HALAL PRINCIPLE AND OPERATIONAL PERFORMANCE OF MSMEs INDUSTRIES: MEDIATING ROLE OF LEAN SIX SIGMA AND SUSTAINABILITY

M. Faishal[1,2], E. Mohamad[1*], H.M. Asih[2], A.A. Abdul Rahman[1], T. Johanuar[3] and O. Adiyanto[2]

[1]Faculty of Industrial and Manufacturing Technology and Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.

[2]Teknik Industri, Fakultas Teknologi Industri, Universiti Ahmad Dahlan, Jl Ringroad Selatan, Tamanan, Bantul 55191, D.I Yogyakarta, Indonesia.

[3]HR Department, PT Deltomet Laboratories Factory, Nangger RT 05 RW 05, Nambangan, Selogiri, Wonogiri 57652, Jawa Tengah, Indonesia.

*Corresponding Author's Email: effendi@utem.edu.my

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ABSTRACT: Improving operational performance in MSMEs within Indonesia's poultry industry is crucial, given the sector's significant contribution to the national economy. However, it continues to face challenges related to Halal Principles (HP), process inefficiencies, quality issues, low product innovation, and adverse environmental and social impacts that may hinder economic growth. This study investigates the influence of HP on Operational Performance (OP), with Lean Six Sigma (LSS) and Sustainability (S) as mediating variables, in the context of Indonesia's poultry industry. Data from 249 randomly selected respondents were analyzed using Structural Equation Modelling (SEM) with IBM SPSS AMOS version 24.0. The results reveal that HP significantly affects both OP and S. LSS was found to have a direct impact on OP and partially mediates the relationship between HP and OP. Similarly, S directly influences OP and acts as a partial mediator between HP and OP, as well as between LSS and OP. The novelty of this study lies in the development of an inductive model, termed the Halal Lean Six Sigma

Model (HLSSM), which theoretically connects HP, LSS, S, and OP. The findings confirm that HP, along with LSS and S, are key influencers of OP. These insights can guide MSME management in Indonesia's poultry sector to strategically address the interrelationships among HP, LSS, and S to enhance operational performance.

KEYWORDS: *Halal Principle; Lean Six Sigma; Sustainability; Operational Performance; AMOS*

1.0 INTRODUCTION

In the halal industry, halal food represents the most significant segment of halal products. This importance stems not only from Islamic law but also from its emphasis on cleanliness and health [1]. The global halal product market is expanding rapidly. In 2017, halal food expenditures were estimated at approximately US$1.3 trillion, accounting for more than 17% of global food and beverage spending, and are projected to reach US$1.9 trillion by 2023 [2]. Numerous public and private institutions have successfully developed halal standards and certification systems [3].

Research on halal has been conducted extensively, not only in Muslim-majority countries such as Indonesia, Malaysia, and Turkey, but also in nations with Muslim minority populations, including the United States, the Netherlands, France, the United Kingdom, and the European Union. In the Netherlands, despite increasing attention to halal products, the halal governance system remains weak and inadequate to meet the diverse needs of its Muslim population [3]. In the United States, although the majority of the 6 to 8 million Muslims follow halal dietary laws, the food industry largely overlooks this consumer segment. Furthermore, in the kosher poultry market, concerns arise among Muslim scholars due to unconventional sources, synthetic materials, and inconsistencies in slaughtering and processing practices. In Malaysia, the promotion of halal is positioned as a bridge between religious values and secular practices, illustrating the alignment of modern Islam, state ethics, business, and ethical Islamic consumption [4].

The sustainability of Chicken Slaughtering Houses (CSHs) must account for various factors, including animal welfare, environmental impact, food safety, and economic viability. Sustainable practices

involve attention to broiler chicken welfare, genetic studies, production processes, feed efficiency, good manufacturing practices, and environmental management. The EU Directive emphasizes the significance of proper management, optimal stocking density, and air quality for animal welfare. Genetic studies are vital for identifying traits associated with slaughter performance, supporting long-term breeding strategies. Moreover, sustainable poultry production methods are essential for addressing socio-economic challenges in the sector. Implementing sustainable models in the poultry industry can help alleviate such challenges. Adhering to good manufacturing practices and sanitation protocols ensures the safety and sustainability of traditional CSH operations while meeting microbiological standards [5-6].

