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[JTI] Submission Acknowledgement

1 message

Shanty Kusuma Dewi <noreply@umm.ac.id> Sun, May 26, 2019 at 5:27 PM
To: Muhammad Faisal Ibrahim <faisalibrahim.ie@gmail.com>

Muhammad Faisal Ibrahim:

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[JTI] Editor Decision: Accept Submission

1 message

Dr. C. K. Sivashankari <noreply@umm.ac.id> Wed, Jul 24, 2019 at 4:09 PM
To: Muhammad Faisal Ibrahim <faisalibrahim.ie@gmail.com>
Cc: Maulin Masyito Putri <maulin.putri@uisi.ac.id>

Dear, Muhammad Faisal Ibrahim:

On behalf of the Editorial Board, I am pleased to inform you that your paper entitled: Jurnal Teknik Industri, "Integrated Green Supply Chain Model to Reduce Carbon Emission with Permissible Delay-in-Payment Consideration" has been accepted to be published in Jurnal Teknik Industri.
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Thanks,
Best Regards
Dr. C. K. Sivashankari
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Integrated Green Supply Chain Model to Reduce Carbon Emission with Permissible Delay-in-Payment Consideration

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ABSTRACT

In practice, the policy of giving a delay in payment period is prevalent between players in a supply chain system; generally, payments are made at the end of the permitted period. Supply chain management is one of the keys to corporate sustainability, and supply chain activities have a considerable impact on the environment. In this research, the author develops a mathematical model to find the effect of delay in payment on emissions costs without ignoring the economic performance of a supply chain. The author develops the model into five different scenarios, then numerical experiment and sensitivity analyze test is performed. The results showed that delay in payment could integrate the players in the supply chain system and have a positive impact on reducing supply chain emission cost.

Commented [H1]: The abstract section of your research paper should include the following:
- Topic
- Purpose
- Methode
- Results
- Conclusion

you must write it straightly

in your article, the purpose of the article has not been written in the abstract

1. Introduction

This paper analyzes carbon emission reduction using permissible delay-in-payment consideration. The environmental effect of carbon emission often ignored in manufacturer and transportation activity. In this paper, the author developed four different case scenarios under permissible delay in payment. The research result shows that the delay in payment mechanism successfully reduced carbon emission, proven by emission costs that are more minimal compared to when no the delay in payment mechanism. This paper also provides some insight for practitioners managerial.

Commented [H2]: why is carbon emissions important to study? you have to explain this clearly. You also need to refer to various sources.

Supply Chain Management (SCM) become one of the centers of attention in a company with the aim of corporate sustainability. The supply chain is a very complex topic when it involves many functional areas inside and outside the company to improving company performance [1]. On the other hand, the supply chain is also run to minimize costs. Some previous researchers include Aljazzar, et al. [2] suggests that order, holding, and setup costs are the essential components in supply chain costs. Related costs in the supply chain have also been stated by Waters [3] where these types of costs continue to grow until now. Inventory along the supply chain must be well maintained to ensure the sustainability of the company. Efficient inventory along the supply chain can occur with reasonable cooperation and coordination [4-9]. With the integration, the supply chain

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must be centralization so that all critical decisions can be considered together for mutual benefit.

Optimizing costs in a coordinated supply chain is easier to do than uncoordinated. Some literature in the different mechanism described proof that coordinating the supply chain could subtract cost [10-12]. With coordination, buyers and sellers will get the benefit. A good coordination scheme can coordinate sellers and buyers more flexible [10]. According to recent research conducted by Sainathan and Groenevelt [11], there are many types of contracts that can coordinate supply chains, including quantity discount, buyback, and revenue sharing. In other studies, delay in payment contract also successfully coordinated several players in the supply chain system [13].

Supply chain management always pays attention to improve company performance and maintain organizational sustainability [14]. Furthermore, the supply chain is an essential branch of operations management, and it has an essential impact on the environment, including emissions, pollutions, the health hazard of community, and so forth. However, unconsciously, inefficient supply chain management activities from upstream to downstream can cause excessive carbon gas emissions. The increase of global warming and changing biodiversity has brought the world's sustainability towards immediate danger. People from different areas, including researchers, academicians, practitioners, and scientists, got all together to suggest ways to maintain environmental sustainability. According to King and Lenox [15] claimed that unplanned and irresponsible actions by industries are potential threats to sustainability. Companies are now trying to minimize environmental impacts by integrating environmental concerns into their supply chain operations. According to Sarkis and Dou [16], the integration of supply chain elements with corporate environmental management that referred to as "Green Supply Chain."

