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PRIORITISING CRITICAL SUCCESS FACTORS OF LEAN IMPLEMENTATION IN THE FOOD SUPPLY CHAIN

Asmae Mohib [1]
Abdelali En-nadi
Brahim Herrou

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A B S T R A C T

Lean initiatives have been largely implemented in organisations as a means to increase productivity and improve performance. Lean has recorded success in different sectors including the food industry. This article focuses on determining the critical success factors (CSFs) for the implementation of lean in the Moroccan food industry then ranking them using fuzzy TOPSIS. The results highlighted that the most six CSFs of Lean in the Moroccan food context are perceptively: communication, leadership and top management commitment, training and education, skills and expertise, employee involvement, and change in the company culture. This paper can help practitioners and professionals in the food industry as a guide for the success of lean implementation in their organisations.

1. INTRODUCTION

Around the world, food processing is among the biggest industries and takes a principal priority in numerous national economies. However, it is expected that by 2075 the world inhabitants will attain 9.5 billion, which will engender an acute rise in food production (Kazancoglu et al., 2021). An important number of challenges will be increased with the increment of the world's demography which are relative to meeting the expanding population needs, particularly the food security (Badraoui, 2019).

According to the report of the FAO (FAO 2011), one-third of the world's production of food is wasted or lost in the whole food supply chain (Zhao et al., 2020). Accordingly, high volumes of food industry waste draw attention at both the national and international level and in the political, scientific and social context.

In order to achieve sustainability in the agricultural sector, it is crucial to make the right decisions concerning the food supply chain (Chen et al., 2020). Furthermore, the elimination of waste in the food business necessitates a methodical and analytical way of thinking, where innovative and new manufacturing initiatives are considered. On the other hand, the lean manufacturing LM concept is a linked collection of tools, principles, practices, and techniques that the main goal is to remove and eradicate waste and non-value added operations. The implementation of the lean in organisations of food manufacturing can improve customer value by reducing cost (Lehtinen & Torkko, 2005). Also it can improve the

[1] Corresponding author: Asmae Mohib
Email: asmae.mohib@usmba.ac.ma

efficiency of production processes. (Goncharuk, 2009; Mahalik & Nambiar, 2010).

Lean is an initiative whose ultimate objective is to eliminate all sources of waste to satisfy the customers and shareholders demands (Asmae et al., 2020). The aim of lean is to enhance quality, and reduce costs and delivery times, as long as ameliorate staff safety. (Womack et al. 1990) described it as a "dynamic process of change, driven by a set of principles and best practices aimed at continuous improvement."

The eradication of waste (or "muda") and operations with non-value added is the focus of lean initiatives. Waste can be defined as anything that does not add value to the customer and add costs. According to Taiichi Ohno, the founding father of the Toyota Production System (TPS), there exist seven categories of wastes: overproduction, unnecessary transportation, unnecessary motion, excessive inventory, defects, waiting and inappropriate processing. The non-exploitation of employees skills and expertise to improve the company performance is added as an eighth category (Asmae et al., 2019).Several empirical studies in various industries, illustrated that LM has engendered multiple concrete and intangible profits as productivity, delivery, and quality improvement improvement and customer and employee satisfaction (Abdulmalek & Rajgopal, 2007; Fullerton & Wempe, 2009).

Encouraged by the effective results of Lean application in Toyota, numerous companies from different sectors and countries have tried the implementation of Lean techniques and tools to improve their productivity and develop their competitiveness. Recently, the increasing pressure from consumers and competitors in the food processing sector have made food organisations increase the adoption of Lean practices (Mahalik and Nambiar 2010; Scott eta al. 2009; Thomas and Barton 2006).

The development of lean methods has been widely linked to the automotive industry and other manufacturing industries (Liu et al., 2020). However, the Lean approach is a common method for the eradication of waste in the food sector (Vlachos, 2015). Several academics have confirmed the success of the application in the food supply chain (Liu et al 2020; Maalouf and Zaduminska, 2019; Vlachos 2015; Idrissi & Benazzouz 2019; Manzouri et al., 2014; Gładysz et al., 2020). The results revealed that the lean initiative is applicable in the agro-food supply chain and leads to waste elimination and performance improvement.

Despite the successful experiences, implementing lean approach in food supply chains is a not fully developed subject due to a number of challenges like insufficient understanding and awareness of the nature of "waste" and the absence of effective methods for eliminating/reducing waste in food supply chains (Folinas et al., 2013). The slow penetration of Lean into the agricultural business is associated with the complication of the agro food supply chain, the perishability of a large number of food products, and active consumer requirements (Dora et al., 2016).
(Maalouf & Zaduminska 2019) assert that the typical features of the food supply chain like seasonality, short shelf-life, and miscellaneous raw elements are the origin for the restricted utilisation of lean in the food sector. (Manzouri et al., 2014) evaluate the implementation of lean initiatives in the Malaysian supply chain of Halal food, the finding highlighted that plus than 70 percent of the firms stated that LM has not yet been applied in their company. (Dora et al., 2012) in their study have found that lean implementation in food processing is generally weak.

Afterward, there is a shortage in reporting the best practices or instructions concerning the evaluation of lean performance in food supply chains (Chen et al. 2020). Moreover, a restricted number of studies focus on the suitability of LM for the food processing industry (Mahalik and Nambiar 2010; Scott et al. 2009). Numerous studies have tackled the implementation of lean in developed countries in the agro food sector. But, only a limited number have been realised in Morocco (Farissi et al., 2021).

Moreover, a lot of researchers have studied the conceptualisation of lean enterprise but the establishment of such an enterprise generally is not as simple as application strategies would imply and the way for a profitable implementation is not clear (Richard et al. 2021). Before the implementation of lean, it is necessary as a first step in any context to determine and prioritise its critical enablers. A successful implementation of lean does not totally depend on correct methods and tools application only but also in determining and understanding the critical success factors that have to be followed (Costa et al., 2018).

There exist various researchers that have addressed the determination and the prioritisation of these enablers, usually introduced as critical success factors (CSFs) in different sectors and industries in the Moroccan context (Belhadi et al., 2018; Elboq et al., 2020; Arabi et al. 2022). Nevertheless, as far as the authors know, there doesn't exist a study that targeted the CSFs of lean implementation in the food manufacturing in Morocco. To close the gap, this article aims to identify and prioritise the CSFs of lean application in the food organisations in Morocco. Fuzzy technique for order of preference by similarity to ideal solution (TOPSIS) is adopted to determine and prioritise CSFs of LM using information that was gathered by distributing a survey to professionals of the Moroccan food organisations. The survey was designed to determine factors that are critical for an organisation to take in consideration when launching a lean project.

The motivation for this research is to figure out the effect of different determinants on the application of lean to help food companies to direct their resources and efforts in an appropriate way to raise the chances of a fruitable application.

The structure of the paper comprises the following sections. Section 2 presents a review of the literature of lean application in the food supply chain, section 3 illustrates the methodology of research. Section 4 introduces the main findings and discussion. The final part presents the conclusion and limitations.

