Journal of Alasmarya University: Basic and Applied Sciences
Vol. 6, No. 5, December 2021, Special Issue for Forth Conference on Engineering Science and Technology (CEST-2021)
مجلة الجامعة الأسمرية: العلوم الأساسية والتطبيقية
المجلد 6 ،العدد 5، ديسمبر 2021، عدد خاص بالمؤتمر الرابع للعلوم الهندسية والتقنية (CEST-2021)

Measuring Performance of Food Supply Chain in Libyan Industrial Organizations: A Balanced Scorecard Approach

Fathi Almbsot[1,2,*], Ahmed El-Assal[2], El-Awady Attia[1,3]

[1]*Department of Mechanical Engineering, Benha faculty of engineering, Benha University, Egypt, fathialmbsot@gmail.com*
[2]*Department of Mechanical Engineering, Faculty of engineering, Elmergib University, Libya, amelassal@yahoo.com*
[3]*Industrial Engineering Department, College of Engineering at Al Kharj, Prince Sattam Bin Abdulaziz University, Al Kharj 16273, Saudi Arabia, elawady.attia@gmail.com*

ABSTRACT

The current paper identifies the most important Key Performance Indicators (KPIs) for measuring the food supply chain's performance using the Balanced Scorecard (BSC). A qualitative analysis was performed in cooperation with domain experts who practise Food Supply Chain (FSC) through interviews with managers from the Libyan food industrial organizations. For each BSC perspective, a set of 20 KPIs was considered in the analysis, a total of 80 KPIs related the four perspectives. KPIs were collected through studying previous studies and researches related food supply chain. The questionnaire was prepared and distributed on (125) individuals who work in the five levels of SC; (25) individuals for each level, namely, suppliers (S), manufacturing (M), wholesalers (W) retailers (R) and customer (C). The questionnaire was analysed, results highlighted only a shortlist of metrics (only 7, 5, 7, 4 KPIs) respectively for financial, customer, internal process, and learning & growth perspectives. Consequently, a generic BSC model was constructed that can be used for any stage of the food supply chain that includes suppliers, manufacturers, wholesalers, retailers, and customers. The proposed model was agreed upon by the industrial experts. Different performance criteria that can be measured by the proposed BSC include reliability, integration, agility, responsiveness, risk management, product safety, collaboration, assets management, cost/profit, time, and sustainability.

Keywords:
Balanced Score card.
Food Supply Chain. Key performance indicators.
Performance measurement.

*Corresponding Author Email: fathialmbsot@gmail.com

1. INTRODUCTION

Over the last decades, Supply Chain Management (SCM) has been considered as one of the major subjects to increase organizational efficiency and achieve the desired business objectives. SCM is focussing on the discipline that optimizes the different processes associated with the materials, goods, services, and information amongst suppliers, manufacturers, and customers. The supply chain focuses to satisfy the end customer's demand via the integration and cooperation of all stages [1]. The supply chain gathers together the different stages that necessary for producing the specified product starting from suppliers, manufacturers, wholesalers, retailers, and customers. These parties or companies construct a

ISSN: 2706-9524 (Print) ISSN: 2706-9532 (Online)

chain/network in which the performance of each one is affected by others [2,3]. The food industry is one of the supply chain systems that are highly sensitive to changes and constrained by many legalisations. This system involves a group of interrelated companies that are working cooperatively in a network to convert raw material to the desired by-product or finished foodstuffs [4]. This chain often starts with production, processing, inventorying, distribution, and customer consumption. The efficient quality assurance and safety systems are essential aspects of the food supply [4]. Increasing products demands, environmental aspects, and overpopulation have an impact on the FSC. There are many parameters for any FSC that should be considered e.g. resources, packaging, waste management, etc. [5]. Although companies are encountering complex challenges to accomplish customer needs in the current dynamic working environment, performance measurement is vital for companies' successes. The relationship between competitive advantages and organizational performance with the SCM practices is significant. Whereas, Li et al. [6] proposed to model the SCM practices using five metrics: partnership, relationship, information sharing, and postponement strategy. They indicated that the higher levels of practices enhance the organizational performance and its competitive advantage.

Hence, an efficient integrated Performance Measurement System (PMS) is required to assess supply chain performance [2]. The PMS is an approach for evaluating the efficiency and perfection of the different supply chain activities [7]. Both practitioners and researchers are interested in having such integrated PMS [8]. The success of the PMS relies on different aspects e.g. the alignment of the business strategies and performance metrics, and the transformation of the organization's vision, mission, value, and strategic directions to employees and external stakeholders [9]. As it is well known, "You can't manage what you can't measure", measuring the supply chain performance is a very important prerequisite for corporate survival, especially nowadays in reasons of globalization and the dynamic nature. In the current working conditions, the supply chain aims to decrease costs, increase agility as well as increase effectiveness by providing better services and rapid responsiveness to customers. For achieving these objectives, firms should develop metrics for performance measurement to gauge their success and ensure sustainable growth. Measuring supply chain performance using appropriate performance metrics is an area under the focus of researchers. The lack of clearness and benchmarking regarding this area creates confusion and makes it difficult to express a clear strategy [10].

According to the review work (Scopus Database) of (Sharma et al. 2020) [4] the scientific publications on the FSC is very Lacking in the developing countries, almost non-existing. After investigating the literature for the consideration of FSC in Libya, there is a lacking of the qualitative or quantitative analysis for the topic of FSC performance management. According to Knoema [11], the Libya food production index is growing at annual rate of 3.53% that indicate a special interest for the food industry. Moreover, the net value of food production based on PPP (purchasing power parity, in constant prices 2004-2006) is annually growing with an average of about 3.49% over the period from 1967 to 2016. Due to this growing interest of the food industry and the research gab for the management of FSC performance, the current work proposes a balanced scorecard for performance

management of FSC for Libyan food industries. In reasons of the enormous number of the SC performance criteria and metrics, organizations are facing difficulties to identify the most important KPIs. Relying on the qualitative analysis, the performance metrics for FSC in Libya can be scrutinized. This work also contributes to the SCPM literature by introducing a generic performance metrics that can be used for the different stages of the FSC. First, the different performance metrics of the four perspectives of the BSC were collected based on the literature. The appropriate indicators to the food industries were discussed and validated by food industry experts. Consequently, a questionnaire was developed and distributed to different food industry organizations. After that the statistical analysis are performed and the BSC model was developed and validated by the industrial experts in Libyan factories.

2. BACKGROUND AND LITERATURE REVIEW

2.1 Process Based Approach

The problem of identifying the performance metrics of the whole sectors of the SC was started by [12]. They divided the SC into four SC processes; plan, source, make/assemble, and deliver. Relying on the literature, they aggregated the metrics and clustered them according to the management level, financial and non-financial. Whereas, the financial metrics are needed for higher management decisions, on the other side the shop floor daily work required the operational/technical metrics. Different measures were proposed for each supply chain process. The main regret for this work is that they highlighted and distributing metrics on the different management levels and SC process without any external consultant from academics or practitioners and the shortage of empirical analysis. After a while, they treated such issues in the work of [13]. After that (Gaiardelli et al. 2007) [14], proposed an SCPM model for aftersales performance measure of the SC network. Their model contains four hierarchical levels: business, process, activity & organizational, and development & innovation. The business level can be measured by the market and cost. The process level can be measured by customer satisfaction, flexibility, and productivity. The activity &organizational level can be measured by assets utilization, wastes and costs, lead time for the back office activities; while reliability and responsiveness can be used to measure the front desk activities. The development & innovation level can be measured by research, human resources, and IT service capacity. Relying on the literature (Bhagwat & Sharma (2007) [15] proposed a set of relevant metrics for each BSC perspective e.g. they proposed 10 metrics for the financial perspectives, 17 metrics for the customer perspective, 15 metrics for the internal process, 12 metrics for the learning and growth. The discussed metrics are associated to the different entities of SC that include planning, partnership, customer, production, delivery, financial and logistics. The cooperation, coordination, synchronization, and integration of the different parties of the SC can be considered as performance determinates. According to (Zhou and Benton 2007) [16], the supply chain practice includes planning, just in time, and delivery practice. Moreover, supply chain dynamism positively affects the SC practice but this effect is less than that of the information sharing. The delivery performance is highly related to the effectiveness of the information sharing and SC practice. Both effective information sharing

