FINANCIAL ANALYSIS OF DAY-OLD CHICK (DOC) LOGISTICS 4.0 SYSTEM IN SULAWESI, INDONESIA

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ABSTRACT

Day-Old Chicks (DOC) should be distributed from the hatchery to the farm which entails a risk that lowers DOC quality due to stress. The DOC logistics from hatchery to the farm does not have sufficient monitoring, tracking, and tracing systems. In the Industrial 4.0 era, companies have a higher competitive advantage by using existing technology to improve customers' satisfaction, however, this requires huge investment. This study sought to describe the current logistics of DOC, analyze the possibility of implementation of logistics 4.0, and analyze the financial feasibility of implementing logistics 4.0. Observations and direct interviews were conducted in April to August 2020. This study employed investment criteria and evaluation of value added (EVA). The logistics system designed using Internet of Things (IoT) and Web System Networking (WSN) would have an EVA value of IDR261,725,367 and logistics operational costs of DOC 4.0 costs would be lower than conventional logistics. The implementation of DOC logistics system 4.0 would provide an advantage to stakeholders, including the increase of company's credibility, delivery flexibility, route optimization and transparency during logistics process.

Key words: Evaluation Value Added, investment criteria, Internet of Things, Web System Networking

INTRODUCTION

Day-Old Chicks (DOC) logistics undergo a complex and prolonged handling process that is influenced by microclimate changes. This may result in high stress as DOC welfare, growth, development, and performance are strongly affected while in transport from hatchery to the farm (Mitchell and Kettlewell 1998; Yerpes et al. 2021). Unlike other mature livestock that are able to metabolically control body temperature, DOC can not fully manage its body temperature since its organs are not functioning perfectly. As a result, it is sensitive to hot and cold stresses thus requiring technological assistance in the management and maintenance of the ideal environmental state during the distribution process for optimal DOC viability (Mitchell and Ketlwell 2009). According to the observation and information conducted and collected by the authors from the site, transportation for 12 hours could lower the weight of DOC by as much as 10%. Farmers also complained that the birds were often found having dried feet, injury and some even die after transportation.

The process of DOC transportation constitutes the final stage of production for a hatchery company, but it strongly affects DOC quality provided to the farmer. Currently, DOC transportation state does not have any sufficient monitoring, tracking, and tracing systems. Furthermore, a majority of hatchery companies rely on the expedition service in distributing the DOC products to the farmer customer using a modified DOC transport truck. There is no comprehensive standardization for this transportation process, it does not address the possibility of decline of DOC quality and fraud during the DOC distribution process. In addition, the lack of knowledge by employees regarding animal welfare, particularly in DOC, can also influence the decline in DOC quality and performance when it reaches the farmer. Moreover, to improving DOC logistics services, the logistic system must have a control system for environmental conditions during the transportation process to maintain DOC conditions and a sense of security for customers. Control system development which facilitates monitoring, tracking, and traceability, and enables welfare improvement for DOC without disregarding economic aspects to boost advantage in broiler industry should therefore be established.

Control during production and distribution processes from hatchery to customer is needed to decrease and anticipate any potential loss. This may be implemented using 4.0 technology for developing the DOC supply chain (Haji et al. 2020). Logistics 4.0 design for DOC business is a system developed by implementing the technologies today including Internet of Things (IoT) and Web System Networking (WSN) (Jiang et al. 2020). By implementing these technologies, stakeholders of DOC business chain will be able to conduct product monitoring, tracking, and tracing during transportation process so as to boost reliability of the transportation system. Meanwhile, each stakeholder needs to know how much capital must be invested and what benefits they can get from them. This study sought to describe the current logistics of DOC, analyze the possibility of implementation of logistics 4.0 and analyze the financial feasibility of implementing Logistics 4.0.

