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LEAN OPERATIONS, WORKLOAD STRESS, AND EMPLOYEE PRODUCTIVITY: A MODERATED MEDIATION ANALYSIS OF EMPLOYEE ENGAGEMENT IN PAKISTAN'S AUTOMOTIVE SECTOR

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ABSTRACT

Lean production systems have spread across automotive manufacturing worldwide, yet their effect on the people who operate them remains contested. some studies find that standardized work clarifies tasks, while others find that it intensifies job demands. This study tests whether employee engagement resolves that inconsistency by mediating the effects of lean operations and workload stress on employee productivity and whether workload stress moderates the direct lean operations productivity relationship. Grounded in Job Demand Resources theory and Conservation of Resources theory survey data were collected from production employees at Honda Atlas Cars Pakistan Limited and analyzed using partial least squares structural equation modeling in SmartPLS 4. Employee engagement mediated the relationship between lean operations and productivity and workload stress significantly moderated the lean operations productivity relationship. The results suggest that the productivity returns to lean implementation depend on whether it builds employee engagement with direct implications for how automotive manufacturers in emerging markets sequence lean rollout alongside employee wellbeing.

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Introduction

Lean operations refer to a management approach rooted in the Toyota Production System that seeks to eliminate waste and variability from production processes through standardized work

continuous improvement and pull based scheduling (Piercy & Rich, 2015). As global automotive assemblers face tighter margins from currency volatility, shorter model cycles, and rising input costs, most manufacturers that have weathered the recent wave of disruption have adopted some version of this lean vocabulary like takt time, kaizen, and structured problem solving. Three decades after lean spread beyond Toyota, however, what happens to the workers who operate these systems once waste has been eliminated remains an open question. Piercy and Rich (2015) note that the operational and human effects of lean are conceptually distinct and that while evidence for the operational gains is reasonably settled evidence for the workforce effects is not.

That inconsistency is not merely a difference in measurement. Conti, Angelis, Cooper, Faragher, and Gill (2006) found that lean production in a sample of UK manufacturing workers raised both output and perceived work intensity and stress. Stimec and Grima (2019) found the opposite pattern in continuous improvement systems with strong worker involvement, where stress fell as employees gained genuine control over process redesign. Both studies used credible designs which suggests the disagreement reflects a missing variable rather than a flawed one. The likely candidate argued two decades ago by Landsbergis, Cahill, and Schnall (1999) but rarely tested with modern structural modeling outside North America, Western Europe and East Asia is the extent to which employees experience themselves as engaged participants in the system rather than as its subjects.

Pakistan's automotive sector offers an unusually direct test of this question. Its lean systems are largely imported from Japanese and Western parent companies onto a workforce with different labor market institutions different job security and a different cultural orientation toward hierarchy and voice. Honda Atlas Cars Pakistan Limited (HACPL), a joint venture between Honda Motor Company and the Atlas Group and the principal producer of Honda vehicles in Pakistan since 1994 has run a formal lean program since 2005 and holds ISO 9001, ISO 14001, and OHSAS 18001 certification. That combination a mature and institutionally embedded lean system operating in a context distinct from where most existing evidence was generated makes HACPL a suitable site for testing the psychological mechanism this study is concerned with.

This study's central argument is that employee engagement functions in this system less as a buffer against the effects of lean than as the conduit through which lean operations and workload stress become productivity at all. Job Demands Resources theory (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) supplies the formal structure for that claim that lean operations combine demand like features, standardized pacing and continuous improvement pressure with resource like features, documented procedures and structured escalation channels while workload stress functions as a comparatively pure demand. Engagement is the personal resource state through which that combination translates into performance. Conservation of Resources theory (Hobfoll, as applied in this literature by Tortorella, Giglio, & van Dun, 2019) supplies the reason for modeling this as mediation rather than as two additive effects one is resource gains from well-designed lean systems and resource losses from workload stress are not assumed to affect output directly but to affect the worker's state of engagement, which in turn affects output.

The study aims to contribute to three literatures. For the lean operations literature, it provides an empirical rather than case based test of how the demand and resource elements of lean reach a performance outcome in an emerging market automotive plant, a setting underrepresented relative to the bulk of lean research conducted in China, India, Brazil, and Western Europe. For Job Demands Resources theory, it adds a dimension in which lean operations function as both a demand and a resource, testing their combined effect on engagement rather than assuming the relationship is positive. For the employee engagement literature, it treats engagement as a mediating variable between operational systems and productivity rather than as an HR outcome managed in isolation which is how much of the practitioner literature treats it.

The disagreement in the literature is instructive rather than merely unresolved. One strand of research, represented by Nawanir, Kong Teong, and Norezam Othman (2013) and Panwar, Jain, Rathore, Nepal, and Lyons (2018), treats lean practices as a package whose overall effect on operational and workforce performance is positive: waste reduction clarifies roles and gives workers a more visible task structure. A second strand represented by Conti et al. (2006) and Landsbergis et al. (1999), treats the same bundle of practices as work intensification, in which tighter takt times and standardized procedures shrink workers' discretionary space and raise physiological and psychological strain. Both strands draw on real plants and real data so the inconsistency cannot be dismissed as a measurement artifact on either side.