and effective practice are important in reaching better SC performance. (Mastering et al. 2017) [17] ,reviewed the literature associated with the supply chain performance management (SCPM) systems with focusing on the definition of performance measurement. (Reddy et al. 2019) [7] considered and classified the SCPM as approaches and techniques, they prioritized simulations over the other approaches for SCPM in an unstable environment. Their study provides a basis for academicians and future researches in applying the PMS for the dynamic supply chain. The performance metrics can be used to manage supply chain risks with suitable risk mitigation strategies [18]. The social issues were also considered in the SCPM framework of (Venkatesh et al., 2019) [19]. The same interest was considered for measuring the performance of FSC. Recently, (Yontar and Süleyman 2020) [5] determined parameters that affect sustainable FSC and attempted to evaluate the different attributes of the supply chain. In their work different performance indicators are defined and several attributes are adopted (e.g. customer satisfaction, resource utilization, product safety, innovation, reliability, company information, packaging and waste management). (Kirwan et al., 2017) [20] recognized five attributes for the FSC performance that includes economic, social, environmental, health, and ethical. (Govindan et al., 2017) [21] proposed a hybrid methodology for assessing FSC performance by considering green performance metrics. For the agriculture sectors, (Yadav et al. 2020) [22] proposed to use the Internet of things (IOT) to collect the performance associated data from remote fields. (Lin and Li 2010) [23] identified some challenges for measuring SCPM. One of these challenges is the lack of approaches that measure the whole system performance.

2.2 Perspective Based Approach

2.2.1 Balanced scorecard

The balanced scorecard (BSC) provides an integrated system to measure the corporate performance relying on four perspectives: Financial, Customer, Internal process, and learning and growth. The BSC was first presented by (Kaplan and Norton 1992) [24]. They proposed it to assess the business performance relying on the four perspectives simultaneously. The BSC was widely used as a supply chain performance management model. (Bhagwat and Sharma 2007) [15proposed a BSC model as an integrated framework for measuring day to day performance of small and medium-sized enterprises (SME). For each perspective, a set of relevant metrics were proposed based on the literature. They suggested certain steps for implementing BSC in SC with advising to use the potential metrics. However, they did not identify the potential metrics that should be used. They found some contradiction between metrics among the different perspectives. Besides, they recommended more research about the viability of the perspectives and metrics. (Varma et al. 2008) [25] evaluated the performance of a petroleum industry supply chain using the BSC and AHP in India. The KPIs used were proposed and validated by industrial experts. AHP results show that for petroleum industries the customer perspective comes with the highest priority, and the learning and growth was ranked the last. (Bigliardi and Bottani 2010) [26] proposed a BSC model for evaluating FSC performance. For the different BSC perspectives, the KPIs were collected from the literature. After that, the Delphi method was adopted to refine the collected KPIs on

two rounds. The amended BSC was implemented to measure the performance of two food manufacturing companies. Similar views for the two companies were found regarding the financial, customer, and internal process perspectives, but they varied for the learning and growth perspective. (Yang 2009) [27] suggested an enhanced version of the BSC to measure an SC performance index. The developed BSC integrates five perspectives that include the intra-flow process, future development, and society development besides the financial and the customer perspective. The learning and growth was replaced with future development. For each perspective, a set of KPIs was proposed for its assessment e.g. the society perspective was proposed to be assessed relying on the efficiency of environment protection, recycling level, usage of the raw material, and employee number with per capital invested. (Xia et al. 2017) [28] proposed BSC model for assessing the sustainability and features of some technologies. (Rasolofo-Distler and Distler 2018) [29] analysed the capability of the BSC to manage the uncertainty of service sectors. They concluded with the capability of BSC to facilitate communication between supply chain stakeholders. (Thanki and Thakkar 2018) [30] proposed a BSC and strategy map based on a quantitative framework for assessing the lean and green performance of the SC in the Indian textile industry. Recently, (Dwivedi et al. 2021) [31] adopted the BSC with the best-worst method to manage the performance of an assurance company.

2.2.2 Supply chain operations reference (SCOR)

The Supply chain operations reference (SCOR) model presents the modelling of the supply chain processes, people, practices, and performance. It was developed by the Supply Chain Council association in 1996. It represents the SC processes in five main clusters; plan, source, make, deliver and return. The SC performance is represented by attributes and metrics. The attributes are not measurable but it is used to establish the strategic directions. But metrics are used to measure the degree of achievement of the strategic direction specified by the attribute. The attributes include reliability, flexibility, responsiveness, cost, and assets. The SCOR model was used by many authors for SCPM. Using data envelopment analysis (DEA) for benchmarking of SC, (Peng Wong and Yew Wong 2008) [32] applied SCOR metrics for the input and output variables. (Thakkar et al. 2009) [33] developed an SCPM system for SME Indian companies by integrating SCOR and BSC. (Cai et al. 2009) [3] proposed a performance measurement and improvement framework. They proposed to quantitatively analyse the interdependent relationships that can be existing among the adopted KPIs during the performance improvement cycle. The process-oriented SCOR model was adopted to identify the basic performance measures and KPIs. A set of performance metrics were adopted/proposed for each SC dimension that includes resource, output, flexibility, innovativeness, and information. A total of 34 metrics were proposed. The proposed approach relies on the Eigen structure analysis. The proposed framework was applied to a large retail firm in china with a set of 20 KPIs for the five SC dimensions. (Essajide and Ali 2017) [34] adopted the SCOR model to represent the pharmaceuticals wholesale distributors considering information sharing amongst SC partners and uncertainty. More recently, (Zuniga et al. 2018) [35] adopted the SCOR model to represent the SC of critical products to reduce the complexities of the SC system during strong earthquakes or tsunamis. (Yadav et al. 2020)

[22] used the second level performance metrics of the SCOR model to manage the agriculture supply chain.

2.3 Evaluation and Prioritization of Performance Metrics

The quantitative approaches were used to explore the importance of the performance criteria and/or metrics. (Bhagwat and Sharma 2007) [15] proposed to use the pairwise AHP method for computing the overall SC performance. The AHP hierarchy was constructed relying on four levels: the lower level (the fourth) represents the four perspectives of the BSC as the AHP alternatives. The third level represents the different KPIs relying on the work of (Gunasekaran et al. 2001) [12]. The second level represents the three managerial levels of strategic, tactical, and operational. The first level is the overall performance of the supply chain. The pairwise comparisons were performed relying on the questionnaires via SME in India. Their results indicate that the four perspectives of the BSC can be ranked in the following order Customer, Internal processes, financial, and then comes the learning and innovation perspective. However, the variations among the perspectives' importance are weak. After that, (Bhagwat and Sharma 2009) [36] proposed to integrate AHP and multi-objective pre-emptive goal programming to optimize the SC performance. (Varma et al. 2008) [25] used also AHP to evaluate the metrics of the BSC for petroleum industries in India. The Experts are asked to perform a pairwise evaluation of the proposed KPIs and the BSC perspectives. Consequently, the AHP method was used for ranking the perspectives and KPIs. Among the adopted KPIs, results prioritize product quality, market share, stability of material supplies, and the wide usage of information technology. (Yang 2009) [27] proposed to aggregate the KPIs of the BSC to formulate a composite SC performance index using a fuzzy-AHP methodology. Recently, (Sufiyan et al. 2019) [37] developed a fuzzy-DEMATEL model to analysis the different criteria and the associated metrics for assessing the FSC. Results indicate three criteria are the most important, which are service to customer, quality, and supply chain performance. On the other side, the qualitative methods were also adopted to identify the most important and practical metrics and criteria. Relying on questionnaires directed to practitioners, (Gunasekaran et al. 2004)]13] ranked the different metrics of the supply chain into three levels of importance (High, Average, Low). The assessment was performed for metrics for processes (plan, source, make/assemble, deliver) and the three management levels. Relying on the companies interviewed, (Bhagwat and Sharma 2007) [15] recommend that the BSC can contain from 4 to 15 metrics for each perspective. (Bigliardi and Bottani 2010) [26] used the Delphi method to evaluate KPIs on two rounds. The amended BSC was tested on two food companies. The stakeholders from each company were asked to rank the importance of each KPI form that was highlighted by the Delphi method. (Dey and Cheffi 2013) [38] presented an empirical study to develop a hierarchical-based performance measurement system in the green supply chain.

