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Break Even Point Concrete Casting using Hand-assembled Mini-batching-plants and Mini-crane in Small Islands and Coastal Areas

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ABSTRACT

The purpose of this study was to analyze the break-even point or to find out a favorable point in using a concrete casting tool, between modern equipment and innovative equipment in small islands and coastal areas. This research method is to analyze by using break-even analysis on concrete casting work by using modern equipment and equipment innovation by researchers on small islands and coastal areas based on Appropriate Technology. The conclusion obtained from the concrete mixing work using modern equipment and equipment innovated by researchers on small islands and coastal areas is that the use of modern equipment is very efficient if the volume of concrete is more than 5,559.19 m^3 and very inefficient if the volume of concrete is less than 5,559.19 m^3. Meanwhile, the use of innovative equipment is very efficient if the volume of concrete is less than 5,559.19 m^3 and very inefficient if the volume of concrete is more than 5,559.19 m^3. Specifically for equipment invaded by researchers, apart from being able to lift fresh concrete according to the analysis, another advantage is that it can still lift all types of materials that will be needed in a project, another advantage is that it is based on Appropriate Technology and is easy to mobilize and demobilize to small islands and coastal areas.

Keywords: *Concrete casting, Mini-batching-plant, Mini-crane, Break-even point, Productivity, Efficiency, Appropriate Technology*

I. INTRODUCTION

Fresh concrete mixing equipment has long been invented, even has been fennel since the invention of the steam engine, engineers tried to make a concrete mixer for infrastructure development needs (Dailey, 1907), in his research on fresh concrete mixer, which is designed simply by using propulsion. The main steam engine, does not make engineers standstill, but this work has been widely used for infrastructure development, research on a concrete mixer is the first research that was developed, and this is the forerunner of the concrete mixer that is now widely used in the world although at the beginning and for the first time made using a steam engine, it was a very significant advance at that time. However, due to the development of the times, today's concrete mixer is very sophisticated using a digital system in operation and can even work alone without being controlled by the operator, this is an extraordinary thing that engineers have done to make technological changes, especially in concrete mixers.

Concrete casting equipment continues to develop, both on a small scale and a large scale, this is thanks to the hard work of engineers who try to do research dynamically and continuously to make changes and improvements to get maximum results (Turley, 1913). from time to time, is a very significant change and is the effort of engineers. Various types and models that have developed a lot and will continue to experience development, especially very much influenced by the conditions and place of use, for small areas or cities, small islands, coastal areas, and even offshore areas in urgent need of a small-scale and permanent concrete mixer. have the principle of using Appropriate Technology, this is highly recommended by many engineers, that the use of concrete mixing equipment and other tools related to infrastructure development must be adjusted to the conditions of the field or project to be carried out, do not be mistaken in choosing the equipment to be used in a certain area. Because this will have consequences related to profit or loss in the project.

The development of concrete mixers is progressing rapidly and is sophisticated and has been widely used in the development of infrastructure in major cities around the world (Sorensen et al., 2014), but the progress and development of concrete mixers that are so sophisticated, cannot possibly be used in cities. -Small cities, small islands, and coastal areas, in general, still use manual labor to do it, but this is often constrained by manual labor that is not available. So the most suitable is with small-scale concrete casting equipment and the use of Appropriate Technology, the reason is that it is very cheap, simple and does not require high technology and most important parts

and technicians are available or can repair without having to bring in technicians from other areas.

Concrete casting work is the most costly work required in a building, from mixing concrete, transportation, or lifting to the final destination or concrete mall where the concrete will harden and become a construction that will be useful as a building structure, especially for transportation. or lifting in modern equipment has used very sophisticated concrete pumping equipment (Jang et al., 2018), in general in concrete casting work there are only two jobs to be done or two equipment that must be provided, namely concrete mixing equipment and transportation equipment and concrete lifting, for transporting concrete usually using trucks and for lifting using concrete pumps or cranes and even bigger tower cranes.

Concrete mixing equipment greatly determines the quality of the concrete to be achieved, for that the rheology or viscosity of the concrete is very important, this is very much determined by the condition of the equipment, the model of the equipment and the working mechanism of the equipment, even though the use of the same material, the concrete mixing mechanism will determine the quality of the concrete to be achieved (Kwon et al., 2016; Choi et al., 2014), thus the concrete mixing mechanism in concrete equipment must really receive special attention and to determine that the equipment can work properly, by looking at the results of the work and the quality of the concrete that can reach a good value then it can be a measure of the success of a good concrete mixer.

In modern times, making concrete with a high-performance concrete(HPC) mixing process is something that has been obtained through several stages of research with various methods and utilizing concrete mixing methods using high technology working principles (de Sensale & Goncalves, 2014), of course, success and technological capabilities will be able to answer what is needed in the process of making high-quality concrete, the existence of sophisticated equipment and supported by advanced research results, so achieving these targets are not too difficult, but all must be supported by hard work and always striving to improve performance. that has been obtained to be even better.