Job Demands Resources theory offers one way to resolve this without declaring either side wrong: because it explicitly separates job demands which raise strain from job resources which mitigate strain and sustain motivation it allows the same lean bundle to carry both properties at once with the net effect on any downstream outcome depending on how the worker's engagement absorbs the combination. Existing lean productivity evidence however has not tested that combination directly. Studies of specific lean tools in Indian automotive plants (Gupta & Kumar, 2021; Kumar & Mathiyazhagan, 2019) link tools such as Heijunka to higher productivity without mapping the psychological mechanism between the tool and the output and are drawn from a labor context different from Pakistan's. Studies of engagement in lean settings (Hawarna, Ahmed, Alqasmi, Ashrafi, Rahman, & Paraman, 2025; Gama & Bonamigo, 2024) treat engagement as a condition for lean's success rather than as a modeled mediator carrying a bootstrapped indirect effect forward to a performance outcome. The case literature on lean–performance in automotive manufacturing is itself geographically narrow concentrated in India, Brazil (Marodin, Chiappetta Jabbour, Godinho Filho, & Tortorella, 2023) and China (Wang, Zhang, Yao, & Zhu, 2025), with no comparable test in a Pakistani joint-venture assembler. Where workload stress is examined at all (Stimec & Grima, 2019; Conti et al., 2006) it is treated as a direct predictor of outcomes rather than as a factor that might moderate the strength of the lean–productivity relationship itself leaving the convergent and divergent findings described above theoretically unreconciled. No study offers one model capable of producing both a clarifying and an intensifying effect depending on the level of a third variable. Nor has Conservation of Resources theory been used alongside Job Demands–Resources theory to explain these effects despite Tortorella, Powell, Hines, Mac Cawley Vergara, Tlapa-Mendoza, and Vassolo (2025) invoking the former without the latter; the two are combined in the

hypotheses developed in Section 2. No study identified for this review, moreover, tests these relationships within a single structural model with bootstrapped indirect effects, which is the specification this study adopts.

The remainder of the paper proceeds as follows. Section 2 reviews the literature on lean operations, workload stress, engagement, and productivity, extends Job Demands–Resources and Conservation of Resources theory to this context, and develops the study's eight hypotheses. Section 3 describes the research design and method. Section 4 presents the PLS-SEM results. Section 5 discusses the findings in relation to theory and prior research, and Section 6 concludes with the study's implications, limitations, and directions for future research.

Research Objectives

Consistent with the gaps identified above, the study pursues three objectives:

1. To examine whether employee engagement mediates the effects of lean operations and workload stress on employee productivity at HACPL.
2. To test whether lean operations and workload stress retain a direct effect on employee productivity once employee engagement is accounted for.
3. To determine whether workload stress moderates the strength of the relationship between lean operations and employee productivity.

Research Questions

1. Does employee engagement mediate the relationship between lean operations, workload stress, and employee productivity at HACPL?
2. Do lean operations and workload stress have a direct effect on employee productivity independent of employee engagement?
3. Does workload stress moderate the strength of the relationship between lean operations and employee productivity?

Literature Review

Lean thinking traces to the Toyota Production System developed by Taiichi Ohno and Eiji Toyoda to eliminate seven forms of waste that are overproduction, waiting, transport, over-processing, excess inventory, unnecessary motion and defects. Garcés, Forcael, Osorio, Castañeda, and Sánchez (2025) trace its diffusion across five phases from its formalization within Toyota through the globalization wave of the 1990s and the extension into services and healthcare in the 2000s to its recent integration with digital technologies and sustainability goals. Its core practices, value stream thinking continuous flow, pull systems, and continuous improvement (Dey, Malesios, De, Chowdhury, & Abdelaziz, 2020) are consistently described in the literature as efficiency enhancing at the level of the plant. Their effect on the people who carry them out is described far less consistently.

Job Demands-Resources theory (Demerouti et al., 2001) offers a way to organize that inconsistency. It separates job demands features of work that require sustained effort and carry a physiological or psychological cost from job resources features that support goal attainment reduce demands or stimulate growth. In a plant such as HACPL both are plausibly present in the same lean bundle standardized work and continuous improvement targets function as demands while documented procedures escalation pathways for abnormalities and channels through which workers' suggestions reach management function as resources that reduce ambiguity and support a sense of control (Florez-Cáceres, Huamán-E, & Quiroz-Flores, 2024). Because HACPL's program combines standardization with structured worker input rather than standardization alone the resource side of that ledger has a credible theoretical basis for outweighing the demand side. Supporting evidence exists outside the automotive sector: Hawarna et al. (2025) report a positive association between structured lean quality improvement processes and engagement in a hospital setting attributed to the clarity and participative nature of the process rather than to any reduction in requirements and Gama and Bonamigo (2024) reach a similar conclusion studying Brazilian automotive firms. That relationship has rarely been tested however where lean operations are specified as containing both demand and resource content within a single structural model isolating this path from the wider mediation chain, which motivates the first hypothesis:

H1: Lean operations have a significant positive effect on employee engagement.