3. RESEARCH METHODOLOGY

Relying on the Balanced Scorecard (BSC), a set of proposed metrics were adopted and proposed to evaluate the performance of the food supply Chain. The BSC consists of four perspectives represented by financial, customer, internal business processes, and learning & growth. The current work aims to specify the most appropriate key performance indictor(s) for each perspective for the Libyan food industries. The adopted methodology relies on five steps. The first step is the preparation phase. It is proposed to perform this phase relying on the Delphi technique. In which, a set of scientific visits were conducted by the researchers to the industrial organizations. Face to face interviews were conducted with employees and managers in the Libyan industrial organizations that are working in food industry. The Delphi method is proposed to build a strong basic for developing a questionnaire that includes number of KPIs related to the four aspects of the BSC. The lists of the identified KPIs related to the four perspectives of the BSC are depicted in Table 1. The second step is to develop the questionnaire that will be used for gathering data. Subsequently, the third step is the distribution and collection of the questionnaires. The questionnaires were distributed on respondents in Libya who are working in the different sectors of the FSC. The respondents belong to the five levels of SC that practice food industry in different places in Libya, namely, suppliers (S), manufacturing (M), wholesalers (W) retailers (R) and customer (C). For each perspective of that four of the BSC the participants were asked to rate the importance of each perspective with a scale [0, 10]. Table 2 shows the average results of responses that were received from respondents who are belonging to different stages of the Libyan food supply chain to prioritize the BSC aspects. In addition, the respondents were asked to rate the different proposed KPIs for each perspective of that of the BSC on using a scale of 1 (unimportant) to 7 (extremely important). In this scale, the points {3, 4, 5} respectively meets the three levels of acceptable importance corresponding to {less important, important, slightly important}. Points of {1, 2} represents the levels for unimportance of a specified KPI respectively as {not important at all, not important}. On the other side, points of {6, 7} gives the levels of high important, that can be written as {highly important, extremely important. Tables 3, 4, 5 and 6 respectively show the aggregation of the obtained data for the financial, customer, internal processes and learning and growth perspectives. The fourth step is the data analysis. Finally, result was extracted and introduced in the fifth step. The last two steps will be discussed in the following section.

Table 1 List of KPIs of BSC to measure food supply chain performance

Financial	**Customer**	**Internal business processes**	**Learning & Growth**
F1: Inventory carrying cost	**C1:** Distribution performance	**IP1:** Customer total order cycle time	**LG1:** Increase employee competence level
F2: Transportation cost	**C2:** Product price relative to competitors	**IP2:** Manufacturing cycle time	**LG2:** Improve motivation

Financial	**Customer**	**Internal business processes**	**Learning & Growth**
F3: Labour cost	**C3:** Effectiveness and efficiency of distribution performance all over the supply chain	**IP3:** Inventory replenishment cycle time	**LG3:** Training to enhance employees skills
F4: Supply chain total cost	**C4:** Ease of communication during distribution	**IP4:** Purchase order cycle time	**LG4:** Sustainability in employees training
F5: Capability of reducing costs during purchasing.	**C5:** Supply chain integration	**IP5:** Total supply chain cycle time	**LG5:** Involvement of employees
F6: Fluctuation of cost against the available budget	**C6:** On–time delivery	**IP6:** Operations cycle time	**LG6:** Employee satisfaction
F7: Product net price	**C7:** Responsiveness to urgent deliveries	**IP7:** Product development cycle time	**LG7:** Employee suggestions for improvement (per year)
F8: Increase sales	**C8:** Reliability of deliveries	**IP8:** Supplier lead time	**LG8:** Employee motivation
F9: Return on investment	**C9:** Quality of the delivered goods	**IP9:** Time to process customer return	**LG9:** Employee capability
F10: Energy cost	**C10:** Lead time of customer's order	**IP10:** Manufacturing lead time	**LG10:** Employee complaints
F11: Market share	**C11:** Number of satisfied customers	**IP11:** Downtime rate per year	**LG11:** Absenteeism
F12: Return on assets	**C12:** Number of customers complaints	**IP12:** Effective working time	**LG12:** Percentage of trained employees
F13: Indebtedness level	**C13:** Number of new customers per period	**IP13:** Time required to repair equipment failure	**LG13:** Employees productivity
F14: Cost of engineering and technical information	**C14:** Time required to close a customer complaint	**IP14:** Storage time	**LG14:** Number of training hours per employee
F15: Financial risk	**C15:** Accuracy of anticipating product delivery time	**IP15: I**nternal supply chain improvement	**LG15:** Level of information sharing amongst employees
F16: Economic value	**C16:** Capability to fulfil the	**IP16:** Hazardous	**LG16:** Employees

Financial	**Customer**	**Internal business processes**	**Learning & Growth**
added	required production	material used	social responsibility
F17: Financial stability improvement	**C17:** Satisfaction of business partners	**IP17:** Ratio of carbon emission	**LG17:** Employees collaboration over SC stages
F18: Reduction of the financial expenditure	**C18:** Damaged shipments	**IP18:** Wastes produced	**LG18:** Employees transparency over SC stages
F19: Operation cost	**C19:** Responsiveness to customers	**IP19:** Energy consumption	**LG19:** Supply chain robustness
F20: Stability of the profit margin during the planned period	**C20:** Customer query time	**IP20: C**ontrol of noise and vibration	**LG20:** Ability for SC risk management

Table (2) Prioritization of the perspectives of the BSC (Priorities between 0 to 10).

BSC aspects	Supplier (S)	Manufacturing (M)	Wholesalers (W)	Retailers (R)	Customer (C)	Overall mean	Std. Deviation
Financial	8.0	7.0	10.0	9.0	9.0	8.6	1.140
Customer	10.0	9.0	8.0	6.0	9.0	8.4	1.516
Internal Processes	7.0	9.0	8.0	7.0	10.0	8.2	1.303
Learning & Growth	6.0	8.0	7.0	10.0	7.0	7.6	1.516

Table (3) Rating of KPIs of the financial perspective of the BSC according to a scale of (1 to 7)

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
F18	6.8	6.5	7.0	6.8	7.0	6.82	0.205
F19	7.0	6.4	7.0	6.5	7.0	6.78	0.303
F15	6.5	6.4	7.0	6.8	7.0	6.74	0.279
F20	7.0	7.0	6.5	7.0	6.0	6.70	0.447

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
F7	7.0	6.4	6.5	7.0	6.5	6.68	0.295
F8	6.0	7.0	7.0	6.5	6.6	6.62	0.415
F2	6.0	7.0	6.0	7.0	7.0	6.60	0.548
F17	6.0	7.0	7.0	7.0	5.5	6.50	0.707
F14	6.6	5.8	7.0	5.6	7.0	6.40	0.663
F11	5.0	6.5	6.0	4.5	6.5	5.70	0.908
F9	5.0	6.0	6.0	5.0	6.0	5.60	0.548
F12	4.5	5.0	4.0	5.0	6.0	4.90	0.742
F1	4.0	6.0	4.5	5.0	4.5	4.80	0.758
F6	5.0	4.0	6.0	5.0	3.5	4.70	0.975
F3	5.0	5.0	6.0	3.0	4.0	4.60	1.140
F4	6.5	5.0	3.0	4.0	4.0	4.50	1.323
F16	4.0	6.5	4.0	5.0	3.0	4.50	1.323
F10	5.0	3.0	4.0	6.0	4.0	4.40	1.140
F13	4.2	5.0	4.0	5.0	3.5	4.34	0.654
F5	5.0	3.5	5.0	4.2	4.0	4.34	0.654

