

DIGITAL HUMAN CAPITAL IN AGRICULTURE: APPROACH MANAGEMENT FOR HALAL FOOD SUPPLY CHAIN EFFICIENCY

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ABSTRACT

Weakness monitoring and security systems food from upstream until downstream Still become challenge main in management system food national, especially in the supply chain supply halal- based food agriculture. Apart from that, there are limitations capacity source Power man agriculture in utilization digital technology and not yet optimally practice management chain supply that causes low traceability, efficiency operational and guarantee security product halal food. Research This aim for analyze the role of Digital Human Capital and Digital Leadership in improve Halal Supply Chain Management as well the impact to efficiency chain supply halal food. Research This use approach quantitative with AMOS based Structural Equation Modeling (SEM) method. Data collected through survey consists of from farmers and actors involved in chain supply halal food in Indonesia. A total of 170 questionnaires were collected and valid for to be continued stage Validity and reliability test analysis construct, relationship causal between variables, as well as role halal supply chain mediation in research models. Research results show that strengthening capacity man digital based and digital leadership plays a role important in increase effectiveness management chain halal supply. In addition, Halal Supply Chain Management has been proven become mechanism important thing that connects digital capabilities of sources Power man with improvement efficiency chain supply halal food. This Research give contribution for development of digital transformation strategies for the sector agriculture through improvement competence human, governance technology and development system more halal food transparent, efficient, and sustainable.

KEYWORDS: Digital Human Capital; Digital Leadership; Halal Supply Chain Management; Agricultural Supply Chain; Digital Transformation.

INTRODUCTION

Resilience food be one of issue global strategy that is not only related with aspect availability food, but also includes accessibility, quality, safety, sustainability, and ability system food in ensure traceability product throughout chain value. Change pattern consumption society, increasing demands security food, as well as the development of the global halal market has push change paradigm management system food from approach-based production going to an integrated, transparent, and sustainability - oriented system. In the context of developing countries, including Indonesia as an agricultural country with population Muslim the largest in the world, strengthening system chain supply halal food becomes aspect important in ensure integrity product from stage production until consumption. Agricultural sector own contribution important to the Indonesian economy, however Still face various challenge structural, especially related productivity, efficiency distribution, as well as management chain supply. Although sector agriculture contributes around 12–13% of Product Gross Domestic Product (GDP), level efficiency sector This Still relatively left behind compared to sector economy other. Problems the more complex Because system food involving Lots actor, start from farmers, processors, distributors, to consumers, who often have limitations coordination and integration information. Conditions This cause height level lost food *loss*, especially at the stage post-harvest and distribution. The Food and Agriculture Organization of the United Nations report shows that lost food in developing countries Lots happen consequence limitations infrastructure, weakness system logistics, and low ability management supply chain [1].

In context chain supply halal food, challenges the become the more complex Because halal system does not only demand quality product end, but also requires guarantee process integrity throughout supply chain. Every stage, starting from material raw materials, production process, storage, transportation, to distribution must fulfil halal

and safety principles food. However, the practice chain supply halal food in Indonesia is still face various obstacles, such as low transparency flow information, weakness coordination between perpetrators, and limitations system monitoring in real-time [2]. Conditions the increase risk mismatch halal standards and lower trust consumer to product halal food.

Problems are also related close with low efficiency system logistics national. Cost Indonesian logistics is still is at a relative level tall compared to developed countries, which shows existence obstacle structural in distribution goods and management network chain supply. In line with World [3] Bank Report 2013 show that cost Indonesian logistics reaches about 24% of Product Gross Domestic Product (GDP), taller compared to countries with system more logistics forward. The height cost the reflect existence inefficiency structural caused by limitations infrastructure, fragmentation network distribution, as well as low integration information between perpetrator chain supply. From the existence of inefficiency logistics, the impact direct to stability price food, quality products, as well as ability system food in respond change market demand. According to Christopher [4] state that in supply chain management practices, effectiveness chain supply is highly dependent on the ability organization in integrate flow information, coordination between actors, as well as utilization technology for increased visibility and control of operational processes.

In line with study Harsanto et al [5] state that in development technology industry 4.0, digital transformation begins viewed as approach strategic for increase performance chain supply food. Technology such as Blockchain, Internet of Things (IoT), intelligence artificial intelligence, and systems digital traceability *system* is capable of increase transparency, accuracy information, as well as monitoring capabilities in chain supply food. Research show that implementation digital technology can increase ability tracking products, reduce risk forgery, as well as strengthen trust consumer to security and authenticity product food [6]; [7]. In system halal food, technology the own role important Because allows the halal verification process to be carried out in a way more transparent and data-driven. However thus, success digital transformation is not only determined by availability technology, but also by capabilities man in adopt and optimize technology said. The low-level digitalization sector Indonesian agriculture shows existence gap between development technology and readiness source Power humans. Most of them perpetrator agriculture Still use digital technology at the level basic, such as communication and marketing simple, but not yet optimally utilize technology for data analysis, retrieval decisions, and management chain supply-based information. Conditions the show importance draft *Digital Human Capital*, namely combination between competence digital, capabilities analytical, literacy technology and capabilities adaptation man in utilize digital technology for increase performance organization [8].

Digital Human Capital has role strategic in system chain halal supply because success implementation technology is highly dependent on capabilities individual in operate, understand, and take decision based on digital information. Limitations digital competence can cause available technology No give optimal benefits, so that hamper the process of quality monitoring, traceability products, and applications system halal guarantee. With Thus, digital transformation in chain halal supply needs an approach that is not only investment - oriented technology, but also on development capacity man as users' main technology in addition to the factors source Power human, aspect leadership also becomes element important in success digital transformation. Digital Leadership plays a role in create vision transformation, pushing change organization, building culture innovation, as well as ensure integration technology walk in accordance objective strategic organization. Previous studies show that digital leadership has connection positive with level digital maturity and capabilities organization in face change technology [9]; [10]. However, some big study previously Still focuses on aspects technology or readiness organization in a way general, while study about how Digital Leadership and Digital Human Capital are simultaneous influence effectiveness chain halal supply is still relatively limited.

The gap studies the show that digital transformation in chain supply halal food requires more perspective comprehensive with consider interaction between technology, people, leadership, and practice management supply chain. The only approach focused on implementation technology Not yet Enough For answer complexity system halal food that involves various actor with level different digital readiness. Therefore, that is, the integration of Digital Human Capital, Digital Leadership, and practices management chain halal supply becomes factor important in build system more food efficient, transparent, adaptive, and sustainable. Based on description said, can identified that problem main in development chain supply halal food in Indonesia is not only related with limitations technology, but also includes low digital capacity of sources Power human, weakness leadership digital transformation, as well as not yet optimally integration practice management supply chain. Condition the implications to low efficiency operational, high-cost distribution, weakness monitoring system, as well as increasing risk mismatch halal standards.

