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Facilitating lean implementation through change management

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Abstract

Implementing lean manufacturing can be challenging and requires all stakeholders to be engaged. Several frameworks have been presented in the last decades, with most of them being conceptual and failing to consider that change inertia exists. In the present paper, a social change management model is used to develop a lean implementation framework, with each step prescribed for the practitioners. The elements of the model are selected after a series of workshops, a thorough literature review, and the development of an interpretive structural model for this reason. The model was validated through experts' opinions and presents an alternative approach to the established lean implementation roadmaps available in the literature.

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Keywords: Lean Manufacturing; Lean Implementation; Change Management; ISM; Implementaiton design

1. Introduction

The "Lean" business philosophy is a company approach that emphasises a high level of customer awareness while simultaneously promoting efficiency and the reduction of waste. Many businesses have adopted the methodology because of this mindset to focus their efforts and outlooks on optimising their operations. This demonstrates how lean is applicable to all types, sizes, and sectors that aim to improve their operational efficiency, competitive advantages, and profitability in local and international markets [1]. To generate the best possible value and to reduce the non-value adding processes to the maximum extent, different organisations pick up and prioritise different approaches of implementation, by selecting different lean management principles, tools and techniques [2].

There is a tendency to oversimplify lean management by portraying it merely as set of tools for enhancing productivity. However lean management goes beyond tools; it profoundly influences the entire organisation. The organization's culture and its willingness to embrace change play crucial roles in the successful implementation. The available frameworks are often vague and conceptual. Therefore, it is evident that various factors must be carefully considered before initiating any lean implementation project, given that stakeholders both within and outside the organization may have conflicting interests.

There have been multiple frameworks of implementation that have been cited in the literature and eventually used in organisations. Table 1 presents some of these frameworks.

There is a need to understand that such framework must fulfil a particular set of criteria to ensure the implementation derives the actual planned benefits in the long run for the organisation. These characteristics include simplicity of structure, ease of understanding, clear linkages between the steps outlined, breadth for horizontal deployment, implementation planning capability and granular enough to answer questions around details of the implementation process. However, it can be evidenced from the literature review (Table 1) that there are specific gaps between what is expected in the framework and what is being implemented in the industry. Examples include manufacturing process-specific frameworks that lack the breadth for horizontal deployment. A number of frameworks also have not considered and integrated into the

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framework all the relevant and essential principles of lean manufacturing. Finally, as highlighted already, most of the frameworks are conceptual and lack the practical element of implementation that poses challenges to deliver results.

Literature also suggests that the successful implementation of lean manufacturing has one common focus area, the effective change management.

Table 1. Lean implementation frameworks.

Reference	Details of the implementation frameworks
Rose et al. (2010), [3]	including the commitment of SMEs, 15 doable lean practises (based on basic, intermediate, and advanced categories), external support, and performance.
Mostafa et al. (2013), [4]	22 components built in four phases and includes integrated monitoring and controlling
Amine et al. (2016), [5]	focused in SMEs, analysing implementation process steps, lean tools, and success factors. Structured in three phases derived from four SMEs and a review of the primary existing framework in lean implementation.
AlManei et al. (2018), [6]	The Kotter's model's eight steps serve as the foundation, emphasising the usage of the roadmap for lean tools in accordance with lean maturity.
Wong and Wong (2011), [7]	Structured in three sections, built through case studies carried out in four Malaysian electrical and electronics companies.
Chong et al. (2019), [8]	Composed of 16 essential elements in a step-by-step guiding flow. Four major phases are identified.
Tiwari et al. (2020), [9]	A sustainable lean production framework (SLPF) based on lean six-sigma and backed by the theory of practice-based view. Composed of five stages and fifteen processes.
Khan et al. (2022), [10]	Structured in three phases: lean conception, lean execution, and lean sustainability. It combines the Six Sigma DMAIC methodology with lean tools and methodologies.
Barot et al. (2020), [11]	Based on Lean Six Sigma and DMAIC focused on the casting process. Extremely process-specific and lacks the breadth for horizontal deployment.
Yadav et al. (2020), [12]	Hybrid Fuzzy Analytical Hierarchy Process (FAHP)-Decision Making Trial and Evaluation Laboratory (DEMATEL) tools are utilised as the framework.
Kumar et al. (2021), [13]	Wastes are identified using value stream mapping tool and fuzzy integrated analytic hierarchy method and complicated proportional assessment of alternatives are used to select lean tools.
Chaple et al. (2018), [14]	A thorough analysis of all LPs found in the literature and ranks them according to how well they perform using interpretive tools.
Mohammad et al. (2020), [2]	Focused on establishing a Lean culture within the organisation. Provides a systematic approach in deploying Lean techniques in seven functional areas.