Table (4) Rating of KPIs of customer perspective of the BSC according to a scale of (1 to 7)

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
C9	7.0	7.0	6.5	7.0	6.4	6.78	0.303
C8	6.8	7.0	6.4	7.0	6.5	6.74	0.279
C1	7.0	6.5	7.0	6.5	6.0	6.62	0.415
C5	7.0	7.0	6.0	6.1	6.3	6.48	0.487
C16	5.0	7.0	7.0	6.0	6.6	6.32	0.844
C7	6.0	6.0	7.0	6.5	6.0	6.30	0.447
C4	5.0	5.0	7.0	7.0	6.5	6.10	1.025
C11	6.5	5.6	6.5	5.0	6.4	6.00	0.675
C15	6.5	4.5	6.0	6.5	5.0	5.70	0.908

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
C6	4.5	6.0	6.5	5.0	6.5	5.70	0.908
C19	6.0	5.0	6.0	6.0	5.0	5.60	0.548
C3	4.0	5.0	5.0	6.0	4.5	4.90	0.742
C13	4.5	4.5	5.0	6.0	4.0	4.80	0.758
C10	6.0	4.0	4.5	5.0	4.5	4.80	0.758
C17	4.0	3.0	6.0	5.0	5.0	4.60	1.140
C20	4.0	4.0	5.0	3.0	6.5	4.50	1.323
C2	4.0	4.0	6.0	3.0	5.0	4.40	1.140
C14	3.0	5.0	4.0	4.0	6.0	4.40	1.140
C12	5.2	4.4	4.0	5.0	3.0	4.32	0.879
C18	5.0	5.0	4.0	3.0	4.5	4.30	0.837

Table (5) Rating of KPIs of internal processes aspect according to a scale of (1 to 7)

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
IP15	7.0	7.0	6.8	6.5	6.4	6.74	0.279
IP19	6.5	6.0	7.0	7.0	7.0	6.70	0.447
IP8	7.0	6.0	7.0	6.0	7.0	6.60	0.548
IP16	6.5	6.3	6.2	6.8	6.5	6.46	0.230
IP4	7.0	6.5	6.0	6.0	6.0	6.30	0.447
IP5	6.0	6.8	6.0	6.4	6.0	6.24	0.358
IP10	6.0	6.0	6.5	6.3	6.1	6.18	0.217
IP12	6.5	6.0	4.5	5.0	6.5	5.70	0.908
IP7	6.0	5.0	6.0	5.0	6.0	5.60	0.548
IP2	6.0	6.0	6.0	5.0	5.0	5.60	0.548
IP6	4.0	5.0	6.0	4.5	5.0	4.90	0.742
IP3	4.5	5.0	4.5	6.0	4.0	4.80	0.758
IP1	5.2	6.2	5.0	4.3	3.0	4.74	1.187
IP20	6.0	5.0	3.5	4.0	5.0	4.70	0.975
IP14	6.0	3.0	4.0	5.0	5.0	4.60	1.140

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
IP13	3.0	4.0	4.0	6.5	5.0	4.50	1.323
IP18	4.0	5.0	3.0	4.0	6.5	4.50	1.323
IP17	4.0	6.0	4.0	3.0	5.0	4.60	1.140
IP11	4.0	5.0	3.5	4.2	5.0	4.34	0.654
IP9	4.0	3.0	4.5	5.0	5.0	4.30	0.837

Table (6) Rating of KPIs of learning & growth aspect according to a scale of (1 to 7)

KPI	(S)	(M)	(W)	(R)	(C)	Mean	Std. dev.
LG18	6.8	6.4	7.0	6.5	7.0	6.74	0.279
LG17	7.0	6.5	6.5	6.4	7.0	6.68	0.295
LG20	6.1	6.0	7.0	6.3	7.0	6.48	0.487
LG19	7.0	5.8	7.0	5.6	6.6	6.40	0.663
LG13	6.4	6.8	6.0	6.0	6.0	6.24	0.358
LG9	7.0	7.0	6.0	5.0	6.0	6.20	0.837
LG16	5.0	6.5	5.6	6.4	6.5	6.00	0.675
LG1	4.5	6.5	6.5	6.0	5.0	5.70	0.908
LG15	5.0	6.0	6.0	6.0	5.0	5.60	0.548
LG3	6.0	6.0	5.0	5.0	6.0	5.60	0.548
LG4	4.0	5.0	6.0	5.0	4.5	4.90	0.742
LG6	4.5	4.5	5.0	4.0	6.0	4.80	0.785
LG5	5.0	3.0	4.3	6.2	5.2	4.74	1.187
LG10	6.0	5.0	3.5	4.0	5.0	4.70	0.975
LG14	4.0	4.0	6.0	5.0	3.0	4.40	1.140
LG12	5.0	4.0	3.5	5.0	4.2	4.34	0.654
LG11	4.0	4.4	3.0	5.0	5.2	4.32	0.879
LG7	5.2	5.0	4.0	4.4	3.0	4.32	0.879
LG8	4.0	3.0	5.0	4.5	5.0	4.30	0.837
LG2	5.0	4.5	3.0	4.0	3.0	4.30	0.837

4. RESULTS AND DISCUSSION

For the selected food industrial firms, the five sectors of the supply chain namely; suppliers (S), manufacturing (M), wholesalers (W) retailers (R) and customer (C). "SMWRC" were asked to give an importance level for each perspective of that of the BSC. The Overall mean was calculated for each perspective (as shown in tables 2 to 6) based on the calculated mean value for each category of respondents. Standard deviation was also calculated as shown in tables 2 to 6.

For the supplier sectors, the most important perspective is the "customer" and the less important is the "learning and growth". In addition, the internal process was prioritized as important than the financial perspective. For the manufacturing sectors, it was noticed that the customer and the internal process are equally important then comes the learning and growth perspective. However, the financial perspective comes in the last category. Regarding the wholesalers, the priority was given to the financial perspectives. The Customer and the internal perspectives were given equally priorities but the learning and growth comes at the last rank. For the retailers' section, their first rank was given to the learning and growth, then comes the financial, internal process and the customer was coming at the last rank. However, the customer sectors prioritized the internal process perspective, and gave equal priority to the financial and customer perspectives, then came the priority of the learning and growth perspective. Generally, all sectors consider the four perspectives of the BSC as important, however, the importance of each perspective is subjective and can differ from one sector to others even in the same company or industry. On overage basis, the four perspectives can be arranged as financial, customer, internal processes, and learning & growth. The variation of the average importance level between the four perspectives can be considered as small.

In order to identify the most important key performance metrics for each perspective of that of the BSC, the experts are asked to give an importance number $\in\{1, 2,\ldots, 7\}$ for each KPI. For the financial perspective, the data were collected and listed as in table 3 on an average basis. The overall mean values were used for ranking the indicators. In case of tie, the minimum standard deviation was preferred. Figure 1 shows the distribution of the KPIs of the financial perspective on the importance levels. As shown, all KPIs are ranked over the interval [3, 7]. Consequently, one can consider all KPIs as important at some levels. As mentioned before, the points {3, 4, 5} respectively represent the three levels of acceptable importance corresponding to {less important, important, slightly important}. Moreover, the points of {6, 7} respectively represent the highly important, and extremely important. The question is: What are the most important KPIs that should be adopted for the financial perspectives for the five sectors of suppliers, manufactures, wholesalers, retailers, customers? Relying on the overall mean ≥ 6 to represent the high and extremely important cases, the most important KPIs can be noticed as {F18, F19, F15, F20, F7, F8, F2, F17, F14}. However, by using figure 1, one can notice that F17 and F14 are not stable as most critical, consequently,

F17 and F14 cannot be considered as most important with complete agreement from respondents. Relying on the complete agreement about the most important KPIs, one can consider the seven indicators. As shown, the first three KPIs of "Reduction of the financial expenditure (F18)", "Operation cost (F19)", and "Financial risk (F15)" can be considered as the extremely important KPIs among the 20 indicators. These KPIs were considered extremely important where all the overall means are greater than "6". In the case of one of the overall mean = 6, this KPI was considered as highly important. Following this rule, the KPIs like "Stability of the profit margin during the planned period (F20)", "Product net price (F7)", "Increase sales (F8)" and "Transportation cost (F2)" can be considered as highly important.

