THE AVAILABILITY OF CEMENT TOWARDS INFASTRUCTURAL DEVELOPMENT IN BANTEN: A DYNAMIC SYSTEM MODEL ANALYSIS

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Abstract-Infrastructures are no doubt important to speed economic development in the province of Banten. Due to this reason the government of Banten gives a serious concern toward infrastructural development in this province. However, studies estimating the availability of cement to support the infrastructural development in Banten have been limited. This study, by using a dynamic system simulations, aims at estimating the availability of cement for the infrastructural construction in the future. The data were collected from the official statistics and other secondary sources. The study found that the demand for cements will exceed the supply of cement between the period 2018 and 2025. This study suggests the following actions that need to be given serious attention by the provincial government of Banten. First, there is a need to increase the number of cement industries in the province of Banten. Second, the provincial government should introduce conducive policies to attract investors to invest in cement industries to support the sustainability of cement production. Third, the development of cement industries should be environmentally friendly. Fourth, there is a need to develop a large capacity of cement production. Finally, the government needs to monitor the availability of cements to mitigate the gap between the supply and demand of cements in this region.

Index terms- the supply and demand of cements, Dynamic Systems model, infrastructural development, conducive policies.

1. INTRODUCTION

Infrastructure can simply be defined as the physical systems that provide transportation, water, buildings, and other public facilities required to meet human basic needs both economically and socially. In the province of Banten, like in many other provinces in Indonesia, the development of infrastructure is no doubt important as the engine of economic growth. This is because the availability of infrastructures is able to increase productivity, cost efficiency and attracting investments (Szirmai, 2010). For this reason, the development of infrastructure is a must for any regions to have rapid economic growth.

In the province of Banten, however, the availability of infrastructure was limited. The provincial government of Banten consequently since 2010 established regional plan to speed the development of infrastructures. This provincial development plan has attracted the growing of construction companies. Between the period 2013 and 2014, the number of construction companies increased from 2,413 units to 2,440 units with the construction value reached 11.8 trillion rupiah. The number of the construction companies was reported increasing since these periods. Judging from the type of work, nearly 60 percent of the construction value was for civil buildings such as roads and bridges. The rest is just only buildings (17.9 %) and other special construction (19.3 %) respectively (Banten Provincial Statistics, 2015).

Apart from the above building types, the development of housing and the like are also rapid in this province. This is not surprising as the population of this province grow quiet rapidly. The rapid development of infrastructures certainly have a linear positive relationship with the need of cement supply as one of the important building materials. However, as there have been limited studies in estimating the supply of cement to support the infrastructural development in this province, this study is considered important to be undertaken.

Method to estimate the supply of cement is by using a dynamic system simulation model. This simulation model will be done by using computer statistical program of SPSS version 20, Power Sim studio for Windows 2005 and Pro model 7.5. Using this simulation model, it is expected that the availability of cement that needs to be supplied in the future by the construction industries in the province can be estimated. This estimation hopefully can be used for the provincial government of Banten in making the policy towards the supply of cement. However, before discussing the findings of the study, the section 2 will briefly review previous studies relevant to this study. Section 3 outlines the research method. In this section a particular concern on the

dynamic systems model and the source of data will be detailed. Section 4, then, discussed the finding of the study. Finally, section 5 will address concluding remarks and recommendation of the study.

II. LITERATURE REVIEW

As has been mentioned at the outset that the study to estimate the future supply of cement for construction industries in the province of Banten was limited. The available studies relevant to this present study is as follows. The first study is the study undertaken by Rahayu Utami (2006) titled Dynamic System Simulation toward the availability of cassava in Bogor, West Java. The second is the study conducted by Erma Suryani (2005) on the Policy Planning scenario towards the capacity of the cement industry using Dynamic system model. The third is the study done by Safitri Ambarsari, et.al. (2015) on the Analysis of Work Core Process of Supply Chain using Lean Six Supply Chain Management in Semen Indonesia company (Persero) Tbk). The fourth study is the study on the Supply Simulation of Maize using the Dynamic Systems Approach in Chareon Pokhpand company in Indonesia. This study was conducted by Alkafi Abdillah (2014). The other relevant study that needs to be informed is the study conducted by EkoWidodo, et.al. (2013). This study was focused on the Dynamic Systems Simulation to Improve supply Performance of the company in Indonesia. The mentioned studies confirmed that there were no available studies on the Dynamic Systems Simulation of the Supply of Cement in the province of Banten.