MATERIALS AND METHODS

This study was conducted at PT. MSP, Maros Regency, South Sulawesi from April to August 2020. Literature study as well as in-depth interviews were conducted with some experts and practitioners of DOC logistics business. The interview was conducted with 2 hatchery managers of different companies, 4 supervisors in the hatchery and DOC transportation services, 5 drivers, 8 farmers, and 3 academics in DOC hatchery industry in a semi-structured manner to gather information on practices and state of logistics process and the implementation of technology 4.0 for DOC logistics. The information gathered such as DOC productions, sales, financial report and logistics cost from 2015 until 2020 were analyzed descriptively for site condition and used as basis for implementation of the logistics DOC 4.0.

Design model framework was made by referring to variable identification of problems and consultation done with several practitioners of DOC for poultry industry in Sulawesi island, then WSN and IoT-based logistics system were designed to facilitate the logistics process and control of DOC transport state. Moreover, further exploration was also conducted in regard with logistics industry today and development of related smart-logistics technology. Therefore, the design of Logistics 4.0 for DOC business was arranged with features which might solve the existing problems.

To decide on whether to invest in logistics system 4.0 or not, three general measures namely Payback Period (PP), Net Present Value (NPV), and Internal Rate Return (IRR) (Mann 2018; Rianto et al. 2018) were used , while performance measurement was conducted using Economic Value Added (EVA) (Septiana 2015). The implementation and accounting adjustment using discounting techniques such as NPV and IRR are required to enhance the implementation and accounting adjustment from the assessment of EVA (Sharma and Kumar 2010). In addition, DOC production in the projected period and delivery frequency to some destination cities was simulated using Monte Carlo with Microsoft Excel (Torok 2015). The simulation result became the basis for calculating the whole delivery distance, total travel in one year, and income from the delivery of each city with the assumption of DOC production transported.

EVA was used to assess how well the company generates operating profit, in accordance with the total capital invested (Chmelikova 2008). EVA concept depicts how efficient or inefficient a company allocated the capital. EVA value was obtained from the difference between Net Operating Profits After Tax (NOPAT) and capital cost (WACC) multiplied by total capital for running the operation (Capital Employed), as identified (Atmadiputra 2019) in the following formula.

$$\text{EVA} = \text{NOPAT} - (\text{Capital Employed x WACC})$$

Where:

NOPAT = Sales revenue – Operating Cost – Tax
Capital Employed = Total Initial Investment
WACC = Capital cost

Cost of capital (*rk*) is the interest from borrowed capital (Stern and Shiely 2001). Calculation of WACC shall be done using the approach of Capital Asset Pricing Model referring to (Benninga 2014) and using the following formula:

$$\text{WACC} = \text{rd}\ (1 - \text{t})\left(\frac{\text{D}}{\text{D+E}}\right) + \text{re}\left(\frac{\text{E}}{\text{D+E}}\right)$$

Where:

rk = Cost of capital, WACC
rd = Cost of debt, CoD = $\frac{\text{interest expense x (1+rate intererst)}}{\text{total debt}}$
re = cost of equity, CoE = $\text{Rf} - \beta(\text{Rm} - \text{Rf})$
D = Total debt
E = Total equity
T = Tax rate

Total debt and total equity from design simulation were determined using Debt to Equity Ratio (DER), which is used to discover debt and equity proportion from simulation cost structure. Debt to Equity is a solvability ratio indicating the extent that a company could comply with the responsibility using capital (equity) possessed by the company (Atmadiputra 2019). The higher DER value, the bigger the company's debt, or it can be perceived that the value of debt is stagnant but the equity declines. This ratio was found out from benchmarking of open logistics company listed in Indonesian Stock Exchange in 2019.

For investment decision-making, if IRR is more than the WACC, then the investment can be accepted. However, in the event that IRR is less than WACC, then the investment is rejected. This criteria was used for the purpose of ensuring that the company at least achieve the desired target in the hope of improving the income and welfare (Auguar 2017).