2. LITERATURE REVIEW

2.1 Critical success factors

CSFs are the satisfactory results of a restricted amount of areas that will guarantee the successful competitive performance of the company (Zwikael & Globerson, 2006). (Rungasamy et al., 2002) considered CSFs as the principal factors that generate the success of any approach or program, according to this definition, if the purpose related with the factors are not realised, the application of the approach will possibly be unsuccessful.

In accordance with the definition of (Boynton & Zmud, 1984), CSFs are those few things that have to work out to assure success for an organisation or a manager. They illustrate those areas of management that must be continually accorded particular attention to attain high performance. CSFs involve issues that are fundamental to present operating activities of an organisation and to its success in the future (Boynton and Zmud 1984).

(Hofer and Schendel 1978) assert that the principal success factors are the variables that can be influenced by the management decisions that would considerably impact completely the competitive position of an industry. Generally, these factors differ from one sector to another. (Leidecker and Bruno1984) as well described CSFs as the variables, conditions or characteristics that may significantly influence the success of the firm when they are properly managed and maintained.

Critical Success Factors (CSFs) represent the main areas that require regular and accurate recognition from management that can be used to manage a working program in a better systematic way (Dobbins & Donnelly 1998). To deeply understand, CSFs allow a company to evaluate its opportunities, threats, strengths, and weaknesses in these dimensions, which is compulsory in establishing a robust strategy to attain desirable objectives (Leidecker & Bruno1984).

The CSFs can directly impact positively or negatively the performance. Actually, if they are correctly determined and applied, they can lead to success. Contrariwise, if the factors are not correctly utilised they can drive to failure (Houti et al., 2019).

2.2. CSFs of Lean implementation in food industry

Besides the successful experiences of Lean implementation, the literature also includes cases of unsuccessful lean adoption (Kundu & Manohar, 2012). The implementation of lean is not just about utilisation of a collection of tools, but it involves the utilisation of principles and systematic methodologies (Abdulmalek & Rajgopal, 2007). The disagreement of the results demonstrates the need to determine and understand the critical success factors (CSFs) or critical failure factors (CFSs) for Lean to ensure an appropriate and successful application.

Various researchers have identified and analysed the CSFs of Lean implementation in different activity sectors. Therefore, a review of different papers that have studied the CSFs and CFFs for a LM adoption in the food industry has been conducted. Table1 presents different sources that address CSFs and CFFs of lean implementation in the food organisations.

(Dora et al., 2013) analysed CSFs of Lean in food SME with a review of the literature and accomplished with a survey of three European food processing firms, the results showed that in-house expertise and skill of the workforce and organisational culture are the most CSFs for Lean initiatives. (Dora et al., 2016) assessed the determinants of Lean application in food SMEs by studying four food companies. They identified 12 determinants that impact the application of lean: piecemeal approach, culture, commitment of top management, training, change agent, multifunctional team, remuneration, resource, organisational structure, nature of the product, nature of the process, and nature of the plant.

(Costa et al., 2018) conducted a literature review concerning CSFs of lean in the food industry. The findings show that managerial factors including skilled workers, training program, management commitment, and change agent participation are the most cited in the literature.

(Farissi et al., 2021) in their study highlighted that the main barriers for lean adoption in the Moroccan food sector are the absence of training and knowledge, absence of management commitment, and poor delegation which means the lack of employee involvement. In addition, (Rifqi et al. 2021) have implemented tools of Lean and six sigma in a Moroccan cookies plant. During the implementation they faced multiple difficulties that influenced the application of lean are the absence of implication of the top management and the poor training and the lack of implication of the employees.

(Azalanzazllay et al., 2022) studied the determinants that influence the pre-implementation of lean and six sigma in the food processing. Based on the results, practitioners need to ensure that LSS implementation is fruitful by considering the following aspects: organisational culture

readiness, management support and leadership, employee involvement, project management, external relations, and process management. In addition, it was found that senior management and leadership is the most critical factor.

Table 1. Literature review of CSFFs and CFFs of lean in food manufacturing

Author	Activity sector	Methodology	Country	CSFs/CFFs	
Upadhye et al. 2010	Food manufacturing	Case study	India	☐ CSFs ☑ CFFs	Low knowledge and skills Low motivation Top management's commitment and support
Dora et al. 2016	Food manufacturing	Survey	Belgium	☑ CSFs ☐ CFFs	Commitment of top management Training Organisational culture Resources, Organisational structure, Multifunctional team, Remuneration and rewards Change agent, Piecemeal approach.
Vlachos 2015	Food manufacturing	Case study	UK	☐ CSFs ☑ CFFs	Lack of top management support Lack of lean knowledge Motivation
Message Costa et al. 2017	Food manufacturing	Literature review	US	☑ CSFs ☐ CFFs	Management commitment Training program Skilled workers Change agent participation
Borges Lopes 2015	Food manufacturing	Case study	Portugal	☐ CSFs ☑ CFFs	Lack of training Lack of involvement of employees Lack of a continuous improvement culture Lack of monitoring
Rifqi et al. 2021	Food manufacturing	Case study	Morocco	☐ CFFs ☑ CFFs	Lack of top management involvement Lack of Training Lack of Employees implication
Farissi et al. 2021	Food manufacturing	Survey	Morocco	☐ CSFs ☑ CFFs	Lack of management commitment Lack of training and knowledge Poor delegation
Azalanzazllay et al. 2022	Food manufacturing	Case study	Malaysia	☑ CSFs ☐ CFFs ☑ CSFs	Management support and leadership Organisational culture readiness Project management Employee involvement Process management External relations
Moya et al. 2016	Food manufacturing	Case study	Ecuador	☐ CFFs	Training Commitment and involvement of high direction Leadership

After reviewing the literature focusing on CSFs of lean, 12 CSFs were extracted and presented in table 2. Actually, during the CSFs' investigation the difficulty faced by the authors was the utilisation of various terms by different researchers for the same CSF.