LITERATURE REVIEW

1. Socio-Technical Systems Theory

Socio-Technical Systems (STS) Theory explains that performance organization is results from balanced integration between subsystem social and subsystem Technical Theory introduced by Trist and Bamforth [11] This confirm that success organization No only determined by adoption technology, but also by capabilities

integrate source Power people, leadership, business processes, and structures organization. As it develops digital transformation, STS is increasingly Lots used in study Information Systems For explain How digital technology creates mark organization through interaction with capability people and organizational processes [12], [13]. Study the latest also shows that successful digital transformation depends on synergy between technology, data, digital competence, and governance organization as One interconnected systems support [14]. In context Halal Food Supply Chain, STS perspective provides runway conceptual that implementation digital technology, such as *Internet of Things* (IoT), *blockchain*, and systems *traceability*, no will produce optimal performance without supported by digital competence sources Power capable human and leadership manage change organization. Therefore that, research This using STS as grand theory for explain that Digital Human Capital and Digital Leadership as dimensions social interact with implementation digital systems in build Halal Supply Chain Success, the next one increase Halal Food Supply Chain Efficiency.

2. Digital Human Capital

Digital Human Capital (DHC) is seen as capability strategic an organization that integrates competence man with digital technology, information, and business processes for create mark as well as increase ability adaptation organization [15]. Different with traditional human capital concept that emphasizes knowledge, experience, and skills general individual, Digital Human Capital more emphasize on ability power Work in understand, adopt, and utilize digital technology, managing data, conducting analysis information, as well as adapt to change ongoing technology in a way dynamic. In context digital transformation, success organization No only determined by availability infrastructure technology, but also by capabilities source Power man in integrate technology to in strategy and activities operational organization [16]. Study García-Fernández et al [17] show that development competence, digital workforce Work become factor important in strengthen ability organization in executing digital strategies. In addition, Rochel [18] explains that the sourcing strategy Power digital human that integrates practice human resource management with digital technology is capable increase ability organization in create adaptive leadership to change technology through Socio-Technical Systems Theory perspective. Based on perspective said, Digital Human Capital becomes foundation that allows organization building Digital Leadership through strengthening competence, pattern digital thinking, and capabilities innovation-based technology. Therefore that, the taller the quality of Digital Human Capital, increasingly strong ability organization in building Digital Leadership.

Apart from playing a role in build digital leadership, Digital Human Capital is also becoming factor important in support success Halal Supply Chain Success (HSC) implementation. Success chain halal supply is not only system dependent technology used, but also on capabilities source Power man in manage halal information, understanding standard compliance, as well as operate supporting technology transparency and traceability product. Source Power man with high digital competence capable increase quality coordination inter-actor supply chain, speed up exchange information, as well as reduce risk error in the management process halal supply chain. In matter in this case, Digital Human Capital plays a role as capability organizations that enable implementation technology such as blockchain, Internet of Things (IoT), Enterprise Resource Planning (ERP), and halal traceability systems for strengthen integrity as well as success halal supply chain. Findings Qu [15] show that digital competence of workforce Work contributes to improvement business process integration and effectiveness management supply chain-based technology. Next, Mentzer [19] confirm that digital capabilities of sources Power man play a role in increase integration, resilience, and success implementation of digital supply chain. With thus, the taller the level of Digital Human Capital, increasingly big ability organization in achieving Halal Supply Chain Success.

Furthermore, Digital Human Capital also has close relationship with increasing Halal Food Supply Chain Efficiency (ESC). Efficiency chain supply halal food requires ability organization in manage flow information, optimizing operational processes, and ensure effective coordination inter-section in supply chain. Digital competence source Power man allows organization utilize technology for increase accuracy taking decision, reduce inefficiency operational, speed up response to change requests, as well as increase quality supervision towards the halal process. Organization with power work that has high digital capabilities will more capably integrating data and technology to in activity procurement, production, distribution, to control quality halal products. The Resource-Based View (RBV) perspective explains that source valuable internal power, difficult imitated, and able to developed become capability organization can become source superiority sustainable competitiveness [20]. In this context, Digital Human Capital becomes source Power strategic support improvement efficiency chain supply through ability organization in optimize technology and information. In In the context of the Halal Food Supply Chain, Digital Human Capital is not only functioning as asset organization, but also as capability socio-technical linking people, technology, and business processes in create system chain more halal supply effective. Digital competence of human resources Work allows organization strengthening Digital Leadership, improving success implementation of Halal Supply Chain Success, as well as reach efficiency more operational high. Based on description said, can concluded hypothesis study as following.

H1: Digital Human Capital has an influence significant towards Digital Leadership.

H2: Digital Human Capital has an influence significant towards Halal Supply Chain Success.

3. Digital Leadership

Digital Leadership is seen as capability strategic organizations that play a role in direct digital transformation through alignment between business strategy, digital technology, and resources Power man [21]. Different with draft leadership more conventional focused on management source Power organization, Digital Leadership emphasizes ability leader in create digital vision, building culture innovation, managing changes, and integrate technology to in business processes for create mark organization [22]. In perspective digital transformation, leaders No only play a role as taker decision related investment technology, but also as driving force changes that ensure technology can accept, utilized, and produced improvement performance organization. Research in Information Systems field shows that Digital Leadership has role important in speed up adoption digital technology, improving capability organization, strengthening taking decision data-based, as well as create environment adaptive work to change technology [23]; [24]; [16]. Leader with digital orientation capable developing effective transformation strategies through ability identify opportunity technology, managing source digital power, as well as build collaboration inter-unit organization. With Thus, Digital Leadership becomes mechanism strategic linking utilization digital technology with achievement performance organization through management change and integration internal capabilities in effective.

In In the context of Halal Supply Chain Success (HSC), Digital Leadership has role important in ensure success implementation chain halal supply through ability leader in direct integration technology, strengthening coordination between perpetrator chain supply, as well as building digital governance that supports transparency and halal compliance. Success chain halal supply needs capable leader integrate various source Power organization for create a system that guarantees traceability, accuracy information, and consistency implementation halal standards. Digital leaders can push use technology such as blockchain, Internet of Things (IoT), Enterprise Resource Planning (ERP), and halal traceability systems for increased visibility chain supply as well as strengthen integrity halal products. In addition, Digital Leadership plays a role in build readiness organization through development digital culture and improvement collaboration between stakeholders' interests. Leaders who have digital vision capable direct source Power man for adapt to change technology, improve ability share information, as well as strengthen coordination between suppliers, manufacturers, distributors, and other parties halal supervisor. This is show that Halal Supply Chain Success is not only determined by the existence of technology, but also by capabilities leadership in manage and optimize technology the in a way strategic. The Dynamic Capability Theory perspective supports view This with explain that ability organization in face change environment depends on ability management in identify opportunities, integrating source power, and do transformation in a way sustainable [25]. Therefore that, the Stronger Digital Leadership, increasingly big ability organization in achieving Halal Supply Chain Success.