The integration of Lean Six Sigma (LSS) in Chicken Slaughtering Houses (CSHs) enhances operational efficiency, product quality, and sustainability. LSS, which combines Lean principles for waste reduction with Six Sigma techniques to minimize process variation, has been widely applied across various industries, including the food sector [7]. Its implementation in CSH operations improves food quality, productivity, safety, and overall operational performance. The "Halal Six Sigma" framework specifically aims to enhance the quality of halal food by systematically reducing defects. A notable case study demonstrates the adoption of LSS in a biogas plant, showcasing structured implementation aligned with Six Sigma principles [8].

This study identifies CSHs as a viable business opportunity in Indonesia, with estimates suggesting over 1,000 CSHs per regency based on interviews with government officials. However, a major challenge lies in the lack of comprehensive data, as the livestock department has not maintained consistent records of the actual number of CSHs. Despite strong market demand, the success of CSHs is often volatile, highlighting the pivotal role of operational performance in determining business outcomes, as supported by prior studies [9].

In addition to operational challenges, CSHs also face community-related issues. Some are forced to relocate due to public complaints regarding waste disposal and environmental impact. This underscores the importance of sustainability in the CSH business, aligning with societal expectations for environmental and social responsibility [10]. This paper advocates operational excellence—achieved through disciplined, consistent processes—as a key strategy for CSH success. The adoption of LSS supports this goal, facilitating performance

improvements while integrating sustainability goals to address environmental and social concerns [11].

Furthermore, the integration of LSS with Industry 4.0 technologies is emphasized as a pathway to optimize resource use and enhance process quality [12]. This paper thus positions operational excellence as a critical business strategy, with LSS serving as a core enabler of success. By embedding sustainability into LSS practices, organizations can achieve long-term performance outcomes that align with broader societal and environmental imperatives.

2.0 THEORETICAL FRAMEWORK AND DEVELOPMENT OF HYPOTHESES

2.1 HP and OP

This study utilized six indicators to assess HP: Halal certification, Halal production process, Halal training, management commitment and support, demand for Halal products, and the maintenance and assurance of Halal integrity. Halal certification is evaluated based on certificate ownership, customer demand, and the impact of certification [13]. The Halal production process involves adherence to standardized procedures in food operations, which include inspection by certification authorities across various stages—slaughtering, hygiene, handling, processing, transportation, and distribution—prior to the issuance of certification. Proper implementation of Halal principles in the poultry industry necessitates comprehensive Halal training for all employee. Strong management commitment and support are critical to the effective application of HPs. The demand for Halal products is substantial, driven by both religious obligations and the expanding global market. Current Halal trends are shaped by increased consumer awareness among Muslims, the perception of Halal products as safer, and rising demand from food companies for Halal-certified goods.

H1: HP have a positive effect on OP

2.2 HP and LSS

Most previous literature studies have explained the HP and LSS separately. HPs are guidelines and rules in Islam about what is allowed

and what is prohibited for Muslims. These principles not only ensure that meat is permissible for consumption under Islamic law, but also extend to various aspects of business processes. LSS is a framework using Lean principles for waste elimination and Six Sigma tools for variance reduction. This synergistic approach systematically improves operational effectiveness by minimizing waste and variability in business processes. This framework aims at reducing defects within the context of Halal practices. It aligned with both quality improvement methodologies and Halal standards in chicken meat industry.
H2: HP have a positive effect on LSS