Change management hence is an important element of implementation frameworks and the actual change that follows the same. This research work attempts to create a lean manufacturing implementation model using Kotter's 8-step model for change and prescribe each step for successful implementation.

2. Critical success factors for implementing lean

As a starting point for developing a lean implementation framework, the key critical success factors need to be identified and ranked. For the identification, a thorough literature review was conducted [15], resulting in 10 critical success (CS) factors (Table 2).

Table 2. Critical success (CS) factors.

CS No	Critical success factor	Supporting references
CS1	Organizational culture	[16 – 21]
CS2	Organizational readiness	[18], [19], [21]
CS3	Senior management commitment	[17], [18], [21]
CS4	Availability of resources for supporting the lean transformation	[18], [21]
CS5	External support (employing consultants, lean experts etc)	[18], [19], [21]
CS6	Effective communication and engagement through the organization	[18], [20], [21]
CS7	Strategic approach to improvements	[18], [20], [21]
CS8	Teamwork and systems thinking	[18], [19], [21]
CS9	Time planning for realistic change	[18], [21]
CS10	Effective use of commitment and enthusiasm for change	[17], [18], [19]

These critical success factors need to be addressed and exploited in order to facilitate lean implementation. In order to manage the limited resources as well as to focus on the few important ones, a systems approach needs to be adopted. Interpretive structural modelling (ISM) can be employed for investigating the variables that define a problem as well as identifying the relationships between these variables. Numerous examples of the use of the ISM method can be found in the literature, and thus in the present paper, the detailed steps followed will not be described. In the present study, a focus group was assembled (the same one used for the validation of the framework as presented in section 4), and two workshops were organized for the focus group to reach a consensus for every pair of variables, identifying the existence or not of the relationship between them. The use of the ISM method resulted in the model shown in Fig. 1.

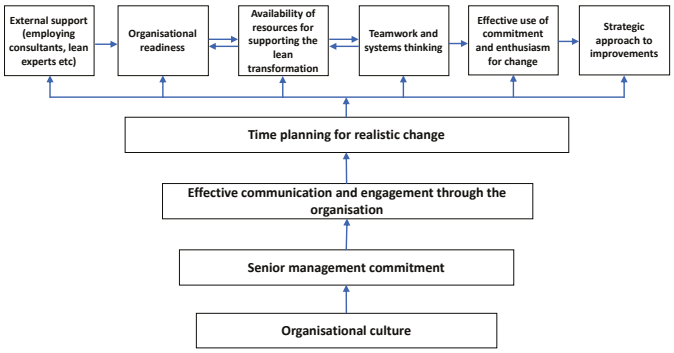

Fig. 1. Critical success factors ISM graph.

Additionally, MICMAC analysis followed that usually complements the ISM analysis. MICMAC analysis allows identifying and quantifying the drive and dependence power of the variables considered in the analysis.

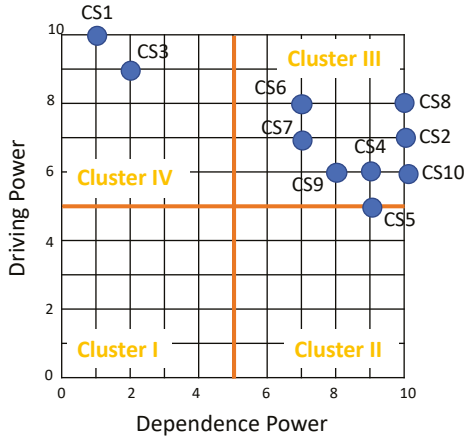

Fig. 2. MICMAC Analysis.