According to Jaber and Osman [17], delay in payment is one of some policy which can be used for coordinating players in the supply chain by allowing customer delay the payment for a specified period without interest. Delay in payment also used as a strategy to increase sales and reduce inventory in the warehouse. Some previous studies that discussed the delay in payment succeeded in proving that the policy had a positive impact on the company [1, 6, 7, 13, 17-19]. When the delay in payment applied in a supply chain system, total supply chain cost will be decreased [1].

In this research, mathematical models developed into some case scenarios according to a recent study by Ibrahim [13], and several variables added with consideration of carbon emission. The numerical experiment deal with several different cases scenarios. Sensitivity analysis is carried out on several variables that are considered significant to the total change of supply chain system cost. In further analysis, it will be seen the effect of delay in payment on carbon emissions that are described from the company emissions cost. The remainder of this paper is organized as follows: Section 2, is for presenting the notation, assumption, conceptual model, and mathematical model. Section 3, is for result and discussion, including numerical example. Section 4, which is, for the conclusion.

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2. Model Development

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The methods section of your research paper should include the following:

- Experimental setup
- Data collection
- Data analysis
- Statistical testing
- Assumptions
- Proposed model

You must describe the research procedure clearly. clear procedure is a description so that you get the results of the research.

In this section, the mathematical model developed according to the conceptual model, and several assumptions explained before. The model is basic on Hill [20] and previously modified in Ibrahim [8]. In this paper, the model has modified again into much consideration according to reducing carbon emission. This section also contains an explanation of the list of notations.

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2.1 Notations

According to performance criteria and decision variables, the following notations will be used to develop the model in this research :

i : Supply chain player *(s : supplier, m : manufacturer, d : distributor)*
j : Type of inventory *(w : raw material, f : finished goods)*
$A_{i,j}$: Setup / order cost incurred by player-i to the item-j
$C_{i,j}$: Production / purchases cost per item issued by player-i for the item-j
$h_{i,j}$: Financial holding cost per item issued by player-i for the item-j
$S_{i,j}$: Physical (storage) holding cost per item issued by player-i for the item-j
Q : Distributor order quantity
n_1 : The number of shipments by the supplier to manufacturing per manufacturing material cycle.
n_2 : The number of shipments by manufacturing to the istributor per distributor cycle
α : The amount of raw materials needed to produce one finished product
t_i : The time period of the delay in payments offered by player-i
τ_i : The payment time made by player-i
k_i : Return on investment (ROI) for player-i
P : The annual production rate of manufacture
D : Distributor annual demand $D < P$
T : Common cycle length $= \frac{n_2 Q}{D}$
T_s : Supplier cycle length $= \frac{n_2 Q}{P}$
T_w : Manufacture raw material cycle length $= \frac{n_2 Q}{n_1 P}$
T_m : Manufacture finish product cycle length $= \frac{n_2 Q}{D}$
T_d : Distributor cycle length $= \frac{Q}{D}$
A_0 : Transport Cost at the start of an order point
T_e : Transport emission tax
T_{ci} : Emission tax rate
T_{cap} : Truck capability
n_t : Number of truck per shipment (Q/T_{cap})
E_m : Manufacturing Emission $E_m = aP^2 - bP + c$, *(a,b,c are parameters)*
SC : Total annual cost of supplier
MC : Total annual cost of manufacturer
DC : Total annual cost of distributor
TSC : Total annual cost of supply chain system

Commented [H5]: you must check the notation outlined again. some notations are not explained in this section such as ts, hmf, etc. all the equations must be clear of notation

2.2 Assumptions

This study uses several important assumptions to limit the scope of the model to be developed, given below:

- One type of product, one supplier, one manufacturer, and one distributor.
- Demand is deterministic based on distributor information.
- Supplier's production level is higher than manufacturer raw material demand, and manufacturer's production level is higher than distributor demand.
- Holding cost component are divided into financial holding cost and physical holding cost.
- Supplier and manufacturer offer delay in payment.
- The period of delay in payment and order quantity becomes the decision variable.

