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Assessing Lean and Human-Centric practices in the fashion industry: a multiple-case study

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Abstract: This paper investigates the integration of the Lean manufacturing and Human-Centric (HC) concepts in the fashion industry through a multiple case study using a custom-developed assessment model. Ten companies were evaluated across three dimensions—Awareness, Implementation, and Effectiveness—in both Lean and HC domains. Our findings reveal varying maturity levels between companies, with some standing out in a positive way ahead of the rest due to dedicated Lean teams and supportive corporate cultures. However, other companies struggle due to e.g. limited resources and high resistance to change. The proposed assessment model provides a practical tool for measuring current practices, and highlight how organizational structure, targeted strategies, capabilities and practices can enhance Lean-HC.

Keywords: Lean Production; Industry 5.0; Human Centric Manufacturing; Human operator support; Manufacturing plant control; Social Manufacturing; Management of competences and knowledge

1. INTRODUCTION

The emerging paradigm of Industry 5.0 (I5.0) places a strong emphasis on human-centricity, sustainability and resilience (European Commission, 2021). Consequently, focusing on Human-Centric (HC) practices has become essential for industries aiming to facilitate and enrich this transition, re-incorporating human intuition, creativity, and values into the manufacturing process (Maddikunta et al., 2022). While the I5.0 concept also includes sustainability and resilience, this paper focuses exclusively on the Human-Centric (HC) dimension, analyzing how Lean methodologies can be integrated with HC principles. In today's competitive business environment, organizations strive to enhance performance by eliminating waste and maximizing value—an underlying philosophy of Lean manufacturing (Alves, 2022). A bottom-up approach ensures that process improvements emerge from workers' commitment and active participation (Benkarim & Imbeau, 2021). Industries primarily reliant on human skills, such as the artisanal fashion sector, benefit significantly from HC adoption (Fani et al., 2023). Integrating Lean and HC fosters operational efficiency while enhancing workforce well-being, driving innovation and social sustainability (Eriksson et al., 2024). Despite Lean's widespread adoption, companies increasingly recognize the need for an inclusive HC approach to tackle modern manufacturing complexities (Subramanian et al., 2023). Assessing Lean and HC practices provides insights into their operational impact and contribution to organizational goals, including social sustainability. Assessment models serve as structured tools to evaluate business practices (Brozzi et al., 2018; Roeglinger et al., 2012).

This research introduces a tailored assessment model to evaluate Lean and HC integration within selected fashion companies. The model categorizes practices into three dimensions—Awareness (AW), Implementation (IM), and Effectiveness (EF)—across five levels. It offers a structured assessment and a roadmap for continuous improvement. The study aims to measure and compare the levels of adopted Lean and HC practices in ten fashion companies, providing a clear perspective on their real-world implementation status.

2. LEAN MANUFACTURING & HUMAN-CENTRICITY

It is assumed that the integration of Lean HC principles is crucial for leveraging human capital as a competitive advantage in manufacturing transformations. The failure of Lean initiatives may in some cases be attributed to inadequate HC practices and resistance to necessary cultural changes (Wickramasinghe & Wickramasinghe, 2020). Challenges arise as organizations transfer to Lean processes, necessitating a tailored approach in HC vision that aligns employee behavior with company objectives (Koemtzi et al., 2023). HC techniques such as continuous training, flexibility, and multi-skilling are vital for fostering employee commitment (Reynders et al., 2022). These elements, coupled with effective communication and comprehensive reward systems, are pivotal in implementing Lean HC (Lista Rossetti et al., 2022). As I5.0 is a new paradigm emphasizing HC manufacturing, it integrates the 6th Lean principle named "respect for people" with a focus on well-being and development, positioning employees at the core of the industry's transformative processes (Zhang et al., 2023). This approach not only meets basic operational needs but also creates environments that foster employee motivation and satisfaction, aligning with the advanced tiers of the Human Needs Pyramid (Lu et al., 2022). The implementation of assessment models offers a structured methodology to gauge and enhance the integration of Lean and HC practices for the transition towards I5.0. Assessment models help organizations assess their strengths and