RESULTS AND DISCUSSION

Current practice of logistics in DOC industry. PT. MSP is a day-old chick hatchery company situated in Maros Regency, South Sulawesi. It has DOC production capacity of up to 50,000 DOC per day. This company serves order for its breeding partners throughout Sulawesi Island and Kalimantan Island. The increase in chicken consumption in Indonesia, triggered PT. MSP to continuously improve its production and product quality. However, the company faces the challenge of maintaining the product's quality during the distribution process particularly while in transport from hatchery to the farm. The DOC are packed in boxes and the total DOC harvested are recorded. The manager adjusts the number of DOC to the existing order and coordinates delivery. The first type of DOC distribution channel in South Sulawesi is from hatchery to plasma farmer, wherein large scale farmers make DOC order through main company, which makes an order to hatchery. The second distribution channel involves independent farmers who order directly to the hatchery.

The hatchery company uses third party logistics for product delivery to the customers. In general, DOCs are transported using trucks with modified compartment. Size, design, number and type of the blower as well the capacity of compartment varied per truck owner. Hence, DOC box compactness within the compartment differs as well because the difference in compartment size and design affects the box arrangement method (Fig. 1) Current loading practice and vehicle design used for DOC logistics. A common issue in the initial phase of distribution (preloading) is the number and grade classification inaccuracy of DOCs in packaging. This is assumed a result of manual packaging method. Loading process is done in the afternoon, around 16.00 p.m., while awaiting transporters' vehicle, the stocks are fed to prevent weight loss during the transportation process. Delivery time is affected by weather condition and absence of routing plan system from the transporting party. One reason for this is that in addition to serving the transportation needs of the PT. MSP's DOC, transporters also provide transportation services to other companies. During transport, there are also DOCs loaded from other hatchery companies for delivery to different destinations, resulting to frequent delays in delivery. Therefore, in a container, DOCs are from at least three different companies experiencing the same problems.

Fig. 1 Current DOC transportation and handling practice

In addition, several trucks with GPS installed enable monitoring of the transport movement and speed. This is important in the estimation of arrival time in the farm and anticipate the risk of any fraud during the transportation. There are no built-in equipment with sensors to monitor temperature, humidity, wind velocity, gas and sound for optimal DOC environment within the transport container. There are two national standards (SNI) regulating logistics governance regarding DOC: SNI 2043:2011 concerning packaging and SNI 2044:2011 concerning transport equipment. The neglected matter during DOC distribution process to date is driver competence on DOC welfare and handling. This becomes the main factor to be mastered by the drivers because it has significant impact on the stability of DOC quality on reaching the farmers customers. During transport, drivers have the full responsibility to maintain DOC state from the hatchery to the farm. Table 1 shows the problems dealt by business actors in the practice of DOC logistics at present.

Table 1. Problems in conventional DOC logistics.

	Stakeholder		Problems
1)	Hatchery	1.	Inaccuracy of DOC number within box
		2.	Inaccuracy of DOC grade type during packing process
		3.	Prolonged and conventional coordination of information and goods delivery
		4.	Improper data archive system
		5.	Prolonged delivery time (delivery only at afternoon and night)
2)	Farmer	1.	Decrease in DOC body weight
		2.	Decline in DOC growth performance
		3.	Lack of DOC volume received
		4.	Inaccurate goods arrival time
		5.	No direct information or access to product specification and traceability
3)	Transporter	1.	Unable to monitor and maintain the condition of container in optimum state for DOC
		2.	Manual delivery planning system
		3.	No data archive
		4.	No monitoring system while in transit
		5.	Challenging road conditions to farm location
		6.	Delivery can only be performed in the afternoon and night
		7.	No detailed information on product delivered
		8.	Penalty agreement has not been systematized well
		9.	No vehicle standard
		10.	Losses during transportation

Possibility of implementing Logistics 4.0 in DOC business. The fundamental function of logistics is to carry the right items with the right quantity and quality, at the right time, to the right place and with the right pricing (Rushton et al. 2014). Logistics 4.0 in 4.0 industry is an integration of various kinds of technologies in order to maximize supply chain efficiency and effectiveness which shifts the focus of an organization toward value chain and also maximize the value provided to the customers by improving competitiveness (Amr et al. 2019). This idea can be achieved by improving transparency and decentralization levels between parties through digitalization.

