Improving production capacity of Pre-Cast Concrete Production Using Simulation

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Abstract. The use of Pre-Cast Concrete (PCC) recently increased significantly as precast components in building construction. This condition has let to the manufacture to increase production capacity to meet the demand. The aim of this study is to develop alternative model combination in order to increased production capacity to each workstation. A discrete event system simulation model in PCC manufacture is built under SIMIO. The case study is investigated based on current data of production flow and capacity of PCC manufacture in Makassar. The result of simulation illustrate that by adopting different capacity combination of the pouring station, cutting, autoclave and packing will obtain optimal production capacity.

Keywords: Aerated Light Concrete, manufacture, simulation, SIMIO

1. INTRODUCTION

In the era of globalization, the development of the manufacturing companies is constantly increasing. In pursuit of the target market needs, the company continues to increase and improve the production processes. The use of new technologies that will encourage optimal production results can be achieved. Efforts to increase production capacity by adding capacity on each production line in the form of additional facilities or the means of production and human resources must pay attention composition that fits into a system that effective and efficient.

The development of eastern Indonesia continues to increase in each of the sectors, not least the buildings materials sector needs. Constructions of large buildings are more and appropriate materials must support faster processing time. Most of these requirements are still derived from industrial production in the island of Java. Seeing the needs of a huge market, the opportunities for companies located in eastern Indonesia to develop its production in this sector.

The precast concrete industry in South Sulawesi is very traditional and highly influenced by fluctuated construction market. PT Bumi Sarana Beton is committed to build a production facility Concrete Aerated Autoclave (AAC) or so-called Brick Light the first in Eastern Indonesia, specifically in the city of Makassar in 2011. It is a lightweight building materials with high strength and ability excellent insulation, also provides the ease, speed, neatness in constructing all types of buildings, residential, commercial and public facilities.

2. LITERATURE REVIEW

Several research projects, using simulation technology to improve the performance of the precast concrete product manufacturing systems, have been conducted. Dawood (1995) developed a scheduling model using the simulation modeling approach in order to help production managers to make better planning decisions, and explore alternative options. Liu (1995) used a discrete-event simulation methodology in modeling the construction of precast concrete parking structures. Marasini, et al (2001), presented an innovative stockyard layout planning system for a precise building products industry.

Vern (1998) developed a simulation model to capture many of the random elements, and facilitate the analyses of complicated "what-if" scenarios, within the precast concrete building elements. Sacks (2004) emphasized on the importance of studying the pre-casting processes in order to find the ways in which companies can manage businesses to achieve best performance of their production systems. Bravo (1998) used the simulation for the production of precast pieces in a workshop to obtain several working alternatives. The main objective was to improve productivity and therefore reduce the production costs. Shi, et al., (1998) adopted the simulation technique for modeling and simulating public housing construction in order to speed up the public housing construction process with the intention to conclude the appropriate floor cycle construction time and necessary resource combinations. Benjaoran, et al. (2005) proposed an integrated, comprehensive planning system called Artificial Intelligence Planner (AIP) to improve the efficiency of the process by targeting production planning as it has a significant impact to the success of business.

The limitations in the above literature are that the modeling has been focused on one part of the system and the lack of applied innovative intelligent enterprise tools where a holistic approach would be more effective.

The rest of the paper is organized as follows: section 3 describes the research methodology; section 4 presents development of ESPC model, section 5 shows the experimental work, section 6 presents results analysis and interpretations, and section 7 outlines the conclusions and future developments.

The next section will define the research methodology and other related objectives.

3. RESEARCH METHODOLOGY

The aim of this ongoing research is substantially to improve the current practice of production planning by applying simulation tools and methods that will integrate the whole precast concrete enterprise. The main objectives of the research are:

1. To study current processes, and develop a improved process of the precast concrete products manufacturing plant, in order to understand the production flow processes that exist.
2. Develop a system framework and a simulation prototype to analyze the precast manufacturing system and to identify the resource bottleneck.

To satisfy the above objectives, the following methodology has been developed:

1. Data collection from the precast manhole manufacturing industry has been conducted through data collection at different precast concrete products manufacturing companies.
2. Integration Definition for Function Modeling (IDEF0) has been used to model the decisions, actions, and activities of the production processes in the precast concrete industry.
3. Discrete Event Simulation methodology is used to develop an enterprise simulation model that will enable the planners to identify the bottlenecks and to improve the productivity to achieve the best course of action using Simio 6. 97. 10725 simulation software.

2. LITERATURE REVIEW

Time measurement is a measurement technique to record periods of work and comparison work on a particular element of work performed under certain circumstances as well, and to analyze the information in order to obtain the time required for execution of the work at a certain achievement level.

Production is a process of converting an input transport (inputs) into outputs that have an added value (Ahyari, 1984). So the value of production is a calculation of output divided by input. So output should have a higher value compared to its input.

