Selecting plant for joint venture scheme using linear programming and enterprise value conversion

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Abstract. Every company in doing business expansion, especially business outside the core business of the previous business field, generally requires sufficient funding sources to ensure that the expansion goes as expected. Funding according to the needs is often a pretty difficult problem especially when faced with choices that have a significant cost impact. In this study we address the problem faced by a cement company in Indonesia that has extra capacity and potentially can be used to produce other products under a joint venture scheme. The company is faced with 3 choices of funding sources to support expansion into the building materials business, one of which was to sell a certain proportion of shares of the capacity of 8 factories that were not absorbed by the domestic sales target in Indonesia to strategic partners. This study attempt to find the most optimal capacity allocation of all factories in meeting the domestic sales volume target by considering the minimal transportation costs using the linear programming method and compare the remaining plant capacity with the magnitude of the converted plant capacity. The results are expected to support funding proposals to realize the vision of entering the building materials business in Indonesia.

1. Introduction

Supply Chain Management (SCM) research in cement industry is interesting, but relatively are quite a lot of previous research with SCM topics such as supply chain strategic, supply chain innovation, supply chain scheduling, and demand forecasting. Noche et al. [1] developed an innovative approach to supply chain strategies using simulation in the cement industry. Dubey et al. [2] investigated the supply chain innovation in Indian cement manufacturing. Naso et al. [3] applied a genetic algorithm for supply chain scheduling with case studies in the distribution of ready-mixed concrete. A few topics in SCM research in cement industry studied to develop an optimization model for production and distribution from the plant until distribute to marketing area to determine which plant that had excess production capacity. This study develops an optimization model for production and distribution to determine which plant are overproduced and to analyze enterprise value conversion in PT A.

The study of the allocation of production volumes mostly aims to determine the most minimal costs, where the goal stops at minimal costs, even though it is often accompanied by the results of subsequent calculations in the form of unused production capacity. This study provides a solution by offering unused production capacity as a funding tool to get capital by offer to new investors with a joint venture scheme.

2. Problem Description

After acquiring the other cement company in case’s company, PT A as case study in this research focused its internal funds only on operational expenditure and capital expenditure on the cement business and in supporting the change in the company’s vision to enter the building materials business. The cement company needs funds for capital expenditure of 3.8 trillion rupiahs. The source of the funds is decided by management using an external source with debts from banks, issued new bonds, or selling the proportion of certain factory shares to strategic partners.
The three funding options above are the main considerations in raising funds because the availability of internal funds is focused on the operation and development of the cement business to be more efficient. From the three alternative options above, options number 1 and 2 face many challenges from banks and financial markets because the burden of financial companies is currently very high due to the previous acquisition of PT Z. This is quite logical because the amount of debt has increased sharply in 2019 when compared to the period of the previous year. The nominal debt of this company of 3.9 trillion rupiah and the leverage ratio of 0.16 in 2014 to 21.4 trillion rupiah and lever ratio of 0.65 in 2019, an increase of 546%. This condition makes the potential choices number 1 and 2 experience considerable difficulties because they have to convince banks or financial markets to mobilize funds, and it is estimated that the negotiation process is quite long with an uncertain success rate in accordance with expectations, either nominal or interest rate. While the third option is to sell the proportion of shares in accordance with the target funds, it is possible to do so considering that many cement companies abroad want to have cement production units in Indonesia where production costs are considered to be quite low and the quality of raw materials such as limestone and clay are among the quality ranks highest in the world but has challenges in making factory investments from the start both in terms of legal, social and project time that is less predictable on time. This third alternative option, does not have a description of which factories can be cooperated or sold a certain proportion of shares to strategic partners except factory decisions that are not optimal in serving the Indonesian domestic market. The funds that will be obtained from the funding plan above will be used to support the new vision of company entered the building materials business with a focus on investment in light brick/panel factories (Autoclaved Aerated Concrete), cement boards, mortar cement, building material applicator companies (residential specialty contractors) and mega distributor companies.