Several interesting conclusions can be drawn from the charts developed. The critical success factors in Cluster IV (Fig. 2), namely "organisational culture" and "senior management", are the ones that deserve the most attention. These are the ones that affect the other variables directly or indirectly. Looking at these at the ISM model, they are located at the bottom. These factors are the ones called "independent" or "driving" factors, and they have strong driving power but weak dependence power. This poses a requirement for the framework to be developed: these variables are the ones that need to be controlled as early as possible to have the maximum impact.

The rest of the factors all lie within cluster III. These are the "linkage" ones, and they have high driving power and high dependence power. These variables are unbalanced since any activity on these will affect others and, furthermore, feedback on themselves. These are sensitive, and any change will have multiple effects. To make things even more complex, there is a "feedback" effect on them since they are interrelated.

According to the analysis from both the MICMAC analysis and the ISM model, "Organizational culture (CS1)" has the strongest driving power, as it influences all other variables. "Senior management commitment" also has high driving power. For both factors, this means that even a slight change in their performance will have a high impact on the whole of the system. Both these two variables have low dependence power, and as such, they are not going to be affected by the rest of the factors. These variables are the ones that need to be controlled early in the implementation of lean. This is in total agreement with the literature review findings.

The factors "Effective communication and engagement through the organisation (CS6)" and "Teamwork and systems thinking (CS8)' also have high driving power. Still, at the same time, they have a high dependence power as well. These are sensitive factors, as a change affecting these factors needs to be very well planned to account for feedback loops internally.

3. Lean Management Implementation Framework based on Change Management

The literature review highlighted a specific gap: lean manufacturing implementation, like any other change project, can benefit from using organisational change management theory and models. Change is not something that happens only once but rather a continuous process. Change affects both the people engaged in the change and the business processes as well. To successfully implement any change project, the business strategy needs to be aligned with the personal goals and objectives. Change management aims to help in achieving this alignment.

The literature review and the ISM revealed that lean implementation is accompanied by a change in how the company values the different dimensions of work. Lean thinking requires change to happen in the organisation's structure, the system itself, the processes employed, and employee behaviour. Thus, A change framework can guide the practitioners on how to implement lean.

In our previous study [6], the different change management theories were reviewed and assessed on whether they were appropriate for lean implementation. We presented a high-level lean implementation framework considering Kotter's change management model. Kotter's model for leading change was mapped to a lean transformation initiative, with the eight steps grouped into three main classes, as seen in Fig. 3. this model is further detailed and verified in the present paper.

Fig. 3. High-level Lean Implementation Framework [6]

In Fig. 3, specific tools that have already been tried for the lean implementation are mapped into these steps and structured. Further detail is required to practically implement such a framework in a real setting. Three workshops were organised to detail these steps and develop support material based on proposals coming from the literature review findings related to both change management and lean implementation. These resulted in detailed graphical representations (such as the ones presented in Figs. 4-6) that highlight the purpose of each step and suggest critical activities in the form of a checklist for a lean practitioner to engage in. It also suggests the expected duration of the step's activities and the type of activities or

deliverables that should be expected (whether it is a workshop, a training session, a report, etc.).

3.1. Creating the climate for change

The first phase comprises steps 1 to 3 and sets up the necessary climate for change. The detailed implementation plan is illustrated in Fig. 4. Usually, this step is considered by most researchers to be the most critical one. The success or failure of lean implementation depends mainly on that. Leadership and management commitment are critical factors for lean implementation, as shown in the ISM model. Strong leadership is required to lead the change to lean manufacturing. Acknowledging this requirement is integrated into the first phases of the change management programme.

