Analysis of Postponement Practice in Cement Supply Chain: A Case Study

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Abstract. *This research focuses on assessing implementing postponement in the cement industry, especially for OPC (Ordinary Portland Cement) in Indonesia. The company offers three postponement points; Ciawi and Kampung Rambutan, and Jatiwarna. This research is done with an observational method to map customer conditions. Moreover, implementing a linear programming model is used to gain an optimal solution for the allocated truck. The highest proportion of OPC customers are in Jakarta, followed by Karawang and Bogor. The simulation results are Ciawi points assigned to serve Jakarta and Bogor's customers. Kampung Rambutan point is for Jakarta, and Kawarang's Jatiwarna point is prepared for Jakarta, Karawang, Bekasi, Lampung, Pekalongan, Tangerang, and Serang' customers. So, implementing postponement can increase customer satisfaction without adding higher costs such as investment costs. The cement factory encounters effectiveness and responsiveness eventough, and some problems shall be taken, such as the double administration process (manual and computerized).*

Keywords: *Cement, OPC, Postponement Supply Chain,*

I. INTRODUCTION

Postponement is one of the strategies in the supply chain to maintain cost-effectiveness. The postponement objectives are increasing economics of scale, forecast-driven accuracy, increasing operating system flexibility, and delivery timeliness (Wang, Chen, and Li, 2006). Postponement can increase product variety, inventory reduction, inventory cost reduction, improve customer service level, reduce cost reduction, and also imply to macroeconomics (Rietze, 2004). Moreover, postponement can reduce process uncertainty, demand uncertainty, and suppliers induce uncertainty (Yang and Burns, 2003), enhance the logistics system's efficiency, be a greater service level, reduce stock obsolesces, and mix push-pull strategy (Gaudêncio and Freires, 2012).

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Several authors define postponement strategy, and they focus on postponement as a recommendation. The recommendation is called internal and external factors. The internal factors are covered by total costs, customer services, and asset management. The External factor is focused on environmental issues (Zhang and Tan, 2001). Furthermore, postponement is a response from the growing business under uncertain demand. In advance, a business person can be changed or responded to their postponement strategy based on their products and advance productions (Szmelter, 2016).