In industry halal food, efficiency chain supply No only related with subtraction costs and processing time, but also with ability organization guard transparency, accountability, and halal integrity of products. With existence implementation of Digital Leadership, enables organization in utilize technology for increased visibility flow information, speed up response to change market demand, as well as reduce risk operational consequence delay information or halal process non-compliance. Research moment This show that, digital leadership contributes to improvement flexibility organization, integration chain supply and capability adaptation to environment dynamic business [26]; [22]; [27]. Based on description said, can concluded hypothesis study as following.

H3: Digital Leadership has an influence significant towards Halal Supply Chain Success.

H5: Digital Leadership has an effect significant towards Halal Food Supply Chain Efficiency.

4. Halal Supply Chain Success

Halal Supply Chain Success (HSCS) reflects level success organization in manage chain halal supply in integrated through implementation halal principles, transparency information, coordination between stakeholders' interests, traceability product (traceability), as well as utilization digital technology for guard integrity product from the procurement process material standard until distribution to consumer [2]. Success chain halal supply is not Again only understood as ability organization in fulfil condition halal certification, but also as ability in build system chain transparent, responsive, integrated and sustainable supply. In environment growing business digitized, HSCS becomes indicator important to show ability organization in integrate aspect halal compliance with effectiveness management chain supply through support technology and governance good organization [28];[5]. Success implementation of Halal Supply Chain Success has connection close with increasing Halal Food Supply Chain Efficiency (ESC) due to practice chain effective halal supply capable increase process coordination, strengthening accuracy information, reduce risk operational, as well as increase efficiency use source power. Successful organizations apply system chain halal supply will own ability Better in manage flow information, optimizing business processes, and ensure every stage chain supply walk in accordance with halal standards. In addition, the implementation of Digital technologies such as blockchain, Internet of Things (IoT), Enterprise Resource Planning (ERP), and digital traceability systems is increasingly strengthening ability organization in increased visibility supply chain, speed up exchange information, reduce process non-conformities, as well as

increase trust consumer to halal products. With thus, the taller Halal Supply Chain Success rate, increasingly high efficiency chain supply halal food that can achieved organization.

In a way theoretical, relationship between Halal Supply Chain Success and Halal Food Supply Chain Efficiency can be explained through Supply Chain Management Theory perspective which emphasizes that success chain supply is greatly influenced by the ability organization in build integration, coordination, and exchange information inter-actor in network chain supply [19]. In context chain halal supply, integration the own dimensions addition in the form of need for guard halal compliance, process transparency, and assurance integrity product. Therefore that, success management chain halal supply is not only give benefit in aspect compliance, but also produce improvement efficiency operational through subtraction process time, control costs, and improvements quality taking decision. In addition to playing a role as factors that are direct increase efficiency chain supply, Halal Supply Chain Success also works as mechanisms that explain How organizational digital capabilities can translated become improvement performance operational. In Socio-Technical Systems Theory perspective, success transformation organization No only determined by the existence of technology, but also by capabilities humans and leadership in integrate technology them to in business processes. Organization with high level of Digital Human Capital own ability Better in manage digital technology, optimizing information supply chain, and build system effective halal control. Ability the Then push the creation of Halal Supply Chain Success which ultimately increase efficiency chain supply halal food.

Furthermore, Digital Leadership also becomes factor important in establishing Halal Supply Chain Success as mechanism improvement efficiency chain supply. Leaders who have digital vision capable direct organization in adopt technology, building culture innovation, improving coordination between stakeholders' interests, as well as ensure that digital systems implemented support objective strategic halal supply chain. Based on description said, can concluded hypothesis study as following.

H4: Digital Human Capital has an influence significant towards Halal Food Supply Chain Efficiency.

H6: Halal Supply Chain Success influential significant towards Halal Food Supply Chain Efficiency.

H7: Digital Human Capital has an influence significant towards Halal Food Supply Chain Efficiency through Halal Supply Chain Success.

H8: Digital Leadership has an effect significant towards Halal Food Supply Chain Efficiency through Halal Supply Chain Success.

CONCEPTUAL FRAMEWORK

The conceptual model developed in study This give contribution theoretical and practical in expand understanding about role digital transformation in strengthening chain supply halal- based food agriculture. Framework study This No only look at digitalization as an adoption process technology, but as phenomenon socio - technical involving interaction between capability human, leadership organizations, digital infrastructure, and governance mechanisms supply chain. Perspective the refers to the Socio-Technical Systems Theory (STS) which explains that success implementation technology in organization determined by suitability and integration between subsystem technical and subsystems social in a way simultaneous.

Based on perspective theory system socio-technical, research This conceptualizing Digital Human Capital is not as factor technology only, but as capacity strategic source Power man in understand, adopt, and optimize digital technology for support activity halal supply chain. Digital competence, ability analytical data- based, as well as readiness individual in use technology become factor important thing that determines effectiveness digital transformation in the sector agriculture. This is in line with view that success digital transformation is highly dependent on the readiness of human capital Because technology only can produce mark plus if supported by skills and knowledge users [29]; [16].

In context study here, Digital Leadership is positioned as element the director who ensures harmony between the organization's digital strategy with need operational halal supply chain. Digital leadership plays a role in build culture innovation, improving readiness organization to change technology, as well as integrate source digital power to in the process of taking decision. Leaders who have digital orientation capable create environment supporting organizations collaboration, sharing information and use technology in a way effective in ecosystem chain supply [9]; [10]. Furthermore, research This using Halal Supply Chain Success as mechanism connector between digital capabilities and upgrades efficiency chain supply halal food. Digital technology provides infrastructure technically possible improvement transparency, traceability, integration information and supervision quality product throughout chain supply. However thus, the benefits technology No will be optimal without existence support subsystem social in the form of compliance to halal standards, mechanisms certification, coordination inter-factors and commitment organization to halal principles. With thus, success chain halal supply is not only determined by the level adoption technology, but by ability organization in integrate technology with effective halal business processes and governance [30]; [28].