On the other end, the ISM model highlights the criticality of the workforce's engagement as well and thus needs to be considered from the very first stages. Following Kotter's change model, the first step is creating urgency internally, which can lead to a better internal understanding of what is at risk. As shown in Fig. 1, one of the first activities in the first step is for a change champion to be appointed. Kotter [22] even suggests appointing many change agents, and "not just the usual few appointees". This would help by sharing the responsibilities among several committed change and lean champions. The ultimate purpose of this step is to raise awareness internally through the simulation of critical situations. The framework considered, especially after integrating the results of the ISM models, the significance of engaging all stakeholders, including senior management and the workforce. For this reason, the second step focuses on establishing a coalition that expands from internal stakeholders to external ones, such as the suppliers and the customers. For this reason, the framework proposes setting several initial workshops/training sessions to allow stakeholders to understand the need for change better. Once the change champion(s) have established the need and formed both the formal and informal relationships, they can work on setting a clear and understandable vision for the change and the associated implementation workplans.

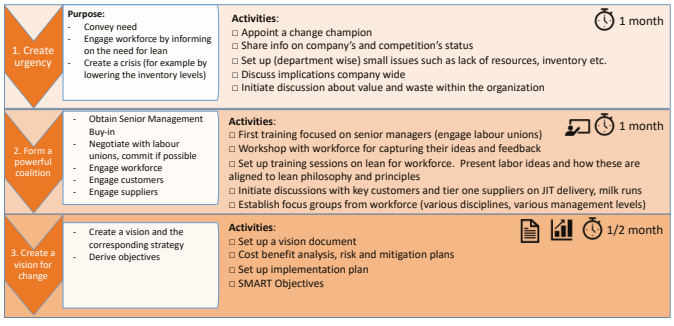

Fig. 4. Phase I: Creating the climate for change.

3.2. Engaging and enabling the organisation

Phase two focuses on engaging and enabling the organisation to go through the proposed change (Fig. 5). As per Kotter's model, the phase is composed of three stages, namely: (1) communication of the vision throughout the organisation, (2) develop and empower the implementation team and (3) create the first short wins that will strengthen the momentum internally.

The focus of this phase is to establish the communication links internally within the organisation. Having the change vision developed in the previous step as a starting point, the change managers must communicate within the extended supply chain of the organisation (from suppliers to customers). Regardless of how good the vision document and supporting material are, sharing and allowing for time for the various stakeholders to understand the implications of the change and their role in the change is critical for success. The communication needs to be augmented in every event that takes place during the introduction and implementation of lean principles. The communication campaign should start well before the project kicks off.

Step five is focused on establishing the teams in the form of quality circles, allowing the delegation of the project tasks to teams and, even more importantly, the engagement of all stakeholders. Furthermore, this is a suitable platform for capturing ideas from the employees and thus enables change from the "bottom". Thus, Quality circles need the resources and time to prepare for the task adequately. Training is a crucial enabler of empowerment by giving them ownership and responsibility for the projects they decide to undertake.

Towards the final step of this stage, implementing simple and small projects that can have easy wins ("harvest the low-hanging fruits") can dramatically increase the commitment of both the senior management and the workforce to the lean implementation change programme. Acknowledging and celebrating such noticeable gains will raise confidence in the change and reinforce the position of the guiding coalition.

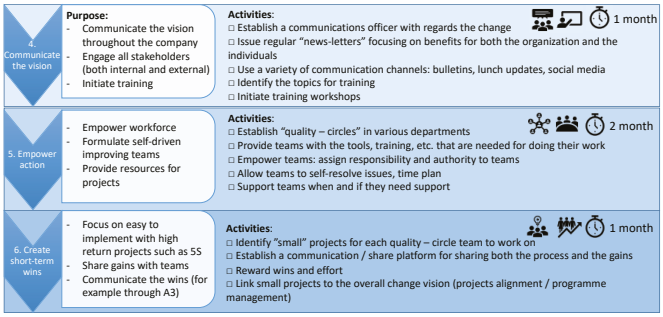

Fig. 5. Phase II: Engaging and enabling the organisation.