According to postponement types, it can be classified as pull postponement, logistics postponement, form postponement, price, time, and place postponement (Mukherjee, 2016). Comparing the postponement strategy with reconfiguration implies that configuration is a type of time postponement with adding formalism and constraints. It has a floating decoupling point instead of the postponement that uses a single or fixed decoupling point (MacCarthy and Brabazon, 2006). Furthermore, the decoupling point's center depends on production strategies such as make to stock, assembly to order, make to order, and engineering to order (Świerczek, 2010). At the macro-economic level that national characteristics refer to cost efficiency, it has differences between the developed and developing countries to
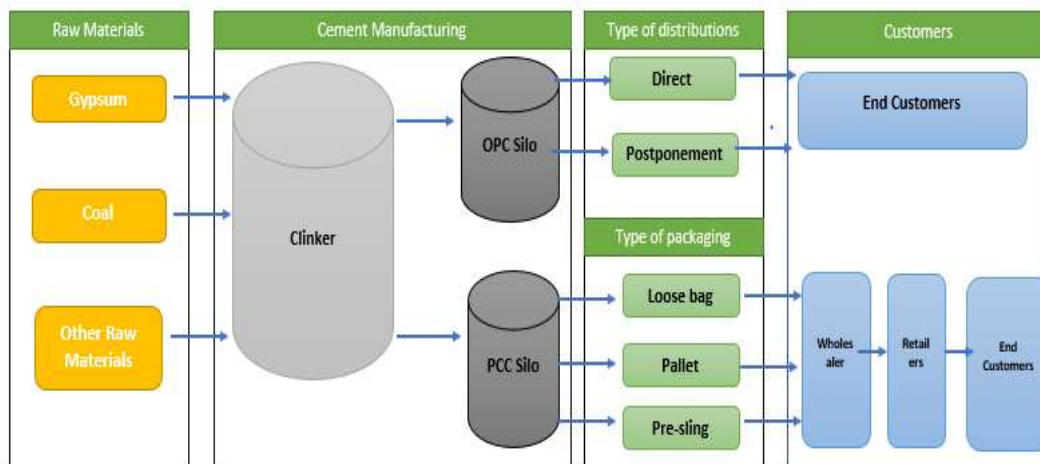
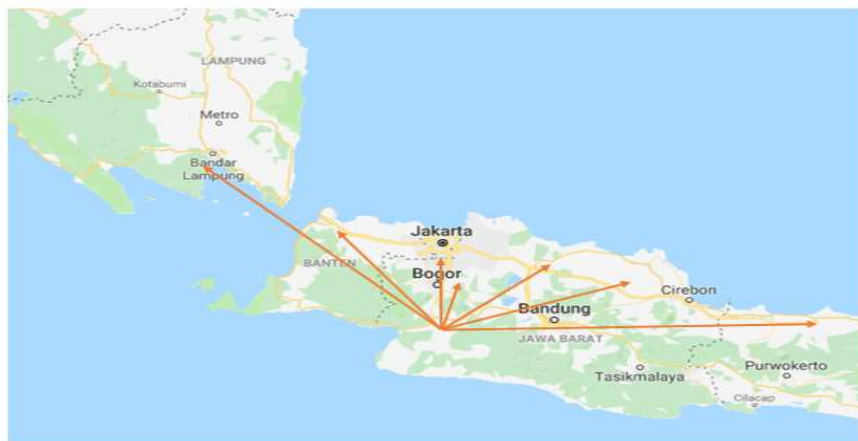**Figure 1**. Cement Manufacturing Process and Delivery Diagram

Figure 2. Spreading OPC customers in Jabodetabek and its surrounding

choose the optimal decoupling point and postponement strategy. Those things have significantly affected overall cost efficiency (Qin, 2011).

By implementing the postponement strategy, the factory reduces profit but significantly decreases supply chain risk (Weskamp et al., 2018). For example, it impacts the distribution package postponement strategy that effectively decreases the inventory in the same service level (Qian et al., 2011). The risk can be occurred at three generic supply chain structures; upstream (sourcing), midstream (manufacturing), and downstream (distribution) (Van Hoek, 2001). Generic supply chain structures and relationships among supply chain actors affect the postponement decision (Yeung et al., 2007). Especially at the upstream phase, it emphasizes eliminating supply risk in the upstream vulnerability to enhance the flexibility (Gualandris and Kalchschmidt, 2011).

Some case studies in implementing postponement have been undertaken. It implements a decoupling point and postponement strategy in the food industry, especially in the cold food chain process. It deals with maintaining the products stay fresh until the end customers. It bridges two cases, make to stock process based on forecasting and planning and make to order process based on the whole

sales order (Salvi and Mayerle, 2015). At soluble coffee, they proposed to delay the labeling and packaging process until receiving customer orders. The principle is maximizing postponement benefit by shifting decoupling point further upstream and differentiation point further downstream and closer to customers (Wong, Potter and Naim, 2011).

Furthermore, study a toy factory postponement strategy. The toy factory can differentiate from the competitors and make a unique proposition in the market by applying a postponement strategy. The company understand the customers better and foster an excellent relationship to improve service levels (Zabeen and Chowdhury, 2017).

The Case Study

The case study comes up from a Cement Factory in Indonesia. The Cement Factory is under a Giant Cement Company from Thailand, and it is located in Sukabumi, West Java Province, Indonesia. It produces two kinds of cement; OPC (Ordinary Portland Cement) and PCC (Portland Composite Cement). PCC and OPC have different characteristics and compositions. OPC is made from clinker that is ground with gypsum and limestone. PCC has a similar composition, but it shall be added additive material such as fly ashes and trass (Hariawan, 2007).