Table 2. CSFs of lean implementation and their frequency in the literature

Critical success factors of Lean implementation		Authors
CSF1	Leadership and top management commitment	(Achanga et al., 2006); (Larteb et al.,2015); (Elkhairi et al., 2019) ; (Bakås Ottar et al., 2011); (Dora et al., 2016); (Belhadi et al., 2018) ; (Chahal et al., 2021); (Yuik et al., 2020); (Houti et al.,2019); (De La Vega et al., 2020) ; (Upadhye et al., 2010); (Vlachos 2015); (Costa et al., 2018), (Rifqi et al.,2021); (Farissi et al., 2021); (Azalanzazllay et al 2022); (Moya et al., 2016)
CSF2	Employee involvement	(Bakås Ottar et al., 2011); (Noori 2015); (Marin-Garcia and Bonavia 2015) ; (Rifqi et al.,2021); (Farissi et al., 2021) ; (Azalanzazllay et al 2022); (Yuik et al., 2020)
CSF3	Suppliers link	(Noori et al., 2015); (De La Vega et al., 2020) ; (Azalanzazllay et al 2022); (Yuik et al., 2020); (Wilfred et al., 2018)
CSF4	Progress monitoring	(Bakås Ottar et al., 2011); (Houti et al.,2019); (Borges Lopes et al., 2015); (Larteb et al.,2015)
CSF5	Skills and expertise	(Achanga et al., 2006); (Dora et al., 2013); (Belhadi et al., 2018); (Houti et al.,2019); (Upadhye et al., 2010); (Vlachos 2015); (Costa et al., 2018)
CSF6	Change in the company culture	(Achanga et al., 2006); (Dora et al., 2016); (Bakås Ottar et al., 2011); (Belhadi et al., 2018); (Elkhairi et al., 2019); (Houti et al.,2019); (Borges Lopes et al., 2015); (Azalanzazllay et al 2022); (Yuik et al., 2020)
CSF7	Communication	(Belhadi et al., 2018); (Elkhairi et al., 2019) ; (Houti et al.,2019); (Yuik et al., 2020)
CSF8	Training and education	(Bakås Ottar et al., 2011); (Dora et al., 2016); (Belhadi et al., 2018); (Elkhairi et al., 2019); (Gandhi et al., 2018) ; (Houti et al.,2019); (De La Vega et al., 2020) ; (Costa et al., 2018); (Borges Lopes et al., 2015); (Rifqi et al.,2021); (Farissi et al., 2021); (Larteb et al.,2015); (Moya et al., 2016)
CSF9	Customer focus	(De La Vega et al., 2020); (Hibadullah et al 2014); (Yuik et al., 2020)
CSF10	Link the method to the company strategy	(Noori 2015); (Houti et al.,2019)
CSF11	Kaizen team	(Dora et al., 2016); (Noori 2015); (Houti et al.,2019); (Costa et al., 2018); (Azalanzazllay et al 2022); (Larteb et al.,2015);
CSF12	Motivation and Reward system	(Dora et al., 2016); (Chahal et al., 2021); (Upadhye et al., 2010); (Vlachos 2015); (Larteb et al.,2015);

2.3. Fuzzy TOPSIS:

Multi-Criteria Decision Making (MCDM) techniques are widely used in several disciplines, they can deal with a large range of economics, engineering, social, and management issues (Salih et al., 2019). The problems of decision making, in many real-world situations, can be a subject to many constraints, consequences and objectives that are not exactly recognised. Fuzzy sets within MCDM were proposed for the first time by (Bellman and Zadeh 1970) to handle the ambiguity of human judgement.

Fuzzy multi-criteria decision making (FMCDM) has been introduced by the integration of MCDM and fuzzy set theory, which includes models for decision-makers that manage uncertain and incomplete knowledge and information (Nădăban et al., 2016). Fuzzy numbers (FN) are used to present linguistic variables and interpret in a quantitative way the subjective assessment of a decision maker.

Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) is one of the popular tools used to solve problems in MCDM (Salih et al., 2019). The idea was proposed by Hwang and Yoon. According to this approach, the selected alternative must be the one that has the greatest distance to the Negative Ideal Solution (NIS) and the shortest distance to the Positive Ideal Solution (PIS) (Nădăban et al., 2016). TOPSIS was extended with FNs by (Chen 2000). Instead of numerical values, the fuzzy TOPSIS method uses linguistic assessments to make it more realistic (Chen 2000). Fuzzy TOPSIS is suggested where the ratings of alternatives and weights of criteria are rated by linguistic variables expressed by fuzzy numbers (Ertuğrul and Karakaşoğlu 2008).

Fuzzy TOPSIS has been used in different contexts in the literature. It was applied by several researchers to weight and prioritise CSFs of different continuous improvement methods and approaches including LM (Ravikumar et al.,

2016; Sohrabi and Khavanin 2015; Little and McKinna 2005).

According to (Chen 2000) fuzzy TOPSIS is applied by following a number of steps:
Step 1: Create a decision-makers commission, then determine the criteria to evaluate.

Step 2: Select which linguistic variables are suitable to rate alternatives and the weighting of criteria based on the linguistic variables (see table 3 and table 4).

Step 3: Combine the weight of criteria to obtain the aggregated fuzzy weight $\tilde{w}_j$ of criterion C_j and pool the decision makers' opinions to get the aggregated fuzzy rating $\tilde{x}_{ij}$ of alternative A_i under criterionC_j.

Assume that a K person's decision group, with respect to each criterion the importance of the criteria and the rating of alternatives can be determined as:

$$\tilde{x}_{ij} = \frac{1}{K}[\tilde{x}^1{}_{ij} + \check{x}^2{}_{ij} + \cdots + \tilde{x}^K{}_{ij}] \quad (1)$$

$$\tilde{w}_j = \frac{1}{K}[\tilde{w}^1{}_j + \tilde{w}^2{}_j + \cdots + \tilde{w}^K{}_j] \quad (2)$$

Where $\tilde{x}^K{}_{ij}$ and $\tilde{w}^K{}_j$ are the rating and the importance weight of the Kth decision maker.

Step 4: Form the fuzzy decision matrix and the normalised fuzzy decision matrix.

A fuzzy multicriteria group decision-making problem which can be briefly presented in the form of a matrix as

$$\tilde{D} = \begin{matrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{matrix} \quad (3)$$

$$\tilde{W} = \tilde{w}_1, \tilde{w}_2, \cdots, \tilde{w}_n \quad (4)$$

Where $\tilde{x}_{ij}$; $\forall i,j$ and $\tilde{w}_j$; j =1,2…, n are linguistic variables. These linguistic variables may be expressed by triangular fuzzy numbers,

$\check{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$
The linear scale transformation is applied here to convert the various criteria scales into a comparable scale, in order to avoid the complex normalisation formula used in classical TOPSIS. Then, we can get the normalised fuzzy decision matrix designated by$\tilde{R}$.

$$\tilde{R}_{ij} = [\tilde{r}_{ij}]_{m\times n} \quad (5)$$

Where B is the benefit criteria and C the cost criteria, and

$$\tilde{r}_{ij} = (\frac{a_{ij}}{c^*{}_j}, \frac{b_{ij}}{c^*{}_j}, \frac{c_{ij}}{c^*{}_j}),\ j\epsilon\ B;$$

$$\tilde{r}_{ij} = (\frac{a^-{}_j}{c_{ij}}, \frac{a^-{}_j}{b_{ij}}, \frac{a^-{}_j}{a_{ij}}),\ j\epsilon\ C$$

$$c^*{}_j = c_{ij}\ \ if\ j\epsilon B$$
$$a^-{}_j = a_{ij}\ if\ j\ \epsilon\ C$$

Step 5: Create the weighted normalised fuzzy decision matrix.

Taking on consideration the different importance of each criterion, we can form the weighted normalised fuzzy decision matrix as

$$\tilde{V} = [\tilde{v}_{ij}]_{m\times n}\ ;\ i = 1,2\ \ldots, m\ ; j = 1,2, \ldots, n \quad (6)$$

Where $\tilde{v}_{ij} = \tilde{r}_{ij} * \tilde{w}_j$

Step 6: Construct FPIS and FNIS.