3.3. Implementing and sustaining the change

The last phase of the framework focuses on the ramp-up of the change programme through the implementation of more advanced lean projects and establishing the sustaining culture and processes for making the changes last (Fig. 6). This last phase is composed of two steps, namely: (1) the building on the change that has been succeeded in the previous phase and (2) the institutionalisation of the strategic changes in the culture of the organisation. This phase builds upon the early wins for fully deploying lean tools and methods and, most importantly, sustaining the change and lean thinking.

In step seven, the quality circles, building up on the confidence they have gained as a team, can explore more lean

opportunities that might require more advanced tools for implementation. Furthermore, during this phase, they can engage more stakeholders, even externals such as suppliers and customers, to maximise the impact of their projects.

In the last step, the team will need to capture and document all lean project attempts, regardless of whether these are entirely successful or not. These documents can serve as lessons for building some preventive measures and avoiding mistakes when the next round of lean implementation starts. At this phase, successes must become the new standards, shared in the organisation, and celebrated. After the first round of lean improvements and at the end of each cycle, the vision and objectives must be reviewed and amended accordingly.

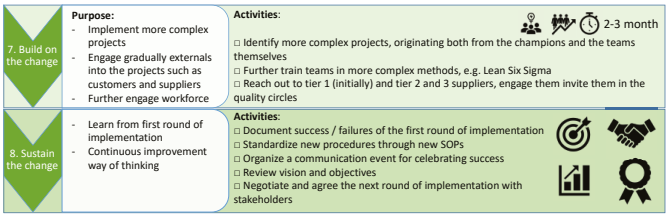

Fig. 6. Phase III: Implementing and sustaining the change.

3.4. The timeframe

Like any other change, Lean transformation is usually not a one-off project. The framework should not be used as another change project but instead, introduce a different culture that welcomes and exploits change. For this reason, a timeframe that complements the framework was developed. This was one of the critical feedback items received while validating the initial conceptual framework. As can be seen in Fig. 7, once Phase 1 and Phase 2 have been completed, then Phase 3 can be repeated as many times as needed to gradually increase the lean maturity of the organisation and benefit from the gains of the transformation.

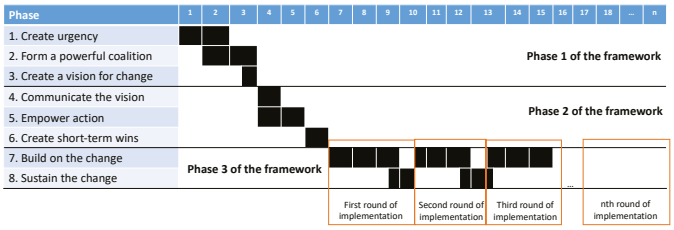

Fig. 7. Timeline for implementing the lean implementation framework.

4. Framework Validation

Experts in the field of lean implementation in manufacturing organisations validated the Lean implementation framework. Five experts were interviewed. Their profiles are documented in Table 3. The validation process during each interview started with the presentation of the framework and then a discussion on (1) its logic and rationale of the framework, (2) its potential applicability to the interviewee's organisation, (3) its user-friendliness, (4) its completeness, and (5) its integrity to existing lean implementation schemes. The participants were asked to rate each theme from 1 to 5, with 1 representing the least favourable option and 5 the highest achievable rating. Fig. 8 illustrates the results from the study.

Table 3. An example of a table.

Expert skills	Experience	Manufacturing Sector
Continuous improvement manager	10 Yrs	Fabricated metal
Operations manager	9 Yrs	Food & Beverage
Technical director	7 Yrs	Food & Beverage
Chief Operating Officer	15 Yrs	Wood & wood products
Production manager	8 Yrs	Wearing apparel

All experts agreed on the need for such a framework. The logic of using a change management model as the basis of the proposed lean implementation framework was highly appreciated by the experts. The experts confirmed the mapping of the lean tools to Kotter's eight steps of change as appropriate.

The experts were asked to rank the framework's applicability to their specific sector. Fig. 9 presents the experts' ranking of the framework for different sectors. The results averaged 3.75 (Fig. 8). However, the experts believe that the framework is more applicable to the manufacturing of discrete products, as is the case in the fabricated metal and wood product sectors. The framework is not as easy to use in more continuous process production environments as in the food and beverage sector. Experts suggested that the framework needs to be customised in such applications.