These KPIs can be adopted for all sectors of the food supply chain. Consequently, these seven indicators can be adopted for the financial perspective of the BSC as listed in figure 5.

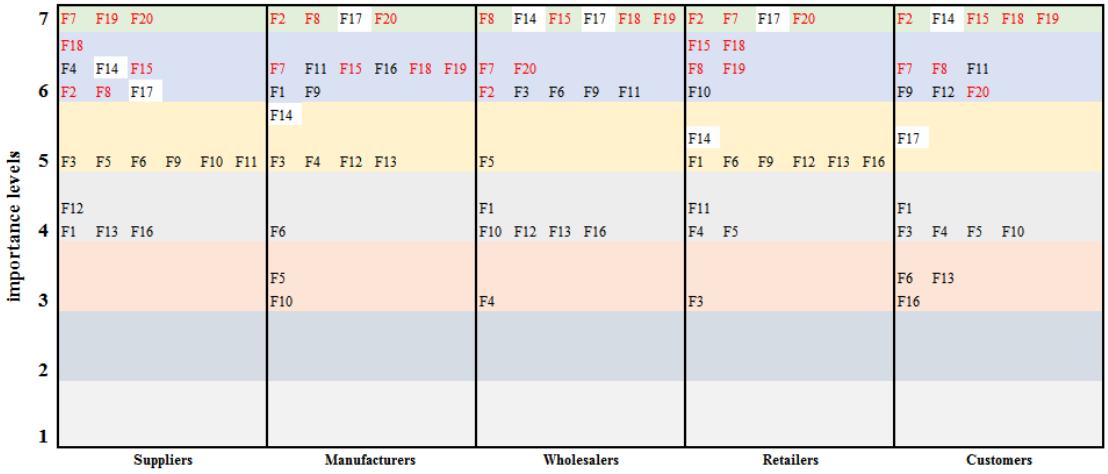

Figure 1 Distribution of the financial KPIs on the SMWRC of the food industry

For the customer perspective, the data were listed in table 4 on an average basis. The overall mean and standard deviations were also computed to be used for ranking. Figure 2 shows the allocation of the KPIs on the seven levels of importance. The same tendency as the financial perspectives was noticed, no KPIs were ranked for "not important at all" or "not important" respectively for levels {1, 2}. Considering only the KPIs on the highly and extremely important levels i.e. KPIs with an overall mean ≥ 6, the most important KPIs can be identified as {C9, C8, C1, C5, C16, C7, C4, C11}. Relying on figure 2, C16, C4, and C11 are not stable on levels {6 and 7} sometimes they are located on level 5, consequently C16, C4, and C11 can be considered as important without a complete agreement. Relying on a full agreement of the most important KPIs, one can consider only the five indicators listed in figure 5 for the "customer perspective" of the BSC. The same results can be obtained by selecting the KPIs with an overall average ≥ 6 and a standard deviation ≤ 0.5. In order to classify these indicators into "highly important" and extremely important", the same rule as in

the financial perspective was adopted. Consequently, only the "Reliability of deliveries (C8)" can be considered as extremely important. However, the "Quality of the delivered goods (C9)", "Distribution performance (C1)" and "Responsiveness to urgent deliveries (C7)" can be considered as highly important. These five indicators can be adopted for all stages of the food supply chain to measure the performance of the BSC's customer perspective.

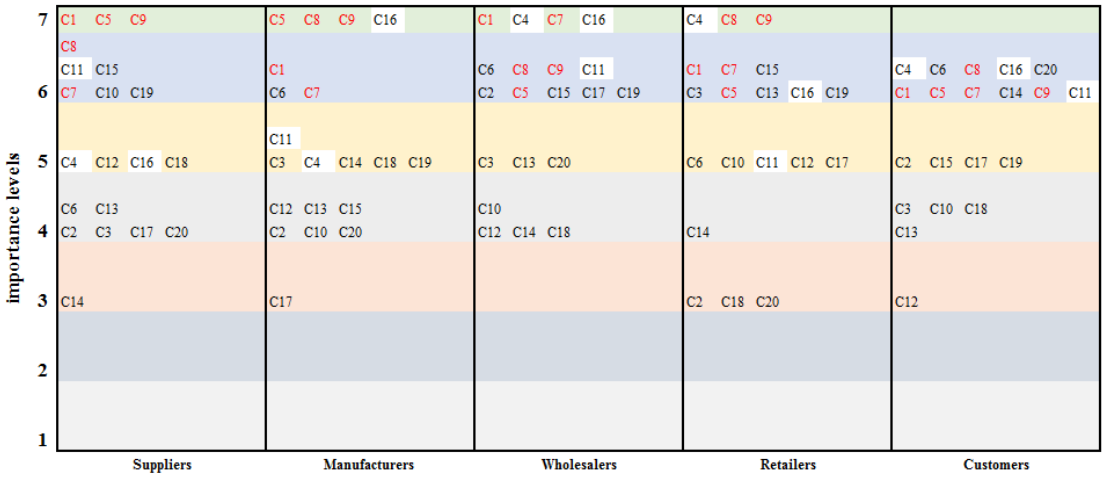

Figure 2 Distribution of the Customer KPIs on the SMWRC of the food industry

For the perspective of the internal process, the data are listed in table 5. The overall mean and standard deviations were computed to be used for ranking. Figure 3 shows the ranking of the internal process KPIs according to their levels of importance that were provided by the experts from the food industry. As shown, there is no KPI located on level 1 or 2, all KPIs are given a level of importance started from low (level 3) to extremely important (level 7). By only considering the KPIs with an overall mean ≥ 6, the most important KPIs can be identified as {IP15, IP19, IP8, IP16, IP4, IP5, IP10}. Relying on figure 3, all of these KPIs can be considered as highly important with a complete agreement. Moreover, their standard deviation < 0.5 except IP8, but IP8 is agreed to be important with grade 6 or 7 for all respondents. Relying on these results, one can consider the seven indicators listed in figure 5 for the "internal process perspective" of the BSC. But, what are the extremely important KPIs and the highly important KPIs amongst these seven indicators. The KPIs with at least one classification with rank = 6 is considered highly important, and all KPIs with all ranks > 6 are considered extremely important. Accordingly, only the "Internal supply chain improvement (IP15)" can be considered as extremely important. However, the other KPIs can be classified as highly important, i.e. "Energy consumption (IP19)", "Supplier cycle time (IP8)", "Hazardous material used (IP16)", "Purchase order cycle time (IP4)", "Total supply chain cycle time (IP5)", and "Manufacturing lead time (IP10)". All of these KPIs can be used to represent the performance of the internal processes for all sectors of the food industry's supply chain according to the experts.

