Productivity Measurement using Objective Matrix (Omax) Method and Efforts to Improve Ready Mix Concrete Industrial in Batching Plant

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Abstract

The productivity of batching plants in the ready-mix concrete industry plays a very important role. It aims to determine the extent of the level of efficiency, effectiveness, and inferential. Batching plant is an areato produce ready mix concrete which is then sent to the construction site using a truck mixer. Some of the problems that occur in the batching plant include the accuracy of the production plan that is not achieved and high overtime hours. This results in losses for the company. The purpose of this study is to measure productivity using the Objective Matrix (OMAX) method. The standard productivity index value in the OMAX method is 300, where this value is at the score level 3. After knowing the productivity index, then look for factors causing low productivity. For this stage, there are color indicators, namely green, yellow, and red. The red color is a factor causing low productivity. The final stage provides recommendations for improvement to increase productivity at the batching plant. During 2020, batching plant productivity experienced a significant decrease in June by -78.72% and the highest productivity index occurred in September at 183.33%. And it is known to increase productivity with a production of 14200 m3/month requires the use of electrical energy of 142.72 kWh, the accuracy of the production plan is 13484.97 M3, a workforce of 70 people, truck mixer 27 units, and overtime hours of 18.15 hours.In addition, it can also be done with real improvement efforts.

KEYWORDS: Measurement, Improvement, Batching Plant, Ready Mix Concrete, Productivity, Objective Matrix (OMAX), Management Control

Introduction

The ready-mix concrete industry is an industry that is currently growing and developing. Every concrete industry is required to try to maintain the stability of its performance, to survive in the competitive competition. Therefore, the company is obliged to improve its performance in each period so that it can be superior to its competitors. Batching plant is a concrete factory that can produce ready mix concrete products. Ready-mix concrete products produced by the batching plant must continue to be maintained for quality and quality until the product arrives at the construction site. therefore, in the delivery process, ready-mix concrete must be stirred in the mixer truck until arrive at the construction site. Continuous increase in productivity at the batching plant is very important to keep the company in good condition. Productivity at the company level is generally used by management to analyze, measure, and improve the level of efficiency, effectiveness and also to measure how optimally the company uses its resources in producing products. The factors that cause, low productivity must be identified, so that they can be evaluated and recommendations for improvement can be found, so that the factors that cause, low productivity do not occur again in the future. To find out the productivity

factor, what needs to be done is to first measure the level of productivity. One method to measure the level of productivity is to use the objective matrix (OMAX) method. Objective matrix (OMAX) is a partial productivity measurement system developed to monitor the productivity of the elements contained in the company, with productivity criteria that are in accordance with the level of importance of these elements (objective). There are three important aspects of measuring productivity by using OMAX, that is:

- Awareness

    Understand productivity problems, there is a possibility of increasing productivity, able to increase productivity.

- Improvements

    Know how to do it, able and willing to carry out repairs.

- Maintenance

    Maintain progress and maintain the spirit of progress.

    There is a period in the Objective Matrix (OMAX) method that is worth 300. This period is considered to standard performancewhich means that the score for all criteria is at level 3. If the productivity index is known, then to find out the lowest productivity period is by analyzing the score results. For this stage, there are color indicators, namely green, yellow, and red.

- Green, namely the achievement of a performance indicator has been achieved.
- Yellow, namely the achievement of a target performance indicator that has not been achieved even though the indicator value is close to the target.
- Red, that is, the achievement of a performance indicator is below the target and needs to be corrected immediately.

    5 Whys Analysis is an approach method to find the root cause of a problem by asking "Why"/"Why" 5 times. Not always five times, sometimes more than five times or less than five times, the point is to keep asking "Why" until you can understand what needs to be done to solve a problem. Then the fishbone diagram will identify all the potential causes of a problem, and analyze the problem through a brainstorming session. Problems will be divided into several related categories, including man, materials, machines, procedures, methode, and so on. Each category has causes that must be described through a brainstorming session. 5W1H is an action plan that clearly states each corrective action.

