Break-even analysis of Clay Transport as Raw Materials in Small Bricks Industry using Grandong based Appropriate Technology in Rural Areas

Sunaryo[1], Sufrianto[2]

ABSTRACT- The main objective of this study is to analyze the break-even point, the point at which total production costs equal income. The break-even point shows that the level of production has generated revenue equal to the production costs incurred, a case study of transporting clay as a raw material for small brick industries using Grandong. Grandong is a small truck, made from scrap metal waste, made by researchers and the community in Onembute District, Konawe Regency. The research method does break-even point analysis, the point at which the total production cost equals income. The break-even point shows that the level of production has generated income equal to the production costs incurred. Based on the results of the study, to transport clay raw materials to small brick industries using alternative transportation equipment in rural or inland areas, it is strongly recommended, especially equipment based on Appropriate Technology and local assemblies, this is due to spare parts, waste of scrap metal is quite a lot and human resources for operators and technicians are quite available and able to handle them, this type of equipment is still very much needed for small industry activists in rural areas.
Keywords: Grandong, Appropriate Technology, Break Even Point, alternative transportation, equipment .

IJSER

1 INTRODUCTION

Since the days of ancient human civilization, clay brick from the combustion process, to this day is still an infrastructure building material that dominates the market [1]. To produce good and quality bricks, a mixture of various types of clay must come from other regions, thus a cheap and simple transportation tool and based on Appropriate Technology is needed. The use of Dump Trucks is very inefficient which results in losses and greatly affects the sustainability of small brick industry businesses, besides that it can influence expensive selling prices and affect market share and public purchasing power. Furthermore, it will affect the growth of development in a region or region within a country.

It is very clear that the use of bricks and ancient brick crafts has been around for thousands of years. The oldest shaped mud brick, found near Damascus in Syria, is estimated to have existed since 7500 BC. Not only that, mud bricks are widely used by Ancient Egyptian civilization and even the first dry clay bricks estimated in 4000 BC, were found in Mesopotamia (now Iraq) [2]. Not only that the Chinese nation is very clever in the field of brick and not only bricks but also includes ceramics or vessels made of clay and the result is very monumental in the form of the Great Wall of China, this is evident that since the 5th century BC and it claims to be the only man-made object visible from space. For a long time, the Romans have used bricks for a long time and became the main ingredient in building their kingdom's infrastructure, even reaching Europe some 2000 years ago. Scientists in Rome developed the manufacture of bricks as a craft, including the use of mortars that function as adhesives during installation or spacing, this was evidenced by the influence of orders from the kingdom, due to the decline of the Roman Empire which finally occurred, the expertise in the field of brick also declined. In the second half of the seventeenth century, after the Great Fire of London in 1666, in fact, there began modern civilization where the British developed innovations using bricks in building and it took nearly 200 years to study them, and in the nineteenth century, the beginning of manufacturing bricks are produced mechanically using modern machines at that time and leave the old method or manual manufacturing method. However, the emergence of mechanical production bricks, growth in the brick industry is relatively slow because clay bricks that have been printed still use very old models of stoves that are very inefficient. And since 1930 the introduction of Hoffmann's stoves in the brick industry has made great progress, at that time brick

- ***Sunaryo***, *Lecturer in Civil Engineering, Sulawesi Tenggara University, Kendari, Indonesia. 1@sunaryocim.com*
- ***Sufrianto***, *Lecturer in Civil Engineering, Sulawesi Tenggara University, Kendari, Indonesia, sufriantosaja@gmail.com*

production in the UK doubled to the start of the Second World War.

Rice-Husk-Ash (RHA) is also an agricultural waste that is not left behind used as a mixture of bricks adding RHA which is useful for reducing the weight of bricks and adding strength [3], all of which are supported by Appropriate Technology that is very helpful in the process of making bricks starting from local transporters, stirrers that can mix until homogeneous and do not miss the gauges of various characteristics of the modified red stone.

In the current era Appropriate Technology seems to have died and abandoned people and turned to modern technology [4], but in fact Appropriate Technology will also grow and develop with the times, only Appropriate Technology is not produced in bulk at the factory and only produced independently or individually in a village, for that economic activist and small industries in rural areas will still look for opportunities to create needs to support their businesses. Thus business people and scientists will work together to create innovations based on Appropriate Technology, the reason being that Appropriate Technology can use old iron waste materials and is based on simple technology using spare parts not owned by them (usually using car and motorcycle parts) and not using imported spare parts.

In addition to clay bricks, there are also many alternative bricks made from cement and are equipped with lime grooves as interlocking [5], are becoming more competitors and becoming a choice for consumers of the choices that will be used between bricks clay or alternative bricks made of cement, whatever production is produced will still run out and even experience shortages so that a project often experiences delays.

It turns out that the application of Appropriate Technology will provide the best results for small industries, therefore the involvement of scientists and practitioners of technology is not only talking about theory but more important is how the application of applications at the field level even to remote areas [1]. Thus it is not mistaken from a Onembute Subdistrict in Konawe Regency, in the process of transporting clay material rows the main material for making red stones must be taken from the mountain and transported to Bangsal using researchers' assemblies with the name Grandong (local name), a four-wheeled haul carrier with a 22 HP diesel engine made from diesel fuel. Axles, transmission, and steering are made from scrap metal. The legality of the driver does not require a license, because the conveyance is only through a village road, and the road is made by the local community. Of course, the use of this transportation equipment is very profitable compared to using a Dump Truck and other modern carriers.