According to Figure 1, the cement manufacturing process is begun by extracting raw materials such as limestone, clay, sand, and additive material. Then, all of the materials are proportioned, blended, and ground on a small scale. After those phases, the cement factory will do pre-heating of the raw material to be clinker. Clinker is the main ingredient of cement. Clinker is processed into the final grinding process to be OPC and PCC. The last process is packing and distribution. In the packing and distribution process, the cement is dispatched to the truck and delivered to customers.

Different products lead to differences in the distribution model. The PCC product is delivered to a distributor who has an affiliation with the company. The PCC product is then delivered to wholesalers, retailers (material shop), and end customers starting at a distributor. In the packaging process, the PCC product uses a paper bag. Furthermore, the truck's PCC product uses three models; loose bag, pallet, or pre-sling. It depends on customer requirements. The loose bag PCC is for small material shops or retailers who do not have forklifts for unloading the cement. They do it manually by relying on human power. For the PCC with pallet is distributed for wholesalers who have big warehouses and forklifts. The wholesalers will keep the PCC for some periods before distributing them to the end customers. Moreover, the PCC with pre-sling is used for inter-island customers. Inter-island cement delivery will be dispatched at the port and delivered by barge.

Another hand, the OPC product is delivered to the customer by the bulk model instead of the packaging model. OPC product is delivered to customers directly from the factory to the end customers. The OPC's customers are Batching Plants, Light Concrete Plants, and Concrete Brick Plants. Most of the OPC customers are big factories, so they do not need any distributor anymore. Mostly, the spreading of OPC's Customers is in Jakarta, Bogor, Depok, Tangerang, Bekasi (Jabodetabek), Pekalongan, Banten, and Lampung (Figure 2). By distributing the OPC from the factory to the end customers, the factory gets difficulty in terms of bad traffic from Sukabumi to Ciawi (Bogor). It makes delivery time-limited, especially in the day time.

Recently, the road condition from Sukabumi to Jabodetabek is narrow, winding, and passing many hills. In some points, the traditional markets contribute to make traffic jam. As information, Ciawi is an entrance gate for a toll road to Jabodetabek, and it has an intersection for vehicles that connected Bandung, Cianjur, and Sukabumi area. The toll road has been installed from Ciawi to the Jabodetabek section only, and the Ciawi-Sukabumi section. The toll road is still under construction. Thus, OPC deliveries are always delayed, and the management has decided on the customer order requests one day before delivering.

In line with increasing demands, the management has applied the postponement

strategy to avoid delayed deliveries. They allocate bulk trucks with the OPC products in Ciawi. Every day, the factory sends the OPC bulk truck amount with the OPC to be stood by at Ciawi. Those ready bulk trucks will be commanded to the certainty customers who need OPC promptly. Before allocating bulk trucks at Ciawi, the management has made the decision to allocate the bulk trucks in Kampung Rambutan, Jakarta. Applying postponement in Kampung Rambutan has pros and cons. The pros are cost-efficient in order to minimize inventory cost and close to the customers. The cons are a limited bulk truck because it has to share the parking area with mixer trucks that belong to Kampung Rambutan Batching Plant.

By applying postponement, the Cement Factory has used an estimation model instead of the optimum model. The model calculates whether Ciawi is a suitable place to implement postponement and how many trucks shall be stood by for. Solving the problems has been done to develop a simulation model under uncertain demand (Guericke et al., 2012). Moreover, by setting the multi-scenario decision point to assess manufacturing strategy, the best production strategy, and the best customer order decoupling point (Minguella-Canela et al., 2017). So, this research is proposed to optimize the OPC supply chain solution in terms of the proposed area and allocated trucks for the postponement. The study emphasizes based on uncertain demand and traffic jam within the distribution route. Furthermore, the implication of the optimal solution is presented based on the Cement Factory's current condition.

II. RESEARCH METHOD

The study is conducted into 300 OPC customers in some provinces, and then, those are depth down into some cities. The data are collected from the OPC deliveries each month during 2017-2018 by random sampling method.