2.3 HP and S

Halal certification ensures compliance with Islamic dietary laws for Muslim consumption [13]. However, ethical concerns arise about the sustainability of halal practices, impacting human welfare, animal rights, and the environment. Integrating halal practices in transportation and storage correlates positively with the financial performance of halal firms. Wholesomeness criteria of halal are linked to sustainability, emphasizing the interconnectedness of halal supply chain management with sustainability [14-15].
The relationship between sustainable production, food integrity, and halal supply chain management practices underscores the importance of sustainable measures within halal food supply chains. The relationship between sustainable production, food integrity, and halal supply chain management practices underscores the importance of sustainable measures within halal food supply chain. The integration of HP with S requires a comprehensive understanding of the interconnectedness of halal supply chain management, ethical considerations, and the promotion of sustainable practices within the halal industry.
H3: HP have a positive effect on S

2.4 LSS and S

The relationship between Lean Six Sigma and sustainability, particularly in the context of the three pillars of economy, environment, and social impact, is a critical area of study that requires a comprehensive understanding of the integration of Lean Six Sigma methodologies with sustainable practices across various industries. Furthermore, a framework proposed for the integration of Green and LSS for superior sustainability performance, highlighting common issues among different S frameworks [29]. This framework emphasizes the potential for LSS to contribute to superior sustainability

performance, indicating a positive relationship between LSS and S. Then, the Lean and Lean Six Sigma methodologies critically reviewed and highlighted their importance in achieving sustainable services. This review emphasized the significance of LSS in achieving sustainability but does not provide a detailed analysis of the relationship between LSS and sustainability.
H4: LSS have a positive effect on S

2.5 LSS and OP

LSS, integrating Lean and Six Sigma, enhances OP by addressing quality concerns and eliminating waste. Extensive studies across various industries confirm LSS's significant positive impact on operational performance. Lean practices improve operational and business efficiency by identifying and eliminating non-value-added activities, while Six Sigma minimizes process variation. The positive relationship between LSS and healthcare performance is established, indicating its impact in the healthcare sector. The positive relationship between LSS and healthcare performance is established, indicating its impact in the healthcare sector [16]. Supporting evidence highlights the positive relationship between internal lean practices and OP, emphasizing LSS's impact on quality, delivery, flexibility, and cost [17]. These previous references demonstrate the positive relationship between LSS and OP across various industries, including healthcare, manufacturing, and service sectors. The integration of Lean and Six Sigma practices has been shown to enhance business performance, reduce process variation, improve efficiency, and drive overall organizational success.
H5: LSS have a positive effect on OP

2.6 S and OP

Studies explore the relationship between S, covering economic, social, and environmental aspects, and OP. For instance, one study investigates the impact of sustainability engagement on the tourism sector's performance, contributing insights into the direct connection between S reporting and OP [18]. Similarly, sustainable innovation performance, reflecting economic, environmental, and social outcomes, is linked to OP, highlighting the complex impact of S on OP. Numerous studies offer valuable insights into the relationships between sustainability and OP, particularly in environmental, economic, and social dimensions, showing positive correlations between sustainable and operations performance improvements.

H6: S have a positive effect on OP

2.7 Mediating role of S

Sustainability means meeting current needs without compromising future generations, involving economic, social, and environmental dimensions. It's crucial in business due to its positive impact on performance outcomes. Halal practices, following Islamic principles in the supply chain, are linked to sustainability and OP. Studies show sustainability mediates the relationship between Halal Practices (HP) and OP, strengthening their connection.

In short, LSS contributes to sustainability by reducing waste and improving efficiency, leading to cost savings and environmental benefits. Sustainability mediates the relationship between LSS and OP, offering a framework for balancing economic, social, and environmental factors.
H7: S mediates the relationship between HP and OP
H8: S mediates the relationship between LSS and OP

2.8 Mediating role of LSS

LSS combines Lean and Six Sigma methodologies for operational improvement. It's widely used across industries to enhance OP, quality, productivity, and customer satisfaction. Halal practices adhere to Islamic principles in goods and services production, gaining importance beyond food and beverages. Halal certification is crucial in various industries, aligning with market requirements. The potential link between LSS and halal practices lies in pursuing operational excellence and continuous improvement. Integrating LSS with halal practices enables companies to enhance production, ensure halal standards compliance, and achieve higher OP.
H9: LSS mediates the relationship between HP and OP