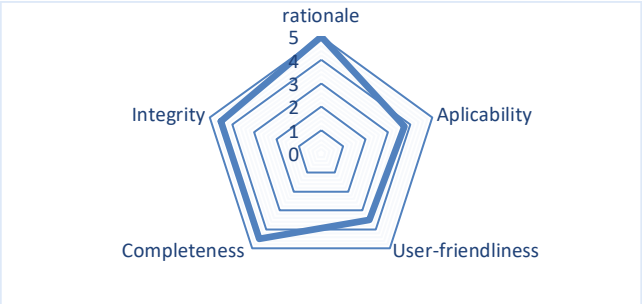

Fig. 8. Framework assessment by experts' opinion.

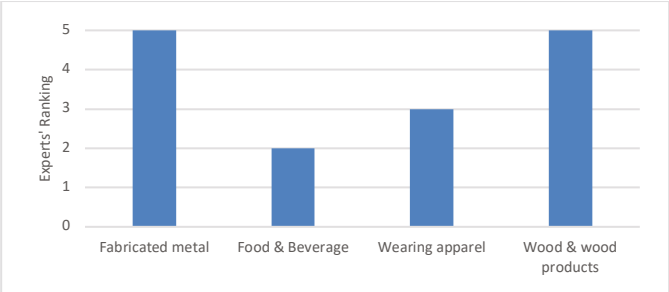

Fig. 9. Applicability of the framework to different manufacturing sectors by experts' opinion.

The possibility of integrating the framework for day-to-day lean implementation and continuous improvement was discussed during the validation interviews. As shown in Fig. 8, the rating was very positive. All experts believe that the

framework can complement the existing lean transformation programmes that organisations might be running and further use it to introduce lean to a new organisation.

The completeness of the framework developed was also discussed during the interviews. Experts were asked to assess whether the framework is complete and can stand independently (with the complementary lean tools roadmap). All experts agreed that the framework includes all the required steps for completion. One expert highlighted that the framework would be even more complete if a lean assessment tool were included for organisations that are not new to lean implementation. In that way, the lean practitioner could assess the organisation's maturity before deciding which step to start with.

4. Conclusions

The overall aim of this study was to develop a novel lean implementation framework that would be able to bring about the transformation required in the organisation. The proposed framework contributes to the body of knowledge on lean implementation as an alternative, more systems approach to the transformation required. The critical assumption is that the organisation is new to lean philosophy, so the framework has been developed to cover this gap. However, this does not exclude this framework from being used to lead change in an organisation that has already had some experience in lean transformation. In that case, the framework can be tailored accordingly and complemented with additional tools. To achieve this, two complementary phases are foreseen to need to be included. The first phase deals with assessing the level of maturing. In that case, a lean assessment framework must be completed before initiating the updated framework. A lot of work has been presented by Oleghe and Salonitis [23-25]. Specific tools such as multi-grade fuzzy logic can be used to assess an organisation's leanness and supply chain [26]. This will provide a visual and numerical representation of the levels of leanness both for the whole organisation and specifically for the various departments within, allowing for the ranking and prioritisation of the follow-up activities. Secondly, alternative routes within the framework depending on the lean maturity of the organisation needs to be provided as well.

References

[1] Alkhoraif A, Rashi H, McLaughlin P. Lean implementation in small and medium enterprises: Literature review. Operations Research Perspectives 2019;6: 100089.

[2] Mohammad IS, Oduoza CF. Lean-excellence business management for manufacturing SMEs focusing on KRI. I J Prod & Perf Man 2020, 69:519–539.

[3] Rose AMN, Deros B, Rahman MNA. Development of framework for lean manufacturing implementation in SMEs. Proceedings of the 11th Asia Pacific Industrial Engineering and Management Systems

[4] Mostafa S, Dumrak J, Soltan H. A framework for lean manufacturing implementation. Production & Manufacturing Research 2013, 1: 44–64.