Logistics 4.0 system for DOC allows for maintenance of ideal DOC conditions by means of a monitoring system called web system networking (WSN) from IoT which records microclimate parameters such as temperature, humidity, gas, vibration, slope, as well as vehicle's speed, position and loading status during the logistics process. It can also improve transparency, real-time data processing and real-time supply chain re-planning. The design of Logistics 4.0 system for DOC business cannot be separated from the improvement of the existing vehicle design. The main consideration in the designing process of DOC transportation vehicle is the capability of minimizing harmful stresses that could later on affect the production performance of the DOCs once they are transferred to the care of the farmers. When compared, it was found that the values of body weight reduction had a significant increment along with the higher transportation duration (Bergoug et al. 2013; Jacobs et al. 2016; Yerpes et al. 2021). Even though the performance of transportation with current vehicle condition did not affect significantly the performance of chicken growth, vehicle improvement is needed to improve customer service. Therefore, improving vehicle design in the Logistics 4.0 design for DOC business should be implemented by installing air-conditioners to maintain the stable condition within the containers, as well as adding some sensors to vehicles and DOC containers (Nazareno et al. 2020).

The information system built should be equipped with special features such as identification, searching, location tracking, monitoring, responsive, and distance and time optimizing features. Product identification will provide the system with information about the right item while the searching feature would enable the system to detect missing items as well as ensure the item quantity. Position monitoring could be performed by the information system via vehicle location tracking. Monitoring toward product condition should also be performed to ensure that product quality is maintained. All the data could be monitored real-time and in detail in the system. Thus, responsiveness toward unexpected events during the logistics process could eventually be handled on time. In addition, the provision of such data can be used as a reference in optimizing logistics process. This process can be conducted with the help of artificial-intelligence which is important in supporting and optimizing all the features.

Shipping is the last process in producing DOC and entails moving it from the hatchery to the customer-farms. Today, the shipping services industry has become much more accurate with the use of improved tracking technology. Accurate tracking services, such as GPS technology, are used to detect the location of the consumers or purchasers while delivering products to the sellers or consumers. This also enables communicating with the driver and alerting him/her if there is a need to check the container for DOC quality maintenance, and sending a notification if the driver is out of the route. Even better, by logging this diagnostic data, the compliance with key DOC transportation safety standards can be shown if needed. Technologies such as geographic information systems (GIS) and remote sensing (RS) are used for transportation services and precision analysis, through the collection and integration of data remotely, and for mapping geospatial variability to highlight the movement of goods throughout the entire shipping process (Bosona and Gebresenbet 2013). Other real-time tracking technologies such as the IoT, Radio Frequency Identification (RFID), and blockchain allow easier updates to the shipping process while transporting large volume of products from the manufacturing firms to the distributors (Rivero-Garcia et al. 2019).

RFID is employed to identify vehicle location during delivery so the delivering fee can be optimized by maximizing vehicle operation (Kim et al. 2008). Furthermore, RFID tagging is implemented in many food industries in order to automate their warehouses and distribution centers so errors can be eliminated by ensuring that the right items are being delivered with the right quantity to the right place. The RFID technology is important for the optimization of various supply chains, so that customers can easily access the products (Kelepouris et al. 2017).

The IoT and RFID technology is attached sensors to identifying, finding, and tracking the status of an asset product in real-time via cloud and internet technologies. A technology which applies IoT system will allow data collection, storage, and data analysis which can be connected to the entire supply chains (Tian 2018). This is important for tracking DOCs during delivery due to their vulnerability toward changes in environmental condition that tend to vary with length of time traveled. DOC quality and safety standards can be achieved via the new system because the IoT and cloud technologies can be applied in every stage of value chain for better data collection, and faster as well as more accurate decision making (Verdouw et al. 2016). In addition, the blockchain technology can also be implemented in this system as in the food supply chain to provide the right information about the food demanded (Tse et al. 2017). Logistics 4.0 system model for DOC business is shown in Fig. 2.

- QR code scanner: QR code scanner or smartphone with QR code scanning app is required to read package information.