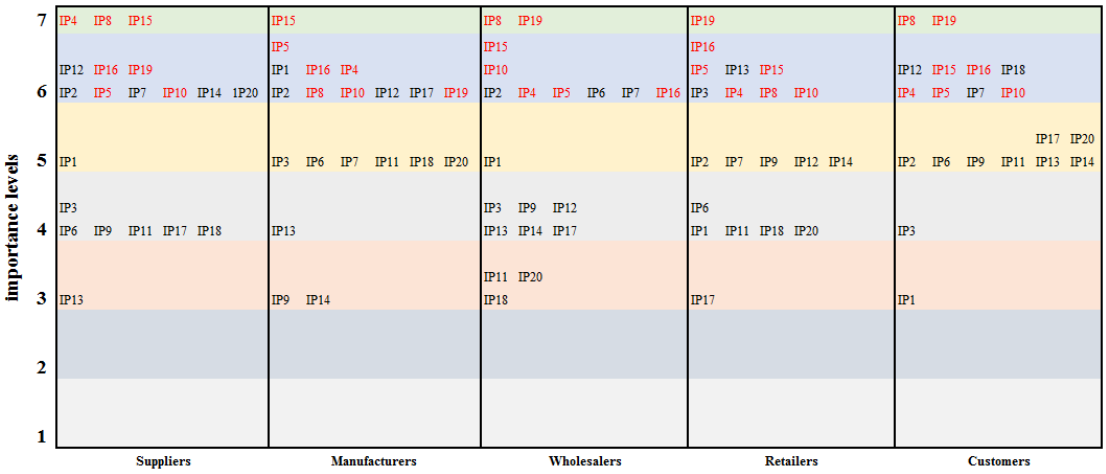

Figure 3 Distribution of the "internal process" KPIs on the SMWRC of the food industry

For the learning & growth perspective, the data are listed in table 6. The overall mean and standard deviations were computed to be used for ranking. Figure 4 shows the distribution of the KPIs of the learning & growth perspective concerning the seven levels of importance. The same trend was noticed, all the proposed KPIs can be considered as important with variable levels from 3 (less important) to 7 (extremely important). For highlighting the highly important and extremely important KPIs, the KPIs with an overall mean ≥ 6 were considered. These KPIs can be identified as {LG18, LG17, LG20, LG19, LG13, LG9, LG16}. Relying on figure 4, LG19, LG9, and LG16 are not stable as most critical consequently LG19, LG9, and LG16 can be considered as important without a complete agreement. Relying on a full agreement of the most important KPIs, one can consider the four indicators listed in figure 5 for the BSC's "learning and growth" perspective. The same results can be obtained by selecting the KPIs with an overall average ≥ 6 and a standard deviation ≤ 0.5. The indicators of "Employees transparency over supply chain (LG18)" and "Employees collaboration over supply chain (LG17)" can be considered as extremely important where all respondents were rated them with values > 6 for all sectors of the supply Chain. On the other side, the indicators of "Employees productivity (LG13)" and "Ability for SC risk management (LG20)" can be considered as highly important where there are some values = 6 for some sectors (as shown by figure 4). These KPIs can be adopted to evaluate the performance of the learning and growth for all sectors of the supply chain of the food industry.

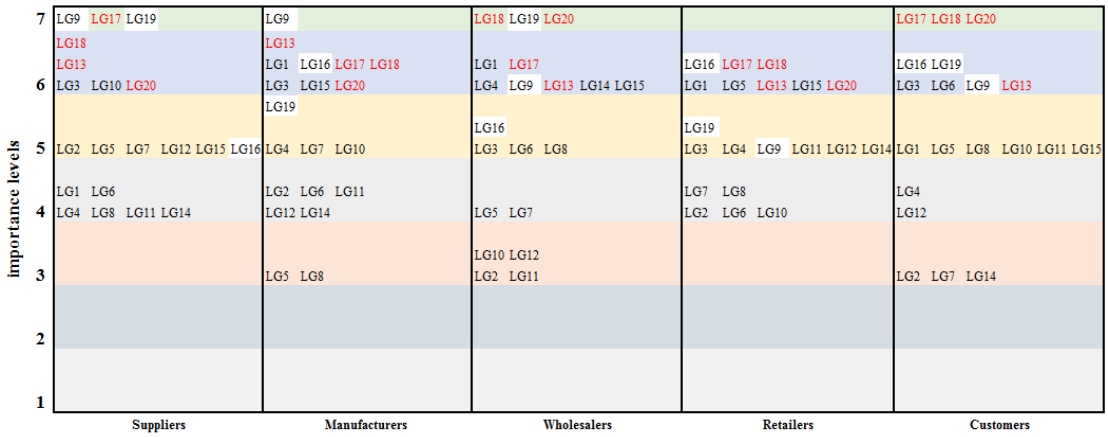

Figure 4 Distribution of the "Learning and growth" KPIs on the SMWRC of the food industry

Finally, the highly and most important key performance indicators are grouped and used to shape the proposed BSC as shown by figure 5. The shown model has been discussed with managers of the food companies and they validated its use for measuring the performance of the different FSC sectors. As shown the selected indicators can cover most of the criteria/attributes for measuring performance. The reliability, integration, agility, responsiveness, flexibility, risk management, product safety, trust, collaboration, assets management, cost, profit, time, and sustainability can be measured by the proposed BSC model. The reliability can be measured directly by "C8: Reliability of deliveries". The integration can be measured by "C5: Supply chain integration". The agility and responsiveness and flexibility of the food supply chain are very important interrelated performance criteria due to the high fluctuation and changes of the customer orders and behaviour. These performance criteria can be measured by "C7: Responsiveness to urgent delivery", "IP10: Manufacturing lead time", and "IP5: Total supply chain cycle time". Total supply chain cycle time. Supply chain risk management is an important criterion in the food supply chain, it can be measured by the ability of the FSC employees to manage risks using "LG20: Ability for SC risk management". The product's safety can be represented by the KPIs of the customer perspective C8 and C9 that represent respectively the product reliability and quality in addition to "IP16: Hazardous material used". The trust among the different stakeholders can be reflected by the level of information sharing that can be achieved via the employees' transparency and collaboration respectively LG17 and LG18. Assets management can be reflected by the internal process indicators that measure the development e.g. IP15: Internal supply chain improvement, IP19: Energy consumption, and IP5: Total supply chain cycle time. The cost and profit and can be measured directly by the different key performance indicators of the financial perspectives. The time criteria can be measured via responsiveness and the different lead time metrics. Sustainability is one of the important criteria that affect the performance of the FSC, this criterion can be measured via different metrics e.g. "F18: Reduction of the financial expenditure", "F20: Stability of the profit margin during the planned period", "C1: Distribution performance", "IP15: Internal supply chain improvement" and "LG20: Ability for SC risk management". Moreover, the model covers the management levels of strategic, tactical, and operational key performance indicators.