Fuzzy positive-ideal solution (FPIS,A^*) and fuzzy negative-ideal solution (FNIS, A^-) can be determined as

$$A^* = (\tilde{v}^*{}_1, \tilde{v}^*{}_2, \ldots, \tilde{v}^*{}_n)\ ;$$
$$A^- = (\tilde{v}^-{}_1, \tilde{v}^-{}_2, \ldots, \tilde{v}^-{}_n)$$

Where $\tilde{v}^*{}_j = (1,1,1)$ and $\tilde{v}^-{}_j = (0,0,0)$; j=1, 2,…,n

Step 7: Calculate the distance of each alternative from FPIS and FNIS, respectively.

$$d^*{}_i = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \check{v}^*{}_j), i = 1,2\ \ldots, m \quad (7)$$

$$d^-{}_i = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \check{v}^-{}_j), i = 1,2\ \ldots, m \quad (8)$$

Step 8: define the closeness coefficient of each alternative. To define the ranking order of all alternatives, the closeness coefficient is calculated.

$$CC_i = \frac{d^-{}_i}{d^*{}_i + d^-{}_i}, i = 1,2, \ldots, m \quad (9)$$

Step 9: The ranking order of all alternatives is defined according to the closeness coefficient. An alternative A_i has the greatest distance from FNIS (A^-) and have the closest distance from the FPIS (A^*) as CC_iapproaches to 1.

Table 3. Linguistic variables for the ratings (Nădăban et al., 2016)

Linguistic terms for alternatives ratings	Triangular FN
Very poor	(1,1,3)
Poor	(1,3,5)
Medium	(3,5,7)
Good	(7,9,10)
Very good	(9,10,10)

Table 4. Linguistic variables for the importance weight of each criterion (Nădăban et al., 2016)

Rank	Triangular FN
Very low	(0.00, 0.10, 0.30)
Low	(0.10, 0.30, 0.50)
Medium	(0.30, 0.50, 0.75)
High	(0.50, 0.75, 0.90)
Very high	(0.75, 0.90, 1.00)

3. RESEARCH METHODOLOGY

As a principal objective, this paper aims to determine lean implementation CSFs in the Moroccan food organisations. The researchers adopted the survey instrument as a data collection strategy. The questionnaire was electronically created employing Google Form ©. Several steps were followed to create the survey as shown in figure1. As a first step, the literature was reviewed to determine the main variables of the survey by reviewing papers dealing with the same subject, focusing on LM in the food industry. After the structure and the formulation of the questionnaire a pre-test of the questionnaire was done by a group of 10 experts qualified in the food industry.

The group of experts include two academics, two CEO of two companies leader in the food industry in Morocco with plus than 15 years of experience, two lean six sigma consultants certified lean six sigma black belt with more than 5 years of professional experience in lean implementation, two food supply chain responsible and two quality engineers with lean six sigma certification. The pre-test assures the validity and the reliability of the questionnaire. Revisions and adjustments have been made to the questionnaire based on their observations and suggestions. Eventually, all the experts strongly affirmed the validity of the final edition of the questionnaire and it was ready to be delivered.

The survey has been distributed randomly to 100 organisations with the activity of food processing in Morocco via e-mail attachments, including a cover letter presenting the objective of the investigation in French language. The survey was distributed from September 2021 through September 2022. Response rate of 40% was achieved with 40 valid responses. The size of the sample is corresponding to surveys previously realised in the field of quality management, as an example (Little and McKinna 2005) with 12 %, (Fotopoulos et al., 2011) with 31 observations, (Kumar and Antony 2008) with 12.8% (64 observations), (Scott et al., 2009) with 11% (48 observations), and (Dora et al., 2016) with 15.2% (35 observations).

The statistical package for social sciences SPSS was adopted to treat the gathered information. Graphs and tables are used to interpret the outputs of data analysis for further discussion.

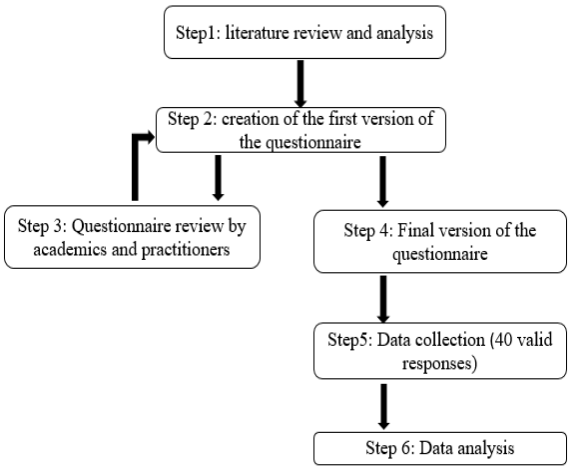

Figure 1. Research methodology

4. RESULTS AND DISCUSSION

The aim of the first section of the survey is to collect general information about the responding organisation's profile like activity area, the size and the age of the organisation, as well as other quality management practices history. The second section aimed to obtain data about the level of lean implementation in the companies (whether lean is implemented or not, how many years lean has been implemented). The third section intended to determine CSFS of lean in the Moroccan food context.

4.1. General information on the respondent organisation

In the first section of the questionnaire, the background of the organisations and the profile of the participants are described. 75 percent of the organisations are large enterprises and 25 percent are SMEs. 25 percent of the companies are aged more than 15 years and only 5 percent are newly settled with an age less than 5 years.
The gathered data of the various activity sectors included beverage 15 percent, Dairy 17.5 percent, vegetables and fruits 12.5 percent, flour milling 10 percent other sectors and more details are presented in table5.

The survey contained respondents from different hierarchies and positions within the firm: senior management 60 percent, middle management 27.5 percent and others (technicians, controllers and operators) with 12.5 percent. The participants were asked to determine the years of experience in their actual position. 35 percent of the participants are beginners with less than 2 years of experience in their posts (the majority have senior management positions that require several years of experience), 42.5 percent are experienced with years of experience between 2 and 10 years, and 22.5 percent are experts with plus than 10 years of experience.

Table 5. Overall representation of the general information of the responding organisations

Characterictics	Frequency	percentage
Company size:		
SME	8	25
Large enterprise	24	75
Activity sector:		
Biscuit	2	5
Beverage	6	15
Charcuterie	4	10
Canned products	2	5
Dairy	7	17.5
Vegetables and fruits	5	12.5
Flour mill	4	10
Fish	3	7.5
Sugar	3	7.5
Others	4	10
Company age:		
Less than 5 years	2	5
Between 5 and 10 years	6	15
Between 10 and 15 years	7	17.5
More than 15 years	25	62.5
Position held :		
Senior management	24	60
Middle management	11	27.5
Others	5	12.5
Experience years in the actual position:		
Beginner "Less than 2 years"	14	35
Experimented "2 to10 years"	17	42.5
Expert "plus than 10 years"	9	22.5
Lean implementation:		
Implemented	32	80
Not implemented	8	20
For how long lean has been implemented?		
Less than 3 years	15	37.5
Between 3 and 6 years	7	17.5
Between 6 and years	3	7.5
More than 9 years	7	17,5
Not implemented	8	20.0
Where lean has been implemented?		
Implemented in few departments	16	40
Implemented in most departments	12	30
Implemented throughout the company including suppliers	4	10
Not implemented	8	20

Furthermore, the participants were demanded to assert what approaches of quality improvement were currently utilising in their organisations and what quality system standardizations their companies were certified. The survey's results show that 3 of the participating organisations were just certified ISO9001, others were certified ISO9001 besides others, while 6 organisations were not certificated.