Workload stress defined here as the physical and psychological strain associated with the pace, accuracy, and efficiency demands of lean systems, is unambiguously a demand in Job Demands Resources terms. Conservation of Resources theory (Hobfoll, as applied by Tortorella et al., 2019) frames it more specifically as a state in which valued resources, time, discretion, and capacity for recovery are threatened or depleted and in which that depletion competes with the psychological investment engagement requires. Conti et al. (2006) found that lean driven work intensification in a UK sample was accompanied by withdrawal rather than engagement behavior and Landsbergis et al. (1999) found a similar pattern across a broader set of lean-adjacent work-reorganization studies, where demands rising without matched resources led to a decline in workers' investment in their roles. That relationship has more often been reported for stress or strain outcomes generally than for engagement specifically and rarely within the same structural model that also links engagement forward to productivity, as this study does jointly with H6 and H7 below.

H2: Workload stress has a significant negative effect on employee engagement.

Employee engagement in Kahn's original formulation is the simultaneous activation of an employee's physical, cognitive, and emotional selves within the job role; later work reframes it as a positive, work-related state of mind marked by vigor, dedication, and absorption (Wang, Zhang, Yao, & Zhu, 2025) and distinguishes trait, state, and behavioral forms of engagement. Much of the lean engagement literature treats engagement either as an outcome of well-designed lean systems (Hawarna et al., 2025) or as a precondition for lean to succeed (Gama & Bonamigo, 2024); both claims can be true without either specifying engagement as a mediator that carries a measurable share of lean's and stress's effects forward to a performance outcome. Read together with the JD-R

logic above, resources raise engagement, demands lower it, and the effect of both on discretionary effort, problem solving, and sustained performance is plausibly channeled through this proximal psychological state rather than acting in parallel with it. Tortorella et al. (2025) treat engagement as a moderator of AI-enabled task change rather than as a mediator which leaves the mediating role this study specifies still untested. The most direct theoretical claim in the model, and the one best supported empirically is that engaged employees convert their psychological resources into sustained effort and output (Wang et al., 2025; Hawarna et al., 2025) what is less established is the size of that path in a South Asian sample where the antecedents and consequences of engagement documented in Western and East Asian evidence may not transfer directly.

H3: Employee engagement has a significant positive effect on employee productivity.

Employee productivity is the study's dependent variable and the point at which the mediation chain becomes organizationally relevant. Gupta and Kumar (2021) report substantial productivity and machine efficiency gains from Heijunka-based production leveling in an Indian automotive OEM and Kumar and Mathiyazhagan (2019) report comparable gains from sustainable lean manufacturing that combined waste reduction with workload balancing across assembly, machining, and molding operations. Gomaa (2025) reports a similar pattern applying 5S and PDCA in an automotive service setting. These studies demonstrate that lean tools raise productivity but they model the tool rather than the psychological state of the worker applying it, leaving open whether lean operations retain a direct effect on productivity once engagement is accounted for or whether their effect runs entirely through engagement. Fatigue and error under sustained pace pressure give workload stress a comparable, engagement-independent route to affecting output. Existing studies have tested lean or stress directly or with engagement as a mediator but not both together which is why this study allows for either full or partial mediation.

H4: Lean operations have a significant direct effect on employee productivity, independent of employee engagement.

H5: Workload stress has a significant direct effect on employee productivity, independent of employee engagement.

The case for treating engagement as a mediator rather than a parallel predictor follows from the same JD-R and COR logic that is when lean operations are high the worker's psychological state should be higher and output should follow; when workload stress is high, the reverse should hold. The closest empirical precedent Tortorella et al. (2025), found that AI-enabled task change affected engagement, which in turn affected performance relevant behavior but did not test the full causal sequence with a bootstrapped indirect-effect estimate. No study identified in this review tests that sequence in a lean automotive context which is the gap H6 and H7 address.

H6: Employee engagement significantly mediates the relationship between lean operations and employee productivity.

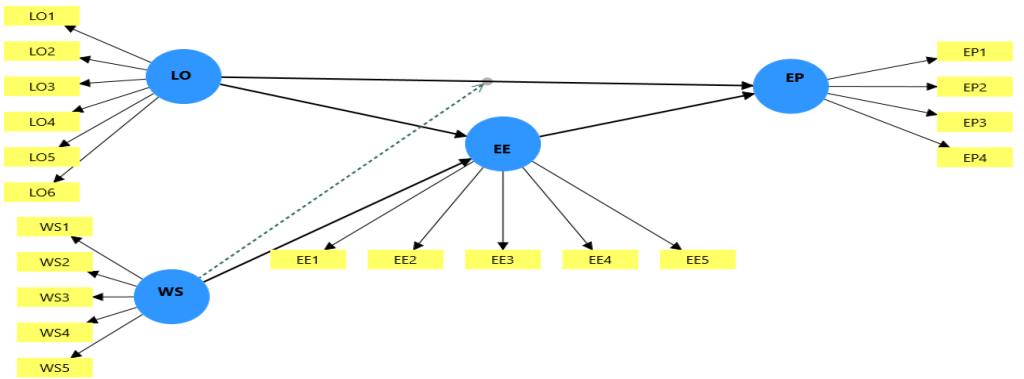
H7: Employee engagement significantly mediates the relationship between workload stress and employee productivity.