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weaknesses (de Bruin et al., 2005), benchmark against peers (Caggiano et al., 2023), and define clear stages of maturity (Sajjad et al., 2023) providing a roadmap for continuous improvement in a socio-technical system where the interactions between social and technological elements are pivotal (Morgan & Liker, 2020, p. 200). These models evaluate capabilities and competencies across predefined criteria, typically using a five-point Likert scale to measure levels from initial states to full adoption or implementation (Kırmızı & Kocaoglu, 2022). An earlier proposed framework integrates Lean, HC, and Industry 4.0 (I4.0) into the emerging paradigm of Lean 5.0, shedding light on the potential transition to I5.0 (Fani et al., 2024). However, for this case study involving best-in-class companies, there is still a need to understand the overall level of the fashion industry in terms of Lean and HC domains. This understanding is essential to evaluate whether the transition to Lean 5.0 complemented by I4.0 technologies, is feasible. In the fashion industry, Lean principles manifest through methodologies like value stream mapping and autonomous maintenance, which are used to identify and eliminate inefficiencies in various sectors, from garment production to leather shoe manufacturing (Hussain & Figueiredo, 2023; Kumar et al., 2020; Reda & Dvivedi, 2022). The integration of Lean tools with HC practices lays the foundation for adaptive strategies to real-world manufacturing challenges (Fonda & Meneghetti, 2022). Thus, examining these practices through the lens of an assessment model can offer valuable insights into the sector's readiness for embracing Lean 5.0.

2.1 Assessment Models

Most existing assessment models focus on technology-driven transitions, including also I4.0 frameworks. These models assess organizations based on their digitalization, automation, and technological integration, often treating human factors as secondary considerations. Technology-driven assessment models primarily assess the digital readiness of organizations and their ability to implement I4.0 technologies, often without making human-centricity a primary focus. A model is propose to evaluate company's manufacturing maturity in I4.0, identifying technological, organizational, and strategic gaps through a structured diagnostic approach (Bayrak & Cebi, 2024). A holistic I4.0 maturity framework is developed, incorporating dimensions such as physical and virtual integration, human resources, strategy, and value chain dynamics (Nick et al., 2021). A assessment model combining Lean and I4.0 principles is presented, utilizing design thinking methodologies to analyze case studies and identify digital transformation gaps (Bauer et al., 2019). A few models attempt to balance human and technological factors, though without fully isolating and prioritizing human-centricity. ECO Assessment Model, which evaluates environmental, competence, and operability factors, integrates human-related dimensions such as workforce skills and adaptability within Industry 4.0 (Bretz et al., 2022). Bajic et al. (2023), introduce a fuzzy logic-based assessment model to measure I5.0 readiness, incorporating dimensions related to human expertise, continuous improvement, and technological integration. Sajadieh et al. (2024) present an assessment framework for Urban Smart Factories, integrating worker well-being, training opportunities, and collaborative decision-making with smart technologies. Although these models consider human aspects, they still balance them with technological development rather than placing human-centricity as the core assessment factor.

Our proposed model fills this gap by focusing on HC within Lean environments, offering a structured evaluation of organizational culture, workforce engagement, and leadership strategies. Unlike existing assessment models, the proposed approach places human engagement, skill development, and workplace well-being at the core, rather than technological advancement. It looks at Lean through a HC lens, assessing how its principles are applied when shaped by organizational culture, leadership commitment, and employee involvement. Following a structured framework, it evaluates AW, IM, and EF across five maturity levels, providing companies with a clear path to strengthening HC practices within Lean environments.

3. RESEARCH METHODOLOGY

Given the existing gap in empirical research within the Lean HC domain, a qualitative and exploratory approach is adopted. This study uses a multiple case study methodology, which is particularly effective in addressing "how" questions and examining contemporary contexts, thereby facilitating theory building in real-life contexts. This approach allows for a comprehensive understanding of complex phenomena in their natural settings and helps identify critical variables and their interrelations (Yin, 2018).

3.1 Case Selection

The cases were selected based on literal and theoretical replication. The focus was on large and medium-sized fashion companies situated in the Tuscany region, closely associated with the Florence district. Company size was determined according to the European Union's classification, with medium-sized companies having 50 to 249 employees, and large companies having more than 250 employees (Belhadi et al., 2020). The prospective companies were initially briefed about the study's aims concerning Lean and HC practices. Participants, primarily in middle managerial positions related to production processes, were approached through the authors' professional network, snowball sampling techniques, and LinkedIn contacts. Table 1 shows the ten cases selected for the multiple case study. The sample size follows the guideline provided by Rowley (2002).