Based on logic system socio-technical said, research This assume that efficiency chain supply Halal food (Halal Food Supply Chain Efficiency) is results from interaction complex between factor people, leadership, technology, and governance supply chain. With existence the concept of Digital Human Capital and Digital Leadership can

give influence direct to halal supply chain success, at the same time give influence no direct through role mediation of Halal Supply Chain Success. Thus, the research model This confirm that digital transformation in sector halal food is not can understood as a technological process only, but as an integration process capability humans and technology that build system chain more supply efficient, transparent, and sustainable. The following is results from the conceptual framework in this study.

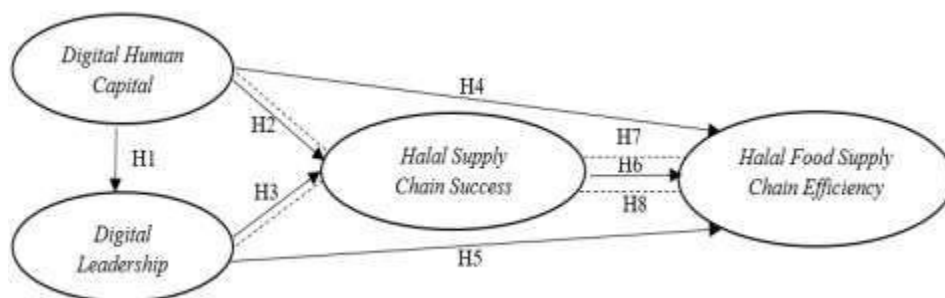


Figure 1. Conceptual Framework

METHODOLOGY

Study This use approach quantitative with method survey explanatory. The goal is for analyze influence digitalization to efficiency of the halal supply chain in Indonesia, in particular in aspect transparency, costs operational and speed distribution. Data collected through distributed questionnaires to perpetrator Halal businesses and related institutions. Population study focused on the whole farmers and parties' others involved in chain supply halal- based food agriculture in the provinces of West Java, Central Java, and West Kalimantan. The selection of regions was based on differences geographical, level adoption technology, as well as infrastructure agriculture for analysis comparative analysis on the effectiveness of digital human capital. The coverage area in West Java includes Bandung and Bogor Regency as center production with activity agribusiness tall as well as start adopt digital technology. Meanwhile that, in Central Java includes Wonosobo and Yogyakarta, as well as in West Kalimantan including Kubu Raya and Singkawang Regencies as area with potential agriculture big However Still face limitations digital infrastructure and logistics.

Based on data from the BPS Agricultural Census, 2023 and the service agriculture area, number farmers in West Java around 3.16 million farmers, Central Java around 4.21 million farmers, and West Kalimantan around 706 thousand farmers. Furthermore, the technique taking sample use criteria: (1) farmers or party active for at least 1 year; (2) involved in chain supply food; and (3) has use technology both digital and results food. Determination amount sample in study This refers to the approach put forward by [31], which states that Structural Equation Modeling (SEM) analysis requires amount sufficient samples so that parameter estimation and model evaluation can be carried out done optimally. The number of samples determined based on amount indicator measurement, namely a minimum of 5 to 10 times the amount indicators used in the research model. Therefore that, research This using a maximum limit of 10 observations for every indicator to obtain size samples that meet the requirements criteria SEM analysis with Maximum Likelihood approach to the AMOS program. A total of 500 questionnaires distributed in a way electronic via Google Forms to farmers and parties' others involved in chain supply halal- based food agriculture. From the number of these, 170 valid responses were collected, resulting in level response by 34%. Respondents are representatives of the responsible parties' answer on halal certification, operational, or management supply chain. Taking strategy adopted sample is taking sample non- probability stratification, for ensure representation across Supply Chain Roles, Food Types, and locations geographic. This method considered appropriate remember No existence framework taking complete sample from the Organizing Body Guarantee Halal Products in Indonesia.

RESULTS AND DISCUSSION

As for the characteristics respondents can see in table 1 below.

Table 1. Characteristics Respondents

Respondent Data	Information	Amount	Percentage (%)
Region	West Java	78	45.8
	Central Java	48	28.2
	West Kalimantan	44	26
Types of Food	Plant-Based Products	142	83.5

Respondent Data	Information	Amount	Percentage (%)
Role in Supply Chain	Animal Products	28	16.5
	Farmers/Supplier	63	37.1
	Manufacturer/Manufacturing	44	25.9
	Collector /Distributor	12	7.1
	Seller /Retailer	51	29.9
Age Respondents	<20	2	1.2
	>41	90	52.9
	21-30	20	11.8
	31-40	58	34.1
Gender	<20	2	1.2
	Man	71	41.8
	Woman	99	58.2
Total Respondents		170	100%

Source: Research Data Processing, 2025.

Based on Table 2 above, the respondents' demographics show variations in terms of region, food type, supply chain role, age, and gender. The majority of respondents were from the West Java region (45.8%), with plant-based products representing the largest category of food types (83.5%). Regarding their roles in the supply chain, the majority were farmers or suppliers (37.1%). In terms of age, the largest group of respondents involved in food supply chain activities fell within the 41-year-old category (52.9%). A total of 170 respondents involved in food supply chain activities participated in this study.

Table 2. Validity and Reliability Test

Construct	Indicator (Likert Scale 1-6)	Validity	Reliability
<i>Digital Human Capital (DHC)</i>	DHC1	0.470	0.731
	DHC2	0.395	
	DHC3	0.440	
	DHC4	0.443	
	DHC5	0.332	
	DHC6	0.341	
	DHC7	0.466	
	DHC8	0.594	
<i>Digital Leadership (DL)</i>	DL1	0.535	0.818
	DL2	0.490	
	DL3	0.484	
	DL4	0.470	
	DL5	0.496	
	DL6	0.502	
	DL7	0.444	
	DL8	0.515	
	DL9	0.474	
	DL10	0.526	
<i>Halal Supply Chain Success (HSC)</i>	HSC1	0.420	0.730
	HSC2	0.376	
	HSC3	0.460	
	HSC4	0.442	
	HSC5	0.483	
	HSC6	0.458	
<i>Halal Food Supply Chain Efficiency (ESC)</i>	ESC1	0.500	0.831
	ESC2	0.472	
	ESC3	0.530	
	ESC4	0.498	
	ESC5	0.478	
	ESC6	0.468	
	ESC7	0.426	
	ESC8	0.437	
	ESC9	0.503	

Construct	Indicator (Likert Scale 1-6)	Validity	Reliability
	ESC10	0.525	

Source: Research Data Processing, 2026.