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- Both manufacture and distributor invest what their vendor owes in risk-free investment during the allowed period.
- Both manufacture and distributor pay debt with one payment.
- An unlimited number of trucks.
- Routes are not considered.

2.3 Conceptual Model

On this study, mathematical models are developed expected to coordinate players in an integrated supply chain system with consideration of reducing gas emissions. Formulation of mathematical models considering the length of the general cycle, where general cycle length is $T = \frac{n_2 Q}{D}$. Mathematical model in this study is the development of previous research has been published without green consideration on Ibrahim [8]. The players in the supply chain system are supplier, manufacturer and, distributor, all players are interconnected. Coordination between players are done by delay in payment consideration. In this study, the previous mathematical model will be modified to determine the effect of delay in payment on reducing gas emissions. Fig. 1 shows the conceptual model where supplier and manufacturer are integrated by delay in payment as well as the integration of manufacturer and distributor.

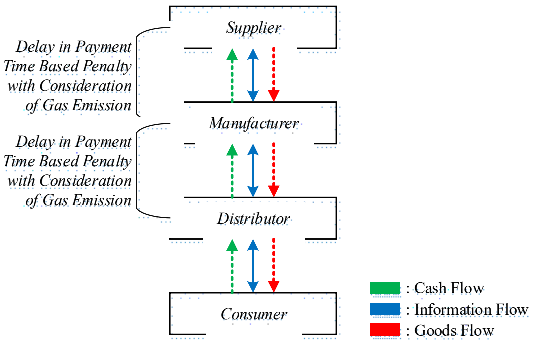

Fig. 1 Conceptual Model

Mathematical models were developed into several case scenarios, and each case is a combination of subcase on echelon 1 (supplier-manufacturer) and echelon 2 (manufacturer-distributor). Table 1 shown the scheme of four case scenarios used in this study. Respectively there are two sub-cases in the first echelon and second echelon. Subcase one on echelon one describe the event when the supplier gives manufacturer delay in payment period during a time t_s to complete payments without interest charges. Manufacturer makes payments τ_m right at the end of the delay in payment period provided by the supplier. In this sub-case, the manufacturer will not provide compensation to suppliers because making payments does not exceed the limit of the delay in payment period provided by the supplier.

While at subcase two on echelon one describe the same event when the supplier gives manufacturer delay in payment period same as the last case, but the manufacturer makes payments τ_m after the end of the delay in payment period provided by the supplier and but before receiving the next shipment. In this sub-case, the manufacturer must compensate to suppliers because making payments over the period of the delay in payment period provided by the supplier.

Two another subcase on echelon two generally same as two subcases on echelon one. The difference is, it applied to the relationship between manufacturer and distributor.

Tabel 1 Case scenario

Echelon 1	Echelon 2	Case Name
$0 \le t_s = \tau_m \le \frac{n_2 Q}{P n_1}$	$0 \le t_m = \tau_d \le \frac{Q}{D}$	1.1
	$0 \le t_m < \tau_d \le \frac{Q}{D}$	1.2
$0 \le t_s < \tau_m \le \frac{n_2 Q}{P n_1}$	$0 \le t_m = \tau_d \le \frac{Q}{D}$	2.1
	$0 \le t_m < \tau_d \le \frac{Q}{D}$	2.2

Commented [H6]: what does this notation show?

From this conceptual model, development was carried out on previous mathematical models and explained in the next section.

2.4 Mathematical Model

On this study, mathematical models are developed expected to coordinate players in an integrated supply chain system with consideration of reducing gas emissions. Mathematical models are formulated by considering general cycle length $T=\frac{n_2 Q}{D}$.