Study Literature

    Gujar et.al (2018) Shantideo Gujar et.al (2018) This study discusses the problem of increasing productivity in the manufacturing industry, where productivity increases are carried out using various types of tools and techniques that can increase efficiency, and industrial productivity., Hasbullah and Kustiadi (2019) This study measures productivity using the objective matrix (OMAX) in the aluminum

diecasting industry. And, to determine the factors causing low productivity, it is done with the Traffic Light System (TLS)., Dewi and Nusraningrum (2020) discuss productivity using the objective matrix (OMAX) and recommend increasing productivity., Damsiar et. Al. (2020) in this study applied lean manufacturing, which aims to help eliminate waste that arises in the metal pressing line in order to determine work productivity., Gupta and Galkwad (2020) discuss the use of the Analytical Hierarchy Process (AHP) in testing the feasibility of the ready-mix concrete industry. Fadli and Nugroho (2021) in this study implement PDCA to increase the productivity of the TBR Off-Road compound tread in the tire factory.

Methodology

The type of research used is descriptive quantitative research. Descriptive quantitative research is one type of research that is detailed, systematic, and structured. This research method focuses on the use of numbers. In addition, this study uses tables, graphs, and diagrams to show the results obtained. In this study, the variables are productivity efficiency, productivity effectiveness, and productivity inferential.

The data used are primary data obtained from focus group discussion (FGD)activities at the batching plant and secondary data, namely data related to production at the batching plant, including production plan data, production realization data, electricity consumption data, total data labor, total truck mixer data, total working time data, total overtime data. Stages of research include:

- Focus group discussion (FGD) is used to obtain more important productivity criteria used in research, and to determine the weight of the predetermined criteria. based on that later the criteria will represent the elements of efficiency, effectiveness, and inferential.
- Measurement of productivity using the Objective Matrix (OMAX) method. This stage is the measurement stage which includes: Calculation of the productivity ratio, Determination of performance standards and performance scales, Determining the score of each criterion, Calculation of the achievement value of each criterion, Calculation of performance indicators, and Calculation of productivity index.
- Measurement analysis. This stage is the analysis stage of the results that have been known from measurements with the objective matrix (OMAX) method, the analysis carried out includes:

  - Analysis of the achievement of the score of each criterion.
  - Analysis of indicators for each criterion.
  - Analysis of the productivity index of each criterion

- Improvement efforts. At this stage, a focus group discussion (FGD) was conducted to find detailed causes, as well description of the causes and effects of the problem, and provide improvement efforts to increase productivity at batching plant. Some of the steps taken at this stage include.

  - Analyse the problem in detail using the 5 whys analysis method.
  - Describing the cause and effect of the problem are carried out using the fishbone diagram method.

- The proposed improvement uses the 5W1H method.

Result

Determination of Productivity Criteria

This study, used productivity criteria as many as 5 criteria which are divided into 3 dimensions, it's:

- Efficiency Criteria

    Is a criterion that shows the types of resources used by the company. Efficiency criteria include:

    - Use of electrical energy
    - Labour
    - Mixer trucks
- Effectiveness Criteria

    Is a criterion that shows the company's performance, based on the results that have been achieved by the company. based also on the accuracy and quality of the resulting product. Effectiveness criteria include: Accuracy of production plan

- Inferential Criteria

Is a criterion that shows a criterion that cannot directly affect the value or level of productivity of a company.Inferential criteria include: Overtime Hour

Data needed to calculate the ratio according to the criteria mentioned above are as follows.