Based on the results of the validity and reliability tests in Table 2, all Testing validity uses Pearson Product Moment correlation between score each item with total score of the variable. Amount respondents in study This as many as 170 people, so that degree's degree of freedom (df) obtained of 168 ($df = n - 2$). Based on level significance of 5% ($\alpha = 0.05$), obtained r- table value of 0.150. An item of statement declared valid if own r - value bigger from r- table (0.150) and has a value positive. On the other hand, if r - value more small from r- table, then the statement item stated invalid. While For Testing reliability use Cronbach's Alpha method, a variable stated own excellent reliability if Cronbach's Alpha value ≥ 0.90 , good if is in the range of 0.80–0.89, sufficient reliable in the range of 0.70–0.79. So that in study This for 17 statement items standard values used for Cronbach's Alpha ≥ 0.70 . In general, overall, from 17 statement items Initially, all items were declared valid and reliable. so that worthy used in analysis more continue. This is show that part big indicator capable represent construct of each variable with good and consistent.

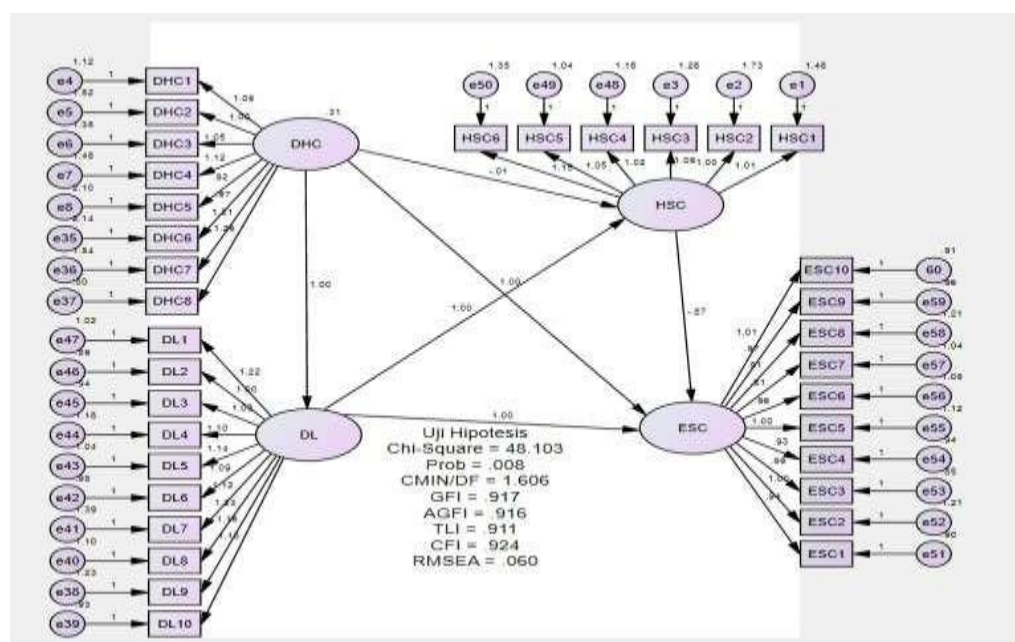


Figure 2. Full Measurement Model.

Based on Figure 2, the research model used is combination between the measurement model and the structural model being analyzed with using AMOS. This model consists of on four latent constructs, namely DHC, DL, HSC, and ESC. Each latent construct is measured by a number of indicators observed. The DHC construct was measured by eight indicators (DHC1–DHC8), DL is measured by ten indicators (DL1–DL10), HSC is measured by six indicators (HSC1–HSC6), while ESC is measured by ten indicators (ESC1–ESC10). Relationship between latent constructs and their indicators shown through arrow One direction that represents connection measurement relationship, where each indicator reflects the latent variable, it represents in the model. In addition to the measurement model, Figure 1 also shows a structural model that describes connection causal between latent constructs according with framework conceptual research. DHC is assumed own influence against DL, HSC, and ESC. Furthermore, DL is assumed influential against HSC and ESC. While that, HSC is also assumed influential towards ESC. Relationship between construct the built based on hypothesis research that has been formulated previously, so this model No only test validity construct, but also test connection structural between latent variables in simultaneous in One framework analysis using SEM-AMOS.

Model Fit Test Results

The model construction test is presented in table following and evaluated based on index model fit. Model and criteria critical that has data conformity can see in table 3 below.

Table 3. Goodness of Fit Test

Goodness of Fit Criteria	Cut-off Value	Results	Note:
Chi-Square (χ^2)	Small/ lower Better	48,103	Marginal
Probability (p)	≥ 0.05	0.008	Fit
CMIN/DF	≤ 2.00	1,606	Fit
RMR	≤ 0.08	0.006	Fit
GFI	≥ 0.90	0.917	Fit
AGFI	≥ 0.90	0.916	Fit
NFI	≥ 0.90	0.953	Fit
RFI	≥ 0.90	0.959	Fit
IFI	≥ 0.90	0.929	Fit
TLI	≥ 0.90	0.911	Fit
CFI	≥ 0.90	0.924	Fit
PGFI	≥ 0.50	0.699	Fit
RMSEA	≤ 0.08	0.060	Fit

Source: Research data processing, 2026.

Based on results testing *Goodness of Fit* in the research model, obtained Chi-Square value of 48.103 with degrees freedom (df) of 528 and the value significance of 0.000. Although mark probability show significance, in Structural Equation Modeling (SEM) analysis Chi-Square value is not used as the only one reference main Because very sensitive to size sample. Therefore that, evaluation more model feasibility emphasized on other indexes such as CMIN/DF which shows mark of 1.606. This value is below the recommended limit of 2.00, so that indicates that the model has level good fit. Furthermore, in the absolute fit test, the RMR value of 0.006 is below the maximum limit of 0.08, which indicates very small residual error. The GFI value of 0.917 and AGFI of 0.916 have also been beyond the cut-off value is 0.90, which indicates that the model is capable represent empirical data with good. In addition, the RMSEA value of 0.060 is still is at in range that can accepted (< 0.08), so that strengthen that the model has level good fit against observation data.

In the incremental fit index, all mark shows very good results, including NFI of 0.953, RFI of 0.959, IFI of 0.929, TLI of 0.911, and CFI of 0.924, all of which be on top cut-off value of 0.90. This show that the research model own improvement good fit If compared to with the basic model. While that, in the parsimony aspect, the PGFI value of 0.699 which is above 0.50 indicates that the model has level good simplicity without sacrifice quality model fit. In terms of overall, various index *Goodness of Fit* the show that the research model has fulfil criteria eligibility, so that can declare fit and proper used for analysis more carry on.