III. RESEARCH METHODS

Dynamic System Model

As discussed previously that cement is one of the raw materials that need to be provided adequately toward the development of infrastructures. However, the supply availability of cement in many regions in Indonesia was considered limited. The reason is simply because efforts to supply cement in the region deal with many complex factors or variables. To solve this problem, a dynamic system model was suggested in the literature. This model is considered able to deal with the complexity of the variables associated with the supply of cement.

The used of system approach begins with problems identification, and followed by the needs analysis and ends by the effective operating system. The system approach has several elements including their methodologies for planning and management which have be multidisciplinary and systematic approaches. This approach should also be able to think in non-quantitative, by using mathematical modelling, simulation and optimization technique. This approach can also be applied using computer (Eriyatno, 1998).

There are at least three stages that need to be done using the system approach. The first is the stage of needs analysis. This includes the department of Public Works, Regional Development Planning organization (Bappeda), and other stake holders including the cement industries and consumers . Having completing this need analysis, the second stage will be problems formulation. In this stage there will be problems formulation towards the development of the cement industry Supply Chain system. However, in this stage there are usually many problems associated with the Supply Chain system of cement. These problems include the problem of the transport system from the distributor to the consumer, and the fluctuations of the price of cement in the industrial market. These problems will affect the cement industry to run the business.

After completing the problems formulation, there is a need to identifying the system itself. In this stage, the analysis needs to focus a chain of relationships between the statement of needs and a special statement of the problem that need to be solved to meet these needs. In this part the analysis needs to consider the interests of the components involved and the linkage components in the system using casual loops (Muhamadi, et.al., 2001).

In modelling dynamic system, the study first conceptualizing the model. In this stage, there should be an understanding of the system that is going to be modelled based on the concept used. This aims to obtain the overall picture of the model that is going to be made. This phase begins with identifying all critical components involved or which will be incorporated into the model and set the model boundaries. The inter relationship of the components are then searched one and another using a causal diagram. The arrows in the diagram marked with (+) or (-) depending on the relationship that occurs whether positive or negative. Sign (+) is used to express the relationship between the two factors that change in the same direction. While the sign (-) is used if the relationship between these two factors change in different direction.

This is then followed by the phase of model formulation. In this phase the true meaning of every relationship that exists in the conceptual model is formulated. This dynamic system will use mathematical equations (differential equations) to describe a system into the model. At this stage the quantification of the model is done by incorporating the quantitative data into a dynamic system diagram in order to obtain the corresponding relationship between the variables in the model consistently.

Finally, it is the stage of model evaluation. In this stage there should be verification and validation of the model. Verification is performed to determine the consistency of the model made by checking the dimensions of the variables used in the model and determine the accuracy of the use of methods of integration (time step) that are selected. Whilst validation is done by comparing the model simulation with the real situation. Validation includes direct structure tests without running the models, and comparing test of the model behaviour with quantitative behaviour pattern.

In organising the model, there are four stages that needs to be given attention. The first is problem identification. Problems associated in this stage include the existence of a fairly complex problems, many variables involved, and time. To clarify the scope of the problem, it is required restrictions on the problem and used the relevant assumptions in building the model. Some of the necessary variables include the total initial value of cement productivity, the amount of cement consumption, and cement industrial capacity.

The second is data collection techniques. The data collection is aimed to collect a variety of data and information related to the cement industry, cement supply chain activities, including the activities of the process of supply, production to distribution. Data that are needed include primary and secondary data which contains the following. The primary data include: 1) the supply chain of the existing condition of the cement in Indonesia in general and in the study area, especially through direct observation in the field survey and interview process with the stakeholders. 2) Historical data of the Indonesian cement production, historical data of cement sales, historical data on cement consumption , historical data in the study area of cement production, historical data of cement consumption in the study area, and the data of infrastructural development plan.