Table 1 Productivity Measurement Data

Month	Production Plan (M3)	Production Realization (M3)	Total Use of Electrical Energy (KWH)	Total Labor (Man)	Total truck mixer (Unit)	Total Normal Working Hour (Hour)	Total Overtime Hour (Hour)
January	16683	15036	136,53	83	43	312	60
February	18685	12127	151,18	83	48	300	48
March	18685	13799	148,22	83	39	312	60
April	18685	12739	149,04	83	41	300	60
May	13346	11768	145,36	83	43	288	84
June	18685	10890	176,03	83	45	300	60

July	18685	16680	178,75	83	34	312	60
August	18685	16482	181,87	82	33	300	72
September	18685	19368	164,10	82	34	312	48
October	18685	14857	244,53	82	30	300	72
November	18685	15052	132,80	82	30	312	48
December	13346	11604	128,91	81	29	312	60

Productivity Criteria Ratio Calculation

The formula used in calculating the productivity ratio is as follows:

Criteria Ratio, 1: Use of electrical energy = $\dfrac{\text{Total production realization}}{\text{Total use of electrical energy}}$ (1)

Criteria Ratio, 2: Labour = $\dfrac{\text{Total production realization}}{\text{Total labour}}$ (2)

Criteria Ratio, 3: Truck mixer = $\dfrac{\text{Total production realization}}{\text{Total truck mixer}}$ (3)

Criteria Ratio, 4: Accuracy of production plan = $\dfrac{\text{Total production realization}}{\text{Total production plan}} \times 100\%$

Criteria Ratio, 5: Overtime hour = $\dfrac{\text{Total overtime hour}}{\text{Total normal working hour}} \times 100\%$ (5)

Table 2: Productivity Ratio

Month	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
January	110,13	181,16	349,67	90,13	19,23
February	80,22	146,11	252,65	64,90	16,00
March	93,10	166,25	353,82	73,85	19,23
April	85,47	153,48	310,71	68,18	20,00

May	80,96	141,78	273,67	88,18	29,17
June	61,86	131,20	242,00	58,28	20,00
July	93,31	200,96	490,59	89,27	19,23
August	90,63	201,00	499,45	88,21	24,00
September	118,03	236,20	569,65	103,66	15,38
October	60,76	181,18	495,23	79,51	24,00
November	113,34	183,56	501,73	80,56	15,38
December	90,02	143,26	400,14	86,95	19,23

Determining Standard value, upper Control Limit, and Lower Control Limit Value

- Determination of the lower control limit value by using the worst ratio value during the measurement period. worst ratio is expressed by level 0.
- Determination of the standard value is obtained from the calculation of the average ratio from January to March. Standard values are expressed by level 3.
- The value of the upper control limit is the value expected by the company. this ratio value is expressed by level 10.

Table 3 : Standard Upper Control Limit, and Lower Control Limit Value Ratio

	Criteria 1	**Criteria 2**	**Criteria 3**	**Criteria 4**	**Criteria 5**
Upper Control Limit	100,00	200,00	500,00	100,00	0,00
Standard value	94,48	164,51	318,71	76,29	18,15
Lower Control Limit Value	60,76	131,20	242,00	58,28	29,17

Calculating Interval Values

The calculation of the interval value is divided into 2. The equations used are as follows:

Interval value, $\overline{\text{level 1-2 = Level 3}}$ − Level 0 (6)

3 − 0

Interval value, $\overline{\text{level 4-9 = Level 10}}$ − Level 3 (7)

10 – 3

The results of the calculation of the interval value of each criterion are shown in table 4.

Table 4 Interval Recapitulation

Interval	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
1 - 2	11,24	11,10	25,57	6,00	-3,67
4 - 9	0,79	5,07	25,90	3,39	-2,59

Calculation of the level value for each criterion with the following formulation:

Level 1 = Level 0 + (standard interpolation level 1-2)   (8)

Level 2 = Level 1 + (standard interpolation level 1-2)   (9)

Level 4 = Level 3 + (standard interpolation level 4-9)   (10)

Level 5 = Level 4 + (standard interpolation level 4-9)   (11)

Level 6 = Level 5 + (standard interpolation level 4-9)   (12)

Level 7 = Level 6 + (standard interpolation level 4-9)   (13)

Level 8 = Level 7 + (standard interpolation level 4-9)   (14)

Level 9 = Level 8 + (standard interpolation level 4-9)   (15)