Table 1. Companies involved

ID	Segment	Size	Employee Role
a	Leather goods	Big	Lean specialist
b	Footwear	Medium	Process Engineer
c	Footwear	Medium	Lean Specialist
d	Leather goods	Big	Process Engineer
e	Leather goods	Big	Lean specialist
f	Leather goods	Big	Process Engineer
g	Footwear	Big	Quality Specialist
h	Leather goods	Big	Process Engineer
i	Leather goods	Big	Quality Specialist
j	Footwear	Big	Quality Specialist

3.2 Data Collection and Analysis

Data collection occurred from January 2024 to July 2024, primarily through semi-structured interviews, which are an efficient way to gather rich empirical data (Eisenhardt & Graebner, 2007). Interviews were conducted by selecting the employees most directly involved in Lean and HC practices within each company, prioritizing the Lean Specialist where available. If a Lean Specialist was not present, the interview was conducted with either a Process Engineer or a Quality Specialist, depending on the company's structure and availability. These interviews, lasted between 90 to 120 minutes, and were primarily conducted face-to-face on-site (Creswell & Poth, 2016). Each interview was recorded, transcribed and then coded by two researchers to minimize observer bias.

An interview protocol was developed to guide the discussions, targeting three dimensions for both Lean and HC approaches: AW, IM, and EF (Yahya et al., 2019). AW refers to the level of knowledge and recognition of Lean and HC principles within an organization, including an understanding of their purpose and potential benefits. IM represents the extent to which Lean and HC practices are actively adopted and integrated into organizational processes. EF reflects the perceived impact and success of these practices in improving efficiency, reducing waste, and achieving business objectives. To ensure accuracy and mitigate bias, a structured summary of the interview transcripts was provided to interviewees for validation and to correct any misunderstandings. This approach not only increased the likelihood of receiving feedback but also enhanced the validity of the data. Data triangulation from multiple sources, such as official company documents, internal presentations, and public web resources, further bolstered the reliability of the findings (Yin, 2018). Data were coded using a five-point Likert scale (Yahya et al., 2019) to quantify the levels of AW, IM, and EF. An additional level, 0, was introduced to indicate "No AW, IM, or EF," reflecting the complete absence of relevant practices. The remaining points follow standard Likert scale definitions equal for AW, IM, and EF: 1 = Very Low; 2 = Low;3 = Medium; 4 = High; 5 = Very High. The aggregated results were then calculated to provide a comprehensive overview of the current state of Lean and HC practices within the selected companies.

4. KEY FINDINGS

In line with literature (Yahya et al., 2019), each dimension was scored based on the interview responses, with the final score calculated as the average of multiple aggregated question scores within the same section (AW, IM, EF) in both the Lean and HC domains, following the structured interview protocol. The overall score (AV) was then determined as the average of the AW, IM, and EF scores. The results are shown in Table 2.

Company a, which is a large player in the leather goods sector, consistently achieves high level in HC practices across all three dimensions, maintaining an average score of 4.43 as observed from the insights shared by their Lean specialist. This reflects a profound commitment to employee-centric strategies, complemented by strong Lean practices that average at 3.17. On the other hand, Company b, a medium-sized footwear manufacturer, shows an average Lean maturity of 2.39, as reported by their Process Engineer. The company faces difficulties particularly with HC implementation, suggesting a gap between understanding and applying HC principles. Company c, another medium-sized footwear producer, evaluated through the insights of a Lean Specialist, excels by achieving the highest scores in both Lean (4.67) and HC (4.86) practices across all dimensions, serving as a role model of ideal integration. In contrast, Company d, a large leather goods company whose Process Engineer provided the data, exhibits a significant discrepancy in the Lean domain with low implementation levels, despite high awareness and effectiveness. This discrepancy suggests that while there is substantial knowledge and confidence in Lean principles within the company, converting this into practical application remains a challenge. However, HC performance is more balanced and robust. Company e, with data from a Lean specialist in the leather goods sector, showcases high scores in both domains but leans slightly more towards advanced Lean practices, suggesting a robust adoption of Lean principles with potential areas for enhancement in HC practices. Company f, where feedback came from a Process Engineer in the leather goods market, struggles significantly with low level in HC and varied levels in Lean, highlighting fundamental areas needing improvement, especially in Lean effectiveness. Company g, represented by a Quality Specialist, is a large footwear company displaying moderate score in both domains but stands out in HC implementation (5.00), indicating a strategic focus on HC strategies within its operational framework. Company h, another large leather goods producer with insights from a Process Engineer, achieves high average scores in both domains but shows weaker Lean implementation (1.67), suggesting areas for better practical application of Lean strategies. Company i, given insights from a Quality Specialist in the large leather goods segment, maintains strong average scores across both Lean and HC, indicating well-rounded capabilities and effective integration of practices. Lastly, Company j, a large footwear manufacturer assessed by a Quality Specialist, faces considerable challenges with the lowest average scores in Lean (0.33) across all companies and moderate performance in HC, highlighting significant issues in implementing Lean methodologies and achieving impactful outcomes from HC initiatives.