![Figure 1. Rich Picture Problem diagram which explains the root causes and impacts that are the focus of research.](image)

Based on the background description explained earlier, the problem discussed in this study is how to determine which factories can be cooperated with strategic partners in supporting funding for the company's capital expenditure in 2020 to 2021. The purpose of this study are optimizing the allocation of supply capacity to each market area, selecting a factory and determining the amount of capacity that is not absorbed by the target demand in the country, calculate the enterprise value and its conversion value with the funds needed, determine the proportion shares of the factory that can be cooperated with
a strategic partner as funding in supporting capital expenditure for building materials outside of cement. The benefit of this study is to provide recommendations on the determination of factories that can be collaborated with strategic partners as an alternative funding for the company in supporting the building materials business.

3. Mathematical Model

3.1 Formulation of conversion of enterprise value to factory capacity (ton)

In general, it is easier to judge a public company than a closed company where stock prices provide an actual barometer of the market value of equity. If debt is also traded in the public, then that value can also be calculated from the market. The total value of equity and debt gives the total market value of the enterprise, which is defined to measure the price that the acquirer will pay for the overall value of the enterprise.

There is a strong correlation between calculating the enterprise value open company approach with the calculation of the enterprise value with the discounted cash flow approach.

- Enterprise Value Formulation

The calculation of Open Enterprise Value can be calculated by the following formula [4]:

\[
EV = (\text{Stock Quantity} \times \text{Avg Price}) + \text{Debt} - \text{Cash}
\]

\[
EV = (5,931,520,000 \times 12,508) + 21,378,095,604,000) - 3,436,124,754,000
\]

\[
EV = 92,133,752,538,888.9
\]

Where:
- \( EV \): Enterprise Value (Rupiah)
- \( \text{Stock Quantity} \): Number of shares outstanding on the exchange (Share)
- \( \text{Avg Price} \): Average price per share on the stock exchange (Rupiah)
- \( \text{Debt} \): Total amount of interest-bearing debt (Rupiah)
- \( \text{Cash} \): Amount of cash and cash equivalents (Rupiah)

- Formulation of Enterprise Value compared to Production Capacity

After knowing the Enterprise Value, the next stage is determined the Enterprise Value formulation compared to the production capacity (Ton).

\[
EV \text{ per ton} = \left( \frac{EV}{\text{Overall Plant Capacity}} \right)
\]

\[
EV \text{ per ton} = \left( \frac{92,133,752,538,888.9}{46,461,000} \right)
\]

\[
EV \text{ per ton} = 1,983,034
\]

Where:
- \( EV \text{ per ton} \): Enterprise Value per ton of factory production capacity (Ton)
- \( EV \): Enterprise Value (Rupiah)
- \( \text{Overall Plant Capacity} \): The total amount of factory production capacity (Ton)

- Formulation of conversion Fund requirements to factory Capacity that can be cooperated

After knowing the enterprise value per ton (EV per ton), a conversion formula can be set for Enterprise Value per ton with funding requirements.

\[
\text{Conversion to Capacity} = \left( \frac{\text{Fund Required}}{\text{EV per ton}} \right)
\]

\[
\text{Conversion to Capacity} = \left( \frac{3870,775,000,000}{1,983,034} \right)
\]

\[
\text{Conversion to Capacity} = 1,952,946
\]
Where:
Conversion to Capacity : The amount of factory capacity that can be cooperated (Ton)
EV per ton : Enterprise Value per ton of factory production capacity (Ton)
Fund Required : Funds needed in an investment plan (Rupiah)

3.2 Development of mathematical models
At this stage the formulation of variables in the research object is formulated into a linear programming mathematical model and then developed based on existing constraints so that the model can describe the conditions of production allocation to meet demand or sales targets in all provinces. Then the total supply is equal to the total demand, and this problem is called a balanced transportation problem.

The formula model in linear programming in this study takes into account the production capacity of each factory, the target volume in 2020, and the distribution costs from each factory to each province. An explanation of the mathematical formula that has been made according to the basic mathematical model is explained as follows.