3.0 METHODOLOGY

3.1 Questionnaire Development

In this research, primary data is collected based on survey with the questionnaire. To collect the information related to the opinions, attitudes, and experiences of the research population, can use the questionnaire survey method [19]. The survey used a quantitative cross-sectional design involving MSME owners in the poultry industry. The questionnaire, with four sections, gathered company profile details

and assessed LSS, HP, sustainability, and OP. Section one covered company information, including certification status and product details. The second and third sections assessed LSS and HP practices, while the fourth focused on sustainability and OP perspectives. A seven-point Likert scale gauged respondents' agreement or disagreement, offering detailed evaluation options and a neutral perspective. This approach enhances point distinction and allows respondents to express preferences effectively. The odd-numbered scale was chosen for neutrality and finer evaluation [20], [21].

3.2 Sampling Technique and Survey Procedure

This research proposes a generic model depicting the integration of HP, LSS, ST, and OP, focusing on the Yogyakarta slaughtering industry. Sample size considerations, following Hair's guidelines, influenced the distribution of questionnaires to chicken slaughtering houses (CSH) in Indonesia. Propose sampling, based on CSH registered on Google Maps due to a lack of official data, aligns with the research criteria, ensuring relevance to the object of study [22], [23].
To ensure a robust study, a minimum acceptable sample size of 150 [24]. Kline recommended that a sample size of 200 or more is regarded sufficient for the application of SEM [78]. To enhance accuracy and address missing values, the final sample size increased by 20% as suggested [25]. 249 out of 270 distributed questionnaires were returned, achieving a 92.2% response rate. Before the survey, a pre-test with ten expert academicians assessed instrument appropriateness. A participant pre-test with 30 respondents confirmed consistent interpretation. Finally, a pilot test with 100 respondents validated the instrument and ensured internal consistency [26].

3.3 Assessment of missing data

Missing data is valid on at least one variable, inaccessible for analysis [27]. Respondents' refusal or skipping questions in the survey results in missing data [28]. The amount of missing data can be assessed, and patterns in sample response help to address missing data issues [29]. If missing data is below 5%, it can be considered by replacing it with the mean of the item [30]. Descriptive analysis frequency identifies missing data in all variables. SPSS analysis confirms no missing data for any variables. The self-administered survey allows analysts to guide respondents, minimizing the preference for missing data. Ignoring missing data increases the investigation's validity. For enhanced validity, only complete data is considered for analysis.

4.0 DATA ANALYSIS AND RESULTS

4.1 Demographics of respondents

The demographic details of the respondents are covered in detail in Table 1.

Table 1: Summary of Demographic Characteristics of Surveyed Population

No	Characteristics	Frequency (N=249)	Percentage (%)
1	**Company Age**		
	Less than 2 years	42	17%
	3-10 years	193	78%
	11-20 years	9	4%
	Above 20 years	5	2%
2	**Certification**		
	Halal Certification	63	25%
	None	186	75%
3	**Company size**		
	Micro	224	90%
	Small	25	10%
	Medium	0	0%
4	**Monthly Capacity**		
	Less than 1500	182	73%
	1500-3000 chicken	26	10%
	More than 3000	41	16%
5	**Involvement in new product development**		
	Yes	11	4%
	No	238	96%

4.2 Measurement Model

This study using SEM to analysis Data. First, the latent constructs were validated through CFA and then executed path analysis in the structural model. The unidimensionality, validity, and reliability of measurement models in CFA were confirmed [82]. Construct validity was assessed through model fitness indices. A good model fit required RMSEA < .08, TLI, NFI, CFI, GFI > .90 with p-value < .005. Measurement model ensured model fitness by obtaining good fitness scores of $\chi 2$, $\chi 2/df = 2.041$, p-value < .005, RMSEA = .068, CFI = .925, TLI = .906. All the obtained values were acceptable and met the threshold (Hair et al., 2014). Convergent validity was assessed through AVE, and reliability was confirmed by calculating CR. To ensure unidimensionality, all the factor loadings should be greater than .60, while AVE > .50 and CR > .60 indicate statistical significance [24]. Factor loadings, CR, and AVE

values are presented in Table 2.