The infrastructure used by humans in this modern civilization, all corners of the world use concrete construction as a structure, the reason is that concrete can be made using local materials with the addition of a few factory materials and the most unique is that concrete can be made using very simple and even can also use the hand method which has resulted in such a large and magnificent building (Kumar & Tegar, 2018). In fact, in big cities the use of concrete construction is very much using modern equipment, with very high quality and quality, this is a technological advancement in concrete construction as part of the infrastructure. To achieve this, it requires the readiness of sophisticated concrete processing technology and equipment that has been established in many big cities around the world (Paleologos, 2018).

The use of ready-mix is a progress that has been achieved and greatly accelerates the process of construction project work (Priya & Neamitha, 2018). However, not all small cities can have ready-mix supply factories, thus it is a challenge for contractors, and many ways are done in concrete casting work using small-scale concrete mixers and many are even found using the hand method. just need to be closely monitored according to the applicable technical specifications. The result is that many infrastructures are well established and there are no problems with construction failures, meaning what has been done or done properly and correctly, according to the technical specifications required in the work.

The use of new innovative equipment for concrete casting work is still very much needed, especially for remote areas and small cities, small islands, coastal areas, because not every small town has built high-tech concrete casting equipment, thus it is necessary carried out innovations to make changes and can help overcome these problems. The development of Appropriate Technology is needed and is the easiest breakthrough compared to other types of innovation, this is because it does not require high technology and only relies on local materials with simple methods that are more effective and efficient (Mujumdar & Maheswari, 2018). Not all types of work can be done using large and sophisticated equipment, in large projects also not all have to be done with large and sophisticated equipment, small-scale equipment is also needed as a combination for small parts because if done with large equipment it will be inefficient, usually left alone later to do with small scale equipment.

The use of Tower Cranes is used for the construction of large-scale projects, the movement of material can move both vertically and horizontally, all of these movements can replace human power which is equivalent to very much and even very crowded if completely replaced (Kaveh & Vazirinia, 2018), for small projects located in small cities and remote areas it is impossible to use a Tower Crane, this is because the rental fee for the equipment is very expensive. Meanwhile, alternative equipment and innovation tools are still lacking, thus for the construction of small cities and small islands, infrastructure development to find construction workers is very difficult, if the wages are very expensive. That is the problem that must be faced, however, the development in the area can run smoothly.

Infrastructure development generally uses a lot of construction equipment as the method used and makes it easier for humans to do a job. However, it is necessary to select and pay attention to the size of the equipment to be used, the condition of the location, the capacity including the volume that will be worked on must be considered (Ridha, 2011). This needs to be done to get the maximum results in construction work and the conditions of a large project being carried out, if the project cost is small then there is no need to use large-scale equipment, because of course it is not efficient, and so it is for projects with large costs. Then regarding the need for equipment using a large scale must also pay attention to the rate of work that requires additional equipment that is tailored to the needs in the field. The manual casting of concrete which costs using construction workers is done starting from mixing the concrete, lifting concrete, transporting concrete from one place to another using only a bucket which is carried out continuously, then the work process like this will cause pain, soreness. on flax, it can even cause work accidents

(Ridha, 2011). For that, it needs to be done properly and correctly by using ergonomic rules, therefore, it is necessary to use the equipment for casting concrete so that it can be designed and does not affect construction workers and to make it more ergonomic.

The ability of technology and the development of human science to make concrete with very strong quality is largely determined by the composition of the mixture of materials and gradations with various compositions, and the use of water content which is measured very accurately and experiments are carried out to obtain concrete with very strong quality (Hocaoğlu and Uygunoğlu, 2019; Caglar, Sezen and Olabi, 2019). All will be determined by the results of experiments in a small scale laboratory. However, if you are in the field of work or a project, it will be greatly influenced by work environment factors, thus it is necessary to do it in a laboratory that is not necessarily directly applicable in the field, especially in its use. Small-scale concrete mixers have never received the attention of researchers and this has long been done by researchers such as (Dailey, 1907; Turley, 1913). Thus, small-scale concrete mixers need modification, innovation, and development, because this type is widely used in small-volume or small-scale concrete casting work. This is because the availability of these tools is not available in small cities and remote areas? What is very important for the modification, innovation, and development of small scale concrete mixer, to get high-quality concrete only with a very accurate water content measuring device because the amount of water given will greatly affect the quality of the concrete.

In general, fresh concrete will compaction and fill in natural fresh concrete or adjust the shape according to a very determined reference or mold which is influenced by the moisture content in fresh concrete, if it does not occur naturally or by compaction itself, it is necessary to add additives (Alpaslan and Main, 2019; Lerner, Author and Führ, 2019). Fresh concrete to be able to self-compact or follow the form of mold is sufficient to increase the moisture content, but by increasing the water content, the quality of the concrete will decrease. The best is concrete with a little moisture content, but it produces high-quality concrete, it's just that compaction will not occur by itself and requires artificial or mechanical compaction or other additives are added. Thus, the water content will be absolute must be measured in a very minimal amount, but the most important thing is that it must be guided by the concrete slump according to the required technical specifications. And what needs to be paid attention to is mechanical compaction, it is not allowed to take too long and includes large vibrations, this will cause segregation of fresh concrete which results in decreased concrete quality so that compaction using mechanical means must be adjusted as necessary and not allowed to vibrate excessively.