The secondary data that needs to be collected include those obtained from the literature and from related agencies. Other secondary data needed include the data of demand for cement in the province of Banten, construction project planning data, and other supporting data. These secondary data was collected from the Indonesian Cement Association, the Central Bureau of Statistics at provincial level, the ministry of public works in Banten and National Planning Agency (BAPENAS)

The third stage is making the Model and Simulation. Modelling, simulation and analysis need to be conducted in accordance with the goals, objectives, and the scenario. Before running the simulation, it is necessary to put the values of the required parameters. The initial value of the variables studied, the fraction or parameters and effect link between a variable with a significant other variables that are determined based on empirical data and information that can be gathered from sources and relevant literatures.

Finally, The stage of model verification and validation. In model verification, there is need to check an recheck the unit size to the variables in the models. This includes the level, rate and the constants of secondary data, and then determines the accuracy of the use of methods of integration and the time step chosen, and asked stakeholders to evaluate the model created. While the model validation was carried out in accordance with the purpose of modelling to compare the dynamic behaviour of the model with the real system conditions. If the model has been deemed valid, then this model can be used as a representative model.

Model Design

In designing the model there are three steps taken. The first is by describing the dynamic system model. In this model design , the analysis will be limited only to matters relating to the supply and demand of cements used for the raw materials that are needed for the construction industry. Any problems associated with the supply and demand for cements are analysed using the causal loop approach which formulated in the stock and flow diagram, and further simulated using Software Powersim Studio2005.

The second is conceptualizing the model. This conceptualisation is done to analyze the availability system of cement by using simulation technique in accordance with the problems that are further going to be solved by the policy makers. This simulation technique was made based on replication of the real system into a sub-system or sub-models. In this sub model, the availability of cement is assumed to be influenced by annual cement production and consumption of cement per year. The causal relationship between variables in the sub model of the production and consumption of cements is described by the causal loops diagram.

Note that, in constructing the casual loop diagram, Powersim 2.5 software program is used. The data that are accommodated in this software are both production and consumption of cements in Banten. The data period used was from 2003 to 2013. The production data were taken from the following cement industries. These are PT. Semen Padang (PT, SP), PT. Indocement Tunggal Tbk (PT. ITP), PT. Semen Balfour (PT, SB), PT. Holcim Indonesia Tbk (PT, HI), PT. Semen Gresik (PT, SG), PT Semen Bosowa Maros. (SBM), while the consumption data was divided into cement consumption for construction and non-construction.

The third is model formulation. However, before formulating the model, the following assumptions need to be mentioned. First, the availability model built should be applicable to both construction and non construction. Second, the cement industries analysed are those in the group of Indonesian Cement Association. Third, the data for cement consumption were limited to cement consumption for constructional purposes in Banten. Fourth, the growth rate of the project was held constant over the period 2004-2025. Fifth, the period of simulation analysis is limited to the period of 2003 to 2025. Finally, it is assumed that the total cement industry was considered fixed during 2003-2013. Note that, before formulating the model, data on the types of distributional patterns are analysed using Promodel Software 7.5 programs.

In the context of the sub model of the cement availability, the study used the following mathematical equations.

• Historical Data of Cement = NORMAL (2.22317 million tons <<>>; 641 070 tons <<>>) where, historical data of cement = normal distribution of cement production in scale year (tons)

• cement consumption data = NORMAL (2.21146 million tons <<>>; 643 820 tons <<>>) where, historical data of cement = normal distribution of cement consumption.

The above equations are the equations to determine the need or the amount of cement required for supporting both construction and non0construction projects. The value of production is based on data from the Indonesian Cement Association in the periods of 2003-2013, while for consumption used data for both construction and non-construction obtained from the result of the normal distribution using the software Promodel 7.5.

Furthermore, in the analysing the availability of cement using dynamic system, the model design, simulation and analysis were conducted in accordance with the objectives and scenarios on the model. Policy scenarios that will be used in the analysis of cement available in Banten province used the following scenario. First , a scenario with no change in policy that describes the condition of the production and consumption of cement during the period of 2003-2013 where there was a tendency of dynamic data or random. Under these conditions then it was predicted the situation in the future. In this model it is assumed there are no expansion on production capacity to improve productivity. This situation illustrates the state without the addition of a new plant. With this model it can be analyzed situations and behaviour of the availability of cement system in the province of Banten in the absence of policy changes or additions to the new cement industry.