The first collected data is customer location points. The customer location point is derived from the "sold to party" and the "ship to party" data. The "sold to party" is the customer who orders the cement (sometimes is called wholesaler), and the "ship to party" is the name of the customer destination (sometimes is called the end customer). Because the "sold to party" and the "ship to party" are different meanings, so this research is focused on the "ship to party" that represent end customer locations. The "ship to party" data are used for examining latitude and longitude coordinate location data by using Google Earth. Then, the Center of Gravity (CoG) model is used to find the optimal place to implement postponement based on Equation 1 (Sutarman, 2017).

Min $\sum_{i=1}^{n} Vi\, Ri\, di$ … (1)

Where,

Vi = The Order volume or quantity at node i

Ri = Transportation cost to node i

di = Facility distance to node i

In calculation, optimal coordinate location of latitude ($\bar{Y}$) dan longitude ($\bar{X}$) values are examined following Equations 2 and 3.

$$\bar{X} = \frac{\sum_{i=1}^{n} Vi\, Ri\, Xi}{\sum_{i=1}^{n} Vi\, Ri} \qquad \text{… (2)}$$

$$\bar{Y} = \frac{\sum_{i=1}^{n} Vi\, Ri\, Yi}{\sum_{i=1}^{n} Vi\, Ri} \qquad \text{… (3)}$$

After getting $\bar{X}$ and $\bar{Y}$ values, those values are used to find the value of di (Eq. 4) where the value of Yi (latitude at node i) and Xi (longitude at node i) has been found.

$$di = \sqrt{(Xi - \bar{X})^2 + (Yi - \bar{Y})^2} \qquad \text{… (4)}$$

After optimizing CoG, a new point or place of postponement with optimal calculation can be set as a new approach for allocated trucks. Jatiwarna (Bekasi) is pointed out based on the optimal solution. Jatiwarna is the optimal solution to set up a postponement point with optimal longitude (-6.30687) and latitude (106.9311). So, after getting Jatiwarna, Cement Factory has three choices places. Ciawi has a coordinate point at (-6.6323508,106.8385908), and Kampung Rambutan is at (-6.309419,106.8721641). The next step is setting up a linear programming model concerning some assumptions.

The objective is to minimize the total cost of the postponement (Eq. 5). The total cost of postponement is a summarizing of inbound cost

and outbound cost. Inbound cost is transportation cost from the Cement Factory to the postponement point, and the outbound cost is transportation cost from the postponement point to customers. The objective function is subject to assign the trucks for the postponement. Still, it is not excessed the postponement limitation area (Eq. 6), the total of the assigned outbound truck is less than the inbound trucks (Eq. 7), The demands must be satisfied (Eq. 8), and the result must be an integer (Eq. 9).

$$\text{Min} \sum_j \sum_k (C_j X_j + d_{jk} Y_{jk}) \qquad \ldots (5)$$

Subject to,

$$X_j \leq n_j, \forall_j \qquad \ldots (6)$$

$$\sum_k Y_{jk} \leq X_j \qquad \ldots (7)$$

$$\sum_j e_k Y_{jk} \geq f_k \qquad \ldots (8)$$

$$integer \begin{cases} X_j \geq 0 \\ Y_{jk} \geq 0 \end{cases} \qquad \ldots (9)$$

Where,

C_j =inbound transportation cost to the postponement point

X_j = assigned truck from the factory

d_{jk} =outbound transportation cost from the postponement point to customers

Y_{jk} =assigned truck from the node postponement point to customers

n_j =limitation of the truck amounts at the postponement point

e_k = truck capacity

f_k = customer demand

III. RESULT AND DISCUSSION

OPC Customer Distribution

OPC customer delivery can be seen in Table 1. The customer is varied from many provinces, especially from Jakarta Province and West Java Province. The OPC Customer cities are dominated by Jakarta, followed by Karawang, Bogor, and Bandung. Most of OPC customers are Batching Plants, and some of them are Light Concrete Plants and Pre-Cast Plants. In this case, there are two types of Batching Plant Customers; internal and external. Internal is a company that has an affiliation with Cement Factory, but external is not. Building cooperation with those Batching Plant, Cement Factory has continuously fulfilled the OPC as raw material.