The last hypothesis addresses the divergence described in Section 1 directly. Whether lean clarifies work (Nawanir et al., 2013) or intensifies it (Conti et al., 2006) may depend on the resource context in which it operates, as Conservation of Resources theory would predict. When workload stress is low, lean's resource elements, clear procedures and structured improvement channels should transfer relatively directly into productivity gains. When workload stress is high the same practices may instead be experienced as additional demands, weakening that transfer. This is a moderation claim rather than a mediation one: workload stress is hypothesized to change the strength of the lean productivity path itself distinct from its mediated effects on engagement and productivity tested in H2, H5, and H7.

H8: Workload stress significantly moderates the relationship between lean operations and employee productivity.

Figure 1 summarizes these relationships in the study's conceptual model, with employee engagement specified as a mediator of the effects of lean operations and workload stress on productivity and workload stress additionally specified as a moderator of the direct lean operations–productivity path.

Figure 1: Conceptual Model



Note: LO = Lean Operations; WS = Workload Stress; EE = Employee Engagement; EP = Employee Productivity. Source: authors' own construction.

Research Design and Methodology

Design, Setting, and Sample

This study uses a quantitative, cross-sectional survey design appropriate for testing a pre-specified structural model at a single point in time. Approximately 710 production employees across six

departments at HACPL were eligible for sampling. The achieved sample was 155 employees recruited through convenience sampling from staff with at least six months of service who were directly involved in production and willing to participate, yielding a 100 percent response rate among those approached and a margin of error of approximately ±8.2 percent at the 95 percent confidence level. HACPL management approved data collection in advance, and surveys were administered on-site using Google Forms, with research-team members present to clarify items; completion took 10-15 minutes per respondent.

All four constructs, lean operations, workload stress, employee engagement, and employee productivity, were measured with multi-item, five-point Likert scales developed for this study's HACPL context: four items each for lean operations and employee productivity, and five items each for workload stress and employee engagement. Lean operations items covered standardized procedures, workplace organization, and workflow continuity; workload stress items covered pace pressure, discretion loss, and disruption-driven strain; employee engagement items covered pride, recognition, discretionary effort, and absorption; and employee productivity items covered task completion, quality, error rates, and overall contribution. Full item wording, construct definitions, and sources are reported in Table 1.

Table 1: Constructs, Definitions, and Indicators

Construct / Definition	Item	Indicator Wording
Lean Operations (LO) A management philosophy aimed at eliminating waste through standardized work, workplace organization, continuous flow, and structured problem solving.	LO1	The standard procedures for my tasks are well-documented and easily accessible.
	LO2	My work area is consistently organized to minimize time spent searching for tools or parts.
	LO3	Parts and materials arrive at my workstation precisely when they are needed.
	LO4	The workflow in my section is smooth and uninterrupted by bottlenecks or waiting times.
	LO5	My suggestions for improving safety, quality, or efficiency are seriously considered by management.
	LO6	When an abnormality (e.g., a defect, machine issue) occurs, there is a clear and effective process to address its root cause.
Workload Stress (WS) The physical and psychological strain associated	WS1	The pace of work on my line is demanding and leaves little room for pause.

with increased requirements for speed, accuracy, and efficiency under lean systems.		
	WS2	I often feel pressured to complete my tasks faster than is comfortable.
	WS3	The amount of work I am expected to do has decreased as processes have become more efficient. (reverse-scored)
	WS4	The strict adherence to standardized procedures limits my ability to use my own judgment to solve problems, which I find stressful.
	WS5	I feel stress when production is disrupted because there is no buffer.
Employee Engagement (EE) A positive, work-related psychological state characterized by pride, recognition, discretionary effort, and absorption in one's work.	EE1	I feel a sense of pride in the quality of work I do.
	EE2	I feel that my efforts are valued and recognized.
	EE3	I am willing to put in extra effort beyond what is strictly required.
	EE4	I am fully focused and absorbed in my tasks while at work.
	EE5	I am personally interested in finding ways to improve the processes I work with.
Employee Productivity (EP) An employee's ability to complete assigned tasks within the allocated time without compromising output quality.	EP1	I am able to complete my assigned tasks within the allocated time without compromising on quality.
	EP2	The work I produce consistently meets the required quality standards.
	EP3	I rarely make errors or cause rework in my part of the process.
	EP4	Overall, I believe I make a highly productive contribution to the production goals.