IV. RESULTS AND DISCUSSION

The General Conditions Cement Industry

Detail of production, consumption and capacity of the cement industry in Indonesia can be seen in Table 1. As can be seen at this Table that there had been an increase of production as well as consumption of cement in Indonesia. However, in terms of trade, there have been deficit of cement in Indonesia between the period of 2009 and 2013 as the data available. This suggests that the local production of cement in Indonesia relatively has been limited to fulfil the demand for cement. Therefore, the government plays important role in bridging the increasing demand of cement in Indonesia.

Table 1. Production, Consumption and Capacity of Cement Industry in Indonesia

Unit: Thousand tons

Description	2009	2010	2011	2012	2013
Production	45,857.1	49,155.2	54,154.2	55,714.2	58,199.20
Import	1,672.8	2,077.0	2,159.8	3,730.5	5,282.10
Export	1,649.1	2,563.1	2,067.4	48.2	936.7
Consumption	45,880.8	48,669.1	54,246.5	58,964.5	62,544,60
Capacity	52,250.4	55,150.5	59,185.3	62,122.2	65,385.00
Utility	87.8	89.1	91.5	89.7	89.0
Domestic Market Power	96.4	95.7	96.0	93.7	91.6

Source : Central Board of Statistics, various years.

In the province of Banten the expenditure of industrial construction per year between the period 2013-2014 continued to increase to reach 11.8 trillion rupiah. Judging from the type of work, nearly 60 per cent of the construction value is the result of the work of civil building construction such as the construction / repair of roads and bridges. The used of cement for construction in this province was about 6 percent of the total national cement production in 2013. Details production and consumption of cement in the province of Banten can be seen at Table 2.

Table 2. Production and Consumption of cement in Banten, 2003-2013

Year	National Production (tons)	Production in Banten (tons)	Percentage of Cement production in Banten of the national production	Consumption of Cement in Banten (tons)
2003	27,539,018	1,400,434	5.09	1,387,189
2004	30,208,479	1,768,082	5.85	1,755,914
2005	31,487,016	2,108,707	6.70	2,093,138
2006	31,975,265	1,877,605	5.87	1,870,801
2007	34,172,436	1,977,810	5.79	1,974,367
2008	38,071,617	2,039,541	5.36	2,015,265
2009	39,050,918	1,837,419	4.71	1,824,526
2010	40,777,865	2,005,185	4.92	1,988,743
2011	47,999,893	2,779,158	5.79	2,762,497
2012	54,969,478	3,186,377	5.80	3,181,169
2013	58,023,626	3,474,591	5.99	3,472,432

Source : Indonesian Cement Association, various years.

The use of cement as a raw infrastructure material in Banten

Construction sector plays an important role in the economic development process, especially to support the creation of economic and social infrastructures in a region and to stimulate the growth of other economic sectors. The number of construction companies in Banten during the period 2013-2014 increased from 2,413 units to 2,440 units. However, the increase of the number of companies was not followed by the increase in the number of permanent workers. During these years, the number of workers reduced from 25 335workers to 24 967 workers (Table 3). This indicates that the growing number of construction company does not always contribute to the increase of the number of workers. Thus, much remain to be done to push the use of workers by the construction companies.

Table 3. The number of Construction Companies in Banten, 2013-2014

Description	2013	2014
The number of Construction companies	2,413	2,444
The number of workers	25,335	24,967
Constructional values (billion Rupiah)	10,904	11,799

Source : Provincial Statistic Bureau, 2015.

It should be noted that the construction companies that grew in Banten from 2013 to 2014 were mostly working on various projects. These projects were funded by the provincial financial sources as well as district / city government funds. This condition indicated the dominant source of funding of construction work coming from local funds. The percentage of funding from budget funds during these periods ranged from 62.6 percent to 70.5 percent of the total value of the completion works. Details of the use of local budget for infrastructure in Banten in 2015 are sown at Table 4.