The highest proportion is in Jakarta with more than 50%. It is caused Jakarta is close to

Table 1. OPC Customer Deliveries

Cities	Estimated Distance from Factory (Km)	Percentage (%)	Customer type proportion (%)		
			Batching Plant	Light Concrete	Pre-cast
Jakarta	110.4	51.7	100	0	0
Karawang	157.0	14.0	33.3	66.7	0
Bogor	79.3	9.0	92.6	0	7.4
Bandung	96.8	6.3	100	0	0
Bekasi	115.0	3.3	100	0	0
Lampung	436.0	3.3	100	0	0
Sukabumi	2.0	2.3	100	0	0
Pekalongan	441.0	2.3	100	0	0
Cianjur	29.9	2.0	100	0	0
Tangerang Selatan	121.0	2.0	100	0	0
Tangerang	143.0	1.3	100	0	0
Cirebon	307.0	0.7	100	0	0
Pandeglang	215.0	0.7	100	0	0
Tasikmalaya	247.0	0.3	100	0	0
Subang	217.0	0.3	100	0	0
Serang	211.0	0.3	100	0	0

Sukabumi, and most of the affiliated Batching Plants are located. Moreover, developing infrastructure projects by Indonesia Government in Jakarta increases cement consumption. Furthermore, the inter-Island deliveries have taken part through Sunda Kelapa Port (Jakarta), especially in quartal two until four.

Another influence is the swing method with a competitor. It means the Cement Factory agrees with the competitor to satisfy unreachable demand in a particular area. For example, Cement Factory A is located in Sukabumi, West Java Province, and Cement Factory B is located in Tuban, East Java Province. Cement Factory A has demand in East Java province, so Cement Factory A assigns Cement Factory B to satisfy demand in East Java Province because logistics cost from Sukabumi is relatively high. On the contrary, if Cement Factory B has demand in West Java Province, it will assign Cement Factory A to fulfill the demand. The model's boundary is that the quantity and quality are equal, but the price is still competitive. The methods are applied for specific customers who have affiliation with Cement Factory A.

Most of the served cities are dominated by Batching Plants. However, Karawang has Light Concrete Plant that is a higher proportion than the Batching Plant at 66.7%. The highest proportion in Bogor is Batching Plants, and it is served for Pre-cast factory also with 7.4%. The main cause is the pre-cast factory that is affiliated with the Cement Factory.

Postponement Practice

Recently, the postponement practices are focused on Jabodetabek, Banten, Lampung, and Pekalongan, especially in the northern area from the Cement Factory. The Customers in Sukabumi, Cianjur, Tasikmalaya, and Bandung (eastern area)

Table 2. The Available Space for Trucks in Each Postponement Point

Postponement point	Max. Space availability (Trucks)
Jatiwarna	7
Kp. Rambutan	3
Ciawi	5

are delivered without postponement. The places are less traffic jam, serve within one day, and less demand compared with northern customers. So, by simulating the model, the customer data in eastern customers are not included.

As information, the Plant Capacity is 5000 Ton/day for both products and are not limited to. The proportion of OPC is higher than PCC. The average of OPC daily production is at 3500 Ton/day, and the rest is for PCC. The higher proportion of OPC deals with higher demand from affiliated customers and inter-island customers. Referring to daily OPC production is at 3500 Ton/day, the proportion of postponement is estimated at 15%. The proportions are based on planning and forecasting from the cement factory management.