The conceptual model is the result of efforts in data collection and formulation of a person's thoughts (with notes and diagrams) of how the system operates. Building a simulation model requires a conceptual model, which is converted to into the simulation model. To perform such a transformation requires two important things in a person's thinking. First, the modeler must be able to think of a system within the paradigm models are powered by software that is being used. Second, a variety of different ways, which makes it possible to model the system, must be evaluated to determine the most efficient and most effective way to represent the system.

Simulation is a methodology for conducting experiments using a model of a real system, the simulation is a decision-making model to imitate or use a real picture of a system 's life without having to experience the real world in real state. Simulation is a technique that can be used to formulate and solve models from a broad group.

Simio in the first release in 2007. Simio created by Dr. C Dennis Pegden (creator SIMAN and Arena) to introduce a leap in the development of simulation technology. Ability to define and align objects using the logic of the process of the code, bringing enables non - programmers to use. Didukun aGoogle Warehouse that provides access to 3D symbols and overcome a major barrier to the effective use of 3D animation.

verification Model

Verification is the process of determining whether to operate in accordance with the model correctly. During the verification process , the modeler trying to detect errors that undue logical data model and then eliminate them

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Model Validation

Validation is the process of determining whether the model has been accurately represents the real system is observed. The model can be run with a precise but not necessarily accurate. Thus it is necessary to test the model validation. The term of validity turned out to have a diversity of categories (Harrel , Ghosh , Bowden 2003)

The steps that must be done to make the process of validation testing, namely:

Ho: $\mu 1 - \mu 2 = 0$

H1 : $\mu 1 - \mu 2 \neq 0$

Where $\mu 1$, is the average output of sistem nyata and $\mu 2$ is the average output of the simulation results. Compute the sample mean by the formula:

$$\bar{x}_{(1-2)} = \frac{\sum_j^n \bar{x}_{(1-2)}}{n} \quad \ldots\ldots\ldots\ldots(1)$$

Calculate the sample standard deviation by the formula:

$$S_{(1-2)} \sqrt{\frac{\sum_{j=1}^n [(x_{(1-2)j} - \bar{x}_{(1-2)})]}{n-1}} \quad \ldots(2)$$

Test Replication with the formula :

$$e = \frac{t_{(n-1,a/2)} s_{}}{\sqrt{n}} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$n' = \left[\frac{z_{(a/2)} s_{}}{e}\right]^2 \quad \ldots\ldots\ldots\ldots\ldots(4)$$

Accept H0 if interval memuat number zero (0)

Note: The model is said to be valid if Ho diterima and is said to be invalid if Ho is rejected.

3. RESEARCH METHODOLOGY

The research methodology is the sequence

of the steps and frame of mind in doing a study. By making a systematic methodology, can help researchers in conducting more focused and make it easier to analyze the problem, and draw conclusions from the problems examined. Berikut diagram flow simulation research methodology and flowchart as shown in Figures 1 and 2.

4. RESULT AND DISCUSSION

Based on the conceptual been made then the next will be to design a simulation in which the First Station (ballmil) not dimsukkan because at this station processes have different units and time operations that do not follow the process wakatu next process because the station results in the form of fluid stored in the tank penyimpana to be used at the next station. Process simulation runs with a duration of 6 days later diukur.hasil outputnaya. Adapaun rare hereinafter namely:

1. Initial Simulation (existing)

a. source

Source of this research is early arrivals started ballmill process.

b. server

Server operations or processes that correspond to the workstation. CCR station, Pouring, Cutting, Autoclave, and Packing. Server was included time distribution has been obtained.

c. sink

Sink is the point show the final result product or point the process is complete. Sink displays the amount of output produced.

d. Combiner and Separator

Use of combiner on the process before the autoclave process that aims to make 10 molding into one molding, so that it can be processed 10 simultaneously. Whereas Separator to restore one molding had to be 10 and make mouldingnya 1 to 3 per 1 cubic

e. path Network

Path Network in this model is the path traversed by the entity from the Source of up to sink or transfer path between server or process stations.

2. Verification Model Home

After all the factors included building a model, a simulation is run and observed. The model is said to pass the verification stage when it does not have bugs and errors.

Based on a conceptual model then the design simulation on the model. The design begins with Source Station ballmil as awalannnya point. Furthermore, to the function server disinih CCR entered the station, pouring, cutting, Autoclave and packing. In this section set according to actual sisitem. Setting capacity in which CCR 1, pouring 21 cutting 1, Autoclave 10 and packing 1. The production facilities in the actual conditions at the cutting station have one engine and the cutting station has three units Autoclave Autoclave with 1 boiler. Including the value of the process or the measurement data that previously had surgery performed adequacy testing began testing the data, test data and test the uniformity of distribution patterns. Extra Separator and Combiner for some stations to adjust to the actual system. Then the Source to the end point of the production process. Recently in an earlier panel did connexion with Time Path pseudo-sections can be run on a simulated system. At the Time Path included Transfer time for which data has been obtained.

