

## Supplementary Material

This section presents the stages of lean manufacturing models reviewed in Section 2. In addition, the questionnaire by García and Sánchez (2015) to assess the maturity of the SME under study is provided. Also, the authors' own questionnaire used to determine the initial lean diagnosis of the SME of interest is introduced. Lastly, the literature review of lean tools used in SMEs is given.

### SM1. Stages of lean manufacturing models reviewed in Section 2

The stages of lean manufacturing models from the literature reviewed in Section 2 are described here. This is intended to provide a more complete context for understanding the analysis and discussion conducted by the authors in Section 2. Thus, the distinctive features of the presented work and, consequently, its contribution are clear.

Table S1: Stages of lean manufacturing models reviewed in Section 2, 1/3. Source: Authors own work.

Cite	Stages of the proposed model
(Anvari et al., 2011)	1. <i>Initial research</i> (understanding the company's conditions by identifying crisis, SME owners' participation, and lean manufacturing knowledge); 2. <i>Preparation</i> (assessing the company's and operators' knowledge of lean manufacturing); 3. <i>Focus on specified pilot</i> (using appropriate lean tools to eliminate waste in a specific area for the scenarios: continuous flow, stability, flexibility, and pull-system); 4. <i>Expand to whole system</i> (transferring what was implemented in the pilot process to other areas); 5. <i>Perfection</i> (measuring and controlling indicators, and continuous improvement).
(Mostafa et al., 2013)	1. <i>Conceptual one</i> (creating a lean expert team to improve success in lean implementation, definition of wastes, and KPI assessment); 2. <i>Implementation design</i> (evaluating the SME current state, identifying opportunity areas, and designing a plan for the lean transformation); 3. <i>Implementation and evaluation</i> (execution and suggestion of a pilot project, reviewing learned lessons and documenting the implementation); 4. <i>Complete lean transformation</i> (expand pilot project establishing lean standards and planning continuous improvement, i.e. controlling the lean implementation to sustain changes).

Table S2: Stages of lean manufacturing models reviewed in Section 2, 2/3. Source: Authors own work.

Cite	Stages of the proposed model
(Belhadi et al., 2016)	1. <i>Pre-implementation</i> (gathering initial data and identifying problems by establishing lean teams and their training, defining initial perimeter, and elaborating a master plan for implementation); 2. <i>Implementation</i> (creating a lean culture and deploying appropriate tools on the identified opportunities); 3. <i>Post-implementation</i> (measuring and controlling changes, and continuing to focus on continuous improvement).
(Minh and Kien, 2021)	1. <i>Stabilizing</i> (ensuring the process of interest is always ready to operate using simple tools like 5S and VSM); 2. <i>Standardizing</i> (detecting improvement opportunities); 3. <i>Smooth</i> (balancing and level operation processes for continuous flow); 4. <i>Slimming</i> (aimed at reducing inventories, workforce per piece, space used, and lead time through pull-system, cell layout or andon).
(Villamil and Arteaga, 2023)	1. <i>Literature review</i> on trends in research on the Lean Production System, 2. <i>Characterization of the production systems</i> of textile SMEs in the department of Cundinamarca and 3. <i>Structuring of the model for production</i> in textile SMEs.
(Hodge et al., 2011)	1. <i>Policy deployment</i> ; 2. <i>Visual management</i> ; 3. <i>Continuous improvement</i> ; 4. <i>Standardised work</i> ; 5. <i>Just in time</i> ; using VSM in all stages. All levels contribute to improving customer satisfaction.
(Kumar et al., 2018)	1. <i>Data collection and current state mapping</i> ; 2. <i>Takt time calculation</i> ; 3. <i>Future state mapping and flow design</i> ; 4. <i>Implement continuous flow and pull mechanisms</i> ; 5. <i>Pacemaker process and production leveling</i> ; 6. <i>Waste identification and process improvement</i> ; 7. <i>Kaizen event implementation</i> . From (Singh et al., 2010; Prashar, 2014; Seth et al., 2017)
(Rochman et al., 2024)	1. <i>Plan</i> : (Determining goals, Communicate importance, Data collection); 2. <i>Do</i> : (Team formation and lean champion designation, Selection of the product family, Identification and measurement of wastes, Creation of VSM, Simulation); 3. <i>Check</i> : (Check waste analysis and eliminate them, Creation of the future VSM); 4. <i>Act</i> : (Formulation of a plan for implementing the future VSM, Implementation of the plan).

Table S3: Stages of lean manufacturing models reviewed in Section 2, 3/3. Source: Authors own work.

Cite	Stages of the proposed model
(Dahab et al., 2023)	1. <i>Project charter</i> ; 2. <i>Current VSM</i> (mesaure cycle time, setup time and raw material waste); 3. <i>Overall Efficiency Equipment OEE</i> ; 4. <i>Improved VSM</i> (improved process flow and further improvement) ; 5. <i>Sustain</i> ;
(Memari et al., 2024)	1. <i>Process review</i> (identifying the standardized process according to Standard Operation Procedures and operation manuals and cycle times computing); 2. <i>Activity mapping</i> (carried out with current and future VSM); 3. <i>Layout of the process line</i> (spots value-added tasks, non-value added, and sources of waste); 4. <i>Flow analysis</i> (estimation of the traveling distance and flow of goods per day); 5. <i>Utilization</i> (balance the lines and increment the labor efficiency).
(Huang et al., 2022)	1. <i>VSM to map the current production flow</i> ; 2. <i>Identify the blast points of production and operation bottlenecks</i> ; 3. <i>Identify improvement items for the blast points</i> ; 4. <i>Set improvement targets for the blast points</i> ; 5. <i>Develop a six-month improvement plan through the PDCA management cycle</i> .