Table 2. Lean HC assessment results

	Lean				**HC**			
	AW	IM	EF	AV	AW	IM	EF	AV
a	2.83	3.33	3.33	3.17	4.43	4.29	4.57	4.43
b	2.83	1.67	2.67	2.39	3.14	0.71	1.14	1.67
c	4.50	5.00	4.50	4.67	4.86	5.00	4.71	4.86
d	4.33	0.00	4.67	3.00	2.86	3.57	4.14	3.52
e	4.50	3.33	4.50	4.11	3.86	3.57	3.00	3.48
f	3.00	2.50	1.00	2.17	3.00	0.00	0.00	1.00
g	2.33	3.33	1.83	2.50	3.43	5.00	3.14	3.86
h	4.00	1.67	3.67	3.11	4.29	1.43	4.43	3.38
i	4.67	2.50	4.00	3.72	3.43	5.00	4.00	4.14
j	1.00	0.00	0.00	0.33	2.57	2.86	1.14	2.19

To position the companies on the assessment matrix, we used the average values for Lean and HC scores obtained from the evaluation process. These values allowed us to create a grid

that highlights different levels. Companies with scores between 0 and 1 were classified at Level 1, those between 1 and 2 at Level 2, between 2 and 3 at Level 3, between 3 and 4 at Level 4, and between 4 and 5 at Level 5. This segmentation helps in identifying companies positioned in different quadrants, distinguishing Beginners, Process-driven, People-driven, and Excellence-oriented organizations based on their Lean and HC levels. (see Figure 1). Depending on their positioning within this matrix, the integration of Lean and HC practices varies in intensity. Beginners exhibit the lowest level of integration between Lean and HC. People-driven and Process-driven approaches could demonstrate partial integration, particularly when positioned closer to the Excellence quadrant, where the highest level of synergy between Lean and HC is achieved.

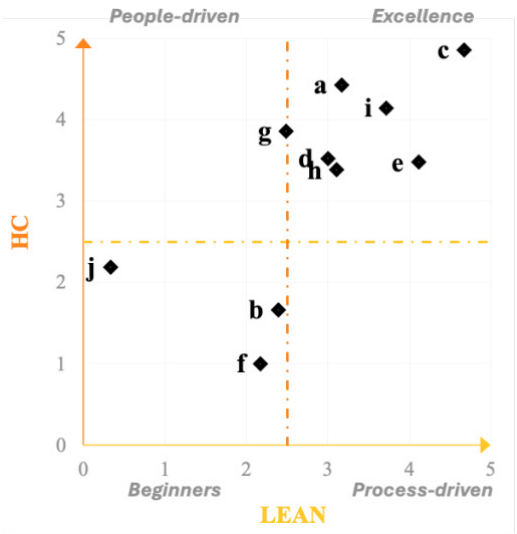

Figure 1. Assessment Lean HC matrix

In the assessment matrix, the Beginners quadrant includes companies f, b, and j, each with distinct Lean and HC scores. Companies f and b lean towards the Process-driven quadrant, possessing low-to-moderate Lean skills but struggling with HC practices. Interviews revealed that Company f has implemented Lean techniques like Kanban but faces employee resistance to collaboration: "*There seems to be reluctance from our team to fully engage with these initiatives*". Similarly, Company b has adopted 5S and Just-In-Time but aims to enhance employee engagement: "*We are actively looking to integrate these with engagement initiatives*". Company j, while lower in Lean domain, shows stronger HC elements by emphasizing flexible scheduling and employee decision-making: "*We focus significantly on human aspects such as workforce flexibility and job enrichment*". Enhancing its HC approach could shift Company j fully into the People-driven quadrant, while Company b could solidify its Process-driven position by strengthening Lean adoption.