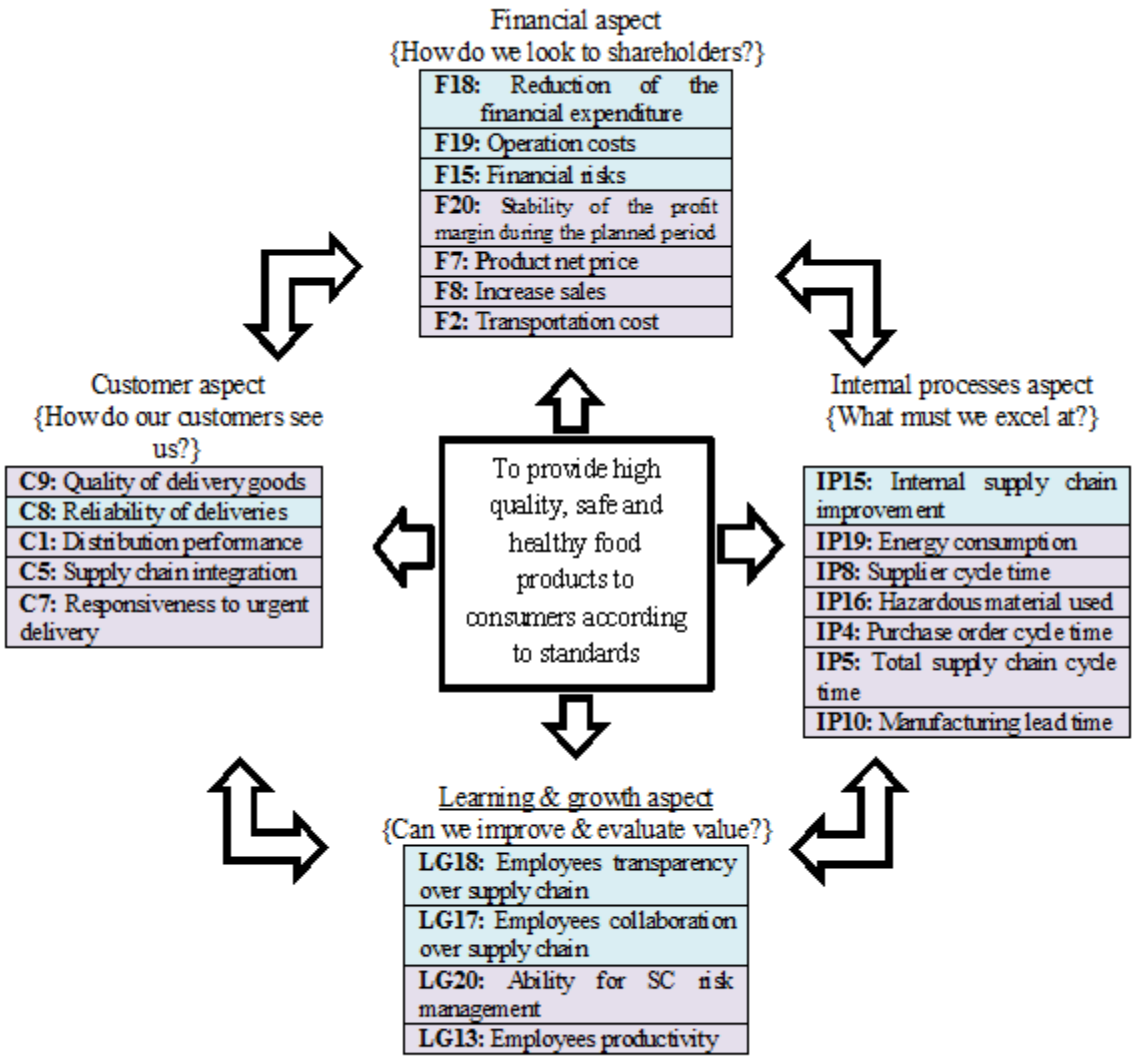

Figure (5) The most important KPI for performance evaluation of food supply chain in Libyan industrial organizations

5. CONCLUSIONS

Libyan food industrial organizations try to improve their performance as a prerequisite for survival in the current globalized working environment with hard completion. Measuring the food supply chain performance is crucial for self-assessment, benchmarking, and setting the corrective action that satisfies the pre-established strategic directions. The current paper introduces a generic balanced scorecard model that can be used to measure the performance of the different sectors of the food supply chain. The model was developed relying on scientific and practical perspectives. In which the different key performance indicators for each perspective of the BSC were collected and discussed with the industry experts to develop

the qualitative analysis. The industrial experts who are working in the different sectors of the food supply in Libyan organizations are asked to give an importance level for each KPIs and the four perspectives of the BSC. Regarding the BSC perspectives, the results show a subjective ranking of the perspectives. In other words, the important perspective depends on the supply chain sector. On an overage basis, the four perspectives can be rearranged as the financial, customer, internal processes, and learning & growth. Relying on the levels of high and extremely important key performance indicators for all the supply chain sectors, a shortlist of KPIs was highlighted for each BSC perspective. Consequently, a generic BSC model was constructed that can be used for any stage of the food supply chain. The proposed model was agreed upon by the industrial experts. Using the developed BSC model, different criteria can be measured for the food supply chain performance that includes reliability, integration, agility, responsiveness, flexibility, risk management, product safety, trust, collaboration, assets management, cost, profit, time, and sustainability. As a perspective of this work, a fuzzy logic approach will be developed to produce a structural approach for measuring food supply chain performance.

REFERENCES

[1] Wong, W. P. (2009). Performance evaluation of supply chain in stochastic environment: Using a simulation based DEA framework. *International Journal of Business Performance and Supply Chain Modelling*, *1*(2–3), 203–228. https://doi.org/10.1504/IJBPSCM.2009.030642

[2] Lambert, D. M., & Pohlen, T. L. (2001). Supply Chain Metrics. *The International Journal of Logistics Management*, *12*(1), 1–19. https://doi.org/10.1108/09574090110806190

[3] Cai, J., Liu, X., Xiao, Z., & Liu, J. (2009). Improving supply chain performance management: A systematic approach to analyzing iterative KPI accomplishment. *Decision Support Systems*, *46*(2), 512–521. https://doi.org/10.1016/j.dss.2008.09.004

[4] Sharma, J., Tyagi, M., & Bhardwaj, A. (2020). Parametric review of food supply chain performance implications under different aspects. *Journal of Advances in Management Research*, *17*(3), 421–453. https://doi.org/10.1108/JAMR-10-2019-0193

[5] Yontar, E., & Süleyman, E. (2020). Investigation of food supply chain sustainability performance for Turkey's food sector. *Frontiers in Sustainable Food Systems*, *4*(June), 68. https://doi.org/10.3389/fsufs.2020.00068

[6] Li, S., Ragu-Nathan, B., Ragu-Nathan, T. S., & Subba Rao, S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega*, *34*(2), 107–124. https://doi.org/10.1016/j.omega.2004.08.002

[7] Reddy. K, J. M., Rao. A, N., & L, Krishnanand. (2019). A review on supply chain performance measurement systems. *Procedia Manufacturing*, *30*, 40–47. https://doi.org/10.1016/j.promfg.2019.02.007

[8] Mishra, D., Gunasekaran, A., Papadopoulos, T., & Dubey, R. (2018). Supply chain performance measures and metrics: A bibliometric study. *Benchmarking: An International Journal*, *25*(3), 932–967. https://doi.org/10.1108/BIJ-08-2017-0224

[9] Mathiyalagan, P., Mannan, K., & Parthiban, P. (2014). Performance evaluation in supply chain using balanced scorecard. *International Journal of Advances in Mechanical & Automobile Engineering (IJAMAE)*, *1*(1), 4–10.

[10] Azfar, K. R. W., Khan, N., & Gabriel, H. F. (2014). Performance Measurement: A Conceptual Framework for Supply Chain Practices. *Procedia - Social and Behavioral Sciences*, *150*, 803–812. https://doi.org/10.1016/j.sbspro.2014.09.089

[11] knoema. (2018). Libya Food production index, 1960-2020. Retrieved June 12, 2021, from Knoema website: https://knoema.com//atlas/Libya/Food-production-index