Case 1.1: $\boldsymbol{0 \le t_s = \tau_m \le \frac{n_2 Q}{P n_1}; 0 \le t_m = \tau_d \le \frac{Q}{D}}$

Supplier Costs

$$\psi_s^{1.1} = A_{s,f} + C_{s,f}\alpha n_2 Q + \frac{n_1(n_1-1)}{2}\left(h_{s,f} + S_{s,f}\right)\left(\frac{\alpha {n_2}^2 Q^2}{{P n_1}^2}\right) + h_{s,f}\tau_m \alpha n_2 Q + \left(C_{m,w} - C_{s,f}\right)\alpha n_2 Q e^{k_s t_s} + E_m D T_{ci}$$

Manufacturer Costs (Raw Materials)

$$\psi_{m,w}^{1.1} = n_1 A_{m,w} + C_{m,w}\alpha n_2 Q + h_{m,w}\frac{\alpha^2 {n_2}^2 Q^2}{2\alpha P n_1} - h_{m,w}\alpha n_2 Q t_s + h_{m,w}\frac{n_1 \alpha P {t_s}^2}{2} + S_{m,w}\frac{\alpha {n_2}^2 Q^2}{2 P n_1} - C_{m,w}\alpha n_2 Q e^{k_m \tau_m}$$

Manufacturer Costs (Finish Goods)

$$\psi_{m,f}^{1.1} = A_{m,f} + C_{m,f} n_2 Q + \left(h_{m,f} + S_{m,f}\right)\left(\frac{n_2 Q^2 (2D + (P-D)n_2 - P)}{2DP}\right) + h_{m,f}\tau_d n_2 Q + \left(C_{d,f} - C_{m,f}\right) n_2 Q e^{k_m t_m} + E_m D T_{ci}$$

Distributor Cost

$$\psi_{d,f}^{1.1} = n_2 A_{d,f} + C_{d,f} n_2 Q + n_2 h_{d,f}\frac{(Q - D t_m)^2}{2D} + \frac{S_{d,f} n_2 Q^2}{2D} - n_2 Q C_{d,f}\left(1 - e^{k_d t_m}\right) + n_t \frac{D A_0}{Q} + n_t \frac{D T_e}{Q}$$

The total annual cost of the system is obtained by dividing the above equation with the length of the general cycle and then doing addition and simplification.

$$\psi_{SC}^{1.1} = \frac{A_{s,f}D}{n_2Q} + C_{s,f}\alpha D + \frac{n_1(n_1-1)}{2}\left(h_{s,f}+S_{s,f}\right)\frac{\alpha n_2 QD}{Pn_1{}^2} + h_{s,f}\tau_m\alpha D + \left(C_{m,w}-C_{s,f}\right)e^{k_s t_s}\alpha D + \frac{E_m DT_{ci}D}{n_2Q} + \frac{n_1 A_{m,w}D}{n_2Q} + \frac{C_{m,w}\alpha n_2 QD}{n_2Q} + \frac{h_{m,w}\alpha^2 n_2{}^2Q^2D}{2\alpha Pn_1n_2Q} - \frac{h_{m,w}\alpha n_2 Qt_sD}{n_2Q} + \frac{h_{m,w}n_1\alpha Pt_s{}^2D}{2n_2Q} + \frac{S_{m,w}\alpha n_2{}^2Q^2D}{2Pn_1n_2Q} - \frac{C_{m,w}\alpha n_2Qe^{k_m\tau_m}D}{n_2Q} + \frac{A_{m,f}D}{n_2Q} + C_{m,f}D + \left(h_{m,f}+S_{m,f}\right)\left(\frac{Q(2D+(P-D)n_2-P)}{2P}\right) + h_{m,f}\tau_dD + \left(C_{d,f}-C_{m,f}\right)e^{k_mt_m}D + \frac{E_mDT_{ci}D}{n_2Q} + \frac{A_{d,f}D}{Q} + C_{d,f}D + \frac{h_{d,f}(Q-Dt_m)^2}{2Q} + \frac{S_{d,f}Q}{2} - C_{d,f}D\left(1-e^{k_dt_m}\right) + n_tA_0n_2 + n_tT_en_2$$

Case 1.2: $\boldsymbol{0 \le t_s = \tau_m \le \frac{n_2Q}{Pn_1}}$ ***dan*** $\boldsymbol{0 \le t_m < \tau_d \le \frac{Q}{D}}$

Supplier Costs 1.1 $\psi_s^{1.2} = \psi_s^{1.1}$, *Manufacturer Costs (Raw Materials) 1.1* $\psi_{m,w}^{1.2} = \psi_{m,w}^{1.1}$.