Construction equipment as a result of the modification, innovation, and development by engineers, both on a small and large scale that has been produced by industry and designed by engineers, if the tool is to be used for construction work in the field of civil engineering, then what needs to be done is measure productivity and efficiency. If it meets the requirements, then all the results of modification, innovation, and development will be acceptable and if it does not meet the requirements, then it needs to be improved continuously until finally, it can meet the acceptable requirements because of good productivity and efficiency have been obtained. Thus it can be modified, innovated, and developed (Sunaryo et al., 2020). Thus this process continues to be carried out by engineers, and the most important thing in the modification is to be able to consider the surrounding environmental conditions, especially the availability of raw materials, spare parts, and other components as support in innovation, the availability of local wisdom and using the principles of technology. Appropriate, and it is hoped that the results of innovation can be carried out by local technicians or personnel and do not require special personnel to be brought in to handle Appropriate Technology.

II. LITERATURE REVIEW

Concrete casting work is a very important and big job in the infrastructure sector, this work process must be done well, to get good quality concrete, it is necessary to learn how to mix concrete. And very importantly this is highly recommended by (A. M. Neville, 2011; A. M. M. Neville & Brooks, 2010), that fresh concrete casting has the properties of a fresh concrete mixture which characteristics must be known so that the concrete casting procedure can be understood properly and correctly. To produce high-quality concrete, it will require materials such as cement, aggregate, the right water, and the latest is how the method of mixing concrete and the concrete mixer itself, mixing concrete without using a concrete mixer will not achieve high-quality concrete results.

In Indonesia, the regulations and guidelines used and explain the procedures for casting concrete and mixing the concrete are described and regulated by the regulations issued by the Ministry of Public Works of the Republic of Indonesia, namely Guidelines for Analysis of Unit Prices for Public Works (*Pedoman Analisis Harga Satuan Pekerjaan Bidang Pekerjaan Umum*) (PU-RI, 2013). This guideline will regulate all types of equipment used in construction work, to calculate the unit price of a work item, if the equipment has not been loaded because it has not been recently made, then what tool approach can be used if it has characteristics or resembles the work process. Likewise, for equipment that refers to the manual or technical specifications issued by the manufacturer, this is not listed in the manual but has been instructed to refer to the specifications book for issued pliers.

III. METHODOLOGY

This research method is to analyze by using break-even analysis on concrete casting work by using modern equipment and equipment innovation by researchers on small islands and coastal areas based on Appropriate Technology.

As a simulation analysis, the island of Wangi-wangi is assumed to be the destination city for the concrete

casting equipment to be mobilized, departing from the city of Kendari as the research node, for more details can be seen on the map Figure 1.

Figure 1 Research Map

IV. DISCUSSION

In Break-even-analysis on concrete casting using assembled mini-batching-plane and mini-crane in small islands and coastal areas based on Appropriate Technology, with the following details:

5.1. Rent Basic prices unit

This basic unit price only contains the wages for construction labor and fuel oil to be used in the equipment and does not include the price of materials for casting concrete, which is described in full in Table 1

Table 1 Basic prices unit

No.	Uraian	Unit	Basic Prices Unit (IDR)		Information
			Days	Hours	
A	Labor				
1	Craftsman	Hours	180,000.00	25,714.29	
2	Skilled labor	Hours	150,000.00	21,428.57	
3	Unskilled labor	Hours	130,000.00	18,571.43	
4	Operator	Hours	200,000.00	28,571.43	
B	Materials				
1	Diesel	Liters	10,000.00		
2	Gasoline	Liters	10,000.00		
3	Lubricant	Liters	50,000.00		

5.2. Rent Equipment Analysis.

In this analysis, the rental value of the tools that will be used in this study will be calculated, in full, it is described very clearly in table 2 as follows:

Table 2 Equipment rent analysis

No.	Discription	Code	Analysis of equipment rental value					Unit	Information
			Mini-crane	Mini-batching-plant	Concrete-mixer truck	Concrete-pump	Excavator		
A.	General								
1	Power	Pw	14	16	200	180	200	HP	
2	Capasity	Cp	200	12,000	6,000	5,000	80	litres	
3	Economics period	A	4	4	4	4	4	Year	
4	Operating Hours/year	W	2,000	2,000	2,000	2,000	2,000	Hours	
5	Local value	B	40,000,000	80,000,000	850,000,000	750,000,000	950,000,000	IDR	
6	Discount rate	i	10	10	10	10	10	%/Year	
7	Tax	T	10	10	10	10	10	%	
8	Insurance	Ins	2	2	2	2	2	%	
9	Fuel prices	Fp	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00	IDR	
10	Lubricant prices	Lp	50,000.00	50,000.00	50,000.00	50,000.00	50,000.00	IDR	
11	Operator		28,571.43	28,571.43	28,571.43	28,571.43	28,571.43	IDR./Hr	
12	Helper		0.00	0.00	0.00	0	0	IDR./Hr	
B.	Fixed cost								
1	Residual value 10%.Lp	C	4,000,000	8,000,000	85,000,000	75,000,000	95,000,000	IDR	
2	Depreciation	D	0.31547	0.31547	0.31547	0.31547	0.31547	-	
a	Return on capital	E	5,678.47	11,356.95	120,667.58	106,471.40	134,863.77	IDR	
b	Insurance and Others	F	400.00	800.00	8,500.00	7,500.00	9,500.00	IDR	
	Subtotal (B)	G	6,078.47	12,156.95	129,167.58	113,971.40	144,363.77	IDR	
C.	Operating cost								
1	Fuel	H	18,900.00	21,600.00	270,000.00	243,000.00	270,000.00	IDR	
2	Lubricant	I	17,500.00	20,000.00	250,000.00	225,000.00	250,000.00	IDR	
3	Workshop	J	1,500.00	3,000.00	31,875.00	28,125.00	35,625.00	IDR	
4	Sparepart	K	3,000.00	6,000.00	63,750.00	56,250.00	71,250.00	IDR	
5	Operator		28,571.43	28,571.43	28,571.43	28,571.43	28,571.43	IDR	
6	Helper		0.00	0.00	0.00	0.00	0.00	IDR	
	Subtotal (C)		69,471.43	79,171.43	644,196.43	580,946.43	655,446.43	IDR	
D.	TOTAL	T	75,549.90	91,328.38	773,364.01	694,917.82	799,810.20	IDR	
		Tx	7,554.99	9,132.84	77,336.40	69,491.78	79,981.02	IDR	
		Total	83,104.89	100,461.22	850,700.41	764,409.61	879,791.22	IDR	

Based on the calculation results in table 2, it can be seen that the value of rental of mini-crane equipment is IDR83,104.89/hours and excavator is IDR 879,791.22/hours.

5.3. Productivity and coefficient analysis

This analysis will calculate the value of productivity and coefficient on each tool that will be used in the research, with the description in table 3 as follows:

Table 3 Productivity and coefficient analysis

Innovation Equipment						Modern Equipment					
No.	Discription	Code	Coefficient	Unit	Information	No.	Discription	Code	Coefficient	Unit	Information
A	Mini-batching-plant					A	Concrete-mixer-truck				
1	Capacity	V	400.0	liter		1	Capacity	V	4,000.0	liter	
2	Equipment factor	Fa	0.81	-		2	Equipment factor	Fa	0.81	-	
5	Cycle time					5	Cycle time				
	- Loading	T1	1.50	minute			- Loading	T1	3.00	minute	
	- Mixing	T2	1.00	minute			- Mixing	T2	1.00	minute	
	- Unloading	T3	1.00	minute			- Unloading	T3	3.00	minute	
	- Manuver, etc	T4	1.00	minute			- Manuver, etc	T4	2.00	minute	
		Ts	4.50	minute				Ts	9.00	minute	
6	Production Capacity	Q	4.32	M^3/Hours		6	Production Capacity	Q	21.60	M^3/Hours	
7	Coefficient	Co	0.2315				Coefficient	Co	0.0463		
B	Mini-crane					B	Concrete-pump				
1	Capacity	V	0.08	M^3		1	Bore Capacity	V	20.0	liter	
2	Equipment factor	Fa	0.81	-		2	Equipment factor	Fa	0.81	-	
4	Bucket factor	Fb	1.00	-		5	Cycle time				
5	Material factor	Fv	1.00	-			- Stroke	T1	0.05	minute	
6	Cycle time						- Manuver, etc	T4	0.10	minute	
	- Loading	T1	1.00	minute				Ts	0.15	minute	
	- Lift Up	T2	3.00	minute		6	Production Capacity	Q	6.48	M^3/Hours	
	- Unloading	T3	1.00	minute		7	Coefficient	Co	0.1543		
	- Manuver, etc	T4	1.00	minute		C	Exavator				
		Ts	6.00	minute		1	Capacity	V	0.80	M^3	
7	Production Capacity	Q	0.65	M^3/Hours		2	Equipment factor	Fa	0.81	-	
8	Coefficient	Co	1.5432	Hours		4	Bucket factor	Fb	1.00	-	
C	Labor					5	Material factor	Fv	1.00	-	
	Total Production	P	34.56	M^3/Hari		6	Cycle time				
1	Craftsman	t	1	Men			- Loading	T1	0.30	minute	
2	Skilled labor	s	10	Men			- Manuver, etc	T2	0.20	minute	
3	Unskilled labor	u	10	Men				Ts	0.50	minute	
4	Coefficient labor/m^3:					7	Production Capacity	Q	77.76	M^3/Hours	
	- Craftsman	ct	0.23	Hours		8	Coefficient	Co	0.0129	Hours	
	- Skilled labor	cs	2.31	Hours		D	Labor				
	- Unskilled labor	cu	2.31	Hours		1	Total Production	P	172.80	M^3/Hari	
						2	Craftsman	t	1	Men	
						3	Skilled labor	s	2	Men	
						4	Unskilled labor	u	4	Men	
						5	Coefficient labor/m^3:				
							- Craftsman	ct	0.05	Hours	
							- Skilled labor	cs	0.09	Hours	
							- Unskilled labor	cu	0.19	Hours	