Note. All items used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). LO = Lean Operations; WS = Workload Stress; EE = Employee Engagement; EP = Employee Productivity. Source: Honda Atlas Cars Pakistan Limited survey, authors' own construction.

The conceptual model tested in this study, in which employee engagement mediates the effects of lean operations and workload stress on employee productivity and workload stress additionally moderates the direct lean operations–productivity path was presented as Figure 1 at the end of Section 2.

Estimation Technique

Structural Equation Modeling (SEM) tests hypothesized causal mechanisms using non-experimental, quantitative data across multiple constructs measured by multiple indicators. Covariance-based SEM (CB-SEM) treats latent constructs as the common cause of their observed indicators and is typically used to confirm a theoretical model's fit to the observed variance-covariance structure. Partial least squares SEM (PLS-SEM) by contrast, treats constructs as weighted composites of their indicators and is oriented toward explaining variance in endogenous constructs rather than confirming overall model fit; it is well suited to models with a moderated mediation structure and an interaction term, a sample size of 155 and a research objective centered on explaining variance in engagement and productivity rather than validating an a priori covariance structure (Hair, Hult, Ringle, & Sarstedt, 2022). This study accordingly used PLS-SEM in SmartPLS 4. The measurement model was assessed first for indicator reliability, internal consistency, convergent validity, and discriminant validity; the structural model was then assessed by bootstrapping with 5,000 subsamples, testing six direct paths (H1: LO→EE, H2: WS→EE, H3: EE→EP, H4: LO→EP, H5: WS→EP, H8: WS×LO→EP) and two specific indirect effects (H6: LO→EE→EP, H7: WS→EE→EP).

Results

Measurement Model: Reliability and Convergent Validity

aThe measurement model was estimated using the PLS-SEM algorithm in SmartPLS 4, with constructs shown as circles measured by their indicators (rectangles) in Figure 2. Following Hair, Hult, Ringle, and Sarstedt (2022), the measurement model was evaluated for reliability, convergent validity, and discriminant validity. Reliability and internal consistency were assessed using outer loadings, Cronbach's alpha, and composite reliability (rho_a and rho_c); convergent validity was assessed using average variance extracted (AVE). As Table 2 reports, all four constructs exceeded the conventional 0.70 threshold by a wide margin: Cronbach's alpha and composite reliability (rho_c) exceeded 0.963 and 0.973 respectively, and AVE exceeded 0.891 against the recommended 0.50 benchmark (Hair et al., 2022).

Table 2: Construct Reliability and Validity

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE
EE	0.977	0.979	0.982	0.917
EP	0.963	0.963	0.973	0.900

LO	0.987	0.988	0.990	0.940
WS	0.969	0.972	0.976	0.891

Source: authors' own analysis.

Table 3 reports the factor (outer) loadings for all indicators, which ranged from 0.925 to 0.979, well above the 0.70 threshold (Hair et al., 2022), indicating that each indicator reliably represents its intended construct. The interaction term (WS×LO) loaded at 1.000, as expected for a single-indicator construct created for the moderation analysis. No items were removed from the analysis.

Table 3: Factor (Outer) Loadings

Indicator	EE	EP	LO	WS
EE1	0.941			
EE2	0.948			
EE3	0.971			
EE4	0.968			
EE5	0.959			
EP1		0.965		
EP2		0.94		
EP3		0.931		
EP4		0.957		
LO1			0.965	
LO2			0.972	
LO3			0.971	
LO4			0.979	
LO5			0.968	
LO6			0.962	
WS1				0.925
WS2				0.96
WS3				0.938
WS4				0.954
WS5				0.941

Source: authors' own analysis.

Discriminant Validity

Discriminant validity, whether each construct is empirically distinct from the others, was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait ratio (HTMT), following Hair, Risher, Sarstedt, and Ringle (2019). Table 4 reports the Fornell–Larcker results: the square root of

each construct's AVE (shown on the diagonal, ranging from 0.944 to 0.970) exceeded its correlations with the other constructs, satisfying the criterion for EE, EP, LO, and WS. Consistent with theoretical expectations, lean operations correlated positively with engagement and productivity, while workload stress correlated negatively with all three constructs.

Table 4: Discriminant Validity — Fornell–Larcker Criterion

Construct	EE	EP	LO	WS
EE	0.958			
EP	0.619	0.948		
LO	0.593	0.688	0.970	
WS	-0.586	-0.573	-0.746	0.944

Note. Diagonal values (bold in the original analysis) are the square root of AVE

Source: authors' own analysis.

Table 5 reports HTMT ratios, which ranged from 0.473 to 0.786, below the conservative 0.85 threshold (Henseler, Ringle, & Sarstedt, 2015), confirming that the four constructs are empirically distinct. The comparatively higher HTMT for the interaction term with lean operations (0.786) reflects the fact that the interaction term is constructed mathematically from lean operations, and does not indicate a discriminant validity problem among the substantive constructs.

Table 5: Discriminant Validity — HTMT Ratios

Construct	EE	EP	LO	WS
EE	—			
EP	0.637	—		
LO	0.601	0.705	—	
WS	0.599	0.591	0.762	—
WS × LO	0.473	0.687	0.786	0.497

Source: authors' own analysis.