Table 2 Factor loadings, AVE and CR values

Variables	Indicators	Factor Loading	AVE (> 0.5)	CR (> 0.6)
HP	Halal Certification	0.64	0.7	0.9
	Halal Production Process	0.83		
	Halal Training	0.69		
	Management Commitment and Support	0.78		
	Demand For the Halal Products	0.84		
	Halal Integrity Maintenance and Its Assurance	0.69		
LSS	DMAIC methodology	0.84	0.6	0.8
	LSS tools	0.23		
	Waste Elimination	0.80		
	Variability Reduction	0.73		
	Measurement Metrics	0.79		
S	Innovation (Eco)	0.68	0.5	0.8
	Health And Safety (Env)	0.56		
	CSR (Sos)	0.66		
	Reuse And Recycling (Env)	0.37		
	Energy Consumption and Control (Env)	0.55		

The measurement model of this study is complicated, constructs are higher-order with a certain number of dimensions, sub-dimensions, and measuring items. According to the recommendation of [83], individual CFA was executed for HP, LSS, S, and OP, and higher-order constructs. Those items were combined to performed pooled-CFA. Factor loading, AVE, and CR values of pooled measurement model are presented in Table 3.

Table 3 AVE and CR of Constructs in Pooled Measurement Model

Items statement for Employee Performance Construct	Factor Loading	AVE (Minimum 0.5)	CR (Minimum 0.6)
OP Construct		0.8	0.9
Y31	0.9		
Y32	0.8		
Y33	0.7		
HP Construct		0.5	0.7
X12	0.4		
X14	0.7		
X15	0.7		
X16	0.5		
LSS Construct		0.7	0.9
Y11	0.7		
Y12	0.8		
Y14	0.7		
Y15	0.8		

S Construct		0.6	0.9
Y21	0.7		
Y22	0.8		
Y24	0.7		
Y25	0.7		

Discriminant validity was calculated by taking the square root of AVE. The level of correlation among constructs of the measurement model less than .85 ensured the problem of multicollinearity and redundant items do not exist [24]. Table 4 presents the discriminant validity of the model.

Table 4 Summary of Discriminant Validity Index

Construct	HP	LSS	S	OP
HP	0.66			
LSS	0.07	0.83		
S	0.17	0.41	0.79	
OP	**0.08**	**0.18**	**0.25**	**0.88**

4.3 Structural Model

Structural model analysis was performed to compute regressions paths and standardized regression weights. The value of R2 is .72, which indicates that 72% of OP could be attained by HP, LSS, S and OP. Fitness index of structural model are also acceptable as show in Figure 1 ($\chi 2/df = 2.3$, $p < .005$, RMSEA = .073, CFI = .94, TLI = .92). Results of the structural model indicated that the structure of the proposed model adequately describes relationships among constructs [22].