plant is 0.231 hours, for the mini-crane, it is 1.543 hours, while for the use of modern equipment for concrete-mixer-trucks is 0.0463 hours, for concrete-pump is 0.1543 hours, and for excavators is 0.0129 hours.

5.4. Unit Price Value Analysis

Analysis of the unit price of concrete casting work, but the unit price of this work only calculates the work wage and does not include the price of concrete material and is completely explained in table 4 as follows:

Table 4 Unit price value analysis

No.	Discription	Unit	Unit Price (IDR)	Bill of Quantity (Wages per m^3)			
				Innovation		Modern	
				coef.	Total, IDR	coef.	Total, IDR
A	Labor						
1	Craftsman	Hours	25,714.29	0.23	5,914.29	0.05	1,285.71
2	Skilled labor	Hours	21,428.57	2.31	49,500.00	0.09	1,928.57
3	Unskilled labor	Hours	18,571.43	2.31	42,900.00	0.19	3,528.57
B	Equipement						
1	Mini-batching-	Hours	100,461.22	0.23	23,254.91	-	-
2	Mini-crane	Hours	83,104.89	1.54	128,248.29	-	-
3	Concrete-mixer-	Hours	850,700.41	-	-	0.05	39,384.28
4	Concrete-pump	Hours	764,409.61	-	-	0.15	117,964.45
5	Exavator	Hours	879,791.22	-	-	0.0129	11,314.19
			Total		249,817.49		175,405.77

Based on table 4, it is obtained that the unit price of a concrete foundry work using innovative equipment is IDR249, 817.49 and using modern equipment is IDR175, 405.77. Thus, the use of modern tools is cheaper than using innovative equipment, but this value cannot necessarily be done by modern tools and it would be more profitable to work with innovative equipment.

5.5. Annual cash outflows analysis

This analysis will calculate the purchase value of the equipment that will be used in this study and include the costs of mobilizing and demobilizing the equipment to the location, in detail described in Table 5 as follows;

Table 5 Annual cash outflows analysis

No.	Discription	Innovation Equpiment		Modern Equipment	
		Value, IDR	Mobilization, IDR	Value, IDR	Mobilization, IDR
1	Mini-batching-plant	80,000,000.00	7,500,000.00		
2	Mini-crane	40,000,000.00	7,500,000.00		
3	Concrete-mixer-truck			850,000,000.00	10,000,000.00
4	Concrete-pump			750,000,000.00	10,000,000.00
5	Exavator			950,000,000.00	20,000,000.00
	Total	120,000,000.00	15,000,000.00	2,550,000,000.00	40,000,000.00

Based on table 5, the value for innovation equipment is IDR120,000,000,00 and for modern equipment is IDR2,5,50,000,000.00, in this analysis, it has started to appear, but not all of it can be concluded that the investment value for modern tools is very large.

5.6. Break Even Point Analysis

To analyze the Break-Even Point, we will use the hand-method because Microsoft Excel has not provided a special formula, but it is still supported by Spreadsheets, why is that, because Microsoft Excel will immediately create a chart. Furthermore, in detail and detail will be explained in table 6 as follows:

Table 6 Break-even point analysis

Discription	Code	Unit	TC_A (Innovation)	TC_B (Modern)
Annual cash outflows	P	IDR	135,000,000.00	2,590,000,000.00
Resale value	S	IDR	96,000,000.00	2,040,000,000.00
Discount Rate	i	%	12.00	12.00
Annual tax value	M	IDR	600,000.00	12,750,000.00
Depreciation	D		0.33	0.33
Unit price value	C_A & C_B	IDR	249,817.49	175,405.77
Total production per year (?)	t	m^3		
Annual cost (P – S) x D + S (i)	$CR(i)_A$	IDR	24,360,143.02	425,878,939.97
$CR(i)_A$ + M + C_A. t	TC_A			
	$CR(i)_A$+M	IDR	24,960,143.02	-
	C_A. t	IDR	249,817.49 t	-
$CR(i)_B$ + M + C_B. t	TC_B			
	$CR(i)_B$+M	IDR	-	438,628,939.97
	C_B. t	IDR	-	175,405.77 t
$((CR(i)_A+M)-(CR(i)_B+M))/(C_B-C_A)$	t	m^3	5,559.19	

Based on table 6, it is obtained the break-even point value of 5,559.19 m^3, which means that this value is the point of intersection between the use of innovative equipment and modern equipment, and can be fully illustrated graphically as in Figure 3 which is generated using Table 7.