$$\psi_{SC}^{1.2} = \frac{A_{s,f}D}{n_2Q} + C_{s,f}\alpha D + \frac{n_1(n_1-1)}{2}\left(h_{s,f}+S_{s,f}\right)\frac{\alpha n_2 QD}{Pn_1{}^2} + h_{s,f}\tau_m\alpha D + \left(C_{m,w}-C_{s,f}\right)e^{k_s t_s}\alpha D + \frac{E_m DT_{ci}D}{n_2Q} + \frac{n_1 A_{m,w}D}{n_2Q} + \frac{C_{m,w}\alpha n_2 QD}{n_2Q} + \frac{h_{m,w}\alpha^2 n_2{}^2Q^2D}{2\alpha Pn_1n_2Q} - \frac{h_{m,w}\alpha n_2 Qt_sD}{n_2Q} + \frac{h_{m,w}n_1\alpha Pt_s{}^2D}{2n_2Q} + \frac{S_{m,w}\alpha n_2{}^2Q^2D}{2Pn_1n_2Q} - \frac{C_{m,w}\alpha n_2Qe^{k_m\tau_m}D}{n_2Q} + \frac{A_{m,f}D}{n_2Q} + C_{m,f}D + \left(h_{m,f}+S_{m,f}\right)\left(\frac{Q(2D+(P-D)n_2-P)}{2P}\right) + h_{m,f}\tau_dD + \left(C_{d,f}-C_{m,f}\right)e^{k_mt_m}D - C_{d,f}e^{k_m(\tau_d-t_m)}D + \frac{E_mDT_{ci}D}{n_2Q} + \frac{A_{d,f}D}{Q} + C_{d,f}D + \frac{h_{d,f}(Q-Dt_m)^2}{2Q} + \frac{S_{d,f}Q}{2} + C_{d,f}e^{k_m(\tau_d-t_m)}D - C_{d,f}D\left(1-e^{k_dt_m}\right) + n_tA_0n_2 + n_tT_en_2$$

Case 2.1: $\boldsymbol{0 \le t_s < \tau_m \le \frac{n_2Q}{Pn_1}}$ ***dan*** $\boldsymbol{0 \le t_m = \tau_d \le \frac{Q}{D}}$

Manufacturer Costs (Finish Goods) $\psi_{m,f}^{2.1} = \psi_{m,f}^{1.1}$, *Distributor Cost* $\psi_{d,f}^{2.1} = \psi_{d,f}^{1.1}$.

$$\psi_{SC}^{2.1} = \frac{A_{s,f}D}{n_2Q} + C_{s,f}\alpha D + \frac{n_1(n_1-1)}{2}\left(h_{s,f}+S_{s,f}\right)\frac{\alpha n_2 QD}{Pn_1{}^2} + h_{s,f}\tau_m\alpha D + \left(C_{m,w}-C_{s,f}\right)e^{k_s t_s}\alpha D - C_{m,w}e^{k_s(\tau_m-t_s)}\alpha D + \frac{E_m DT_{ci}D}{n_2Q} + \frac{n_1 A_{m,w}D}{n_2Q} + \frac{C_{m,w}\alpha n_2 QD}{n_2Q} + \frac{h_{m,w}\alpha^2 n_2{}^2Q^2D}{2\alpha Pn_1n_2Q} - \frac{h_{m,w}\alpha n_2 Qt_sD}{n_2Q} + \frac{h_{m,w}n_1\alpha Pt_s{}^2D}{2n_2Q} + \frac{S_{m,w}\alpha n_2{}^2Q^2D}{2Pn_1n_2Q} + \frac{C_{m,w}\alpha n_2Qe^{k_s(\tau_m-t_s)}D}{n_2Q} - \frac{C_{m,w}\alpha n_2Qe^{k_m\tau_m}D}{n_2Q} + \frac{A_{m,f}D}{n_2Q} + C_{m,f}D + \left(h_{m,f}+S_{m,f}\right)\left(\frac{Q(2D+(P-D)n_2-P)}{2P}\right) + h_{m,f}\tau_dD + \left(C_{d,f}-C_{m,f}\right)e^{k_mt_m}D + \frac{E_mDT_{ci}D}{n_2Q} + \frac{A_{d,f}D}{Q} + C_{d,f}D + \frac{h_{d,f}(Q-Dt_m)^2}{2Q} + \frac{S_{d,f}Q}{2} - C_{d,f}D\left(1-e^{k_dt_m}\right) + n_tA_0n_2 + n_tT_en_2$$