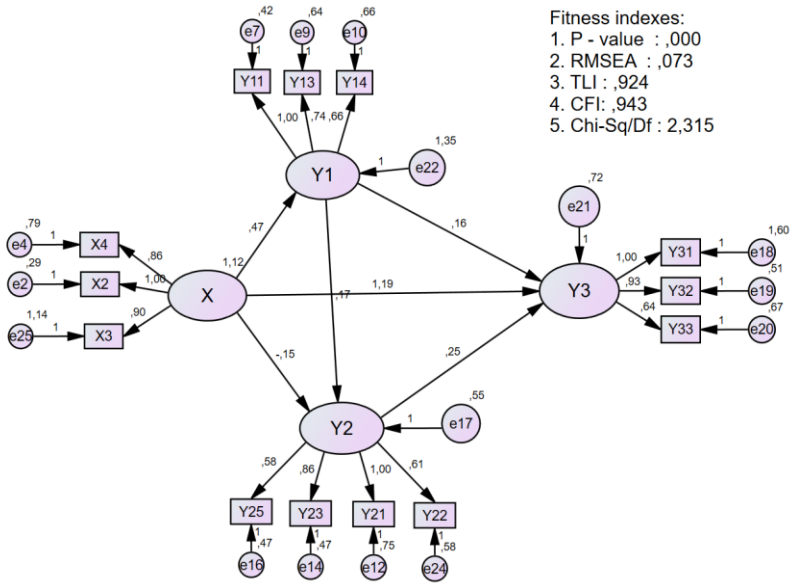

Figure 1. Structural Model in AMOS

4.4 Hypothesis Testing

SEM technique was used to test the hypotheses. Hypotheses H1-H6 examine the direct causal relationship, while H7 and H9 examine the mediational influence. HP had positive effects on LSS (H1) (β = .47, p = ***). HP had a positive effect on OP (H2) (β = .203, p = .001). HP did not have a positive influence on S (β = -0.146, p = .027). LSS had positive effects on S (β = .174, p = .003) and OP (β = .155, p = .042). S was found to be significantly related to OP (β = 0.249, P = 0.048). H1, H2, H3, H3, H4, H5 and H6 are supported as presented in Table 4.

4.5 Mediation Effect

Bootstrapping Maximum Likelihood Estimation (MLE) method with 1000 bootstrap samples and 95% confidence interval was used to examine the mediational effect of service innovation and organizational commitment. As presented in Table 5, the indirect effect of (HP → S → OP) revealed was not positively significant (β = -0.20, p = .027). Whereas the direct effects of (HP → OP) were significant (β = .79, p = ***). Thus, H7 is supported, and S fully mediates the effect of LSS on OP. The indirect effect of HP, LSS, and OP was positively

significant (.40*.79, β = .38, p < .05), while beta value of direct effect was positively significant (β = .79, p = ***). H8 is supported, and LSS act as a partial mediator. The indirect effect of S, LSS, and OP was positively significant (.28*.12, β = .12, p < .05), while beta value of direct effect was positively significant (β = .12, p = .048). H9 is supported, and S act as a partial mediator.

Table 5 Results of Hypotheses Testing

Hypotheses	Results
H1: HP have a significant and positive impact on LSS	Supported
H2: HP have a significant and positive impact on S	Supported
H3: HP have a significant and positive impact on OP	Supported
H4: LSS have a significant and positive impact on S	Supported
H5: LSS has a significant and positive impact on OP	Supported
H6: Sustainability have a significant and positive impact on OP	Supported
H7: Sustainability mediates the relationship between HP and OP	Full Mediation
H8: LSS mediates the relationship between HP and OP	Partial Mediation
H9: Sustainability mediates the relationship between LSS and OP	Full Mediation

5.0 DISCUSSION

This study reveals a positive impact of HP on LSS, highlighting specific HPs (Halal production process, Management commitment and support, Demand for Halal products, and Halal integrity maintenance) influencing radical and incremental LSS adoption. These results are similar to research which conducted a longitudinal study in accordance with several indicators in the HPs and concluded that the halal production process is influenced by the commitment of government support [29]. The study also identifies a significant, albeit potentially conflicting, relationship between HP and Sustainability (p-value .029, beta value -0.163). While the common perspective is to address everything related to HP for product innovation, it requires substantial effort. Moreover, the study successfully establishes the achieved objective of understanding the relationship between HP and OP.

SEM and empirical findings confirm the significant and positive impact of HP on OP (beta: 1.26). Likewise, LSS shows a significant positive impact on OP (beta: 0.16, p-value: 0.042), supporting the hypothesis. Sustainability also demonstrates a significant positive impact on OP (beta: 0.25, p-value: 0.048), affirming the hypothesis. The study reveals that LSS acts as the highest mediator among variables, especially between HP and OP. Sustainability, as a partial mediator between LSS and OP, emphasizes the importance of efficient resource use and environmental impact reduction for sustainability.