Table 4. Hypothesis Test Results (Direct Effect)

Hypothesis	Relationship between variables	Estimate	SE	CR	P-value	Note:
H1	Digital Human Capital (DHC) → Digital Leadership (DL)	1,047	.201	5,207	***	Accepted
H2	Digital Human Capital (DHC) → Halal Supply Chain Success (HSC)	0.916	.230	3,980	***	Accepted
H3	Digital Leadership (DL) → Halal Supply Chain Success (HSC)	1,119	.213	5,251	***	Accepted
H4	Digital Human Capital → Halal Food Supply Chain Efficiency	0.976	.226	3,665	***	Accepted
H5	Digital Leadership (DL) → Halal Food Supply Chain Efficiency (ESC)	1,212	.221	5,482	***	Accepted
H6	Halal Supply Chain Success (HSC) → Halal Food Supply Chain Efficiency (ESC)	0.965	.235	4.110	***	Accepted

Source: Results of research data processing, 2026.

Table 6. Hypothesis Test Results (Indirect Effect)

Hypothesis	Mediation Path	Indirect Effect	p-value	Note: *
H7	Digital Human Capital (DHC) → Halal Supply Chain Success (HSC) → Halal Food Supply Chain Efficiency (ESC)	0.120	0.012	Accepted
H8	Digital Leadership (DL) → Halal Supply Chain Success (HSC) → Halal Food Supply Chain Efficiency (ESC)	0.169	0.001	Accepted

Source: Results of research data processing, 2026.

Based on the test results eighth hypothesis stated accepted, thing This show that Critical Ratio value > 1.96 and $p\text{-value} < 0.05$. So, all over connection intervariable in the research model own influence positive and significant, both in direct and indirect effects. Findings This confirm that the variables Digital Human Capital (DHC), Digital Leadership (DL), and Halal Supply Chain Success (HSC) are factor strategic role in increasing Halal Food Supply Chain Efficiency (ESC) especially in the sector halal food.

DISCUSSION

Digital Human Capital towards Digital Leadership

Test results hypothesis First show that Digital Human Capital (DHC) has an influence positive and significant towards Digital Leadership (DL) with the estimated value is 1.047, the Critical Ratio (CR) is 5.207, and the $p\text{-value}$ is 0.000 so that hypothesis First accepted. The results indicate that the taller implementation of Digital Human Capital, then the higher ability too organization in building Digital Leadership. In other words, increasing digital competence resources Power man capable strengthen capacity leader in direct digital transformation, taking decision data- based, as well as create culture adaptive work to development technology. Findings This show that Digital Human Capital is not only play a role as asset organization, but also become foundation main in form effective digital leadership. Digital Human Capital reflects competence, knowledge, digital skills, abilities analytical, as well as readiness source Power man in utilizes digital technology for support business processes. The taller digital capabilities possessed someone, the bigger support provided to leader in implement innovation, optimization utilization technology information, speeding up the decision-making process decisions, and manage change organization in a way sustainable. On the other hand, limitations digital competence can hinder implementation digital leadership because organization will face resistance to change, low adoption technology, as well as not enough optimally digital collaboration.

In a way theoretical, results study This in line with the Human Capital Theory put forward by [32], which explains that investment in knowledge, skills and competencies source Power man will increase productivity individual at a time create superiority competitive organization. In the era of digital transformation, investment the realized through development digital literacy, improvement ability data analysis, as well as mastery technology information that ultimately strengthen effectiveness digital leadership. According to Sousa and Rocha [8], that development employee digital competency can strengthen capacity organization in operate digital transformation. Furthermore, Verhoef et al [16] confirm that success digital transformation is greatly influenced by the ability organization in integrate capability source Power man with the digital strategy implemented. Other research shows that digital workforce development is prerequisite for formation capable digital leadership push innovation, improving agility organization, and strengthen ability adaptation in face dynamics environment business [18]. With thus, the organization is supported by human resources Work with high digital competence own more capacity big for support leader in formulate digital strategies, accelerate taking decision data- based, as well as manage change organization in a way more effective.

Digital Human Capital towards Halal Supply Chain Success

Test results hypothesis second show that Digital Human Capital (DHC) has an influence positive and significant towards Halal Supply Chain Success (HSC) with the estimated value is 0.916, the Critical Ratio (CR) is 3.980, and the $p\text{-value}$ is 0.000, so the hypothesis second accepted. The results indicate that the taller quality of Digital Human Capital, then the higher success rate implementation of Halal Supply Chain Success. In other words, increasing digital competence resources Power man give contribution real to success management chain halal supply through improvement effectiveness operational, transparency information, as well as ability organization in managing business processes based digital technology. Findings this show that, success chain halal supply is not only determined by availability digital technology, but also by capabilities source Power man in operate,

integrate, and optimize technology mentioned in each activity supply chain. Digital Human Capital includes digital skills, literacy technology, skills data analysis, as well as capacity individual in adapt to development technology. Competence the allows organization increase quality coordination between partners supply chain, speed up exchange information, reduce error operational, as well as support taking more decisions fast and accurate. With thus, Digital Human Capital becomes asset strategies that strengthen effectiveness of the supply chain process supply at a time increase ability organization in guard integrity and sustainability halal system. In the era of digital transformation, development digital competence becomes form possible investments organization utilizes technology optimally for create more efficient business processes efficient, adaptive, and empowered competitive.

Organizations that have source Power man with high digital literacy tend more capable integrate information, managing digital systems, and supports coordination cross organization that becomes prerequisite modern supply chain success. Research by Qu [15] show that improvement employee digital competency contributes to business process integration and effectiveness management supply chain-based technology. Gracia [17] also explains that digital competence resources Power man strengthen ability organization in carry out information sharing, improve collaboration between partners, as well as speed up implementation digital transformation in the supply chain supply. Next, Mentzer [19] find that development digital capabilities of power Work influential to improvement resilience, integration, and success digital supply chain implementation. Findings the show that digital capabilities of sources Power man are factor important in build system chain integrated, responsive and sustainable supply.

Digital Leadership towards Halal Supply Chain Success

Test results hypothesis third show that Digital Leadership (DL) has an impact positive and significant towards Halal Supply Chain Success (HSC) with the estimate value is 1.119, the Critical Ratio (CR) value is 5.251, and the p-value is 0.000, so the hypothesis third accepted. The results show that improvement ability digital leadership in organization capable increase success implementation halal supply chain. With thus, the hypothesis the third one stated that Digital Leadership has an impact towards Halal Supply Chain Success is stated accepted. Digital Leadership plays a role important in increase success implementation chain supply through ability leader in direct digital transformation, building culture innovation, as well as integrate technology to in business processes. Leaders with digital orientation no only focused on use technology, but also capable creating strategies, managing change organization, and encourage utilization technology as source improvement performance supply chain. Research previously show that digital leadership is capable speed up adoption technology, improve coordination inter-unit, support taking decision data-based, as well as strengthen collaboration cross organization that becomes factor important in success chain supply [23]; [24]; [22].