Case 2.2: $\boldsymbol{0 \le t_s < \tau_m \le \frac{n_2 Q}{P n_1}}$ ***dan*** $\boldsymbol{0 \le t_m < \tau_d \le \frac{Q}{D}}$

Supplier Costs $\psi_s^{2.2} = \psi_s^{2.1}$, *Manufacturer Costs (Raw Materials)* $\psi_{m,w}^{2.2} = \psi_{m,w}^{2.1}$, *Manufacturer Costs (Finish Goods)* $\psi_{m,f}^{2.2} = \psi_{m,f}^{1.2}$, *Distributor Cost* $\psi_{d,f}^{2.2} = \psi_{d,f}^{1.2}$.

$$\begin{aligned}
\psi_{SC}^{2.2} = {} & \frac{A_{s,f}D}{n_2 Q} + C_{s,f}\alpha D + \frac{n_1(n_1-1)}{2}\left(h_{s,f}+S_{s,f}\right)\frac{\alpha n_2 Q D}{P{n_1}^2} + h_{s,f}\tau_m \alpha D + \left(C_{m,w}-C_{s,f}\right)e^{k_s t_s}\alpha D \\
& - C_{m,w}e^{k_s(\tau_m - t_s)}\alpha D + \frac{E_m D T_{ci} D}{n_2 Q} + \frac{n_1 A_{m,w} D}{n_2 Q} + \frac{C_{m,w}\alpha n_2 Q D}{n_2 Q} + \frac{h_{m,w}\alpha^2 {n_2}^2 Q^2 D}{2\alpha P n_1 n_2 Q} \\
& - \frac{h_{m,w}\alpha n_2 Q t_s D}{n_2 Q} + \frac{h_{m,w} n_1 \alpha P {t_s}^2 D}{2 n_2 Q} + \frac{S_{m,w}\alpha {n_2}^2 Q^2 D}{2 P n_1 n_2 Q} + \frac{C_{m,w}\alpha n_2 Q e^{k_s(\tau_m - t_s)} D}{n_2 Q} \\
& - \frac{C_{m,w}\alpha n_2 Q e^{k_m \tau_m} D}{n_2 Q} + \frac{A_{m,f}D}{n_2 Q} + C_{m,f}D \\
& + \left(h_{m,f}+S_{m,f}\right)\left(\frac{Q(2D+(P-D)n_2-P)}{2P}\right) + h_{m,f}\tau_d D + \left(C_{d,f}-C_{m,f}\right)e^{k_m t_m}D \\
& - C_{d,f}e^{k_m(\tau_d - t_m)}D + \frac{E_m D T_{ci} D}{n_2 Q} + \frac{A_{d,f}D}{Q} + C_{d,f}D + \frac{h_{d,f}(Q-Dt_m)^2}{2Q} + \frac{S_{d,f}Q}{2} \\
& - C_{d,f}D\left(1-e^{k_d t_m}\right) + n_t A_0 n_2 + n_t T_e n_2
\end{aligned}$$

3. Results and Discussion

In this section, some numerical experiments are solved to compare four scenarios which have been developed in Section 2. Moreover, the numerical example can illustrate the behavior of the model according to four scenarios and investigates the impact of delay in payment.

Most of the input parameter values used in this example adopted from previous studies conducted by Aljazzar, et al. [6], where: $D = 1000$, $P = 3200$, $\alpha = 1$, $A_{s,f} = 441$, $A_{m,w} = 206$, $A_{m,f} = 175$, $A_{d,f} = 384$, $C_{s,f} = 20$, $C_{m,w} = 30$, $C_{m,f} = 50$, $C_{d,f} = 70$, $h_{s,j} = 3$, $h_{m,w} = 3$, $h_{m,f} = 12$, $h_{d,f} = 13.3$, $S_{s,f} = 3$, $S_{m,w} = 7.5$, $S_{m,f} = 9$, $S_{d,f} = 7.7$, $n_1 = 1$, $n_2 = 2$, $k_s = 0.01$, $k_m = 0.08$, $k_d = 0.04$, $e = 0.10$, $T_{ci} = 20$, $n_t = 7$, $A_0 = 10$, $T_e = 20$, $E_m = 0.632$, $T_{cap} = 80$.