After research, the existing system simulation system will be run where the system timed yaknik 6 working days. After the run if the simulation does not run into bugs and errors then the model is said to pass the verification stage. Furthermore aplakasi replication is performed 5 times, to see whether the output results obtained in accordance with the number of replication minimu. Results replication then do a test to determine the replication test standard deviation in advance and enter into the equation replikas test. Results are obtained initial replication as much as 4 or 5 already stated enough. After that the output results have didapatka then dilakuakan Validation testing to compare with the condition actuatl. The results are displayed on table.1.

Comparisons are then tested T -test, disinih researchers used a helper program MINITAB. MINITAB pengolaha results with the results obtained show that the Mean output in ectual group by 1002 with a standard deviation of 16.4, while the existing group Mean of 1015.2 with standard deviation of 10.7. The result is the t value of 1.5 on a degree of freedom (df) 6 with p value of 0.138 which is greater than the critical limit of 0.05 so the answer is to accept H0 or hypothesis , which means there are similarities Mean meaningful / significant between groups actual and exiting.

Once the simulation has completed the draft design of experiments conducted unusual models. Seeing the actual condition of the stations that need additional facilities based sequence procurement costs and facility needs of the system. Do alternative combination with penanmbahan capacity at each station. Then gained the capacity in the test range and combined the pouring 21-40, Packing 1-6, Autoclave 3-4 and cutting 1 - 2. After dilakukann experiments on the simulation program based on the combination gained 480 scenarios. Simulations will run 5 times replication and the resulting output will look for value - average in each scenario. The results shown in Lampiran.1.

Based on the results didadat on a combination of 21-40 pouring, 1-6 Packing, 3 auoclave and 1 cutting the obtained optimum results at 40 pouring and 3 packing with the result output as much as 1032 m3 unit brick Ringa, Although the In Packing 6 also get output the same one. However consideration in penerpannya which will cost more.

Didadat results in a combination of 21-40 pouring, 1-6 Packing, 3 autoclave and 2 cutting optimal results are obtained at 38 and 3 packing pouring with output results as much as 1050 m3 lightweight brick unit. When compared to the other scenarios in this combination, it is the most optimal scenario with a balanced combination between stations.

Didadat results in a combination of 21-40 pouring, 1-6 Packing, 4 autoclave and 1 cutting optimal results are obtained at 31 and 6 pouring packing with the result output as much as 1362 m3 lightweight brick unit. By packing the same in the pouring 32 obtained the same results. Companies can choose this scenario because the actual moment happens applied kondisis will change - change and may be a delay.

The results obtained in combination 21-40 pouring, 1-6 Packing, 2 auoclave and 2 cutting optimal results are obtained at 38 and 5 packing pouring with output results as much as 1380 m3 lightweight brick unit. When compared to the other scenarios in this combination, it is the most optimal scenario with a balanced combination between stations.

Based on the results that have been obtained, the obtained four alternative proposal which is as follows:

From the picture above, it can be seen with the addition of capacity that exists today it is necessary to increase the capacity of pouring. Even though the result is not significant but will have no effect on the actual conditions in case keterlamabatan. With the addition will balance each production line. So even with the addition of Cutting machine, the addition will reduce production ketelambatan if there is damage to one of the cutting machine. Also cutting machine operator does not need to be added because the use is not too heavy. Unfortunately this will take a large fee for the procurement costs significantly. Addition of Autoclave berengaruh would significantly increase the range of 200 units. This is especially useful if the demand is quite large. Companies will be able to meet the demand. However, this composition will charge lainnnya station, then need to be supplemented with an engine capacity and cutting as many as two other stations that are tailored to the simulation results. If this system is applied then Sagat well with the actual conditions of today, where there is a fluid tank on the station ballmill are not enabled.

5. CONCLUDING REMARK

After the design simulation on the existing condition which was further verified, validated test of replication and the obtained results in 1015 output per m3 lightweight brick. In the simulation of alternative 1 with the addition of pouring and packing capacity obtained optimum results in 1032 per m3 lightweight brick. In the simulation of alternative 2 with the addition of capacity pouring, cutting and packing obtained optimum results 1050 per m3 lightweight brick. In the third alternative simulation with pouring capacity additions, autoclave and packing obtained optimum results in 1362 per m3 lightweight brick. And at alternative simulation 4 with the addition of capacity pouring, cutting, autoclave and packing obtained optimum results in 1380 per m3 lightweight brick.

2. Based on the results of some of the alternatives that have been obtained, the alternative to a 4 as the best alternative proposals with the highest output results that is 1380 per m3 lightweight brick. In alternative 4, the addition of capacity at the station pouring, cutting, autoclave and packing. Where to detail combined capacity that is 38 pouring, cutting 2, 4 and 5 packing autoclave.

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