[5] Belhadi A, Touriki FE, el Fezazi S. A framework for effective implementation of lean production in Small and Medium-sized Enterprises. J Ind Eng & Man 2016, 9:786–810

[6] Almanei M, Salonitis K, Tsinopoulos C. A conceptual lean implementation framework based on change management theory. Procedia CIRP 2018, 72:1160–1165.

[7] Wong YC, Wong KY, Ali A. A Study on Lean Manufacturing Implementation in the Malaysian Electrical and Electronics Industry. European Journal of Scientific Research 2009, 38:521-535.

[8] Chong JY, Perumal PA. Conceptual framework for lean manufacturing implementation in SMEs with PDCA approach. Lecture Notes in Mech Eng 200, pp. 410–418.

[9] Tiwari P, Sadeghi JK, Eseonu C. A sustainable lean production framework with a case implementation: Practice-based view theory. J Clean Prod 2020, 277:123078

[10] Khan MA, Ali MK, Sajid M. Lean Implementation Framework: A Case of Performance Improvement of Casting Process. IEEE Access 2022, 10:81281–81295.

[11] Barot RS, Patel J, Sharma B, Rathod B. Solanki H, Patel Y. Lean six sigma feasibility and implementation aspect in cast iron foundry. Mater Today Proc 2020, 28:1084–1091

[12] Yadav G, Luthra S, Huisingh D, Mangla SK, Narkhede BE, Liu Y. Development of a lean manufacturing framework to enhance its adoption within manufacturing companies in developing economies. J Clean Prod 2020, 245:118726

[13] Kumar MB, Parameshwaran R, Antony J, Cudney E. Framework for Lean Implementation Through Fuzzy AHP-COPRAS Integrated Approach. IEEE Trans Eng Manag 2023, 70:3836-3848

[14] Chaple AP, Narkhede BE, Akarte MM, Raut R. Interpretive framework for analyzing lean implementation using ISM and IRP modeling. Benchmarking 2018, 25:3406–3442

[15] Almanei M, Salonitis K, Xu Y. Lean Implementation Frameworks: The challenges for SMEs. Procedia CIRP 2017, 63:750-755

[16] Hamid RA. Factors influencing the success of lean services implementation: conceptual framework. 2nd ICBER 2011. Langkawi Kedah, Malaysia

[17] Rose ANM, Deros B, Rahman MN. Critical Success Factors for Implementing Lean Manufacturing in Malaysian Automotive Industry. Research Journal of Applied Sciences, Engineering and Technology 2014, 8:1191 – 1200

[18] Salonitis K, Tsinopoulos C (2017). Drivers and Barriers of Lean Implementation in the Greek Manufacturing Sector. Procedia CIRP 2017, 57:189–194

[19] Zhang Q, Irfan M, Khattak MAO, Abbas J, Zhu X, Shah MS. Critical success factors for successful lean six sigma implementation in Pakistan. Interdisciplinary Journal of Contemporary Research in Business 2012, 4: 117 – 124

[20] Herzog NV, Tonchia S. An Instrument for Measuring the Degree of Lean Implementation in Manufacturing. Journal of Mechanical Engineering 2014, 60:797-803

[21] Achanga P, Shehab E, Roy R, Nelder G. Critical success factors for Lean implementations within SMEs. Journal of Manufacturing Technology Management 2006, 17:460–471

[22] Kotter J. (2012) Accelerate!. Harvard Business Review. Available at: https://hbr.org/2012/11/accelerate

[23] Oleghe O, Salonitis K. A lean assessment tool based on systems dynamics. Procedia CIRP 2016, 50:106 – 111

[24] Oleghe O, Salonitis K. Leanness Assessment Tools and Frameworks. In: Progress in Lean Manufacturing 2018, pp. 1 – 37

[25] Oleghe O, Salonitis K. A comparative analysis of quantitative-based methods used for lean index assessment. International Journal of Engineering Management and Economics 2018, 6:186 – 206

[26] Almutairi A, Salonitis K, Al-Ashaab A. Assessing the leanness of a supply chain using multi-grade fuzzy logic: a health-care case study. International Journal of Lean Six Sigma 2019, 10:81 – 105

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