Index
Indexes on the mathematical model of this study include :
i : Cement Factory i, i = 1,2 .... , 8
j : Market j, j = 1,2 .... , 34

Parameters
The parameters in the mathematical model of this study include :
C_{ij} : Cost of cement distribution from factory i to market j
d_j : Demand volume in market j
s_i : Factory production capacity i

Decision Variables
Decision variables in the mathematical model of this study are :
x_{ij} : The volume of cement sent from factory i to market j

Purpose Function
The objective function of this research is to minimize the cost of cement distribution costs at each supply facility and is expressed in equation 4 as follows.

\[
\text{Min} \sum_{i=1}^{8} \sum_{j=1}^{34} C_{ij} x_{ij}
\]

Where,
C_{ij} : Cost of cement distribution from factory i to market j
x_{ij} : The volume of cement sent from factory i to market j

Constraints
Constraints in this problem are the production capacity of each factory, demand or target sales volume, company policies, and non negative constraints. The constraint function is as follows,

(1) Obstacles to cement demand
Constraint equation for the demand for cement which explains that the volume of cement allocated from plant i must be equal to the volume of demand in the market j.

\[
\sum_{i=1}^{8} x_{ij} = d_j , \forall j
\]

(2) Capacity constraints for cement production
Constraint equation for the capacity of cement production which explains that the volume of cement allocated from plant i must be equal or lower than the plant volume capacity i.
\[ \sum_{j=1}^{34} x_{ij} \leq s_i, \forall i \]  

(3) Minimal factory allocation volume
Constraint equation in the form of company policy in determining the minimum production capacity to be offered to strategic partners, which is no more than 49%, or if it is converted into factory capacity that the company must maintain at least 51% of total factory capacity i.

\[ \sum_{j=1}^{34} x_{ij} \geq 0.51 s_i, \forall i \]  

(7)

(4) The \( i_1 \) factory and the \( i_2 \) factory only serve \( j_1 \)-\( j_{10} \)
Equality constraints in the form of company policy in supplying to the market, namely the volume of cement supplied from the \( i_1 \) factory and the \( i_2 \) factory does not serve other areas besides the \( j_1 \)-\( j_{10} \) market.

\[ \sum_{j=11}^{34} c_{ij} = \infty , \forall i=1,2 \]  

(8)

(5) The \( i_8 \) Factory only serves other than the \( j_1 \)-\( j_{10} \) and \( j_{11} \)-\( j_{16} \) market
Constraint equation in the form of company policy to supply to the market, namely the volume of cement supplied from the \( i_8 \) factory does not serve \( j_1 \)-\( j_{10} \) and \( j_{11} \)-\( j_{16} \) market.

\[ \sum_{j=1}^{16} c_{8j} = \infty , \forall i=8 \]  

(9)

(6) Non-Negativity Constraint
Non-negativity constraint equation which explains that the volume of cement allocated from plant i to market j cannot be negative.

\[ x_{ij} \geq 0 \]  

(10)

**4. Results and Discussions**

4.1 Enterprise value calculation results
In accordance with the formulation of Schmidlin [4], it can be calculated that the PT A’s Enterprise Value is Rp92,133,750,538,889,- and the Enterprise Value per ton is Rp1,983,034 per ton, it can be easily determined that the total capacity of factories that can work together with strategic partners is 1,952,946 tons.

4.2 Optimization results
An optimal volume allocation has been generated with a total demand volume of 38582921 tons for one year. Markets \( j_1 \) to \( j_{10} \) as a whole are supplied by \( i_1 \) and \( i_2 \) factories with support from \( i_3 \) factory which supply \( j_8 \) and \( j_9 \) markets. The \( j_{11} \), \( j_{12} \) and \( j_{13} \) markets are supplied by \( i_3 \) factories supported by \( i_4 \) factories supplying almost half of the total volume in \( j_{13} \). The \( j_{14} \) market is supplied by factory \( i_5 \) with full allocation supported by factories \( i_4 \) and \( i_7 \). The \( j_{15} \) market is fully supplied by factory \( i_6 \).