Table 5: Level Value Recapitulation

Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Skor Level
100,00	200,00	500,00	100,00	0,00	10
99,21	194,93	474,10	96,61	2,59	9
98,42	189,86	448,20	93,23	5,19	8
97,63	184,79	422,31	89,84	7,78	7
96,85	179,72	396,41	86,45	10,37	6
96,06	174,65	370,51	83,07	12,97	5
95,27	169,58	344,61	79,68	15,56	4

94,48	164,51	318,71	76,29	18,15	3
83,24	153,40	293,14	70,29	21,83	2
72,00	142,30	267,57	64,28	25,50	1
60,76	131,20	242,00	58,28	29,17	0

Before calculating the productivity index, the thing that must be done is to calculate scores, value, and performance indicators.

Table 6: Recapitulation of Productivity Criteria Score

Month	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
January	10	6	4	7	2
February	2	1	0	1	3
March	3	3	5	2	3
April	2	2	3	2	2
May	2	1	1	7	0
June	0	0	0	0	2
July	3	10	9	7	3
August	3	10	9	7	1
September	10	10	10	10	4
October	0	7	9	4	1
November	10	7	10	4	4
December	3	1	7	6	3

Furthermore, the calculation of the value of the productivity criteria is carried out. the value is obtained from the result of multiplying the score with the weight. The weight value is determined based on predetermined criteria using focus group discussions (FGD), which will be obtained as follows:

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Table 7: Recapitulation of Productivity Criteria Values

Month	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5
January	100	150	60	175	50
February	20	25	0	25	75
March	30	75	75	50	75
April	20	50	45	50	50
May	20	25	15	175	0
June	0	0	0	0	50
July	30	250	135	175	75
August	30	250	135	175	25
September	100	250	150	250	100
October	0	175	135	100	25
November	100	175	150	100	100
December	30	25	105	150	75

Productivity Calculation of Performance Indicators and Productivity Index

Performance indicators aim to see whether there is an increase or decrease in productivity. To calculate the perfor-mance indicator, it is obtained from the sum of the values of the overall criteria ratio. The productivity index is calculated using the productivity index formula. used a base period of 300 with an estimate that the company's productivity reaches the initial standard, which is reaching a score of level 3. The calculation of this productivity index is obtained by comparing the results of the current period with the previous period. For the productivity index value before January, it is called the base period so that for that period it is considered a standard performance. The following table shows the results of the calculation of the overall productivi-ty index for productivity criteria. The productivity index is calculated using the formula:

$$\text{IP} = \frac{(\text{Indikator performansi saat ini} - \text{Indikator performansi periode sebelumnya})}{\text{Indikator performansi periode sebelumnya}}$$

(16)

$$IP = \frac{(\text{Indikator performansi saat pengukuran} - 300)}{(300)}$$

(17)

Table 8: Performance and Productivity Index in January

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Score Level
Ratio	110,13	181,16	349,67	90,13	19,23	
Upper Control Limit	100,00	200,00	500,00	100,00	0,00	10
	99,21	194,93	474,10	96,61	2,59	9
	98,42	189,86	448,20	93,23	5,19	8
	97,63	184,79	422,31	89,84	7,78	7
	96,85	179,72	396,41	86,45	10,37	6
	96,06	174,65	370,51	83,07	12,97	5
	95,27	169,58	344,61	79,68	15,56	4
Standard value	94,48	164,51	318,71	76,29	18,15	3
	83,24	153,40	293,14	70,29	21,83	2
	72,00	142,30	267,57	64,28	25,50	1
Lower Control Limit	60,76	131,20	242,00	58,28	29,17	0
Scor	10	6	4	7	2	
Weight (%)	10	25	15	25	25	
Value	100	150	60	175	50	
Performance Indicator	Current Performance	Basic Periode	Productivity Index			
	535	300	78,33			

The following table shows the results of the calculation of the performance indicators and the overall productivity index of the productivity criteria.