[12] Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management*, *21*(1/2), 71–87. https://doi.org/10.1108/01443570110358468
[13] Gunasekaran, A., Patel, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal of Production Economics*, *87*(3), 333–347. https://doi.org/10.1016/j.ijpe.2003.08.003
[14] Gaiardelli, P., Saccani, N., & Songini, L. (2007). Performance measurement of the after-sales service network—Evidence from the automotive industry. *Computers in Industry*, *58*(7), 698–708. https://doi.org/10.1016/j.compind.2007.05.008
[15] Bhagwat, R., & Sharma, M. K. (2007). Performance measurement of supply chain management using the analytical hierarchy process. *Production Planning & Control*, *18*(8), 666–680. https://doi.org/10.1080/09537280701614407
[16] Zhou, H., & Benton, W. C. (2007). Supply chain practice and information sharing. *Journal of Operations Management*, *25*(6), 1348–1365. https://doi.org/10.1016/j.jom.2007.01.009
[17] Maestrini, V., Luzzini, D., Maccarrone, P., & Caniato, F. (2017). Supply chain performance measurement systems: A systematic review and research agenda. *International Journal of Production Economics*, *183*, 299–315. https://doi.org/10.1016/j.ijpe.2016.11.005
[18] Qazi, A., Dickson, A., Quigley, J., & Gaudenzi, B. (2018). Supply chain risk network management: A Bayesian belief network and expected utility based approach for managing supply chain risks. *International Journal of Production Economics*, *196*, 24–42. https://doi.org/10.1016/j.ijpe.2017.11.008
[19] Venkatesh, V. G., Zhang, A., Deakins, E., Luthra, S., & Mangla, S. (2019). A fuzzy AHP-TOPSIS approach to supply partner selection in continuous aid humanitarian supply chains. *Annals of Operations Research*, *283*(1), 1517–1550. https://doi.org/10.1007/s10479-018-2981-1
[20] Kirwan, J., Maye, D., & Brunori, G. (2017). Acknowledging complexity in food supply chains when assessing their performance and sustainability. *Journal of Rural Studies*, *52*, 21–32. https://doi.org/10.1016/j.jrurstud.2017.03.008
[21] Govindan, K., Mangla, S. K., & Luthra, S. (2017). Prioritising indicators in improving supply chain performance using fuzzy AHP: Insights from the case example of four Indian manufacturing companies. *Production Planning & Control*, *28*(6–8), 552–573. https://doi.org/10.1080/09537287.2017.1309716
[22] Yadav, S., Garg, D., & Luthra, S. (2020). Development of IoT based data-driven agriculture supply chain performance measurement framework. *Journal of Enterprise Information Management*, *34*(1), 292–327. https://doi.org/10.1108/JEIM-11-2019-0369
[23] Lin, L.-C., & Li, T.-S. (2010). An integrated framework for supply chain performance measurement using six-sigma metrics. *Software Quality Journal*, *18*(3), 387–406. https://doi.org/10.1007/s11219-010-9099-2
[24] Kaplan, R. S., & Norton, D. P. (1992, January 1). The Balanced Scorecard—Measures that Drive Performance. *Harvard Business Review*, (January–February 1992), 71–79.
[25] Varma, S., Wadhwa, S., & Deshmukh, S. G. (2008). Evaluating petroleum supply chain performance: Application of analytical hierarchy process to balanced scorecard. *Asia Pacific Journal of Marketing and Logistics*, *20*(3), 343–356. https://doi.org/10.1108/13555850810890093
[26] Bigliardi, B., & Bottani, E. (2010). Performance measurement in the food supply chain: A balanced scorecard approach. *Facilities*, *28*(5/6), 249–260. https://doi.org/10.1108/02632771011031493
[27] Yang, J. (2009). Integrative performance evaluation for supply chain system based on logarithm triangular fuzzy number-AHP method. *Kybernetes*, *38*(10), 1760–1770. https://doi.org/10.1108/03684920910994277
[28] Xia, D., Yu, Q., Gao, Q., & Cheng, G. (2017). Sustainable technology selection decision-making model for enterprise in supply chain: Based on a modified strategic balanced scorecard. *Journal of Cleaner Production*, *141*, 1337–1348. https://doi.org/10.1016/j.jclepro.2016.09.083
[29] Rasolofo-Distler, F., & Distler, F. (2018). Using the balanced scorecard to manage service supply chain uncertainty: Case studies in French real estate services. *Knowledge and Process Management*, *25*(3), 129–142. https://doi.org/10.1002/kpm.1572
[30] Thanki, S., & Thakkar, J. (2018). A quantitative framework for lean and green assessment of supply chain performance. *International Journal of Productivity and Performance Management*, *67*(2), 366–400. https://doi.org/10.1108/IJPPM-09-2016-0215
[31] Dwivedi, R., Prasad, K., Mandal, N., Singh, S., Vardhan, M., & Pamucar, D. (2021). Performance evaluation of an insurance company using an integrated Balanced Scorecard (BSC) and Best-Worst Method

(BWM). *Decision Making: Applications in Management and Engineering*, *4*(1), 33–50. https://doi.org/10.31181/dmame2104033d

[32] Peng Wong, W., & Yew Wong, K. (2008). A review on benchmarking of supply chain performance measures. *Benchmarking: An International Journal*, *15*(1), 25–51. https://doi.org/10.1108/14635770810854335

[33] Thakkar, J., Kanda, A., & Deshmukh, S. G. (2009). Supply chain performance measurement framework for small and medium scale enterprises. *Benchmarking: An International Journal*, *16*(5), 702–723. https://doi.org/10.1108/14635770910987878

[34] Essajide, L., & Ali, R. (2017). *Planning and Modelling of Pharmaceuticals Wholesale-Distributors Supply Chain Using SCOR Model: A Moroccan Case Study* (SSRN Scholarly Paper No. ID 2947573). Rochester, NY: Social Science Research Network. Retrieved from Social Science Research Network website: https://papers.ssrn.com/abstract=2947573

[35] Zuniga, R., Icarte, G., Griffiths, J., Lopez, J., & Quezada, J. (2018). Modeling of Critical Products Supply Chain Required to Affected People on Earthquakes and Tsunamis Through Use of SCOR Model. In M. Freitag, H. Kotzab, & J. Pannek (Eds.), *Dynamics in Logistics* (pp. 53–57). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-74225-0_7

[36] Bhagwat, Rajat, & Sharma, M. K. (2009). An application of the integrated AHP-PGP model for performance measurement of supply chain management. *Production Planning & Control*, *20*(8), 678–690. https://doi.org/10.1080/09537280903069897

[37] Sufiyan, M., Haleem, A., Khan, S., & Khan, M. I. (2019). Evaluating food supply chain performance using hybrid fuzzy MCDM technique. *Sustainable Production and Consumption*, *20*, 40–57. https://doi.org/10.1016/j.spc.2019.03.004

[38] Dey, P. K., & Cheffi, W. (2013). Green supply chain performance measurement using the analytic hierarchy process: A comparative analysis of manufacturing organisations. *Production Planning & Control*, *24*(8–9), 702–720. https://doi.org/10.1080/09537287.2012.666859

قياس اداء سلسلة التوريد الغذائي في المنظمات الصناعية الليبية باستخدام بطاقة الاداء المتوازن

فتحي المبسوط[1,2,*]، أحمد العسال[2]، العوضي عطية[1,3]

[1]قسم الهندسة الميكانيكية، كلية الهندسة، بنها، جامعة بنها، مصر، *fathialmbsot@gmail.com*
[2]قسم الهندسة الميكانيكية، كلية الهندسة، المرقب، جامعة المرقب، *amelassal@yahoo.com*
[3]قسم الهندسة الصناعية ، كلية الهندسة، الخرج، جامعة سطام بن عبد العزيز، السعودية، *elawady.attia@gmail.com*

الملخص

الورقة الحالية تحدد أهم مؤشرات الأداء الرئيسية لقياس أداء سلسلة التوريد الغذائي في ليبيا باستخدام بطاقة الأداء المتوازن. حيث تم إجراء تحليل نوعي بالتعاون مع خبراء في سلسلة الإمداد الغذائي من خلال مقابلات عقدت مع مسؤولين في المنظمات الصناعات الغذائية الليبية. وبهذا الصدد تم تجميع (20) مؤشر اداء لكل محور من محاور بطاقة الاداء المتوازن بحيث تم الحصول على 80 مؤشر للمحاور الاربعة المختلفة من بطاقة الاداء المتوازن ،هذه المؤشرات تم الحصول عليها وتجميعها من خلال دراسة الدراسات والبحوث السابقة المتعلقة بسلسلة التوريد الغذائي، حيث تم إعداد استبيان وتوزيعه على (125) شخصاً يعملون في المستويات الخمسة لسلسلة التوريد، (25) فردًا لكل مستوى وهم الموردين (S) والمصنعين (M) وتجار الجملة (W) وتجار التجزئة (R) والعملاء او الزبائن (C). تم تحليل الاستبيان ، وسلطت النتائج الضوء على قائمة مختصرة تشتمل فقط على عدد من مؤشرات الاداء كالاتي : (7) من المؤشر المالي، (5) من مؤشر الزبائن ، (7) من مؤشر العمليات الداخلية، (4) من مؤشر التعليم والنمو وبالتالي تم إنشاء نموذج عام لبطاقة الاداء المتوازن يمكن استخدامه لقياس الاداء في أي مرحلة من مراحل سلسلة التوريد الغذائي. ولقد تمت الموافقة على النموذج المقترح من قبل الخبراء الصناعيين ، كما انه يمكن ايضا بهذا النموذج قياس معايير اخرى مثل الموثوقية والاستجابة وادارة المخاطر وسلامة المنتج وادارة الاصول ، كذلك التكلفة والربح ايضا الوقت والتنمية المستدامة .

*البريد الالكتروني للباحث المرسل: fathialmbsot@gmail.com

الكلمات الدالة:
بطاقة الاداء المتوازن.
سلسلة التوريد الغذائي.
قياس الاداء.
مؤشرات الاداء.