Commented [H7]: this data should be in the method section

3.1 Numerical Examples

This section showed the result of numerical example, and the result is done with the purpose to compare the four scenarios which have been developed and explained in Section 2. Moreover, the numerical example also was done with another scenario which does not use delay in payment, and it can be seen in the scenario (0.0). The author uses the values of the input parameter already explain before to get the optimal solution. In this paper, Solver on Excel Software has been used to search the optimal solution of the model. The solver was chosen because simple and have relatively short computing time. Furthermore, Maple software used to validate the calculation. Through a series of formulations and validations the result of optimum values Q, t_s, τ_m, t_m, and τ_d under four different scenario are shown in Table 1.

Next, sensitivity analysis is carried out for some important parameters. Distributor Return on Investment (ROI), emission tax rate when the delay in payment allowed and not allowed. Very interesting to pay attention to the ROI of the distributor. Based on several previous studies conducted by [6, 8, 13, 17], distributor ROI is always interesting to discuss because it is very influential in the supply chain system under study. So in this experiment, the author experimented by varying the distributor ROI into several different percentages. Table 2 shows the results of sensitivity analysis by varying distributor ROI.

Table 2 Numerical experiment result

Scenario Name	0.0	1.1	1.2*	2.1	2.2
Q	542	491	800	599	800
t_s	0.00	0.01	0.01	0.01	0.01
τ_m	0.00	0.01	0.01	0.02	0.02
t_m	0.00	0.40	0.64	0.49	0.64
τ_d	0.00	0.40	0.65	0.49	0.65
SC	42,083	43,358	38,203	10,995	8,240
MC	90,452	93,223	24,900	125,410	54,947
DC	76,813	70,642	140,343	70,490	140,344
TSC	209,348	207,224	203,446	206,894	203,531
EC	23,738.39	26,190.41	16,175.03	21,523.9	16,175.01

Commented [H8]: This experiment procedure must be explained in the method section

Table 3 Effect of varying distributor ROI

k_d	Q	t_m	τ_d	EC
0.01	683	0.33	0.34	18,908.47
0.02	782	0.46	0.47	16,547.43
0.04	800	0.64	0.65	16,175.03
0.06	867	0.85	0.86	14,962.43
0.08	880	0.87	0.88	14,738.64
0.1	960	0.95	0.96	13,541.68

Emission tax rate considered as one of the critical parameters, variations are made on these parameters. Several previous studies that discussed the low carbon supply chain always discussed emission tax rates or emission rates. According to Bai, et al. [21], policies such as cap-and-trade are effective methods for reducing carbon emissions. Surely such policies consider tax rates or emission rates. Nevertheless, aside from being encouraged by the company's internal desire to reduce gas emissions, the role of the government as the policy giver is vital here one of them is the cap-and-trade policy [21-23]. Table 3 shows the results of sensitivity analysis by varying emission tax in two different conditions, delay in payment is allowed and not.

Table 4 Effect of varying emission tax rate when the delay in payment allowed and not allowed

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Delay in Payment Allowed							Delay in Payment not Allowed						
T_{Ci}	Q	t_s	τ_m	t_m	τ_d	EC	T_{Ci}	Q	t_s	τ_m	t_m	τ_d	EC
5	448	0.01	0.01	0.37	0.38	7,464.31	**5**	404	0.00	0.00	0.00	0.01	8,275.77
10	560	0.01	0.01	0.46	0.47	11,660.72	**10**	542	0.00	0.00	0.00	0.01	12,063.16
15	717	0.01	0.01	0.58	0.59	13,588.19	**15**	651	0.00	0.00	0.00	0.01	14,988.19
20	800	0.01	0.01	0.64	0.65	16,175.01	**20**	744	0.00	0.00	0.00	0.01	17,396.06
25	880	0.01	0.01	0.70	0.71	18,329.57	**25**	827	0.00	0.00	0.00	0.01	19,511.08
30	960	0.01	0.01	0.76	0.77	20,125.00	**30**	902	0.00	0.00	0.00	0.01	21,419.24
Total Emission Cost						**87,342.80**	Total Emission Cost						**93,653.50**

Please cite this article as: Utama, D. (2017). Model Penentuan Lot Pemesanan Dengan Mempertimbangkan Unit Diskon dan Batasan Kapasitas Gudang dengan Program Dinamis. Jurnal Teknik Industri, 18(1), 94-102. doi:https://doi.org/10.22219/JTIUMM.Vol18.No1.94-102 (diisi oleh editor)