Table 9 Performance Indicator and Productivity Index

Month	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Performance Indicator	535	145	305	215	235	50	665	615	850	435	625	385
Basic Period	300	300	300	300	300	300	300	300	300	300	300	300
Productivity Index (%)	78,33	-51,7	1,67	-28,3	-21,7	-83,3	121,7	105	183,3	45	108,3	28,33

Determining Low Performance Criteria

The analysis aims to see the scores generated by each of the productivity criteria that are below, right, or above the standard performance. Below are the provisions for analyzing the criteria for low performance.

🟩	Green color with a threshold (Level 7 to level 10) means that the performance has reached the Lowest value
🟨	Yellow color with a threshold (Level 3 to level 6) means that the performance has reached the Average value
🟥	Red color with a threshold less than level 3 means that the performance has reached the Lowest value

From the above provisions, we can specify each score as in the table below :

Table 10 Performance Criteria Analysis

Month	Score 1	Score 2	Score 3	Score 4	Score 5
January	10	6	4	7	2
February	2	1	0	1	3
March	3	3	5	2	3
April	2	2	3	2	2
May	2	1	1	7	0

June		0		0		0		0		2
July		3		10		9		7		3
August		3		10		9		7		1
September		10		10		10		10		4
October		0		7		9		4		1
November		10		7		10		4		4
December		3		1		7		6		3

From the table above, we can see the criteria that have a sub-standard value given the identity in red, while the values entered in the standard are colored yellow, and the values that are above the standard or in accordance withthe target value of the company is being colored green.

Recommendations and Efforts to Increase Productivity

Of the five productivity criteria measured, it can be seen that criterion 1 (overtime hours) got the worst achievement, were from the 12 Month measurement period, there were 6 months whose score was below the standard value of 3, with a total score of only 28. For the analysis of the causes of the low productivity index based on fishbone diagram analysis, the results are as shown in the following table.

Table 11: Fishbone Diagram Analysis

Factor	Causes Analysis
Man	High employee overtime hours
	Overtime based on own intuition
Method	Production plan changed
	Work concept that doesn't work
Material	There are requests on holidays
	Material conditioning
Machine	Machine breakdown

Then proceed with using why-why analysis to find the causes of factors, as described in the following table.

Table 12: Why-Why Analysis

Problem	Why	Why	Why	Why	Why
Decreased productivity of overtime hour criteria	a) High employee overtime hours (Man)	No overtime limit	There is no overtime regulation	No overtime requirements	Managerial less effective
	b) Overtime based on own intuition (Man)	Lack of supervision	Leaders are not firm	No overtime requirements	Managerial less effective
	c) Production plan changed (Method)	There was a technical problem on the site	Customers are not prepared	The customer does not re-check	Customers lack manpower
	d) Work concept that doesn't work (Method)	Lack of supervision	Leader supervision is less effective	The training program has not been effective	The concept of training has not been effective
	e) There are requests on holidays (Material)	Lack of coordination	Leaders are not incentivized in communication	The managerial system has not been effective	The training program has not been effective
	f) Material conditioning (Material)	Mixed materials	Materials are not separated	QC lacks coordination	Leaders are not firm
	g) Machine breakdown (Machine)	Machine is not maintained	Lack of supervision	Empty spare parts	Leader lacks communication

To facilitate the analysis of the cause of each factors, the analysis was performed using 5W1H as shown in the following table:

Table 13: 5W1H Approach

What	Why	Who	Where	When	How
a)	So that employees are monitored in working overtime so that performance can be optimal	All employees	Batching plant	Every day	Provide overtime limits and provide overtime requirements in accordance with the production schedule. As well as the determination of overtime regulations and optimal implementation
b)	So that employees work according to their needs	All employees	Batching plant	Any production outside planned hours	Making overtime regulations and selecting employees according to the needs of the production schedule.
c)	To make production activities clearer and smoother	Dispatcher (Production Leader) & Customer	Production Division	Every day	Conduct a site survey to ensure the production plan changes or not, Adjusts to the production plan that will be implemented
d)	So that work is more disciplined, organized, and according to work instructions	Plant Manager	Batching plant	Every day	Directing each division leader to increase supervision for each member of his division
e)	So that the use of production inputs is in accordance with existing demand	Dispatcher (Production Leader)	Production Division	Every day	Conduct intensive coordination with consumers to minimize impromptu POs and make policies related to labor outside of production hours
f)	So as not to cause production delays	Laboratory leader	Laboratory Division	Every day	Separating materials, between qualified materials and pending materials