Table 4. Budget Allocation for Infrastructures in Banten, 2015

Unit : Million Rupiah

Ministry of Public Works	869,787.8
Housing development Programs	**200,610.8**
Housing Monitoring, controlling, and implementation	31,834.7
Management of Official Buildings and Housing	28,188.3
Sanitation and Waste Management	35,167.8
Drinking Water system Management	102,648.0
Policy and program Formulation, International Cooperation and Data Information	2,771.7
Road Construction Program	**273,782.5**
Capacity Development and Preservation of National Roads	273,782.5
Regional Spatial Planning	0.0
Regional Spatial Plan Implementation	0.0
National Plan Implementation	0.0
City Development Plan	0.0
Spatial Development Plan	0.0
Water Management Program	**395,394,8**
Irrigation Development and Management	51,489,7
Natural Disaster Management	45,554.1
Water Integrated management	32,666.9
Conservation and Development of Dams	224,684.3
Water supply and management	40,999.7

Source : National Development Plan Agency, 2015.

The Cement Industries in Banten

There are three types of the cement industries in the province of Banten. These are Indonesian Cement Association (ASI), PT Cemindo Gemilang (White Cement Industries), and PT Semen Hippo. The Indonesian Cement Association was founded on October 7, 1969 and consisted of two state-owned cement plants that exist at the time as the P.N. Semen Padang and P.N. Semen Gresik. Indonesian Cement Association was originally established as a forum for communication, consultation and coordination for the purposes of cooperation between its members in developing the cement industry both in terms of production, quality, marketing, research and development as well as in other matters where deemed necessary by the members, society and the State. Details of the supply of cement produced by the member companies of this association are shown at Table 5.

Table 5. Cement Production Produced by Cement Companies under ASI, 2003-2013

Unit : tons

Years	PT. SP	PT. SB	PT. ITP	PT. HI	PT.SG	PT SBM
2003	16,665	80,950	829,193	215,123	258,503	-
2004	40,581	88,911	907,246	328,5873	402,770	-
2005	107,308	94,511	918,893	388,732	501,462	97,800
2006	165,383	69,634	780,444	313,504	419,984	128,656
2007	157,728	44,921	976,213	385,365	305,904	107,679
2008	225,567	3,462	1,804,843	443,268	242,016	40,385
2009	251,137	18,404	1,001,731	348,108	216,709	233,521
2010	198,210.71	8,205	1,153,184	383,282	258,936	3,367
2011	223,732.85	1,800	1,490,213	543,528	483,005	36,877
2012	307,182	-	1,600,362	648,134	553,429	72,270
2013	416,128.62	-	1,650,918	600,476	785,968	21,100

Source : The Indonesian Cement Association, 2015.

PT.Cemindo Gemilang is the holder of the Red and White Cement brand was founded in 2011. In order to provide quality raw materials for the country, the current PT. Cemindo Gemilang build an integrated plant in the area Bayah, Banten, with a clinker production capacity of 10,000 tons per day, equivalent to production of 4 million tons of cement per year. In addition to

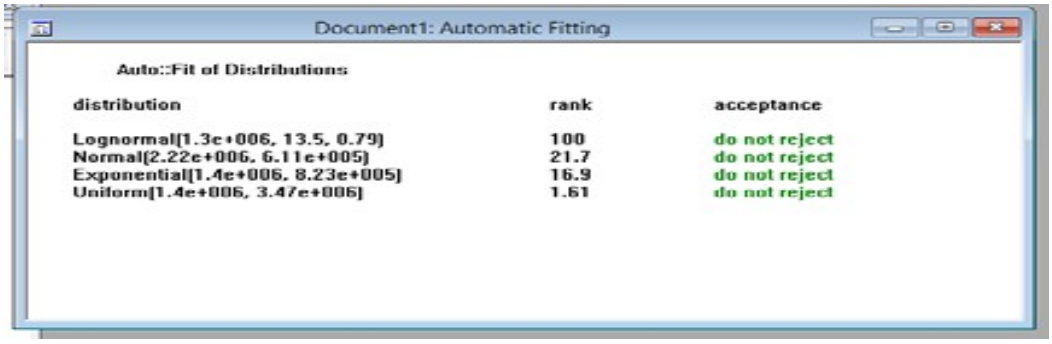
building an integrated cement factory in the area Bayah, PT. Cemindo Gemilang also have a grinding plant in the area Ciwandan, Banten, with a two-line production capacity of 750,000 and 1,000,000 tons years.