4.2. Level and motivation of implementing LM in the organisations

A survey was conducted with Moroccan food industry participants to determine the status of lean adoption, the participants were asked if their company has implemented lean approach and if yes for how many years and in how many departments. The results showed that 80 percent of the respondents have applied lean in their organisations and 20 percent have not applied lean. Amid the organisations that have implemented lean 37.5 percent have implemented Lean for Less than 3 years, 17.5 percent between 3 and 6 years, 7.5 percent between 6 and 9 years, and 17.5 percent have implemented Lean techniques for more than 9 years. Lean techniques and tools have been implemented in a small number of departments for 40 percent of the organisations and 30 percent have applied Lean in most departments, while only 10 percent of companies have implemented Lean through the whole company.

In order to determine determinants that drove organisations in the food industry to embrace lean. The respondents were requested to indicate the motivation factors of lean implementation. After a revision of the previous studies, and adopting the classification of costa 2018 the motivation factors were classified in 4 categories as follow: time, value, defect and cost. The participants were required to select one or more appropriate factors. This question is a multiple choice question from which it is allowed to simultaneously choose one or multiple options. Table 6 presents the table analysed by SPSS of multi-response frequencies including numbers and percentages.

Table 6. Motivation factors of lean implementation

Motivation factors	Answers		Percentage of observations
	N :	Percentage :	
Time	25	24.3%	67.6%
Value	24	23.3%	64.9%
Defect	26	25.2%	70.3%
Cost	28	27.2%	75.7%
Total	103	100.0%	278.4%
a. Group of dichotomies tabulated at value 1.			

It is noted that the sum of answers (103) is higher than the total of participants which is 40, and the total of the observations percentage (or participants percentage) 278.4 percent is higher than 100 percent which illustrate the sum of the percentages, because multiple options are possible and participants can select 4 answers at a time. This result signifies that every participant has an average of 2.784 motivations or reasons to implement lean.

As shown in table 4 cost (75.7 percent) ranked as the most important factor motivating food industry participants to apply lean practices in their companies followed by defect (70.3 percent), time (67.6 percent), while value (64.9 percent) was the last ranked factor. The

results confirm the founding of costa et al 2018 which indicate that drivers related to cost are what motivate organisations the most for lean implementation followed by defects.

The cost related factors are the main factors that motivate food companies to adopt lean. This result can be explained by the usual price reduction in the food products required by the powerful retailers who apply a high pressure on food producers (Jain and Lyons 2009). In addition the food sector has become more competitive and customers have become more selective which pushes professionals in the food industry to decrease cost and time and enhance quality by eliminating defects to meet customer demands. On the other hand, other factors are explicitly related to the cost factor as reported by (Hopp and Spearman 2004). The elimination of waste presented in time and defects will lead to the reduction of cost.

4.3. Prioritising CSFs using fuzzy TOPSIS

To define the main critical success factors for Lean implementation in the Moroccan food supply chain, a list of 12 items (table 2) presenting success factors considered critical for lean application extracted from previous studies in lean implementation. The list was afterward inserted in the survey, and the respondents were required to assess the importance of the factors according to the Likert scale. The question was developed in a 5 point Likert scale from 1 to 5 to determine CSFs of lean: not important (1), slightly important (2), important (3), very important (4), critical (5).
The empirical validation of the information was executed by applying Cronbach alpha to check the internal consistency and the reliability of the 12 items of the measurement instrument. The Cronbach alpha value differs from 0 to 1. A greater consistency of the items is defined by a higher value of alpha (Cronbach 1951). Generally, an alpha value is acceptable and indicates high internal consistency when it ranges from 0.70 to 0.95 (Mpofu et al., 2017; Jin et al., 2017). In this study the alpha value of the scale is 0.9 greater than 0.7, which signifies a high internal consistency of the five-point scale measurements and ratifies the reliability of the scale for the objective of this survey.

To have a relevant sampling, the answers of participants who have not implemented lean (they are the same organisations that are not certified) in their organisations (8 participants) have been eliminated and 32 answers were considered. The likert scale was converted to the linguistic variables of TOPSIS as shown in table 7.

Table 7. Motivation factors of lean implementation

Likert scale	**TOPSIS linguistic variables**
Unimportant	Very poor
Slightly important	Poor
Important	Medium
Very important	Good
Critical	Very good

For the ranking of the 12 factors, the fuzzy TOPSIS steps were followed as presented above in the fuzzy TOPSIS approach section. In the first step the linguistic weighting variables (presented in Table 8) were used to assess the importance of the items. In Step2 the linguistic rating variables (presented in Table 3) were used to assess the rating of alternatives with respect to each criterion. By using step3 the linguistic evaluation was transformed into triangular fuzzy numbers to create the fuzzy decision matrix and define the fuzzy weight of each criterion as Table 4.

The matrix is based on all the information available on factors. Every row of the matrix is allocated by one factor and every column is assigned a value by an expert. As a step4 the normalised fuzzy decision matrix was formed and presented in table. Next the weighted normalised fuzzy decision matrix was formed and the negative and positive ideals for the CSFs were calculated. The equations 7 and 8, were used to obtain the distance d+ and d− for each factor. The CCi is defined for each factor utilising equation 9. The values of d+, d− and CCi with the rank of CSFs are presented in Table8.

Table 8. TOPSIS linguistic variables corresponding to likert scale

CSFs	d*	d^-	CCi	Rank
Communication	2,99	12,80	0,81	1
Leadership and top management commitment	3,05	12,63	0,80	2
Training and education	3,57	11,74	0,77	3
Skills and expertise	3,98	11,17	0,74	4
Employee involvement	4,17	10,99	0,73	5
Change in the company culture	5,08	9,85	0,66	6
Progress monitoring	6,28	8,76	0,58	7
Motivation and reward system	6,66	8,37	0,56	8
Link the method with the company's strategy	7,97	7,75	0,49	9
Customer focus	8,20	6,08	0,43	10
Kaizen team	10,25	5,10	0,33	11
Supplier link	11,43	3,88	0,25	12

The findings show that the six most important CSF for lean implementation in the food industry for Moroccan professionals are respectively communication, leadership and top management commitment, training and education, skills and expertise, employee involvement, and change in the company culture. For the six less important CSFs include respectively: progress monitoring, motivation and reward system, link the method with the company's strategy, customer focus, Kaizen team and supplier link.

LM initiatives necessitate essentially a completely distinctive management philosophy than the approach of

classical mass production (Larteb et al., 2015). Furthermore, to attain superior results and organisational objectives in product and process quality the integration of LM practices in the shop floor by the means of an accurate and superlative lean leadership is required (Moya et al., 2016).