The \( i_6 \) factory is still focused on supplying the \( j_{16} \) market, while the \( i_7 \) factory besides supplying the \( j_{16} \) and \( j_{14} \) markets, it also supplies in the \( j_{17} \) Market as a single source, and supplies in the \( j_{18}, j_{19}, j_{20}, j_{31}, j_{32} \) and \( j_{33} \) markets as shown in table 1.

The distribution range between factories has quite large differences, this is due to the size of the target sales volume or demand of each different market area and factory capacity, and this is also
reflected in the constraints that create 3 cluster coverage where the size is different, for example cluster 1 has the ratio between demand and capacity is 94.8% (9661000 tons capacity and 9160787 tons demand), cluster 2 is 82.7% (capacity 29400400 tons and demand 24324559 tons) and cluster 3 has 75% ratio (capacity 7400000 tons and demand 5552211 tons).

Table 1. The results of optimization of the allocation of the supply volume of 8 factories to 34 marketing areas can be seen from the allocation of each factory in meeting sales targets of 38582921 tons.

| Market = j | Factory Supply = i | Target Sales / Demand |
|------------|--------------------|-----------------------|
|            | Lhonga  | Indarung | Narogong | Cilacap | Rembang | Tuban SI | Tuban SI | Pangkep |
| j1         | 1184648 |          |          |         |          |          |          |        |
| j2         | 476352  | 1540837 |          |          |          |          |          |        |
| j3         | 1318637 |          |          |         |          |          |          |        |
| j4         | 1567146 |          |          |         |          |          |          |        |
| j5         | 499906  |          |          |         |          |          |          |        |
| j6         | 370127  |          |          |         |          |          |          |        |
| j7         | 734897  |          |          |         |          |          |          |        |
| j8         | 344293  |          |          |         |          |          |          |        |
| j9         | 110644  |          |          |         |          |          |          |        |
| j10        | 1013299 |          |          |         |          |          |          |        |
| j11        |          | 1350085 |          |         |          |          |          |        |
| j12        |          | 1861778 |          |         |          |          |          |        |
| j13        |          | 2033199 | 2073361 |         |          |          |          |        |
| j14        |          |          | 172848  | 3000000 |         |          |          |        |
| j15        |          |          |          | 949791  |          |          |          |        |
| j16        |          |          |          | 2040000 | 5625862 |          |          |        |
| j17        |          |          |          |          | 708686  |          |          |        |
| j18        |          |          |          |          | 526280  |          |          |        |
| j19        |          |          |          |          | 363705  |          |          |        |
| j20        |          |          |          |          | 320889  |          |          |        |
| j21        |          |          |          |          |          | 630391  |          |        |
| j22        |          |          |          |          |          | 107379  |          |        |
| j23        |          |          |          |          |          | 1823403 |          |        |
| j24        |          |          |          |          |          | 284604  |          |        |
| j25        |          |          |          |          |          | 560342  |          |        |
| j26        |          |          |          |          |          | 99038   |          |        |
| j27        |          |          |          |          |          | 325744  |          |        |
| j28        |          |          |          |          |          | 579099  |          |        |
| j29        |          |          |          |          |          | 228411  |          |        |
| j30        |          |          |          |          |          | 122318  |          |        |
| j31        |          |          |          |          |          |          | 144949  |        |
| j32        |          |          |          |          |          |          | 247752  |        |
| j33        |          |          |          |          |          |          | 273612  |        |
| j34        |          |          |          |          |          |          |          |        |
| j35        |          |          |          |          |          |          |          |        |
| j36        |          |          |          |          |          |          |          |        |
| j37        |          |          |          |          |          |          |          |        |
| j38        |          |          |          |          |          |          |          |        |
| j39        |          |          |          |          |          |          |          |        |
| j40        |          |          |          |          |          |          |          |        |
| Total Supply Volume | 1661000 | 7044850 | 5700000 | 3200000 | 3000000 | 2040000 | 10384559 | 5552512 | 38582921 |

The remaining total capacity resulting from optimization is 7878079 tons, with four factories that have utilization below 100%, namely i2, i6, i7, and i8. Factories, detailed data are in table 2.