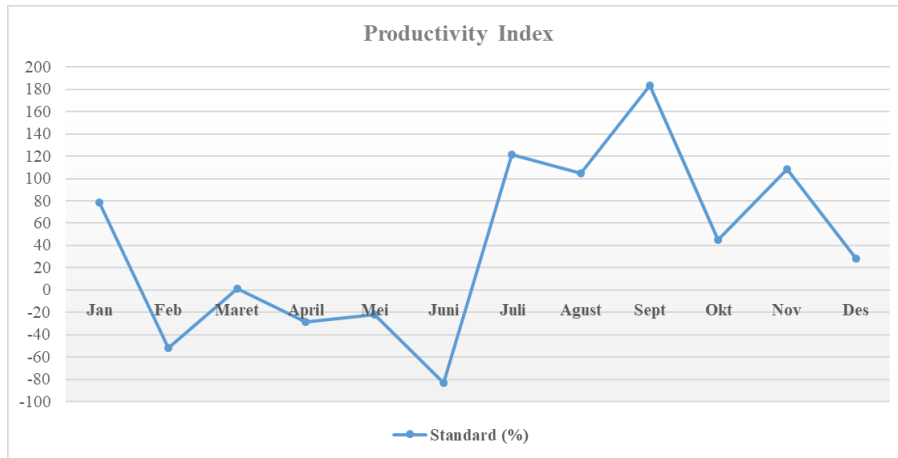| g)	So that the damaged machine is quickly resolved	Mechanic leader	Mechanical Division	Every 1 month	Providing spare parts stock and maintaining the cleanliness of machine tools so as to increase productivity and long-lasting machine quality

Conclusion

Figure 1: Productivity Index

This research was conducted to measure the productivity of batching plants in the ready-mix product industry using the objective matrix (OMAX)method. then look for the root cause of the problem of low productivity, and recommend efforts to increase productivity. from the results of the study can be seen in the form of a graph of the condition of productivity when measurements are made.

In the picture, can be seen that the company's productivity decreased significantly in June by -83.33% and, the highest productivity index was in September, which was 183.33%. The increase in productivity was caused by a very sharp increase in the performance indicator of 850. Therefore, it is necessary to take corrective measures. From this re-search and in accordance with the conclusions obtained, there are several things that become recommendations for improvement, namely:

- Productivity Improvement Recommendations based on measurement results

Table 14 : Repair Recommendations

Productivity Criteria	Production Quantity	Usage per Month	Improvement Proposal	Waste	Efficiency (%)
Use of electrical energy	14200 M3/Month	161 Kwh	142,75 Kwh	18,25 Kwh	11,33
Labor		83 Man	70 Man	13 Man	15,66
Truck Mixer		37 Unit	27 Unit	10 Unit	27,03
Accuracy of production plan		17628 M3	13484,97M3	4143,03 M3	23,5
Overtime hour		61 Hour	18,15 Hour	42,85 Hour	70,25

- Increase control in the implementation of production activities where this control must be applied at all levels, namely the level of leader, supervisor, head section, and also at the managerial level.
- Improve the discipline of all employees and increase the socialization of company regulations.
- Increase the role of leaders and supervisors in supervising.
- Improving the ability of employees by providing training that is directly related to their daily work, so that employees can understand their work and responsibilities.
- Perform regular machine maintenance, either for minor/partial repairs or overall repairs.
- Conduct intensive and continuous communication to consumers and material suppliers
- Improve the work environment by adding traffic signs and prohibition signs.
- Determination of overtime regulations, providing overtime limits and overtime requirements in accordance with the production schedule.

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