Findings study This show that existence a leader who has digital vision to become factor strategic in build chain more halal supply integrated. Digital leaders are able to push organization for develop system supporting information transparency of processes, strengthening digital governance, and create environment adaptive organization to change technology. The role of Digital Leadership is the more important Because success chain halal supply is not only determined by efficiency operational, but also by the ability organization in guard halal integrity, transparency information and traceability product (traceability) from upstream until downstream. Digitally oriented leadership enables organization strengthen coordination inter-actor supply chain, increase accuracy exchange information, as well as ensure compliance to halal standards through utilization digital technologies such as system information supply chain, technology tracking, and data integration. Research results This in line with Kane et al[9] which explains that success digital transformation is greatly influenced by the ability leader in build digital vision and creating culture supporting organizations changes. In addition, research Zailani et al [33] explain that success chain halal supply needs system strong coordination and control for ensure the halal process remains awake throughout supply chain.

Digital Human Capital towards Halal Food Supply Chain Efficiency

Test results hypothesis fourth show that Digital Human Capital (DHC) has an influence positive and significant towards Halal Food Supply Chain Efficiency (ESC) with the estimate value is 0.976, the Critical Ratio (CR) value is 3.665, and the p-value is 0.000 so that hypothesis fourth accepted. The results show that improvement capability source Power man digital- based capable increase efficiency chain supply halal food. Digital Human Capital (DHC) is increasingly recognized as capability strategic contributing organizations to improvement efficiency operational through strengthening digital competence, ability analytical, as well as ability in utilizes technology for support business processes. Source Power human beings who have digital competence is not only capable

operate technology, but also capable integrate technology them to in activity operational, management information, and retrieval decision strategic. Research latest show that organization with level digital capabilities of sources Power more human tall capable optimize management information, improve coordination cross function, as well as speed up taking decision data -based so that give impact positive to improvement efficiency supply chain [34].

Findings study This show that the existence of Digital Human Capital becomes factor important in support effectiveness management chain supply halal food. Digital competencies possessed by the source Power man allows organization for manage information chain supply in a way more accurate, improve integration interposes, as well as reduce obstacle operational that can lower efficiency. This is in line with Resource-Based View (RBV) perspective which explains that source internal power that has mark strategic can become source superiority competitive organization when capable developed and utilized optimally [20]. Based on Digital Human Capital, it has a very important role Because efficiency chain supply halal food requires management transparent information, effective coordination between perpetrator chain supply, as well as digital system that is capable support monitoring and traceability processes product. Digital competence source Power man allows organization increase accuracy recording halal information, ensuring process conformity with halal standards, as well as speed up response to change market demand and halal regulations. With support power work that has high digital skills, organization can reduce inefficiency operational, improving quality process control, and strengthening integration supply chain. Research results this also supports Wamba et al [35] research states that that digital capabilities and utilization technology information can increase performance chain supply through improvement quality information, coordination, and effectiveness taking decision. In addition, research by Jing and Fan [34] confirm that success digital transformation is highly dependent on readiness competence man in adopt and manage technology.

Digital Leadership towards Halal Food Supply Chain Efficiency

Test results hypothesis fifth show that Digital Leadership (DL) has an impact positive and significant towards Halal Food Supply Chain Efficiency (ESC) with the estimate value is 1.212, the Critical Ratio (CR) value is 5.482, and the p-value is 0.000, so the hypothesis fifth accepted. The results show that the taller ability digital leadership in something organization, then the higher-level efficiency chain supply halal food that can achieved. Digital Leadership play's role important in increase efficiency operational through ability leader in integrate digital technology to in business processes, strengthening coordination organization, as well as push taking decision data-driven. Digital leadership is not only related with ability understand technology, but also includes ability leader in direct change organization, building culture innovation, and ensure utilization technology walk in harmony with objective strategic company. Research latest show that effective digital leadership capable speed up implementation digital transformation, improving integration chain supply, as well as repair flexibility and response organization to change environment business. In addition, the leader with digital vision capable optimize utilization technology for simplify operational processes, improve collaboration between partners chain supply, as well as strengthen quality taking decision so that impact on increasing efficiency organization [22]; [26]; Salamah & Alzubi [27].

Research results This show that the existence of Digital Leadership becomes factor strategic in push creation chain supply more halal food efficient. Leaders who have digital capabilities are capable direct organization in adopt system supporting technology integration information, process control, and coordination inter-unit in supply chain. Capability the allows organization reduce delay information, improve accuracy taking decisions, and optimize use source Power operational. Based on the Digital Leadership variable, it becomes factor strategic Because management chain halal supply needs transparency information, strong coordination, and consistent supervision to fulfillment halal standards. Capable leaders build digital culture and integrating technology with activity operational can increase efficiency in various stages chain supply, start from procurement material raw material, production process, distribution, to supervision halal compliance. Utilization digital technology also supports improvement traceability of halal products so that organization can ensure integrity product throughout supply chain. Findings This strengthen research by Kane et al [9] which explains that success digital transformation is highly dependent on the role of leader in build digital vision, creating readiness organization, and encourage change culture work. In addition, research Zailani et al [33] show that effectiveness chain halal supply is influenced by the ability organization in build system coordination, transparency, and appropriate process control with halal principles.

Halal Supply Chain Success towards Halal Food Supply Chain Efficiency

Test results hypothesis sixth show that Halal Supply Chain Success (HSCS) has an impact positive and significant towards Halal Food Supply Chain Efficiency (ESC) with the estimate value is 0.965, the Critical Ratio (CR) value is 4.110, and the p-value is 0.000, so the hypothesis sixth accepted. The results show that the taller level success implementation halal supply chain, then the higher efficiency chain supply halal food that can achieved organization. Halal Supply Chain Success (HSCS) reflects ability organization in integrating chain processes halal supply through transparency information, traceability, coordination between perpetrator supply chain, as well as compliance to halal standards. Success implementation chain halal supply is not only fulfillment-oriented condition halal products, but also contribute to improvement effectiveness and efficiency operational through better process management structured research latest show that success implementation halal supply chain capable increase efficiency operational through strengthening integration information, process standardization, and subtraction risk emerging operations throughout activity chain supply. In addition, the implementation of digital systems that support end-to-end traceability enable organization increase visibility chain supply, speed up flow information, and reduce waste operational so that impact on increasing performance chain supply in a way overall [36]; [37].