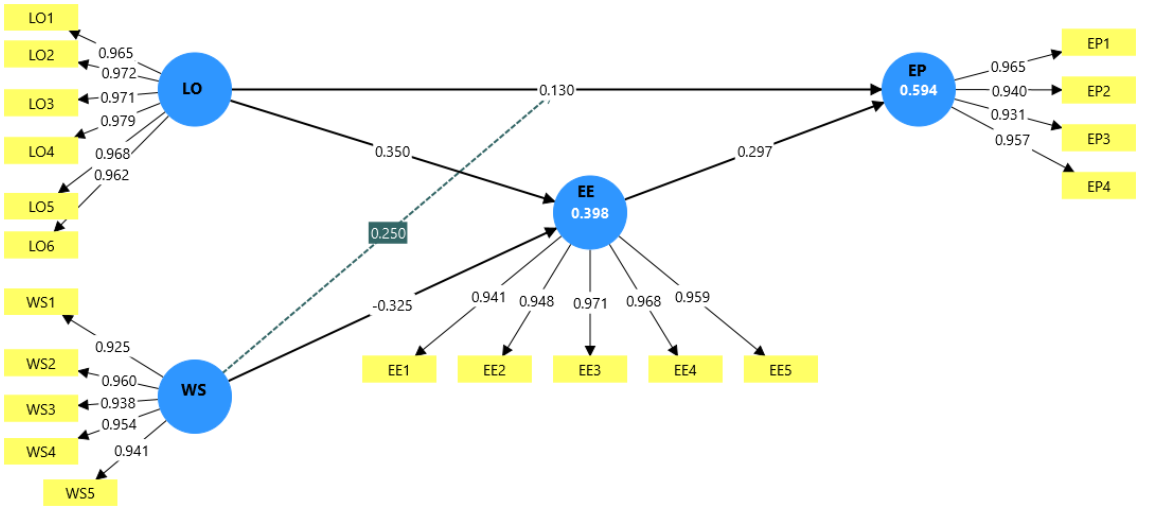
Inner-model variance inflation factors (Table 6) ranged from 1.671 to 4.747, below the conservative threshold of 5.0 (Hair et al., 2022), indicating that multicollinearity among the predictors of employee productivity does not distort the structural coefficients reported below.

Table 6: Collinearity Statistics (VIF) — Inner Model

Predictor	EE	EP	LO	WS
EE		1.671		
LO	2.252	4.747		
WS	2.252	2.569		
WS × LO		2.723		

Source: authors' own analysis.

Figure 2: Measurement and Structural Model — PLS Algorithm Results



Source: authors' own analysis, SmartPLS 4 output.

Structural Model: Explanatory and Predictive Power

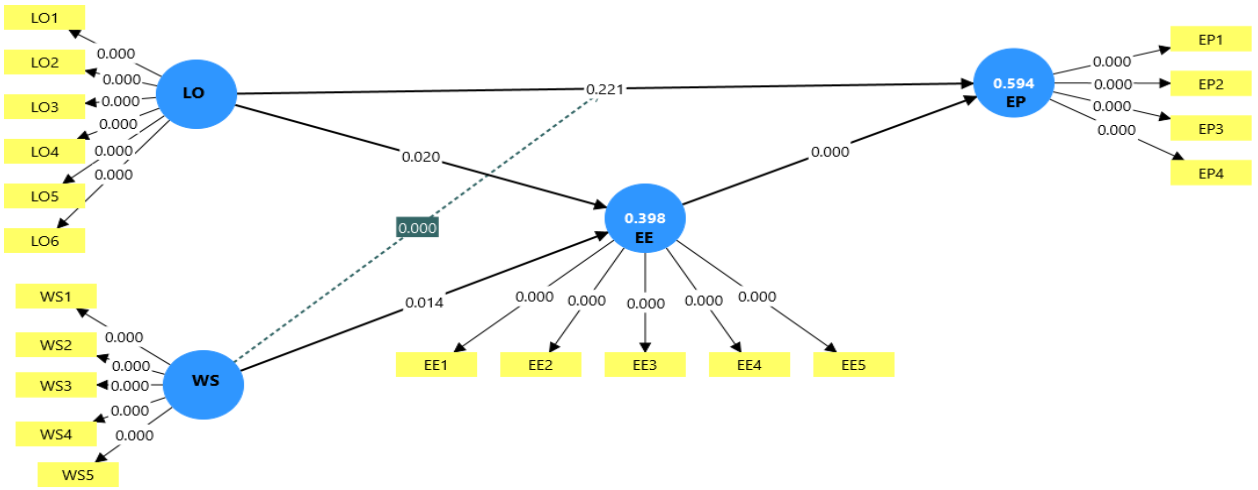
Lean operations and workload stress jointly explained 39.8 percent of the variance in employee engagement (R^2 = 0.398, adjusted R^2 = 0.390) a moderate effect by Cohen's benchmarks for PLS-SEM given that engagement is also shaped by factors not modeled here, such as supervisory relationships, compensation, and personal disposition. The full set of constructs explained 59.4 percent of the variance in employee productivity (R^2 = 0.594, adjusted R^2 = 0.584) a substantial share for a single-firm field study. Effect sizes (f^2, Table 7) were largest for employee engagement's effect on productivity and for the workload stress × lean operations interaction, both approaching Cohen's medium-effect benchmark of 0.15; the direct effects of lean operations and workload stress on productivity were small once the engagement and interaction pathways were included (f^2 = 0.009 and 0.013, respectively).