Communication is a very important enabler for lean implementation success and it is considered as a main characteristic for an effective leadership of LM. Developing and applying both visual and verbal and mutual effective communication structures and systems play a vital role in engaging and involving staff in the improvement process of LM (Laureani and Antony 2017).

The success of LM in the food industry necessitates an important degree of skills and knowledge of lean initiatives. The qualified skill and knowledge consist of the competence of the workers, the training and the learning of employees (Punnakitikashem et al., 2013). Training must also be at the level of management not only at the employee level to expand the management changes dynamics in the whole organisation (Asnan et al., 2014).

The training and the educational programs must develop the knowledge on the particular aspects of the food industry. Because, without an appropriate understanding of the particular features of the food sector, the LM practices may not lead to the wanted outcomes or would even be unprofitable (Cox, A., and D. Chicksand. 2008).

In addition, food supply chains have multiple characteristics that distinguish them from other supply chains. So organisations need to improve dynamic competences and an organisational learning culture in order to allow quick and effective response to the challenges of the rapid changing and hypercompetitive environment (Manville et al 2012) of the food industry. Consequently, the process of the LM implementation has to be regulated to distinct internal and external characteristics of food organisations.

5. CONCLUSION:

Lean approach is considered as an applicable improvement initiative for food manufacturing. The successful implementation of LM in food organisations can eliminate food waste which is considered as a very important issue worldwide. To attain the desirable improvement and guarantee a successful lean implementation, it is critical for organisations to establish an effective CSFs-based implementation roadmap.

In this context, this study can help professionals and researchers to gain an accurate and deep understanding of lean CSFs and provide them with insights about some features regarding lean implementation in the field.

The survey results of 40 organisations operating in the food industry in Morocco indicate that the plurality of the enterprises have been implemented lean in less than 3 years (37.5 percent) and the tools and techniques of LM have been applied in a small number of departments (40 percent). Which confirms that lean is an evolving approach in the food industry and its implementation is low and still in the first stages.

The findings of prioritising CSFS using fuzzy TOPSIS identified the most important CSFs in the point of view of Moroccan food professionals. It was found that the most six CSFs of lean in the Moroccan food context are respectively: communication, commitment and support of top management, training and education, skills and expertise, employee involvement, and change in the company culture. The factors are management-resource related which are linked and complete each other.
This paper reply to the need determined in the literature of lean philosophy in the food sector to examine the factors that affect the implementation of LM, since there is a shortage in the literature about lean CSFs in the food industry in general and in the Moroccan context in specific.

This study is limited to the Moroccan food industry only. On the other hand, the number of companies questioned is limited and the gathered data are restricted; but it can be the base of a case study that will examine the applicability of the CSFs in the Moroccan food industry.

References:

Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of production economics, 107*(1), 223-236.

Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of production economics, 107*(1), 223-236.

Achanga, P., Shehab, E., Roy, R., & Nelder, G. (2006). Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management, 17*(4), 460-471. doi: 10.1108/17410380610662889

Arabi, S., Bajjou, M. S., Chafi, A., & El Hammoumi, M. (2022, March). Evaluation of critical success factors (CSFs) to lean implementation in Moroccan SMEs: A survey study. In *2022 2nd International Conference on Innovative Research in Applied Science, Engineering and Technology (IRASET)* (pp. 1-10). IEEE.

Asmae, M., Abdelali, E., Youssef, S., & Brahim, H. (2019, June). The utility of Lean Six Sigma (LSS) in the Supply Chain agro-industry. In *2019 International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA)* (pp. 1-7). IEEE.

Asmae, M., En-Nadi, A., & Herrou, B. (2020, December). The integration of Lean Manufacturing in Supply Chain: principles, wastes and tools. In *2020 IEEE 13th International Colloquium of Logistics and Supply Chain Management (LOGISTIQUA)* (pp. 1-6). IEEE, 9353896.

Asnan, R., Nordin, N., & Othman, S. N. (2014). Lean implementation in service sector: the role of change agent. *Proceedings of the 4th International Conference on Technology and Operations Management*, Malaysia, Universiti Utara Malaysia, 1- 6.

Azalanzazllay, N. N., Lim, S. A. H., Abidin, U. F. U. Z., & Anass, C. (2022). Uncovering Readiness Factors Influencing the Lean Six Sigma Pre-Implementation Phase in the Food Industry. *Sustainability*, *14*(14), 8941.

Badraoui, I. (2019). Horizontal logistics collaboration: cases from agri-food supply chains in Morocco (Doctoral dissertation, Wageningen University and Research).

Bakås Ottar, Govaert Tim, and Van Landeghem Hendrik. Challenges and success factors for implementation of lean manufacturing in European SMEs. MITIP 2011, Norwegian University of Science and Technology, Trondheim, Norway.

Barclay, R. C., Cudney, E. A., Shetty, S., & Antony, J. (2022). Determining critical success factors for lean implementation. *Total Quality Management & Business Excellence*, *33*(7–8), 818–832. https://doi.org/10.1080/14783363.2021.1894919

Belhadi, A., Touriki, F. E., & Elfezazi, S. (2018). Evaluation of critical success factors (CSFs) to lean implementation in SMEs using AHP: A case study. *International Journal of Lean Six Sigma*, *10*(3), 803-829.

Bellman RE, Zadeh LA. *Decision-making in a fuzzy environment. Management Science 1970*, *17*(4): 141-164.

Borges Lopes, R., Freitas, F., & Sousa, I. (2015). Application of lean manufacturing tools in the food and beverage industries. *Journal of technology management & innovation*, *10*(3), 120-130.

Boynton, A.C., Zmud, R.W. (1984), "An Assessment of Critical Success Factors", Sloan Management Review, Vol. 25 No. 4, pp.17-27.

Chahal V., Narwal M.S., Kumar S. (2021) *Ranking of Lean Critical Success Factors in Manufacturing Industry: AHP Approach*. In: Pandey C., Goyat V., Goel S. (eds) Advances in Materials and Mechanical Engineering. Lecture Notes in Mechanical Engineering. Springer, Singapore. https://doi.org/10.1007/978-981-16-0673-1_34

Chen, C.-T. (2000). Extensions of the TOPSIS for group decision-making under fuzzy environment. *Fuzzy Sets and Systems*, *114*(1), 1–9. https://doi.org/10.1016/S0165-0114(97)00377-1

Chen, H., Liu, S., & Oderanti, F. (2017). A knowledge network and mobilisation framework for lean supply chain decisions in agri-food industry: *International Journal of Decision Support System Technology*, *9*(4), 37–48. https://doi.org/10.4018/IJDSST.2017100103

Costa, L. B. M., Godinho Filho, M., Fredendall, L. D., & Gómez Paredes, F. J. (2018). Lean, six sigma and lean six sigma in the food industry: A systematic literature review. *Trends in Food Science & Technology*, *82*, 122–133. https://doi.org/10.1016/j.tifs.2018.10.002

Cox, A., & Chicksand, D. (2008). Rethinking policy options for industry: Appropriateness in policies for industry and uk farming and food. *Public Administration*, *86*(3), 813–836. https://doi.org/10.1111/j.1467-9299.2008.00726.x

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. https://doi.org/10.1007/BF02310555

Dobbins, J. H., & Donnelly, R. G. (1998). *Summary research report on critical success factors in federal government program management*. DEFENSE SYSTEMS MANAGEMENT COLL FORT BELVOIR VA.

