discussed in the literature, this refers to using appropriate value-adding processes in order to enhance supply chain and global competitiveness. The results of the analysis are given in Table 5.

Table 5. Proposed ABC Analysis of Purchased Items

Class	No of items in the class	Items %	Quantity %
A	4	2.17 %	78.84 %
B	15	8.15 %	12.92 %
C	165	89.7%	8.34 %

Source: Developed by the authors.

5.1.2 Proposed ABC Analysis Based on Consumption

The ABC analysis can also be done based on items' annual consumption. This will define the fast moving items (F), Medium moving items (M) and Rare moving items (R). The FMR analysis is critical for the warehouse management. Items' location and the warehouse design are highly affected by this analysis. F class items should be in low racks and near the picking/receiving areas. In contrast the R class items could be placed at high racks and away from picking/receiving areas. Another point of importance is the inventory policy; F items need continuous inventory monitoring as the inventory levels are changing rapidly unlike R items. It is found that the four items belonging to the F class are (these are the same four items in the ABC analysis made based on the purchased quantities):

1. Polypropylene Granules
2. SBR LATEX
3. Jute 20/1
4. Polyester Chips Semi Dull

5.2 Proposed Supply Chain Management Practices

As discussed in the literature, an increased strategic and global focus by the supply chain needs to be sustained by adequate information flow. According to the world class supply chain practices, the carpet company has to improve the following:

5.2.1 Defining Supply Chain Strategy

The first step is to set the supply chain strategic objectives. The strategy of the supply chain should be aligned with the carpet company competitive strategy. The trade-off between responsive and efficient supply chain strategy should be defined. The responsive dimensions must be determined. For this purpose, the following key activities are recommended to be carried out:

- Analysing and revising the carpet company competitive strategy.
- Survey top management to determine which aspects of responsiveness are required by customers.
- Define the trade off limits between efficient supply chain and responsive one.
- Develop the carpet company supply chain strategy and strategic objectives.

As discussed in the literature, there is a need for the strategic linkages between supply chain capabilities, configuration, and performance in carpet industry, with a focus on social and environmental technical and relational capabilities.

5.2.2 Improving the Internal Supply Chain Coordination

The coordination of the internal supply chain is essential to boost the

improvement research at the carpet company. It can be considered as the foundation of any future improvement. The diagnostic study of the internal supply chain revealed that the SOPs at the carpet company were either not implemented or poorly designed. In this research, the coordination schemes and mechanisms are recommended between SOPs of Supply Chain, Marketing, Sales and R&D functions. The can be achieved as follows:

- Set the functional objectives and governing policies.
- Design a detailed SOP for each of the internal supply chain related functions.
- Define a clear coordination scheme through identifying the shared information between functions.
- Design work instruction for particular activities if needed.
- Train the carpet company personnel on the designed SOP.

5.2.3 Building Collaboration with Suppliers and Customers

After establishing a solid internal supply chain at the carpet company, it will be possible to extend this coordination across the organization boundary reaching for suppliers/customers. Coordination and collaboration schemes with suppliers and/or customers have to be developed. All these schemes will

require information sharing with suppliers and customers. It is proposed that the information sharing has to be done with the key suppliers and customers, while the official agreements have to be drafted and signed in order to assure that the collaboration between SC partners.

5.2.4 Raising the Human Skills at the Carpet Company

Any improvement to be made at the carpet company will be carried out by the staff. The question raised in the diagnosis is the readiness of the staff at the carpet company to carry out such improvement. As discussed in the literature, SC in carpet company can be improved using suitable leading technology applications and people-valuing and innovation-fostering company environments. That is why Training Need Assessment (TNA) should be made for the staff working at supply chain and related functions to stand on their level of knowledge and skills. Tailored training courses should be designed and implemented for the carpet company staff to be able to carry out all needed improvements. The following key activities are recommended as follows:

- Analyse the developed the carpet company supply chain strategy.
- Analyse the organization structure of the carpet company to stand on the jobs and functions of the organization.
- Perform a survey for the staff to determine the needed skill and knowledge for each staff member.
- Define the gap between the staff actual skills and knowledge and the needed ones.
- Propose and execute a group of training courses to bridge the gap.

5.2.5 Define New KPIs for The Supply Chain Related Functions

There are several indicators in the literature and in business organisations recommended for use in measuring the performance of an SCM system. In the carpet company case study, the conducted survey has shown that the current supply chain lacks accurate indicators of performance for comparison, benchmarking and decision-making. A group of KPIs are designed in this research to measure how each function is moving to achieve its objectives.

The proposed KPIs represent SC functions and coordination between partners, such as external, consumer, value-based competition, network performance and intellectual capital. In addition, the KPIs represent the operational areas, such as delivery performance, flexibility and responsiveness, logistics costs and asset management. Figure 6 shows a recommended list of possible 18 KPIs that could be used to enhance the overall supply chain performance, coordination between SC partners and measuring the improvement of SC functions.