Findings study This show that success management chain halal supply becomes factor important in create efficiency operational in industry halal food. Organizations that are capable of apply practice chain halal supply in consistent will own ability Better in manage connection between perpetrator supply chain, ensure quality information, as well as guard business process continuity. Good process integration allows organization reduce obstacle coordination, speed up distribution information, and improve accuracy in taking decision operational. In Supply Chain Management Theory perspective, effectiveness chain supply is greatly influenced by the ability organization in build integration between activity, increase coordination between stakeholder's interests, as well as create flow effective information [19]. In context halal supply chain, principles the become the more important because organization no only issued for reach efficiency economic, but also ensure halal integrity throughout the procurement, production, distribution, and processing processes until to consumers.

Success from implementation practice chain halal supply is not only ensure compliance to halal requirements, but also increase efficiency through more coordination good, accuracy information, and integration of business processes throughout supply chain. Organizations that have high level of Halal Supply Chain Success will more capably optimize activity procurement material raw materials, production processes, distribution, and halal supervision in general integrated. Condition the can reduce process time, pressing cost operational, minimizing potential mismatch products, as well as increase ability organization in respond change market needs. Research results This support study Zailani et al [33] explained that success chain halal supply is determined by ability organization in guard coordination, transparency, and control of the halal process comprehensive. In addition, research by Fernando [36], and Sarasi & Satmoko [37] show that integration halal supply chain practices with support digital technology is capable increase performance and efficiency operational.

Digital Human Capital towards Halal Food Supply Chain Efficiency through Halal Supply Chain Success

Test results hypothesis seventh show that Halal Supply Chain Success (HSC) is capable mediate the influence of Digital Human Capital (DHC) on Halal Food Supply Chain Efficiency (ESC) with the indirect effect value is 0.120 and the P-Value < 0.05 so that the hypothesis seventh accepted. The results show that Digital Human Capital is not only give influence direct to efficiency supply chain halal food, but also deliver influence No direct through success implementation supply chain halal. Findings This show that digital competence resources Power man become factor important in build success chain ultimately halal supply increase efficiency operational. Digital Human Capital includes ability power Work in understand, adopt, and utilize digital technology for support activity organization. When the source Power man own good digital competence, organization will more capably manage information supply chain, increase coordination between perpetrators, and develop system supporting process control success supply chain halal.

Mediating role of Halal Supply Chain Success shows that existence source Power man with digital capabilities yet fully produce efficiency chain supply without existence mechanism management chain effective halal supply. Digital competence is necessary translated through practice chain halal supplies, such as improvement transparency information, reinforcement traceability, business process integration, and assurance compliance to halal standards. Through success implementation chain the halal supply, digital capabilities of the source Power man can give more contributions big to improvement efficiency operational. Research results This support

Resource-Based View (RBV) perspective which explains that source internal organizational power can become source superiority competitive if capable developed become capability strategic that produces mark for organization [20]. In this context, Digital Human Capital is asset strategic that allows organization develop ability chain halal supply in more effective. In addition, the Dynamic Capability Theory approach also explains that organization need own ability for integrate source internal power with change technology to be able to increase performance and adaptability to environment dynamic business [25].

Furthermore, the role of Halal Supply Chain Success becomes the more important Because industry halal food requires management chain supply that is not only efficient in a way operational, but also capable guard halal integrity of the procurement process material standard until distribution product to consumers. Source Power human beings who have digital competence can support implementation technology like system information supply chain, digital monitoring, and systems traceability product. However, the benefits technology the will more optimal when organization has own practice chain successful halal supply implemented in a way comprehensive. Findings This in line with research by Jing and Fan [34] which explains that digital capabilities of sources Power man play a role in increase performance organization through improvement ability integration technology and management information. In addition, research Zailani et al [33] show that success chain halal supply contributes to improvement performance operational through transparency, coordination, and control of the halal process.

Digital Leadership towards Halal Food Supply Chain Efficiency through Halal Supply Chain Success

Test results hypothesis eighth show that Halal Supply Chain Success (HSC) is capable mediate the influence of Digital Leadership (DL) on Halal Food Supply Chain Efficiency (ESC) with the indirect effect value is 0.169 and the P-Value < 0.05 so that the hypothesis eighth accepted. The results show that Digital Leadership is not only influential in a way direct to efficiency chain supply halal food, but also deliver influence No direct through success implementation supply chain halal. Research results This show that role digital leaders become factor important in push success chain halal supply which then impact to improvement efficiency operational. Digital Leadership enables organization develop digital transformation strategies, build culture innovation, as well as direct utilization technology for increase coordination and integration in supply chain. However, the influence the become stronger when realized through success implementation Halal Supply Chain Success practices. mediating role of Halal Supply Chain Success shows that digital leaders do not in a way direct create efficiency chain supply only through use technology, but through ability they in build system chain integrated halal supply. Leader with digital vision capable push implementation system information, improve data transparency, strengthening coordination between stakeholder's interests, as well as ensure business processes still in accordance with halal standards. Conditions they will produce chain more supply responsive, efficient, and capable reduce risk operational. Findings This support research by Kane et al. [9] which states that success digital transformation is greatly influenced by the ability leader in create digital vision, managing change organization, and building readiness source manpower.

Digital Leadership has role strategic Because management chain halal supply needs capable leadership combine digital technology with principal halal compliance. Digital leaders can push organization in apply system traceability, improving transparency halal information, as well as strengthen connection coordination between suppliers, producers, distributors, and consumers. Through success chain the halal supply, the organization can increase efficiency procurement, production, distribution, and halal supervision. Research results This in line with study [22], [26], Salamah and Alzubi [27] who show that Digital Leadership plays a role in increase performance organization through ability digital transformation and business process integration. In addition, Fernando 's [36] research; Sarasi and Satmoko [37] confirm that success halal supply chain practices can increase efficiency through strengthening integration information and coordination supply chain.

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CONCLUSION

Based on results research that has been discussed, can concluded that from to eight hypothesis that has been done testing Good There are direct and indirect effects six hypothesis in a way direct can accepted, and two hypotheses in a way no direct can accepted. Digital Human Capital and Digital Leadership are capability influential strategic positive to increasing Halal Food Supply Chain Efficiency, good in a way direct and through role Halal Supply Chain Success mediation, which shows that strengthening digital competence resources Power human, leadership-based technology, as well as success implementation practice chain halal supply becomes factor important in build system chain supply integrated, transparent, and sustainable halal food. In general, practical, research This give implications that organization in industry halal food is necessary prioritize development digital competence of workforce work, improve capacity digital leadership, as well as strengthen system chain halal-based supply technology for increase efficiency operational, strengthening traceability product (traceability), maintaining compliance to halal standards, and improve Power competition organization in face dynamics digital transformation.

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