- Asset creation: After the product (DOC box) is first entered into the warehouse, a new asset data is created in the system. All product information is stored in a QR code.

- Sensors (IoT): These sensors are required in the DOC box and in the container in order to monitor temperature, RH, and when the DOC box was opened. This sensor is required when the product is in transit, and after the consumer (farmer) receives the product, the sensor QR code is scanned by the courier, and if there is death, injury or the quality received does not match the agreed specs, the consumer can refuse and return the goods.

- Product visibility: All stakeholders can see product details in the supply chain that have been inputted in the mobile application. After the user scans the QR code of an existing product or sensor, the user will get all the information about the product in the DOC supply chain via a normal smartphone by using a mobile application or web application.

To synchronise and optimise the inventory, the data and information are inputted to an intelligent inventory management engine to handle order change and picking problems, among which data clustering and some machine learning methods as well as fuzzy inference system are applied for information processing in decision-support. The output is transmitted back to the host application and shares the results with the mobile apps. Hence, the staff involved in this IoT-based can receive the corresponding action information.

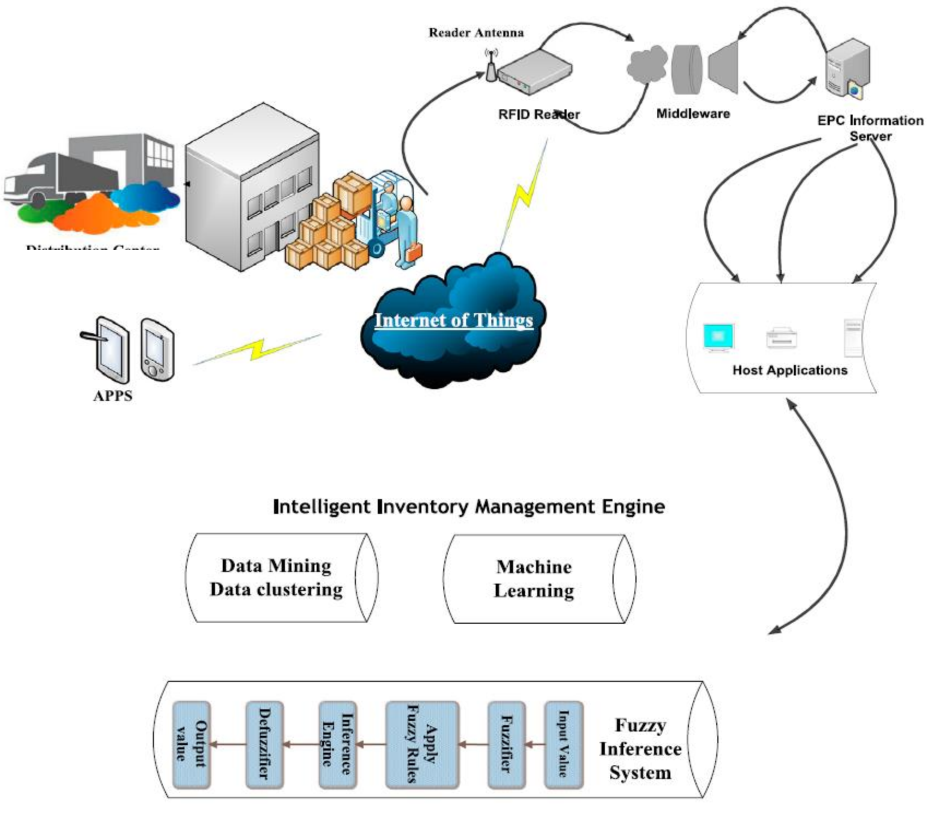

Fig. 2. Integrated Iot and WSN on Logistics 4.0 System

Financial analysis and benefit of Logistics 4.0 for DOC business implementation. The evaluation of the planned Logistic 4.0 System was conducted by creating financial simulation. There will be changes in the cost structure because the adoption of logistics 4.0 requires initial investment as presented in Table 2. Initial Investment, which comprises installation of IoT sensor (Pang et al. 2012), installation of temperature control system, installation of IoT server (Kurniawan 2015), the purchase of IoT sensor for scanning and data input process, bandwidth, installation of server services, as well as labour training will be a total of IDR1,308,061,624.