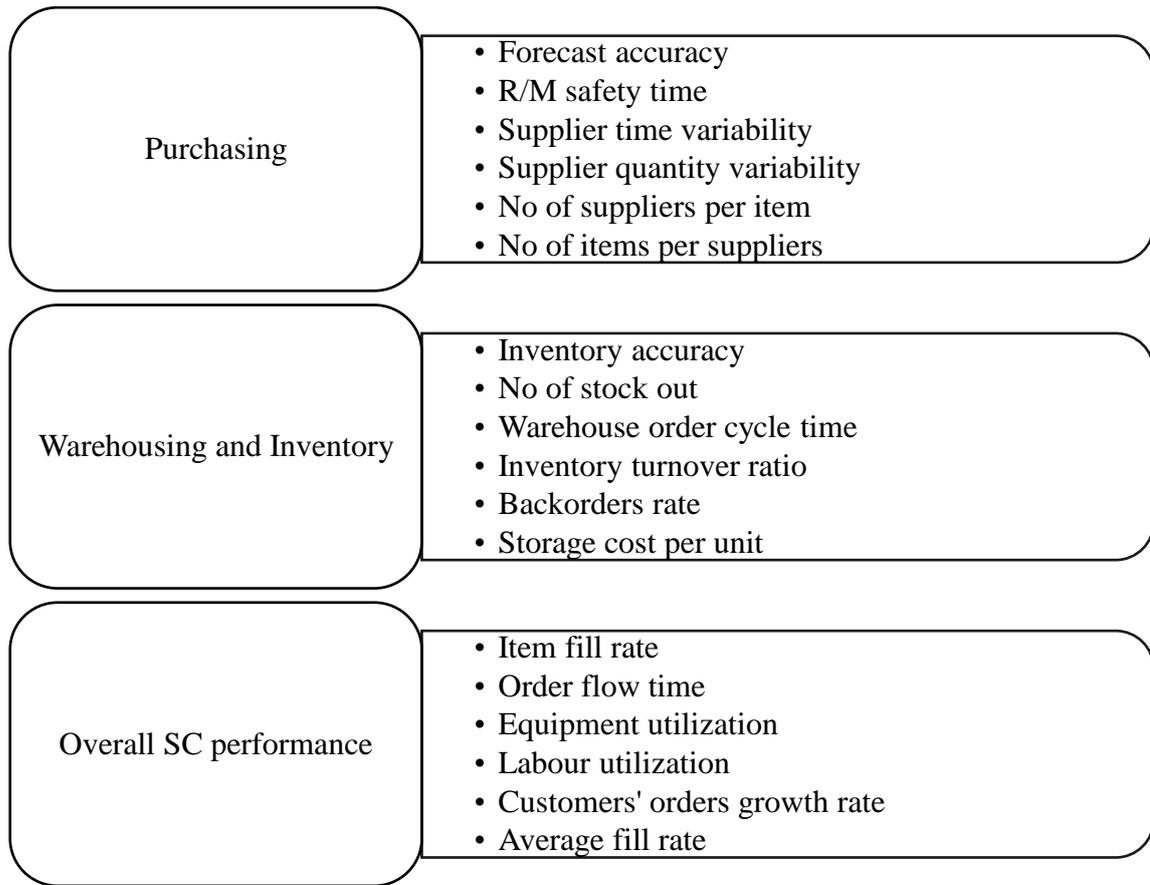


Figure 6 – Proposed KPIs for the Carpet Company

Source: developed by the authors

6. Conclusion:

As global competition increases, weaver businesses should be more involved in how their suppliers and customers do business. They need to focus on process that has an impact on enhancing supply chain Management practices such as where materials come from, how their suppliers' products are designed and assembled, how products are transported and stored and what consumers really wants. Thus, carpet companies, like other companies, should be able to integrate effectively the internal functions within a company and link them with the external operations of suppliers and supply chain members. This will help carpet companies to compete successfully in today's challenging weaver business environment.

In this research, an analysis of the one of the leading Egyptian carpet company has conducted in order to understand the current SC practices. It is concluded that the carpet company has several challenges and weaknesses, where the purchasing cycle is not clearly defined, about 18 vendors supply a single item,

and only one vendor supplies more than 75% of an item's quantity. Furthermore, the company suffers the collaboration with suppliers, the weak interaction and follow-up with customers, and the weak flow of information from customers to the carpet company. It is also concluded that the information shared between the carpet company and its business partners has less degree of accuracy, and the coordination between the supply chain functions and the R & D function is not satisfactory. The missing of formal long term forecasting is implying that the strategic plans at the carpet company may be subjective plans, and thus the current KPIs are not measuring the organizations' performance.

Therefore, it is recommended in this research that the ABC analysis should be based on purchased quantities and on the items' annual consumption. The strategy of the supply chain should be aligned with the carpet company competitive strategy, where the trade-off between responsive and efficient supply chain strategy should be defined. The coordination schemes and mechanisms are recommended between SOPs of supply chain, marketing, sales and R&D functions. Finally, the Training Need Assessment (TNA) should be made for the staff working at supply chain and related functions to stand on their level of knowledge and skills. The carpet company is recommended to apply proposed 18 KPIs in order to measure the coordination between SC partners and the SC functions.

Theoretical Implications

As theoretical implications, this research has provided an analysis of SC in carpet industry, where the flow of materials, capitals and information between SC partners starting from suppliers to the customers are examined. This helps theoretically to understand the structure of the SC structure and strategy, and the coordination and integration between internal external SC partners. Examining the efficiency of current KPIs is another implication.

Practical implications

As a practical implication, the proposed SC practices roadmap in this research can be applied in other manufacturing sectors. This helps to provide a managerial tool for evaluating SCM practices and to propose a practical roadmap for more appropriate SCM integration and hence better performance. Setting proper KPIs in carpet industry is another practical implication, which are based on understanding the SC functions and processes and flow of products. In carpet industry, this road map helps to improve overall SC performance of carpet businesses.

Future Research

As a future research, it is recommended to conduct Value Stream Maps (VSM) in carpet industry. Value Stream Maps can be used to illustrate and strengthen the process of carpet product delivery and service. It is a quite useful in

exploring items that have less value to customers and reducing waste in carpet industry. Also, VSM helps managers to identify the root cause of the waste by visualizing the current process.

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