Table 7 Break-even point data chart analysis

Discription		Innovation (A)	Modern (B)	Information
Annual cash outflows:				
- Mobilization, IDR		15,000,000.00	40,000,000.00	
- Value, IDR		120,000,000.00	2,550,000,000.00	
Resale value (IDR)		96,000,000.00	2,040,000,000.00	
Annual tax value (IDR)		600,000.00	12,750,000.00	
Unit price value (IDR/m^3)		249,817.49	175,405.77	
Total number of periods		4	4	
Discount Rate (%)		12	12	
D = A/P.i.n		0.3292344		
M^3	$CR(i)_A$	$TC_{(A)}$	$CR(i)_B$	$TC_{(B)}$
0	19,421,626.47	20,021,626.47	412,709,562.52	425,459,562.52
10		22,519,801.36		427,213,620.20
100		45,003,375.36		443,000,139.37
500		144,930,370.90		513,162,446.77
800		219,875,617.55		565,784,177.33
1000		269,839,115.32		600,865,331.03
2000		519,656,604.17		776,271,099.54
3000		769,474,093.01		951,676,868.05
7500		1,893,652,792.83		1,741,002,826.35

Based on table 7, the break-even point value of 5,559.19 m^3 is obtained, this means that if the concrete casting work will be more effectively and efficiently carried out with innovative tools if the concrete volume is less than 5,559.19 m^3, and it will be more effective and efficient to do with tools. moderate if the volume of concrete is more than 5,559.19 m^3, and it can be graphically depicted on the graph of Figure 3.

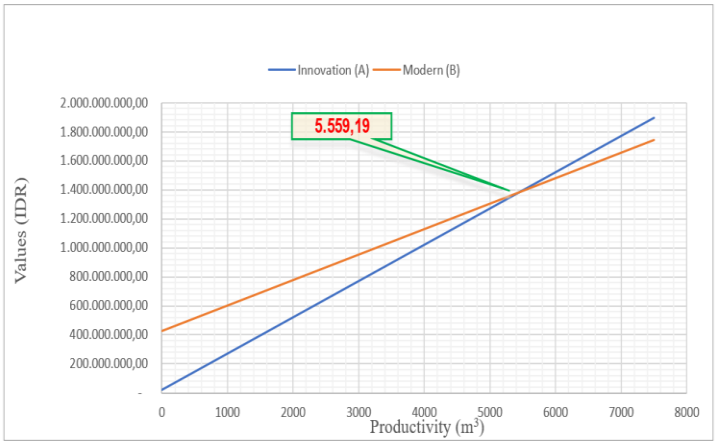

Figure 3 Break-even point chart analysis

5.7. Innovation Equipment Specifications

Concrete casting equipment, the result of innovation by researchers, is specially designed and assembled to answer and answer directly to the difficulties and scarcity of construction equipment and labor in small islands and coastal areas based on Appropriate Technology. The use of modern equipment may not be used because it is very inefficient and will be high cost and if it is forced, there will be losses.

The use of equipment based on Appropriate Technology in modern times like today is still very relevant and greatly reduced because it is simpler and cheaper and does not require high technology and spare parts are not available in imported products.

Specifications for mini-crane with a maximum lifting capacity of 800kg, 2-stroke gasoline engine (Suzuki motorcycle waste), controlled by 1 operator. For a mini-batching-plant with a capacity of 2x200 liters, equipped with a digitally controlled water pump, equipped with a material lifting bucket, using a 16 HP diesel motor main drive, the operating system is equipped with a microcontroller and controlled by 1 operator, in detail. Concrete casting equipment as a result of the researcher's innovation can be seen in figures 5 and 6.