Company g, positioned between the People-driven and Excellence quadrants, excels in HC practices but has moderate Lean capabilities. As noted by its Quality Specialist: "*We've seen success with initiatives like 5S and value stream mapping, but there's room for improvement in how these tools drive performance and waste reduction*".

Most companies are in the Excellence quadrant but exhibit varying strengths. Companies d and h show strong but not yet optimal integration. Company d integrates JIT and TPM, enhancing efficiency and HC through employee wellness and participatory decision-making: "*We are now looking at how we can fine-tune these initiatives to maximize impact*". Similarly, Company h focuses on data-driven analytics and comprehensive training programs: "*Our Lean journey has been fruitful, but we need to push further to lead in our industry*". Company e, at Level 5 in Lean, demonstrates high efficiency and process optimization but needs to enhance HC strategies. Its Lean Specialist highlighted: "*We consistently operate at peak efficiency but are exploring ways to better integrate employee feedback*". Strengthening employee engagement through regular feedback loops and career development could balance its HC approach. Companies a and i are among the most HC-mature, emphasizing employee well-being and engagement, while both remain at Level 4 in Lean. Company a's Lean Specialist noted: "*We apply advanced techniques like value stream mapping, but there's still room to better integrate these with HC initiatives*". Similarly, Company i aims to enhance Lean practices to further support its strong HC culture: "*We maintain high levels of production quality, but we are exploring ways to elevate Lean to align better with HC efforts*". Company c stands out as a best-in-class example, achieving top levels in both Lean and HC. It has effectively combined Lean and HC strategies, fostering high productivity and employee engagement. Its Lean Specialist stated: "*We have fully integrated Lean while ensuring every employee feels valued*". Flexible work arrangements, continuous development, and team-building activities have helped sustain a high-performance culture. While Company c benefits from a structured corporate culture within a larger holding, Company b lacks such support, explaining its challenges in HC implementation despite familiarity with Lean. This aligns with Lean adoption barriers found in literature, such as budget constraints (Bathrinath et al., 2022), management resistance (Fernando & Ratnayake, 2021), and workforce reluctance to change (Abu et al., 2021). The Lean Specialist plays a key role in overcoming these barriers, reinforcing the importance of structured guidance in Lean and HC practices. Thus, in the assessment matrix, companies with a dedicated Lean Specialist—Companies a, c, and e—achieved the highest positions.

6. CONCLUSIONS

This paper explored the integration of Lean and HC practices within the fashion industry through a multiple case study approach, using a custom-designed assessment model. The assessment included ten fashion companies based on three core dimensions (AW, IM, EF) across both Lean and HC domains. The findings reveal significant variability in levels, with some companies demonstrating well-rounded capabilities and others struggling to align Lean principles with HC practices. Notably, companies with dedicated Lean teams and structured support systems, such as those embedded within larger corporate holdings, performed better, highlighting the critical role of organizational structure, culture, and resources. The study offers both practical and theoretical contributions. Practically, it provides a roadmap for companies aiming to

integrate Lean and HC practices by identifying key areas of strength and improvement. Managers can use the proposed assessment model to assess their current state and design targeted strategies aimed at fostering a HC culture while driving performance improvements. Theoretically, the paper extends the existing body of knowledge on Lean HC integration by highlighting how these practices can be measured, offering new insights into the interplay between operational efficiency and workforce engagement in the human centricity I5.0 settings. The study also bridges a gap in the literature by applying an assessment model specific to the fashion industry, which is less explored in Lean and HC research.

Despite its contributions, this research has some limitations. First, the sample size is limited to ten companies within the Italian fashion industry, restricting the generalizability of the findings. Second, the assessment model could be further refined by incorporating additional variables such as digital readiness, which may play a crucial role in future Lean 5.0 paradigm. Lastly, only one employee per company was interviewed. However, this constraint was dictated by company availability and organizational policies, which limited the possibility of gathering multiple perspectives within the same firm.

Future research could broaden the sample by including companies from different industries and regions, enhancing the generalizability of the findings. Additionally, a quantitative approach incorporating performance metrics such as productivity, employee satisfaction, and financial outcomes could validate the proposed assessment model's effectiveness on a larger scale. Furthermore, expanding the number of employees interviewed within the same company would provide a more comprehensive perspective, capturing different roles and viewpoints to strengthen the reliability of the assessment.

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