Dora, M., Kumar, M., & Gellynck, X. (2016). Determinants and barriers to lean implementation in food-processing SMEs – a multiple case analysis. *Production Planning & Control*, *27*(1), 1–23. https://doi.org/10.1080/09537287.2015.1050477

Dora, M., Kumar, M., Van Goubergen, D., Molnar, A., & Gellynck, X. (2013). Operational performance and critical success factors of lean manufacturing in European food processing SMEs. *Trends in Food Science & Technology*, *31*(2), 156–164. https://doi.org/10.1016/j.tifs.2013.03.002

Dora, M., Van Goubergen, D., Molnar, A., Gellynck, X., & Kumar, M. (2012). *Adoptability of lean manufacturing among small and medium food processing enterprises*. In IIE Annual Conference. Proceedings (p. 1). Institute of Industrial and Systems Engineers (IISE).

Elboq, R., Hlyal, M., & El Alami, J. (2020). Empirical assessment of critical success factor of lean and six sigma in the Moroccan automotive industry. *IOP Conference Series: Materials Science and Engineering*, *827*(1), 012043. https://doi.org/10.1088/1757-899X/827/1/012043

Elkhairi, A., Fedouaki, F., & Alami, S. E. (2019). Barriers and critical success factors for implementing lean manufacturing in smes. *IFAC-PapersOnLine*, *52*(13), 565–570. https://doi.org/10.1016/j.ifacol.2019.11.303

Ertuğrul, İ., & Karakaşoğlu, N. (2008). Comparison of fuzzy AHP and fuzzy TOPSIS methods for facility location selection. *The International Journal of Advanced Manufacturing Technology*, *39*(7–8), 783–795. https://doi.org/10.1007/s00170-007-1249-8

FAO: Food and Agriculture Organization of the United Nations (2011). *Global food losses and food waste: Extent, causes and prevention*. Retrieved from https://ec.europa.eu/knowledge4policy/publication/global-food-losses-food-waste-extent-causes-prevention_en

Farissi, A., El Oumami, M., & Beidouri, Z. (2021). Assessing lean adoption in food companies: The case of morocco. *International Journal of Technology*, *12*(1), 5. https://doi.org/10.14716/ijtech.v12i1.3837

Folinas, D., Aidonis, D., Triantafillou, D., & Malindretos, G. (2013). Exploring the greening of the food supply chain with lean thinking techniques. *Procedia Technology*, *8*, 416–424. https://doi.org/10.1016/j.protcy.2013.11.054

Fotopoulos, C., Kafetzopoulos, D., & Gotzamani, K. (2011). Critical factors for effective implementation of the HACCP system: A Pareto analysis. *British Food Journal*, *113*(5), 578–597. https://doi.org/10.1108/00070701111131700

Fullerton, R. R., & Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management*, *29*(3), 214–240. https://doi.org/10.1108/01443570910938970

Gandhi, N. S., Thanki, S. J., & Thakkar, J. J. (2018). Ranking of drivers for integrated lean-green manufacturing for Indian manufacturing SMEs. *Journal of Cleaner Production*, *171*, 675–689. https://doi.org/10.1016/j.jclepro.2017.10.041

Gładysz, B., Buczacki, A., & Haskins, C. (2020). Lean management approach to reduce waste in horeca food services. *Resources*, *9*(12), 144. https://doi.org/10.3390/resources9120144

Goncharuk, A. G. (2009). How to make meat business more effective: A case of Ukraine. *British Food Journal*, *111*(6), 583–597. https://doi.org/10.1108/00070700910966032

Hibadullah, S. N., Habidin, N. F., Zamri, F. I. M., Fuzi, N. M., & Desa, A. F. N. C. (2014). Critical success factors of lean manufacturing practices for the Malaysian automotive manufacturers. *International Journal of Quality and Innovation*, *2*(3/4), 256. https://doi.org/10.1504/IJQI.2014.066382

Hofer, C. W., & Schendel, D. (1978). *Strategy formulation: Analytical concepts*. West Pub. Co..

Hopp, W. J., & Spearman, M. L. (2004). To pull or not to pull: What is the question? *Manufacturing & Service Operations Management*, *6*(2), 133–148. https://doi.org/10.1287/msom.1030.0028

Houti, M., & El Abbadi, L., & ABOUABDELLAH, A. (2019). Critical Success Factors for Lean implementation Projection on SMEs". *In Proceedings of the International Conference on Industrial Engineering and Operations Management* 526-537.

Idrissi, I., & Benazzouz, B. (2019). Lean or Six Sigma for food industry? Perspectives from previous researches and case studies in industry. *International Journal of Civil Engineering and Technology*, *10*(4), 1732-1739.

Jain, R., & Lyons, A. C. (2009). The implementation of lean manufacturing in the UK food and drink industry. *International Journal of Services and Operations Management*, *5*(4), 548-573.

Jin, R., Hancock, C., Tang, L., Chen, C., Wanatowski, D., Asce, M. and Yang, L. (2017). Empirical study of BIM implementation - based perceptions among Chinese practitioners. *Journal of Management in Engineering*, *33*(5), 1-11.

Kazancoglu, Y., Ekinci, E., Ozen, Y. D. O., & Pala, M. O. (2021). Reducing food waste through lean and sustainable operations: A case study from the poultry industry. *Revista de Administração de Empresas*, *61*(5), e2020-0226. https://doi.org/10.1590/s0034-759020210503

Knol, W. H., Slomp, J., Schouteten, R. L., & Lauche, K. (2018). Implementing lean practices in manufacturing SMEs: testing 'critical success factors' using Necessary Condition Analysis. *International Journal of Production Research*, *56*(11), 3955-3973., doi: 10.1080/00207543.2017.1419583

Kumar, M., & Antony, J. (2008). Comparing the quality management practices in UK SMEs. *Industrial Management & Data Systems*, *108*(9), 1153–1166. https://doi.org/10.1108/02635570810914865

Kundu, G., & Manohar, B. M. (2012). Critical success factors for implementing lean practices in it support services. *International Journal for Quality Research*, *6*(4).

La Vega, M. D., Baez-Lopez, Y., Limon-Romero, J., Tlapa, D., Flores, D.-L., Borbon, M. I. R., & Maldonado-Macias, A. A. (2020). Lean manufacturing critical success factors for the transportation equipment manufacturing industry in mexico. *IEEE Access*, *8*, 168534–168545. https://doi.org/10.1109/ACCESS.2020.3023633

Larteb, Y., Haddout, A., & Benhadou, M. (2015). National culture impact on lean leadership and lean manufacturing maturity—Case study of multinationals based in morocco. International Journal of Research in Engineering and Technology, 04(02), 542–547. https://doi.org/10.15623/ijret.2015.0402074

Laureani, A., & Antony, J. (2017). Leadership characteristics for lean six sigma. *Total Quality Management & Business Excellence*, *28*(3-4), 405-426.