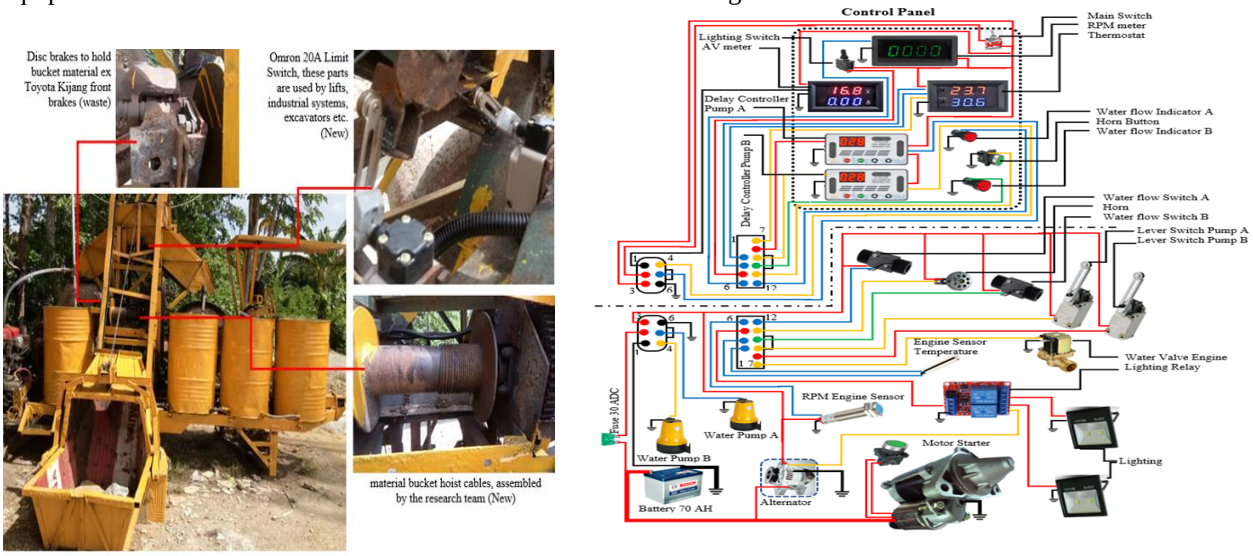

Figure 4 Mini-batching-plant and electrical wiring diagram circuit

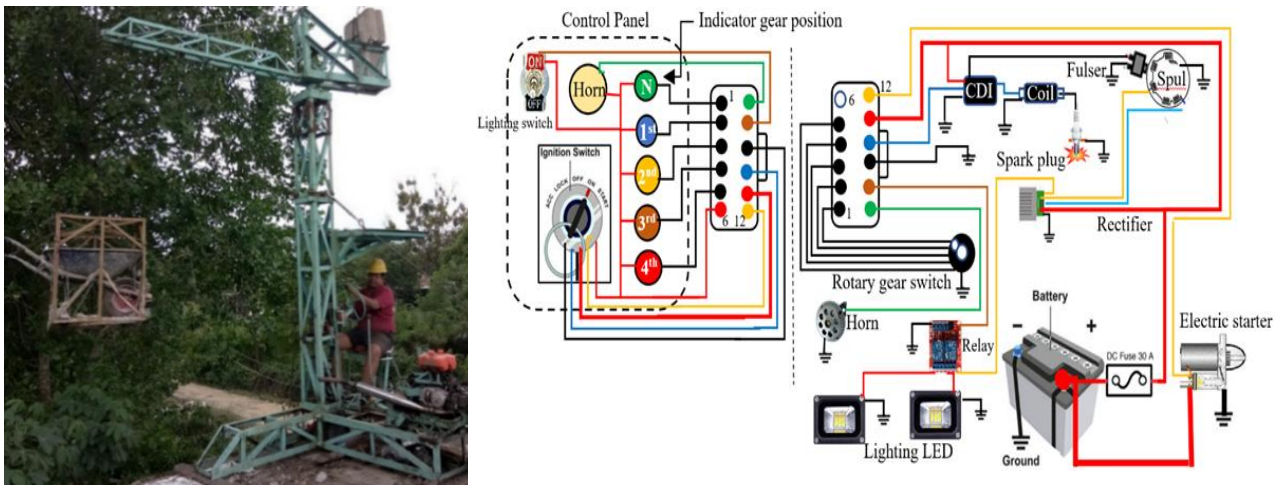

Figure 5 Mini-crane and electrical wiring diagram circuit

V. CONCLUSIONS

The conclusion obtained from the concrete mixing work using modern equipment and equipment innovated by researchers on small islands and coastal areas is that the use of modern equipment is very efficient if the volume of concrete is more than 5,559.19 m^3 and very inefficient if the volume of concrete is less than 5,559.19 m^3. Meanwhile, the use of innovative equipment is very efficient if the volume of concrete is less than 5,559.19 m^3 and very inefficient if the volume of concrete is more than 5,559.19 m^3.

Specifically for equipment invaded by researchers, apart from being able to lift fresh concrete according to the analysis, another advantage is that it can still lift all types of materials that will be needed in a project, another advantage is that it is based on Appropriate Technology and is easy to mobilize and demobilize to small islands and coastal areas.

REFERENCES

Alpaslan, M., & Main, K. (2019). Mechanical properties of self-compacting concrete with recycled bead wires. *Revista de La Construccion*, *18*(3), 501–512. https://doi.org/10.7764/RDLC.18.3.501

Blank, L., & Tarquin, A. (2012). *Engineering Ekonomi 7 Edition*. Mc Graw Hill Book Company. https://people.utm.my/shamsul/wp-content/blogs.dir/949/files/2016/03/Engineering-Economy.pdf

Caglar, N., Sezen, H., & Olabi, M. N. (2019). Numerical evaluation of core concrete quality on the response of concrete jacketed columns. *Revista de La Construccion*, *18*(2), 301–310. https://doi.org/10.7764/RDLC.18.2.301

Choi, M. S., Kim, Y. J., & Kim, J. K. (2014). Prediction of Concrete Pumping Using Various Rheological Models. *International Journal of Concrete Structures and Materials*, *8*(4), 269–278. https://doi.org/10.1007/s40069-014-0084-1