PT. Cement Hippo or PT. Sun Fook Industries Indonesia are companies manufacturing cement with trademark CEMENT HIPPO which was established on 22 January 2013, with the aim to meet the demand for high-quality cement in Indonesia. This company has adopted the Quality Management System ISO 9001: 2008 as a standard procedure Operation. This company was able to maximize production capacity to reach 1.2 million tons per year. Note that in this paper, PT. Hippo cement is not included in the study analysis.

The Analysis of Cement Production and Consumption

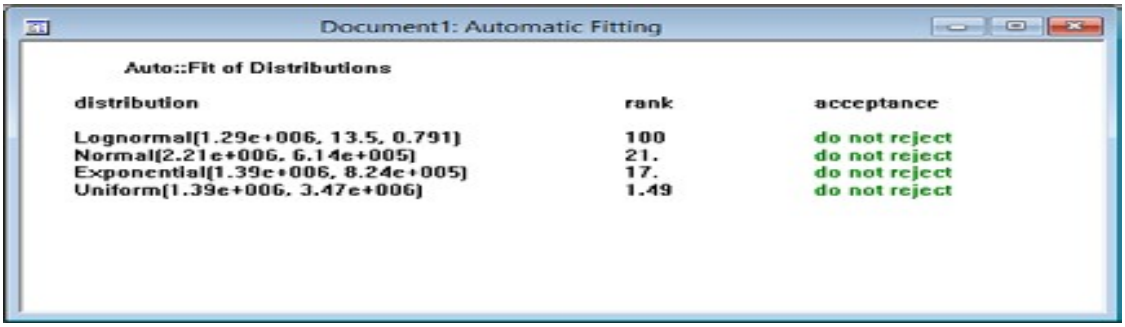
Using the dynamic system model, it was found that the production of cement are distributed normally which have mean value of 2.223.170 and the standard deviation of 641.070 (Table 6).

Table 6. Automatic Fitting of Cement Production using ProModel Software Program



In terms of the cement consumption, it was found that the cement consumption are also normally distributed with a mean value of 2.21146 and standard deviation of 643.820 (Table 7). Note that the normal distribution is a bell-shaped function with parameter μ (mean) and σ (standard deviation). Normal random variables used to model many random phenomenon that can be expressed as the number of random variables, based on the central limit theorem. The analysis should be careful in using the normal distribution to model random phenomena which cannot assume a negative value. The normal distribution is generally used to describe process, while model formulation model is a formulation of the problem into mathematical form to represent the real system. Model formulation links variables that have been identified in the conceptual model with symbolic language.

Table 7. Automatic Fitting cement consumption using Promodel 7.5 software program



The result using simulations under the scenario of no policy change was shown in Table 8. It can be seen that in 2014-2025 the production of cement is going to be fluctuated. This suggests that the cement consumption in these periods cannot be met. However, this finding is subject to the condition that the physical infrastructure development projects in the province Banten will be in accordance with the Medium Term Development Plan (RPJMD) of Banten Province between the year 2012 and 2017. This RPJMD is called specifically as the Development of Growth Centre and Strategic Area . These development 'doorway' Banten consists of (1) Soekarno-Hatta International airport , (2) International hub port of Bojonegara, and (3) the settlement area

of large-scale Maja, the construction of International Port Bojonegara, and the construction of the Sunda Strait Bridge. Table 8 shows the simulation results of the cement production from the year 2003 to 2015.