## **SM2. Survey based on García and Sánchez (2015)**

The translation of the questionnaire by García and Sánchez (2015) to assess the maturity of a SME is presented here.

### *General Information about the Company*

1. Is the company registered as a legal entity or an individual?
2. Is the capital of foreign or Mexican origin?
3. Is the company family-owned?

### *Management*

4. Does the company have a defined mission statement?
5. If so, are employees familiar with it?
6. Do you have organized departments such as production, sales, etc.?
7. Are there specific goals and objectives for each department?
8. Do you have a formal organizational chart?
9. Do you have a manual of methods and procedures?
10. Is there an established area or process for research and development?

### *Market*

11. Has the company defined its sales objectives?
12. Do you conduct international business activities?
13. How many customers do you currently serve?
14. Would you like to expand your customer base?
15. Do you carry out sales forecasting?
16. Are you aware of your distribution channels (direct or through intermediaries)?
17. Are you familiar with government programs that support product exportation?
18. Does your production volume allow you to export?

### *Finance*

19. Have you adopted new technologies in the past year?
20. Do you prepare financial statements? How frequently (monthly, semi-annually, etc.)?
21. If financial statements are prepared, are they analyzed by the manager or owner?

22. Do you know the unit cost of your products, including fixed and variable costs?
23. Do you comply with your tax obligations?
24. Have you received financing from any financial or governmental development institution?

*Production*

25. Do you have a process manual?
26. If so, is it known and used by personnel?
27. Do you have a designated person in charge of the production area?
28. Is production scheduled based on purchase orders or estimated demand?
29. Do you have a control mechanism to evaluate deviations between planned and actual production?
30. Are you aware of bottlenecks in your processes?

*Technological Development*

31. Do you have technological development projects?
32. Do you have sufficient technological resources to meet your goals?
33. Do you analyze complaints and claims to improve product development?
34. Do you conduct technological benchmarking of your competitors' products, services, or processes?
35. Do you know what a patent is?
36. Is your brand registered?
37. Do you have a person responsible for technology management?
38. Are the technological competencies of your personnel documented?
39. Have you implemented technology in your products or production processes in the last year?
40. Do you have a modernization or equipment update program?
41. Do you take technical corrective actions to reduce costs and increase production?
42. Have you received professional consulting services?
43. Do you have internet access?
44. Do you have an internal IT network (computer-based communication)?
45. Have you engaged in e-commerce?

46. Do you use an administrative system (ERP)?
47. Do you have automated systems for routine tasks (e.g., accounting, payroll)?
48. Do you have a quality department?
49. Do you have quality agreements with your suppliers?
50. Have you received customer complaints in the last month?
51. Do you inspect raw materials upon delivery?
52. Do you use statistical or sampling control methods?
53. Is your measurement equipment part of a calibration and verification program?
54. Do your products meet an acceptable range for your customers? Are you aware of that range?
55. Do you have a quality assurance and continuous improvement system?
56. Do you require support to implement a new quality assurance system?

#### *Human Resources*

57. Do you consider that personnel is selected according to the job profile required by the company?
58. Do you have personnel selection policies?
59. Do you request and verify employment references?
60. Do you have an onboarding and initial training process?
61. What is your personnel turnover rate?
62. How difficult is it for you to hire personnel?
63. Do you have permanent training programs or plans?

#### *Corporate Image*

64. Do you have a logo, and is it registered?
65. Do you have a company slogan?
66. Have you created a brochure or pamphlet to present your company?

### **SM3. Lean initial diagnosis questionnaire**

The questionnaire developed by authors to assess the knowledge level of LM approach in an SME is provided here.

*Application date:*

*Instructions:* Respond to the following questions, underlining or circling the answer that you consider adequate.

1. Do you have any knowledge on lean manufacturing term?
  - a. Yes
  - b. No
2. Do you any tool used in lean manufacturing?
  - a. Yes
  - b. No
3. Do you have any knowledge on kaizen term?
  - a. Yes
  - b. No
4. Do you have any knowledge on Value Stream Mapping?
  - a. Yes
  - b. No
5. Do you have any knowledge on 5S tool?
  - a. Yes
  - b. No
6. Do you have any knowledge on the productivity term?
  - a. Yes
  - b. No

#### SM4. Literature review of lean tools used in SMEs

Table S4 summarizes the literature review performed to identify the lean tools commonly used in SMEs.

Table S4: Lean tools commonly used in SMEs. Source: Authors own work.

Cite	5S	kaizen	VSM	TPM	SMED	Kanban
(Demirtas et al., 2023)	X	X				
(Huang et al., 2022)		X	X			
(Hodge et al., 2011)	X		X			
(Nedra et al., 2021)		X	X	X		
(Robertson et al., 2022)	X		X	X		
(Dhingra et al., 2019)		X	X			
(Garza-Reyes et al., 2022)		X				
(de Paula Ferreira et al., 2022)			X			
(Sánchez-Partida et al., 2018)					X	
(Pérez-Pucheta et al., 2019)			X			
(Carvalho et al., 2017)	X	X				
(Damian-Garcia et al., 2023)	X	X				
(Saleeshya et al., 2012)	X	X				X
(Bhattacharya and Ramachandran, 2021)	X	X				X
(Alefiari et al., 2020)	X	X		X	X	
(Villamil and Arteaga, 2023)	X	X	X			X
(Rochman et al., 2024)			X			
(Kumar et al., 2018)		X	X			X
(Sarria et al., 2017)	X		X		X	X
(Koloszar, 2018)	X					
(Bugvia et al., 2021)			X			
(Choudhary et al., 2019)		X	X			
(Díaz-Reza et al., 2016)		X	X			
(Memari et al., 2024)			X			
(Ahmad et al., 2022)			X			



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