Table 7: f^2 Effect Size

Path	f^2	Interpretation
EE → EP	0.130	Approaching medium effect
LO → EE	0.091	Small-to-medium effect
LO → EP	0.009	Negligible effect
WS → EE	0.078	Small effect
WS → EP	0.013	Negligible effect
WS × LO → EP	0.128	Approaching medium effect

Source: authors' own analysis.

Figure 3: Structural Model — Bootstrapping Results



Source: authors' own analysis, SmartPLS 4 output.

Hypothesis Testing: Direct and Interaction Effects

Table 8 reports the bootstrapped path coefficients for H1–H5 and H8. Lean operations had a significant positive effect on employee engagement (β = 0.350, p = .020, 95% CI [0.015, 0.603]), supporting H1. Workload stress had a significant negative effect on employee engagement (β = −0.325, p = .014, 95% CI [−0.634, −0.119]), supporting H2. Employee engagement had a significant positive effect on productivity (β = 0.297, p < .001, 95% CI [0.188, 0.425]), the strongest path in the model, supporting H3. The direct effect of lean operations on productivity was not significant (β = 0.130, p = .221, 95% CI [−0.074, 0.340]); H4 was not supported. The direct effect of workload stress on productivity was significant and negative (β = −0.118, p = .041, 95% CI [−0.241, −0.012]); H5 was supported. The workload stress × lean operations interaction had a significant positive effect on productivity (β = 0.250, p < .001, 95% CI [0.150, 0.351]), supporting H8. Figure 4 plots the simple slopes of lean operations on productivity at low (−1 SD) and high (+1 SD) workload stress, computed directly from the reported path coefficients: the lean–productivity slope is steeper under high workload stress than under low workload stress, indicating that lean's structural resources become more, rather than less, productive as workload stress rises.

Table 8: Bootstrapping Results

Path	β	t-value	p-value	95% CI	Hypothesis	Decision
EE → EP	0.297***	4.973	0.000	[0.188, 0.425]	H3	Supported
LO → EE	0.350**	2.335	0.020	[0.015, 0.603]	H1	Supported

LO → EP	0.130	1.224	0.221	[-0.074, 0.340]	H4	Not supported
WS → EE	-0.325**	2.461	0.014	[-0.634, -0.119]	H2	Supported
WS → EP	-0.118**	2.041	0.041	[-0.241, -0.012]	H5	Supported
WS × LO → EP	0.250***	4.801	0.000	[0.150, 0.351]	H8	Supported

Note. * p < .10, ** p < .05, *** p < .01. Source: authors' own analysis.

Mediation Effects

Table 9 reports the specific indirect effects testing H6 and H7. The indirect effect of lean operations on productivity through engagement was significant (β = 0.104, p = .045, 95% CI [0.004, 0.210]), supporting H6; combined with the non-significant direct effect (H4), this indicates full mediation. The indirect effect of workload stress on productivity through engagement was also significant (β = -0.096, p = .026, 95% CI [-0.200, -0.032]), supporting H7; combined with the significant direct effect (H5), this indicates partial mediation, consistent with an additional fatigue- or error-based pathway from stress to productivity that does not run through engagement.

Table 9: Specific Indirect Effects (Mediation Tests, Bootstrapping)

Path	β	t-value	p-value	95% CI	Hypothesis	Decision
LO → EE → EP	0.104	2.006	0.045	[0.004, 0.210]	H6	Supported
WS → EE → EP	-0.096	2.221	0.026	[-0.200, -0.032]	H7	Supported

Source: authors' own analysis.

Discussion

Table 10: Summary of Hypothesis Testing

Hypothesis	Relationship	Result
H1	Lean operations → Employee engagement (positive)	Supported
H2	Workload stress → Employee engagement (negative)	Supported
H3	Employee engagement → Employee productivity (positive)	Supported
H4	Lean operations → Employee productivity (direct)	Not supported
H5	Workload stress → Employee productivity (direct, negative)	Supported
H6	Employee engagement mediates Lean operations → Employee productivity	Supported (full mediation)
H7	Employee engagement mediates Workload stress → Employee productivity	Supported (partial mediation)
H8	Workload stress moderates Lean operations → Employee productivity	Supported

Source: authors' own analysis.