Table 8. The Result of Simulation of the cement Production, 2003-2015 (unit: tons)

Year	The consumption of cement	The production of Cement
2003	3,050,507.57	2,097,740.44
2004	3,043,730.87	1,809,041.12
2005	2,002,908.18	1,112,391.42
2006	2,245,589.13	2,777,194.44
2007	817,001.77	2,712,010.18
2008	3,334,073.76	2,538,801.02
2009	2,640,784.10	2,793,890.95
2010	3,022,189.22	1,977,037.49
2011	2,004,151.45	2,580,400.02
2012	1,502,185.24	2,071,595.78
2013	1,750,954.49	653,390.50
2014	1,770,954.49	2,324,350.91
2015	1,825,122.81	3,281,947.32
2016	3,004,524.02	1,403,483.87
2017	1,454,342.09	2,950,115.07
2018	1,572,080.40	2,428,539.11
2019	2,026,029.71	1,081,343.02
2020	2,155,122.00	3,541,402.04
2021	3,122,529.44	2,001,231.13
2022	2,023,825.50	1,748,089.18
2023	2,941,710.03	3,593,825.44
2024	2,099,252.98	1,619,945.91
2025	3,109,329.24	1,950,563.12

Source : estimated by using Powersim for windows 2005.

To validate the model, the application of statistical method was used. This was done by comparing model output (simulation results) with the actual data. The statistical test used was Paired simple t-test. This test can be categorized as parametric statistical group that can be used in testing the hypothesis and to determine whether there is a significant difference of the actual data and the results of the simulation.

If the results of the simulation showed : (a) t- value is more than t- table (- 0,523 <- 2.228) at the level of 5 percent , then H0 is accepted. This means that there is no difference between the average value of the actual cement consumption with the average consumption of cement simulation. Moreover, if the t value is more than t- table (0.351 <2.228) at the level of 5 percent, then H0 is accepted. This means that there is no difference between the average value of the actual cement production with an average of the simulation of cement production.

In terms of cement consumption, the results of simulation towards the cement consumption based on the fiscal budget of Banten, the study found the following results as shown at Table 9. Note that, the data are estimated by multiplying the fiscal value of the province in 2015 and the results of the analysis of cement consumption in the periods 2016-2025.

Table 9. Cement Consumption towards development in Banten Province, 2016-2025

Units: Tons

Year	Housing Infrastructural Programs	Road Development Programs	Water Resources Development Programs
2016	707,905.04	965,325.06	1,391,293.90
2017	335,953.00	458,117.73	660,221.27
2018	363,150.48	495,205.20	713,724.32
2019	468,151.30	638,388.14	920,089.57
2020	497,833.18	678,863.43	978,425.39
2021	721,304.20	983,596.64	1,417,628.17
2022	467,503.58	637,504.88	918,816.60
2023	679,535.01	926,638.65	1,335,536.34
2024	484,927.21	661,264.38	953,060.41
2025	732,114.99	998,338.64	1,438,875.37

Source : estimated by using Powersim for windows 2005.

V. CONCLUDING NOTES

The results of the dynamic system model simulation confirm that the cement production is influenced by historical data of the cement industry as well as cement consumption data used for both construction and non-construction purposes from 2003-2013 year. However, in terms of the cement production, the study indicated that in 2014-2025 the production of cement will be fluctuated. This fluctuation is estimated to be unable to meet the cement consumption in these years.

To improve the above estimated results of dynamics system model, further studies need to accommodate other variables including the rate of production, production capacity, exports, inflation, exchange rate, growth rate of construction projects, economic growth , global economic and population growth. The inclusion of these variables in the dynamic system model will give a better estimation. In addition, there is also a need to update the period under estimation from the period of 2003-2015 to the period of 2005-2015. Also, there is a need to specify location under study from the provincial level to the city or districts level. This is mainly because a simulation technique using dynamics model at the provincial level needs many assumptions. Therefore, caveat applies towards the findings of this study.

However, this study can be used as the starting point in estimating the future needs of cement production in the province of Banten. Based on the findings, the study suggests the following. First, there is a need to increase the number of cement industries in the province of Banten. Second, the provincial government should introduce conducive policies to attract investors to invest in cement industries to support the sustainability of cement production. Third, the increase of cement industries should be environmentally friendly. Fourth, there is a need to develop a large capacity of cement production. Finally, the government needs to monitor the availability of cements to mitigate the gap between the supply and demand of cements in this region. Thus, much remain to be done by the government of the province of Banten to sustain the availability of cement for infrastructural development.