Table 2. Initial investment for Logistic 4.0 System adoption.

Description	Unit	Amount	Economic age
IoT sensor installation	IDR	446,453,700	10
Temperature controlling system	IDR	596,607,924	20
IoT server installation	IDR	25,000,000	20
IoT installation	IDR	30,000,000	10
Bandwidth	IDR	90,000,000	10
Installation of service from server	IDR	120,000,000	10
Total initial investment	IDR	1,308,061,624	-

Investment simulation was conducted for a period of 10 years (t = 10) and the amount of delivered DOC was also simulated using Monte Carlo to determine distance travelled and frequency of trips per year in a 10-year period. There was an increment in the delivery cost, truck maintenance cost, employee's salary, delivery price, and cost savings in the allocation of cost for risks during transport (Table 3). In the simulation of Model Logistics 4.0 system, the delivery fee increased due to the addition of sensors and temperature controlling systems which consumed more fuel, with an assumption that the increment of fuel consumption in every truck would be 2% of the fuel consumption prior to Logistics 4.0 simulation. The fuel needed in every transportation fleet was based on Nurhayati (2017) which was IDR4,383.- km^{-1}, while the needed fuel in every transportation fleet during the adoption of Logistics 4.0 system was assumed to increase by 2% which was computed to be IDR4,471 km^{-1}. The increment in delivery cost could be interpreted as the cost of quality improvement provided to farmers and hatchery companies as the customers. Optimization of route which was promoted by the Machine Learning and the IoT of transportation fleet tracking affected the cost of truck maintenance. The truck maintenance fee was projected to decline generating savings of IDR1,113,514 for every truck per year in the Logistic 4.0 system, indicating a huge value-added in the customer service in DOC delivery fleets.

The adoption of Logistics 4.0 System also affected management, via the centralized and integrated data management, which could reduce administrative necessities. The simulation of this system assumed that it will only require one person to complete all the administration works due to IoT and IoT server enabling the downsizing of staff. Such reduction in the number of staff employed would decrease labor cost and increase operating profit. Nonetheless, profit was not the only objective of this system. The investment was also focused on the human resources being involved with the system, and these resources are employees. Thus, workforce training must continue to be carried out periodically to improve their ability to operate the new system.

Based on interviews conducted, fraud is often carried out by corrupt couriers during the shipping by taking DOC or exchanging DOC with low quality during the journey. This can occur due to the lack of welfare of couriers so that an increase in employee salaries is expected to improve employee welfare and have an impact on improving performance. The most important employee motivation is salary (Wiley 1997). Companies can increase profits and productivity of their logistics services by focusing on improving employee skills by training, increasing salaries, and improving workplace conditions (Jhawar et al. 2016). Thus, workers will have a good commitment to the company so that fraud that often occurs can be reduced.

The DOC delivery fees varied according to the destination. The simulation used five destination cities/regencies, namely, Maros Regency, Palu City, Bulukumba Regency, Luwuk Regency, and Kendari City, with an assumption that the DOCs were delivered from Maros Regency. The delivery fee increased by IDR 2,044 for each box (Table 3). It was applied due to the upgrade of the services being offered which can provide added values for the customers, improve customer's loyalty, and attract new customers so the trips could possibly be done in full capacities. It was found that the change in the fee in for the 10-year period simulation, as well as the increment in employee's salary, were not harmful to the employment of this system. Instead, the efficiency generated by the Logistics 4.0 system improved the operational profit by IDR 321,763,955 compared with the system before the adoption of Logistics 4.0 .