The proportion will follow the percentage of each customer demand, where Jakarta has a higher proportion of demand and leads to a higher truck proportion. It then follows Karawang, Bogor, Bekasi, Lampung, Pekalongan, Tangerang, and Serang. Each postponement point has a limited parking area. So, it can be assumed that Jatiwarna point has a maximum of seven trucks, Kampung Rambutan point is three trucks, and Ciawi point is five trucks (Table 2). Limited truck spaces are set to emphasize minimizing additional costs, such as investment costs or inventory costs. The simulation results can be seen in Table 3.

Ciawi point can serve Jakarta and Bogor customers, and it has a limitation of five trucks only. The limitation is from the limited rest area and shares with other trucks commodities such as food and oil. At Kampung Rambutan point, the capacity is for three trucks, and it can serve Jakarta and Karawang. Limited area in Kampung Rambutan is influenced by sharing location with mixer trucks and other raw material trucks.

Jatiwarna point can serve Jakarta, Karawang, Bekasi, Lampung, Pekalongan, Tangerang, and Serang' customer. Jariwarna is not prepared to serve Bogor because Bogor is close to Ciawi than Jatiwarna. In Jatiwarna point, the capacity location is for seven trucks. The truck capacity is highest than the others because Jatiwarna is the new

Table 3. The Optimized Allocated Truck Results

From/to	Jakarta	Karawang	Bogor	Bekasi	Lampung	Pekalongan	Tangerang	Serang
Jatiwarna	1	1	0	1	1	1	1	1
Kp. Rambutan	2	1	0	0	0	0	0	0
Ciawi	4	0	1	0	0	0	0	0
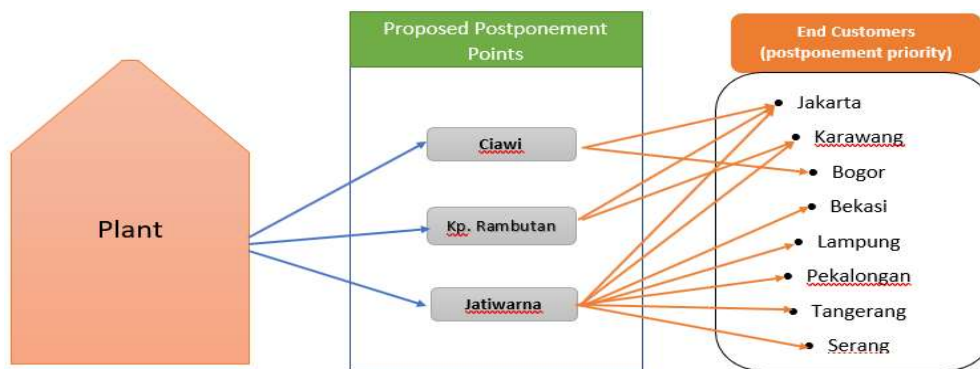
Figure 3. The Postponement Map after being Simulated

place to develop and gain more truck spaces (Figure 3).

Cost implication

Cost implication can be categorized by two, cost of efficiency and cost of responsiveness. Cost of efficiency deals with a limited portion of daily demand to be postponed. The portion of the daily demand effect the allocated truck. The portion is set to be 15% max because of the limited postponement area and avoiding allocated truck overnight.

There is no penalty cost for overnight trucks. The Cement Factory will compensate if the truck is overnight and then assign it to deliver cement to distant locations such as Pekalongan and Lampung to get more additional cost.

The second category is the cost of responsiveness. The cost of postponement is higher than a direct trip. The Cement Factory shall pay two times, first from the Cement Factory to the postponement point and then from the prioritized customers' postponement point. But the marginal cost is not too far, so profit still can

be gain. The additional costs are for improving responsiveness to the customers by avoiding the traffic jam. Satisfying customer is more critical to minimize shifting to the competitors. Especially in Jabodetabek, it needs more cement than other areas because it has many infrastructure projects such as Jakarta Outer Ring Road II, Elevated Toll Road Jakarta Cikampek, MRT (Mass Rapid Train), LRT (Light Rapid Train), and Jakarta- Bandung Rapid Train.