5.1 Theoretical implications

This study introduces the Halal LSS Model (HLSSM), integrating HP and LSS in MSMEs Chicken Slaughtering House in Yogyakarta, Indonesia. It measures OP through dimensions like customer satisfaction, production cost efficiency, and product quality, providing novel insights for MSMEs in this context. Additionally, the study explores the previously unexamined mediational roles of LSS and S in MSMEs Chicken Slaughtering Houses. While the effect size is small, it offers new perspectives, as no prior study has assessed these mediation constructs' effect size. The research highlights the significance of LSS and sustainability as mediators between HP and OP, addressing a gap in existing literature by examining the integrated relationship among HP, LSS, sustainability, and OP.

5.2 Practical implications

This study offers insights to MSMEs, especially in the Chicken Slaughtering House sector. MSMEs CSH owners stand to benefit the most from this research. Implementing halal and Lean Six Sigma principles can enhance business existence, build trust with Muslim consumers, and tap into a larger market. This strengthens the business reputation and opens up global opportunities. Encouraging commitment from owners to employees is crucial for successful implementation, reflecting in improved Employee Performance. The research aims to raise awareness among business owners about maintaining commitment to HPs and efficient processes, staying sensitive to negative impacts, and fostering sustainability. It is expected to guide poultry business owners in formulating effective policies for operational efficiency and competitive advantage in a market increasingly valuing sustainability and HPs.

5.3 Limitations and Recommendations

This study has limitations. Firstly, it focuses on HP, LSS, and S influence on MSMEs Chicken Slaughtering Houses in Yogyakarta, Indonesia. Secondly, data is from SCH in 48 districts of Special Region Yogyakarta, limiting generalizability. Thirdly, due to time and budget constraints, it's cross-sectional. While findings show a low significant direct effect of HP, LSS, S on OP, a longitudinal study can provide better insights over time. Consideration of HP's impact on business processes, worker learning capabilities, and skills development is needed. Evaluating the financial and marketing performance of the

poultry industry is also essential. Future research may explore mediating constructs like organizational capability and change resistance to examine their role between HP and OP in the poultry industry.

6.0 CONCLUSION

This study is the first to examine the effect of HP on the performance of MSMEs CSH of Indonesia, through the mediational effect of LSS and S. This study provides substantial contributions to the available literature related to HP, LSS, S, and OP in a developing country's context, such as Indonesia. The emphasis on performance improvement of poultry industry was based on the consideration that quality economy of a country is not possible without the better performance of MSMEs especially in Indonesia where MSMEs in one of the economic support foundations. There is a need to uplift HP for better performance. Therefore, the study on HP, LSS, and S is important to offer insights related to MSMEs CSH performance. Mainly the study contributed two-folded insights. Firstly, it provides answers to different research questions according to the prerequisites expressed in the literature. This study employed mediational constructs to answer the gap that exist regarding the relationship between HP and the performance of poultry industry. Secondly, this study offered better understandings of LSS and S. LSS and S as mediating constructs significantly influence the relationship between HP and OP. Thus, LSS and S need to be boosted to increase OP.

The findings of this study offered some areas for future research: first, future studies could evaluate the performance of poultry industry in some other aspects such as financial performance, market share, market innovation etc. Secondly, a similar model can be applied to measure the performance at different industries levels, i.e., medium level performance, big national level performance, or performance of big multinational level. Although in this study, the developed model specifically addressed the performance of poultry industry. Generally, this model can be implemented in other sectors to evaluate the role of HP, LSS, and S in improving OP.

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Conceptualization, M.F.; methodology, M.F.; software, M.F, and O.A.; re-sources, M.F and TJ; writing—original draft preparation, M.F.; writing—review and editing, E.M and A.A.A.R.; supervision, E.M., and A.A.A.R. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its submission and declare no conflict of interest on the manuscript.

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