3.2 Analysis & Discussion

Result in Table 1 shows in all scenarios supplier always give short period delay in payment. The minimum total supply chain costs occur when using scenario (1.2). The findings state that the short period delay in payment from supplier occurs because of a small percentage of supplier ROI, and it becomes longer when the ROI increases. From this numerical experiment, it is known that the ROI parameter is very influential on the player's income. It can be seen from period delay in payment from the manufacturer is longer than supplier proportional to bigger ROI owned by the manufacturer. On the other hand, the minimum emission cost also occurs in a scenario with a delay in payment. Decreasing emission cost occur due to an increase in quantity order. This decrease happened because delivery is done in larger volumes, and this makes the efficiency of vehicles and trips that can cause a reduction in emission.

Table 2 shows the effect of varying distributor ROI. From the result of sensitivity analysis, it can be concluded that the higher distributor ROI will produce in a higher delay in the payment period. This sensitivity analysis also concluded when the manufacturer gives longer delay in payment to the distributor makes distributor order more than standard. When distributor ROP 0.01, manufacturer give 0.34 unit of time delay in payment to distributor and distributor order quantity as big as 683 unit. On the other hand, the manufacturer gives longer delay in payment as big as 0.65 unit of time when distributor ROP 0.04, it also makes increased order quantity become 800 unit. The higher order quantity produces a smaller emission cost. This smaller emission cost can occur due to various events, but in this study, transportation costs are used to represent emissions costs.

Table 3 shown the result of the numerical experiment when varying emission tax rate. The result shows a relationship between the emission tax rate with delay in payment period and order quantity. When the emission tax rate increases, the delay in payment period offers by the manufacturer will improve indirectly. On the other side, order quantity will also indirectly increase in conjunction with the increase of delay in payment period offers by the manufacturer. This event automatically occurs and proves the model successful integrates the supply chain system under study. Players in the supply chain system will endeavor to reduce total emissions costs by coordinating through delay in payment when the emissions tax increased. So, manufacturers provide a longer delay in the payment period, and distributors will increase their order quantity with the common goal of minimizing emissions costs.

From all the results of numerical experiments, the results of lower emission costs result when the delay in payment is permitted. It can be concluded, a delay in payment can be used as a coordination medium in an integrated supply chain system to reduce gas emissions. The success of delay in payment in reducing gas emissions of a supply chain system occurs because the period of delay in payment provided by the supplier will make the buyer buy in larger quantities. Besides, the purchased quantity is also strongly influenced by distributor ROI. Can be seen in Table 2, the higher the distributor ROI will produce a higher order quantity as well. Higher order quantities can optimize shipping from suppliers to buyers, thereby reducing gas emissions. With this mechanism, both parties will benefit from each other

Commented [H10]: The results and discussion section of your research paper should include the following:
- Findings
- Comparison with prior studies
- Limitations of your work
- Casual arguments
- Speculations
- Deductive arguments

4. Conclusion

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- Overall summary
- Further research

The model developed in this study succeeded in integrating a multi-echelon supply chain system under low carbon emissions consideration with delay in payment as a coordination medium. Coordination with delay in payment has succeeded in reducing the total supply chain costs, especially the cost of carbon emissions in the supply chain system. Lower emission costs show successful coordination in the supply chain; even the total cost of the supply chain system is lower when the period of delay in payment is given compared to not. Period of delay in payment provided by the supplier will make the buyer buy in larger quantities. Moreover, the order quantity is also strongly influenced by distributor ROI. The higher the distributor ROI will produce a higher order quantity as well. Higher order quantities can optimize shipping from suppliers to buyers, thereby reducing gas emissions.

The contribution of this paper is an integrated low carbon two-echelon supply chain model with media coordination delay in payment. Through numerical experiments, the model has proven to be successful in integrating supply chain systems and reducing emissions costs while increasing economic performance. Utilizing delay in payment with an agreement as a media of coordination proved to benefit both parties, both buyers and sellers. The model that has been developed can be useful for practitioners in the supply chain field.

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In this study, the cost of carbon emissions is obtained by considering transportation costs and distribution related to emissions. In further research can be developed by adding consideration to the costs that occur during production and other business processes.

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