These results speak directly to the study's three objectives. Employee engagement, rather than lean operations as such is the more direct pathway to productivity gains at HACPL: engagement fully mediates the effect of lean operations on productivity (H1, H3, H6), and it also mediates most, though not all, of the effect of workload stress (H2, H3, H7). Lean operations and workload stress retain little to no direct effect on productivity once engagement is accounted for, apart from a modest direct penalty from workload stress consistent with a fatigue or error mechanism (H4, H5). Workload stress does moderate the strength of the lean operations–productivity relationship though not in the direction a simple intensification account would predict (H8).

This pattern qualifies the productivity claims made in the tool focused lean literature. Gupta and Kumar (2021) and Kumar and Mathiyazhagan (2019) attribute productivity gains directly to specific lean tools, Heijunka, standardized work, waste reduction, without treating the worker's psychological state as part of the causal chain. The findings reported here suggest that account is incomplete for HACPL: lean's resource content, documented procedures, structured escalation, and participative improvement channels, appears to raise productivity primarily by raising engagement, not by operating on output directly. This is consistent with Stimec and Grima (2019), who found that continuous improvement reduced stress only when workers genuinely participated in redesigning their own processes, and is a further argument against treating lean as a self-executing set of procedures.

The workload stress results are the more theoretically complex piece of the pattern. Its negative relationship with engagement (H2) and its negative indirect effect on productivity through engagement (H7) both match Conservation of Resources theory's resource-depletion account, as does its direct negative effect on productivity (H5) which most plausibly reflects fatigue and error rather than reduced motivation. The positive interaction effect (H8) requires more careful interpretation: a positive WS × LO coefficient does not mean stress is good for productivity, a claim the negative direct effect under H5 already rules out. It means the lean operations–productivity relationship strengthens as workload stress rises, the opposite of the straightforward lean-intensifies-work account found in the Western manufacturing literature (Conti et al., 2006; Landsbergis et al., 1999). Read through Job Demands-Resources theory, one plausible account is that HACPL's lean structure has comparatively less compensating work to do under low stress and comparatively more under high stress, precisely when workers need it most. This is a pattern the Western lean-stress literature has not reported, and one that this Pakistani manufacturing context helps surface.

Read together, Conservation of Resources theory frames this not as demand and resource acting separately but as jointly determining whether a worker is on a resource gain or a resource loss trajectory. A well-structured lean system is plausibly the kind of resource that slows a resource loss spiral when demands are high, and does comparatively less of that work when demands are low. Under that reading, the eight hypotheses resolve into a single account that is lean operations build engagement, workload stress erodes it, engagement carries both effects forward to productivity and lean's structural resources become more, not less productive as workload stress rises.

Three implications follow for lean implementation at HACPL and similar plants beyond generic lean best practice. First, further productivity gains from lean rollout are more likely to come from its engagement building elements participative improvement channels, recognition and transparent communication than from procedural expansion on its own since the direct lean to productivity pathway was not statistically supported here. Second, workload stress should be treated as a productivity issue and not only a wellbeing issue given its direct negative effect on output. Third, and least intuitively, periods of high workload stress are not the time to relax lean discipline, the interaction results suggest this is precisely when lean's structural resources do their most compensating work.

Conclusion

This study examined the mechanism connecting lean operations and workload stress to employee productivity at a Pakistani automotive manufacturer and tested whether workload stress moderates the strength of the lean–productivity relationship. Using PLS–SEM on survey data from 155 production employees at Honda Atlas Cars Pakistan Limited, it finds that employee engagement fully mediates the relationship between lean operations and productivity partially mediates the relationship between workload stress and productivity and that workload stress significantly moderates the lean operations productivity relationship with the model explaining 39.8 percent of the variance in engagement and 59.4 percent of the variance in productivity.

Theoretically, the study repositions employee engagement from a condition for lean's success to a formally tested mediating mechanism, using a bootstrapped indirect effect specification rather than a narrative or correlational claim. It extends Job Demands Resources theory by showing within a single structural model that a structural job resource (lean's procedural architecture) can become more rather than less productivity–relevant as a competing job demand (workload stress) intensifies a resource–demand interaction pattern that departs from the intensification account found in the Western lean–stress literature.

Methodologically, the study applies a rigorously tested PLS–SEM measurement and structural model jointly examining mediation and moderation a combination still uncommon in the lean operations literature. Practically, it suggests that the sequencing of lean implementation, prioritizing engagement building mechanisms over procedural rollout alone matters as much as whether lean is implemented and that treating workload stress as a productivity lever rather than only a wellbeing concern has direct managerial value.

These conclusions are bounded by the study's limitations. The single–firm, cross–sectional, convenience–sampled design (n = 155) limits generalizability beyond HACPL and does not support causal inference; item counts per construct are moderate, and the use of a single self–report survey instrument for all four constructs leaves common method variance an open concern. Future research should test this moderated mediation model in other Pakistani and South Asian automotive plants to assess generalizability, incorporate objective productivity measures alongside self–reports to address common method concerns and examine whether the resource compensation pattern found

in the workload stress × lean operations interaction replicates in other high demand manufacturing settings or is specific to HACPL's implementation of lean.

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