Dailey, J. A. (1907). *Concrete Mixing Machinery* [University of Illinois]. https://www.ideals.illinois.edu/bitstream/handle/2142/51649/concretemixingma00dail.pdf?sequence=2

de Sensale, G. R., & Goncalves, A. F. (2014). Effects of Fine LWA and SAP as Internal Water Curing Agents. *International Journal of Concrete Structures and Materials*, *8*(3), 229–238. https://doi.org/10.1007/s40069-014-0076-1

Hocaoğlu, İ., & Uygunoğlu, T. (2019). Effect of electrical cure of concrete on maturity and compressive strength. *Revista de La Construccion*, *18*(2), 214–225. https://doi.org/10.7764/RDLC.18.2.214

Jang, K. P., Kwon, S. H., Choi, M. S., Kim, Y. J., Park, C. K., & Shah, S. P. (2018). Experimental Observation on Variation of Rheological Properties during Concrete Pumping. *International Journal of Concrete Structures and Materials*, *12*(1). https://doi.org/10.1186/s40069-018-0310-3

Kaveh, A., & Vazirinia, Y. (2018). Optimization of tower crane location and material quantity between supply and demand points: A comparative study. *Periodica Polytechnica Civil Engineering*, *62*(3). https://doi.org/10.3311/PPci.11816

Kumar, R., & Tegar, J. P. (2018). Critical Analysis of Properties of Ready Mix Concrete with Site Mix Concrete of Smart Road Project. *International Research Journal of Engineering and Technology (IRJET)*, *05*(06), 1734–1739. https://www.irjet.net/archives/V5/i6/IRJET-V5I6327.pdf

Kwon, S. H., Jang, K. P., Kim, J. H., & Shah, S. P. (2016). State of the Art on Prediction of Concrete Pumping. *International Journal of Concrete Structures and Materials*, *10*(3), 75–85. https://doi.org/10.1007/s40069-016-0150-y

Lerner, L. R., Author, M., & Führ, L. M. (2019). Influence of the molding process and different surface regularization methods on the compressive strength of concrete specimens. *Revista de La Construccion*, *19*(1), 159–169. https://doi.org/10.7764/RDLC.19.1.159-169

Mujumdar, P., & Maheswari, J. U. (2018). Design iteration in construction projects – Review and directions.

Alexandria Engineering Journal, *57*(1), 121–130. https://doi.org/10.1016/j.aej.2016.12.004

Neville, A. M. (2011). *Properties of concrete*. Pearson. https://www.pdfdrive.com/properties-of-concrete-by-am-neville-e18823278.html

Neville, A. M. M., & Brooks, J. J. J. (2010). *Concrete Technology Second Edition* (Vol. 11). Pearson. https://doi.org/10.1016/0360-1323(76)90009-3

Paleologos, E. (2018). *optimization of ready-mix concrete delivery operations from optimization of ready-mix concrete delivery operations*. *May*. https://www.researchgate.net/.../325077024

Priya, P. K., & Neamitha, M. (2018). *a Review on Precast Concrete*. 967–971. https://www.irjet.net/archives/V5/i1/IRJET-V5I1204.pdf%0A

PU-RI. (2013). *Pedoman Analisis Harga Satuan Pekerjaan Bidang Pekerjaan Umum*. PU RI. http://birohukum.pu.go.id/uploads/DPU/2013/PermenPU11-2013.pdf

Ridha, M. (2011). *Comparison of the Costs and Time of Using Tower Crane Heavy Equipment and Crane Cars in Surabaya Hajj Hospital Project*. https://doi.org/10.11606/issn.1984-5057.v9i2p4-15

Sorensen, C., Berge, E., & Nikolaisen, E. B. (2014). Investigation of Fiber Distribution in Concrete Batches Discharged from Ready-Mix Truck. *International Journal of Concrete Structures and Materials*, *8*(4), 279–287. https://doi.org/10.1007/s40069-014-0083-2

Sunaryo, Bahrun, A., Magribi, & Hatani, L. (2019). Financial Feasibility Analysis of Concrete Casting Using Mini-Cranes in Coastal Areas and Small Islands. *International Journal of Scientific & Engineering Research*, *10*(7), 527–536. https://doi.org/https://www.ijser.org

Sunaryo, Bahrun, A., Ode, La Magribi, M., & Hatani, L. (2020). Productivity analysis and efficiency of concrete casting using mini-cranes with a capacity of 200 kg based on appropriate technology. *Revista de La Construccion*, *19*(2), 198–208. https://doi.org/10.7764/RDLC.19.2.198

Sunaryo, & Sufrianto. (2020). Break-even analysis of Clay Transport as Raw Materials in Small Bricks Industry using Grandong based Appropriate Technology in Rural Areas. *International Journal of Scientific & Engineering Research*, *11*. http://www.ijser.org

Turley, R. E. (1913). *Concrete Mixer* [University of Illinois]. https://www.ideals.illinois.edu/bitstream/handle/2142/51648/concretemixers00turl.pdf?sequence=2