Table 3. Changes in the cost components before and after simulation of Logistics 4.0 design adoption

Description	Unit	Before Adoption of Logistics 4.0	After Adoption of Logistics 4.0	Increment	Benefit
Expedition					
Avg. of delivery fee	IDR km^{-1}	4,690	4,847	156	Service upgrade
Avg. of maintenance fee	IDR $truck^{-1}$ $year^{-1}$	6,156,493	5,042,979	(1,113,514)	Route optimization
Avg. of risk fee during transport	IDR rit^{-1}	26,631	8,586	(18,045)	Savings
Required number of admin staff	Person	7	1	(6)	HR efficiency
Avg. of employee's salary	IDR	49,820,109	65,655,787	15,835,678	Increment of HR welfare
Avg. of delivery fee	IDR box^{-1}	51,100	53,144	2,044	Increment of price
Avg. of operating profit	IDR	253,235,977	574,999,932	321,763,955	Increment of income
Hatchery					
Required number of admin staff	Person	7	5	(2)	HR efficiency
Avg. of employee salary	IDR	21,137,961	19,002,813	(2,135,148)	Savings
Number of DOC mortality	Box $year^{-1}$	1,286	219	(1,068)	Quality increment
Fee of claim on DOC mortality	IDR $year^{-1}$	1,783,100	303,127	(1,479,973)	Reduction of risk in terms of DOC mortality claim

The decision to invest in the adoption of Logistics 4.0 system, financial analysis using the return period (payback period, PP), NPV, IRR, was performed and evaluation of system performance was calculated by EVA in order to strengthen the implementation of system (Sharma and Kumar 2010).

The payback period of the system would be 3.09 years, suggesting that the cash flow resulting from the adoption of the Logistics 4.0 system could pay back the initial investment in an amount of IDR1,308,061,624 within 3.09 years or 3 years and 1 month (Table 4). A consideration on the lifetime of this system was 10 years in minimum (Table 1), and it was assumed that the investment would be accepted with the return level of less than 4 years. Thus, such return period of 3.09 years was deemed to be acceptable and worth continuing.

The NPV value gained from project's cash flow was multiplied by the rate of WACC discount (8%) and then compared to the rate of the prevailing commercial bank interest. The calculated NPV value of the Logistics 4.0 system indicated a positive nominal amount of IDR 1,207,221,305 indicating that the capital invested in Logistics 4.0 system gave more benefits when not being saved with the rate of return of 3.75% (based on BI 7 days reverse repo rate). The NPV value of more than zero indicates that the amount generated from the investment decision is feasible. The NPV value was then multiplied by the discount rate until it generated zero in number, to arrive at the internal rate of return (IRR). IRR is one of the key variables for investment feasibility which depicts the level of return toward the entire investment (Berutu, 2017). The investment is feasible based on the IRR value of the simulated Logistics 4.0 system investment which was 27% higher than the level of minimum return which was 7.75%.

Table 4. Assessment toward the adequacy of Logistics 4.0 system simulation

Description	Unit	Amount
Initial investment	IDR	1,308,061,624
Payback period	Year	3.09
NPV	IDR	1.228.389.872
IRR	%	28
WACC	%	8
EVA	IDR	261,725,367

CONCLUSION

The existing DOC logistics from the hatchery to the farm is not equipped with adequate monitoring, tracking, and tracing systems, resulting in losses for the stakeholders. Therefore, the Logistics 4.0 System was designed using IoT and WSN and was simulated for a period of 10 years. Under the declared assumptions, the simulated Logistics 4.0 system has value-based benefit potential for the stakeholders in the DOC business which results in a reduction in the workforce for administrative activities by 85%. Thus the company can focus on increasing skills and wages to improve employee welfare. Therefore, the company may take the implementation of Logistics 4.0 system into consideration because the increments of added value to be offered can improve the company's credibility, delivery flexibility, and route optimization which can enhance customer satisfaction. To ensure a committed transport staff the company needs to provide professional training including the chick delivery training not only for the new technology but also on the needs and behaviour of day-old chicks. The implementation Logistic 4.0 in DOC business to ensure its traceability still needs standardization of the equipment, processes and interfaces, joint platform and independent governance as the key boundary conditions for successful implementation of day-old chicks logistics.

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