Lehtinen, U., & Torkko, M. (2005). The lean concept in the food industry: A case study of contract a manufacturer. *Journal of Food Distribution Research*, *36*(856-2016-56436), 57-67.

Leidecker, J. K., & Bruno, A. V. (1984). Identifying and using critical success factors. *Long Range Planning*, *17*(1), 23–32. https://doi.org/10.1016/0024-6301(84)90163-8

Little, D. & McKinna, A. (2005). *A lean manufacturing assessment tool for use in SMEs*, University of Strathclyde, Scottish School of Further Education.

Liu, Q., Yang, H., & Xin, Y. (2020). Applying value stream mapping in an unbalanced production line: A case study of a Chinese food processing enterprise. *Quality Engineering*, *32*(1), 111-123.

Maalouf, M., & Zaduminska, M. (2019). A case study of VSM and SMED in the food processing industry. *Management and Production Engineering Review*, *10*(2), 60-68.

Mahalik, N. P., & Nambiar, A. N. (2010). Trends in food packaging and manufacturing systems and technology. *Trends in food science & technology*, *21*(3), 117-128.

Manville, G., Greatbanks, R., Krishnasamy, R., & Parker, D. W. (2012). Critical success factors for Lean Six Sigma programmes: A view from middle management. *International Journal of Quality & Reliability Management*, *29*(1), 7–20. https://doi.org/10.1108/02656711211190846

Manzouri, M., Ab-Rahman, M., Zain, C., & Jamsari, E. (2014). Increasing production and eliminating waste through lean tools and techniques for halal food companies. *Sustainability*, *6*(12), 9179–9204. https://doi.org/10.3390/su6129179

Marin-Garcia, J. A., & Bonavia, T. (2015). Relationship between employee involvement and lean manufacturing and its effect on performance in a rigid continuous process industry. *International Journal of Production Research*, *53*(11), 3260-3275.

Mehralian, G., Nazari, J. A., Rasekh, H. R., & Hosseini, S. (2016). TOPSIS approach to prioritize critical success factors of TQM: Evidence from the pharmaceutical industry. *The TQM Journal*, *28*(2), 235–249. https://doi.org/10.1108/TQM-03-2014-0028

Moya, J. V., Déleg, E. M., Sánchez, C. V., & Vásquez, N. R. (2016). Implementation of lean manufacturing in a food enterprise. *Enfoque UTE*, *7*(1), 1-12.

Mpofu, B., Ochieng, E. G., Moobela, C., & Pretorius, A. (2017). Profiling causative factors leading to construction project delays in the United Arab Emirates. *Engineering, Construction and Architectural Management*, *24*(2), 346–376. https://doi.org/10.1108/ECAM-05-2015-0072

Nădăban, S., Dzitac, S., & Dzitac, I. (2016). Fuzzy TOPSIS: A general view. *Procedia computer science*, *91*, 823-831.

Noori, B. (2015). The critical success factors for successful lean implementation in hospitals. *International Journal of Productivity and Quality Management*, *15*(1), 108. https://doi.org/10.1504/IJPQM.2015.065987

Punnakitikashem, P., Buavaraporn, N., & Chen, L. (2013). *An investigation of factors affecting lean implementation success of Thai logistics companies*. Proceedings of POMS Annual Conference. Denver, Colorado, USA.

Ravikumar, M. M., Marimuthu, K., Parthiban, P., & Zubar, H. A. (2016). Evaluating lean execution performance in Indian MSMEs using SEM and TOPSIS models. *International Journal of Operational Research*, *26*(1), 104. https://doi.org/10.1504/IJOR.2016.075652

Rifqi, H., Souda, S. B., Zamma, A., & Badder, O. (2021). Lean Six Sigma in agribusiness: A Case Study in a Cookie Production Plant. *International Journal of Engineering Trends and Technology*, *69*(1), 56-65.

Rungasamy, S., Antony, J., & Ghosh, S. (2002) Critical success factors for SPC implementation. *TQM Mag*, *14*(4), 217-224.

Salih, M. M., Zaidan, B. B., Zaidan, A. A., & Ahmed, M. A. (2019). Survey on fuzzy TOPSIS state-of-the-art between 2007 and 2017. *Computers & Operations Research*, *104*, 207-227.

Scott, B. S., Wilcock, A. E., & Kanetkar, V. (2009). A survey of structured continuous improvement programs in the Canadian food sector. *Food Control*, *20*(3), 209–217. https://doi.org/10.1016/j.foodcont.2008.04.008

Scott, B. S., Wilcock, A. E., & Kanetkar, V. (2009). A survey of structured continuous improvement programs in the Canadian food sector. *Food Control*, *20*, 209-217.

Sohrabi, T., & Khavanin, A. (2015). Identifying the key success factors (CSF) for the deployment of lean manufacturing techniques by using fuzzy TOPSIS (FTOPSIS)(Case Study: Iran Khodro Company). *Fen Bilimleri Dergisi (CFD)*, *36*(4).

Thomas, A., & Barton, R. (2006). Developing an SME based six sigma strategy. *Journal of Manufacturing Technology Management*, *17*, 417-434

Upadhye, N., Deshmukh, S. G., & Garg, S. (2010). Lean manufacturing in biscuit manufacturing plant: a case. *International Journal of Advanced Operations Management, 2*(1-2), 108-139.

Vlachos, I (2015) Applying Lean thinking in the Food Supply Chains: A Case Study. *Production, Planning and Control, 26*(16). 1351-1367. ISSN 0953-7287

Womack, J. P., Jones, D. T., & Ross, D. (1990). *The Machine that Changed the World*. Rawson Associates, New York.

Yuik, C. J., Perumal, P. A., & Feng, C. J. (2020). Exploring critical success factors for the implementation of lean manufacturing in machinery and equipment SMEs. *Engineering Management in Production and Services, 12*(4), 77-91.

Zhao, G., Liu, S., Lopez, C., Chen, H., Lu, H., Mangla, S. K., & Elgueta, S. (2020). Risk analysis of the agri-food supply chain: A multi-method approach. *International Journal of Production Research, 58*(16), 4851-4876.

Zwikael, O., & Globerson, S. (2006). From critical success factors to critical success processes. *International journal of production research, 44(*17), 3433-3449.

Asmae Mohib
Industrial techniques laboratory,
Sciences and Techniques Faculty, Sidi Mohammed Ben Abdellah University.
FES,
Morocco
Asmae.mohib@usmba.ac.ma
ORCID 0000-0002-1129-2956

Abdelali En-nadi
Industrial techniques laboratory,
Sciences and Techniques Faculty, Sidi Mohammed Ben Abdellah University.
FES,
Morocco
Abdelali.ennadi@usmba.ac.ma
ORCID 0000-0002-1021-7030

Brahim Herrou
Industrial techniques laboratory,
Superior School of Technology, Sidi Mohammed Ben Abdellah University.
FES,
Morocco
brahimherrou@yahoo.fr
ORCID 0000-0001-6249-485X