Table 2. Optimal factory capacity and unused maximally. Optimal factory capacity and not used maximally. This table explains that there are variations in the utility of each factory, from 100% to as low as 51%.

| Factory | Capacity Used | Factory Capacity | Capacity Usage | Unused capacity |
|---------|---------------|------------------|---------------|----------------|
| i1      | 1661000       | 1661000          | 100%          | (0)            |
| i2      | 7044850       | 8000000          | 88%           | 955150         |
| i3      | 5700000       | 5700000          | 100%          | (0)            |

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### 4.3 Analysis of Factory Selection

The factory capacity needed for cooperation with strategic partners is only 1,952,946 tons, while the remaining capacity of the \( i_2 \) plant is 955,150 tons and the \( i_8 \) plant is 1,847,488 tons so that candidate 4 factories have shrunk to 2 factories, \( i_6 \) and \( i_7 \) factories. Subsequent elections require further analysis to determine which of the two factories has remaining capacity. Then the selection is conducted through an assessment with criteria and linkert scale.

#### Table 3. Final determination of factories that can be used as a basis for joint venture schemes

Factory \( i_6 \) was chosen because it has the highest score.

| Num | Criteria                  | Weight | Factory \( i_6 \) | Factory \( i_7 \) | Rating Scale |
|-----|---------------------------|--------|-------------------|-------------------|--------------|
| 1   | Port Ownership            | 30%    | 5 1.5             | 5 1.5             | 1            |
|     |                            |        | The factory does not have a port and has no agreement on the use of the port with other parties | The factory does not have a port but has a port use agreement with another party | 5            |
|     | Dock usage capacity (tons per month) | 20%    | 5 1               | 5 1               | 3            |
|     |                            |        | > 0 < 25000      | > 0 < 25000      | 3            |
|     | Distance to port (km)     | 15%    | 5 0.75            | 5 0.75            | 4            |
|     |                            |        | > 40 km           | > 30 km - 40 km  | 4            |
|     | Projection of share ownership (%) | 35%    | 5 1.75            | 1 0.35            | 4            |
|     |                            |        | < 15%             | > 15% - 25%      | 4            |
|     | Total Score               | 100%   | 5 3.6             | 3.6               |              |

Determination of rating and weighting is based on internal discussions at the top management level which have also met with several potential investors. PT A wants to remain as the majority shareholder of at least 51% and the investor wants to be a shareholder of at least 30% and in addition is also very concerned about infrastructure equipment such as port ownership, dock capacity and access distance from port factories that can ensure supply to their markets overseas can be fulfilled on an ongoing basis. Based on the discussion, the highest weight is in the criteria of share ownership and port ownership.

Table 3 shows result of the assessment is that the \( i_6 \) factory was chosen because it has a higher score than the \( i_7 \) factory, even \( i_6 \) dominates \( i_7 \). The main criterion that most influenced the setting up of the \( i_6 \) factory was the projected share size of 1.75. With almost the same ownership, making potential investors have higher control in controlling operations and providing certainty of long-term sustainable market allocation abroad while for PT A is in accordance with the minimum shareholding of 51% and remains as the controlling shareholder.

#### 5. Conclusion

The Transportation Problem Model with the associated Enterprise Value can be used as a solution in solving the problem of divesting assets in the context of funding to support business expansion without
reducing operational effectiveness and sustainability of the core business. The optimization results state that there are 4 factories that still have remaining capacity that cannot be absorbed by the Indonesian domestic market, namely \(i_2, i_6, i_7\) and \(i_8\) Factory with a total remaining capacity of 7878079 tons or 17% of capacity overall plant with middle utility. The Enterprise value of PT A by the end of 2019 is Rp92 T with a conversion of Rp1,983,034 per ton of factory capacity. The factory chosen to cooperate with strategic partners is the \(i_6\) factory with a share ownership that is relatively as large as PT A.

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