Production and storage facilities implication

Recently, implementing postponement practice affects daily cement production. Cement Factory will increase the production capacity volume. By increasing the capacity volume, space for raw material will be increase too. Furthermore, the inventory cost will be lower because the cement manufacturing capabilities proceeded (Agudelo, 2009). By implementing postponement at 15% allocated demands, it shall be concerned regarding the uncertainty. The company can also estimate how much the cement capacity has to be reached and optimize the silo capacity.

Another concern is the EBITDA margin. It is counted before interest, taxes, depreciation, and amortization costs. It is used to measure a company's financial health and performance. The cement factory uses EBITDA margin to compare their performance against their competitors. The EBITDA margin is calculated from EBITDA divided by revenue in a given year. Higher EBITDA margin will follow better financial and industrial performance. Thus, the cement company shall increase its revenue by ascending the production capacity. This model seems like a hub and spoke will reduce inventory holding cost and help the Cement factory to handle high demand in the peak season (Dubey, Singh and Tiwari, 2012).

Transportation implication

The Cement Factory manages trucks by itself under the logistics team. The logistics team manages trucks, including truck allocation and truck availability. Their duty is delivering the OPC to the customers at the right time, right place, and right quantity. The logistics team shall optimize how much trucks shall park at the factory area even though the space is limited. The team also ensures that the trucks that have been got DO (Delivery Order) will park at the factory. Otherwise, it is not. After getting DO, the truck is sent to the dispatching channel to load cement and do tare weight to get shipment document.

Implementing postponement will affect to maximize the allocated truck to be assigned. The Cement Factory shall be reasonable to estimate and prepare the truck. The allocated truck can be optimized by minimizing the idle trucks at the factory. Besides, the Cement Factory shall anticipate overnight trucks at the postponement point. Otherwise, they will pay the additional cost.

The government shall also speed up the infrastructure project to connect Sukabumi and Jabodetabek, so the cement and other products supply chain will flow well. So, producer oriented perspectives will change into customer-oriented views (Noche and Elhasia, 2013).

Administration implication

In fact, applying the postponement has difficulty for administration, especially for non-manual administration using SAP software. The Cement Factory shall combine both manual and computerized administration to create a shipment document. They have tried some models to minimize administration errors. First is placed a small office in Jakarta to create the new shipment document after getting the order during the postponement. The model is discontinued because the cement order is 24 hours, but the office is close after five pm. The second model is to use manual and computerized shipment documents. The Postponement truck will get a computerized shipment document from the Cement Factory, and the driver will receive a manual customer signature from the customer. The driver will get the shipment order at the postponement point by phone from the Cement Factory staff.

After finishing unloading the customers' cement, the trucks will return to the factory. The factory' staff will print out shipment documents from the postponement point to prioritized customers as payment evidence. It needs communication or sets up an application to connect among the Cement Factory, drivers, and customers. The Cement Factory must guarantee that their product reaches customers on time by communicating intensively with the drivers. The collaboration and information sharing practices among the stakeholders are significant in gaining alignment for the Cement Factory (Agudelo, 2009).

IV. CONCLUSION

This study probes a case study of the postponement practice in the cement industry, especially OPC products. Previously, the postponement practice is held at Kampung Rambutan point and Ciawi point. However, by increasing demand, the cement factory set up a new alternative point; the Jatiwarna point. According to each point's limited space and proportion demand at each customer area, the linear programming model is set up. The optimum result has been gained, and each postponement point serves a particular area based on transportation cost (inbound and outbound cost) and the demands. Implementing

the postponement can increase customer satisfaction without adding higher costs such as investment costs. The cement factory encounter effectiveness and responsiveness in the cement supply chain. Even though, some problems shall be taken, such as double administration (manual and computerized) and improving allocate truck by minimizing idle and stayed overnight trucks. Next research can focus on developing an application or software that controls the postponement process and facilitates communication among the stakeholders. Moreover, the software shall be set to create and simplify the shipping document.

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