REFERENCES

(1) Allen, Edward, 2005. Dasar-dasar Konstruksi Bangunan Bahan-bahan dan Metodenya. Erlangga, Jakarta.

(2) Badan Pembinaan Konstruksi Pusat Pembinaan Sumber Daya Investasi. 2012. Kajian Rantai Pasok Semen untuk Mendukung Investasi Infrastruktur.

(3) Balai Jembatan dan Bangunan Pelengkap Jalan,Pengaduan Jalan, 2000. Panduan Pengujian Agregat dan Pembuatan Beton, Pusat Penelitian dan Pengembangan Jalan dan Jembatan.

(4) BonettSatyaLelonoDjati.2007. SimulasiTeoridanAplikasinya.PenerbitAndi, Yogyakarta.

(5) Ilhami, Muhammad Adha.2011. Tutorial PowerSim LM Sipro. FakultasTeknik Universitas Sultan Ageng Tirtayasa, Banten.

(6) Institut Teknologi Bandung dan Lablink, IndocementTunggalPrakasaTbk, 2014. Laporan Tahunan 2014 ,Jakarta.

(7) Jurusan Teknik Sipil. 2012, Pedoman Penulisan Dan Penyusunan Penelitian Mahasiswa, Universitas Sultan Ageng Tirtayasa, Banten.

(8) Kantor Statistik Provinsi Banten 2015. Statistik Daerah Provinsi Banten. Pemerintah Daerah Provinsi Banten, Serang

(9) Kholil,2005. Penelitian Rekayasa Model Sistem Dinamik Pengelolaan Sampah Terpadu Berbasis Nirlimbah (Zero Waste) Studi Kasus di Jakarta Selatan. Jurusan Teknologi Industri Pertanian, Sekolah Pascasarjana, Institut Pertanian Bogor.

(10) Marzuki,Puti Farida, 2007. Sustainability dalam Bidang Material, Rekayasa dan Konstruksi Beton (Prosiding Seminar Nasional).FTSL-ITB, Bandung.

(11) McCormac,Jack. 2004. Desain Beton Bertulang (EdisiKelima). Erlangga, Jakarta.

(12) Muhammadi, Erman Aminullah, Budhi Soesilo. 2001. Analisis Sistem Dinamis Lingkungan Hidup, Sosial, Ekonomi, Managjemen.,UMJ Press, Jakarta.

(13) NovitaAnggraeni. 2006. Supply-Chain Management. Yogyakarta.

(14) Nyoman Pujawan, 2011. Supply Chain Management Agroindustri yang Berkelanjutan. Lubuk Agung, Bandung.

(15) RahayuUtami. 2006. Penelitian Simulasi Dinamika Sistem Ketersedian UbiKayu di Bogor.Jurusan Teknologi Industri Pertanian, Institut Pertanian Bogor.

(16) Rosman, Ahmad. 2007. Bahan Bangunan Sebagai Dasar Pengetahuan.Bangun Cipta, Jakarta.

(17) Suryawan, A,2009, Perkerasan Beton Semen Portland (Rigid Pavement)- Perencanaan Metode AASHTO 1993 Spesifikasi Parameter Desain.Beta Offset, Yogyakarta.

(18) TetenW.Avianto. 2007. Tutorial PowerSim, Publikasi System Dynamics.Lablink,Jakarta.

(19) Tirta,DanuG. 1999. Teknologi Beton Lanjut. Universitas Katolik Parahyangan, Bandung.

(20) Thomas J. Kakiay.2004. Pengantar Sistem Simulasi.Penerbi Andi, Yogyakarta.

(21) Tomy Perdana dan Teten W.A 2014. Analisis Kebijakan Pengembangan Sistem Rantai pasok Industri perberasan dengan pendekatan system Dynamic.Laboratorium Fakultas Agribisnis, Universitas Padjajaran, Magister Study.

http://www.bappenas.go.id/id/id/ [4 April 2016, 20.00 WIB]

http://www.semenindonesia.com[27 Maret2016, 14.00 WIB]

http://www.bantenprov.go.id[15 Maret2016, 17.00 WIB]