Human Factors and Ergonomics Society became a new name after Europe gradually experienced traditional binding to the basic sciences or application fields that put forward human factors and ergonomics that work must be made according to the size of the human body [6]. It is highly prioritized for scientists and activists, tool designers who can help human tasks according to the size requirements of the human body so that they always return to humans as subjects.

2 LITERATURE REVIEW

Appropriate Technology rarely explains it, the word is not purely from the technology itself, it is true that Appropriate Technology means that the technology used is very simple, but the word comes from economics that has nothing to do with technology, the word came from an economist from Germany named EF Schumacher. This German writer has written the book "Small is Beautiful", believes that "small businesses will increasingly contribute strongly in the future for the prosperity of a nation"[7] [7]. That Appropriate Technology starts from the small can be useful and contribute in the future to the prosperity of a nation. On the other hand, Appropriate Technology is also growing rapidly in addition to the use of high technology. Appropriate Technology by (Mc Grow Glencoe, 2001) in his book entitled "Appropriate Technology for Sustainable Living" says what is Appropriate Technology but still Schumacher's book is used to explain and summarize the philosophy of Appropriate Technology in his book, Small Is Beautiful (1978) where he describes the central doctrine of Appropriate Technology as (a) simple, (b) small scale, (c) low cost, and (d) without violence. The US Office of Technology Assessment has perfected these principles by describing Appropriate Technology as (a) small scale, (b) saving energy, (c) environmentally friendly, (d) labor intensive, (e) controlled by the local community, and (f) sustainable at the local level. [8] also says about the definition of Appropriate Technology that can be defined as "intentional formation of matter, energy, and processes to meet needs". Technology and design processes are closely interrelated, for the creation of all artifacts, environments, and man-made systems is the result of deliberate activity by the designer, whether he is an architect, a farmer, a housewife, or a child. The design, whether we choose to call it or not, is around us. Actually what is the purpose of Appropriate Technology, still in his book [8] says that "Designers work in a variety of obstacles, and trade-offs are always involved. First, there are broad goals determined by society or by business plans: increased productivity; greater market share; higher level of employment; more interesting community; etc". And the next goal is to be more clear and detailed then; "In its most basic sense, the right technological goals represent the basic human and social values that we hope for everyone."

The clay brick industry works and methods from time to time have been very different, for now, it has been very advanced but it is still dominated by Appropriate Technology, but even so what is important is the factor of worker safety and ergonomic equipment which are the main requirements must be fulfilled [9]. For the role of scientists and technicians, it is very important to provide innovation and understanding so that in a process work can be done easily. Fast and correct.

Many people argue that designing for technology in a process of work is a natural and ordinary thing, and is always guided by ergonomic rules. And if something is designed properly it can maximize the results of work using equipment that has met ergonomic principles or rules [10]. Likewise, with the small brick industry that used to transport soil from the quarry using cattle-drawn carts, it has now turned into a diesel-driven cart that can all be adapted to the conditions of the human body so it is very ergonomic. Such conditions can increase people's income because the work process does not experience extreme fatigue and can

save energy for the following days.

Likewise according to [11]that: "In each equipment use and equipment selection in project development, it must be considered, namely the location and condition of the project, the project development plan including time and cost as well as the working method of the equipment" the condition of the magnitude of the project being worked on.

Before the development of science, monumental artifacts or sites were built without having to think about how much money was used, and after civilization and the emergence of philosophies of science and science developed, then monumental and present artifacts or sites were called infrastructure, the development process must use or adhere to the principles economics and the most famous is called cost estimation or engineering estimation [12].

In project activities, construction equipment is the main factor that is of particular concern in budgeting, every detail must be measured in designing a budget, whether it is rented or bought, if it is rented, the user will be adjusted to the needs and if purchased, the project does not buy at full price except in multi-year project [13].

But the machine productivity model can be solved using mathematical equations, but it must be seen the characteristics and uses, of course, all will be controlled by humans or operators, so that sometimes the productivity can be in accordance with the speed and skills of the users. operator, but in this mathematical equation has been calculated, including natural factors, material factors and conditions of equipment that will work or work [14] [15] [16].

Break-even analysis is an instrument that will measure or determine the value of a variable or parameter of the project or alternative that makes two elements the same [17] [18] [19], the volume of production that will equalize income and costs. Break-even analysis is carried out for two alternatives to determine when one alternative is equally acceptable. Break-even analysis is generally applied in making-or-buying decisions when decisions are needed about sources for components, services, etc. Return analysis determines the minimum age required for an asset, process, or system to restore the initial investment. There are two types of returns: returns (i> 0%) and no returns (i = 0%) occur. Return analysis must not be considered the final decision maker; this is used as a filter tool or to provide information from break-even analysis or return on capital. In mathematical equations can be explained as follows:

When the costs of the two alternatives are influenced by a variable (variable), then a value can arise from an irregular factor where the alternative will bring the same cost. The costs of each alternative can be expressed as a function of non-ordinary factors that are free and will take the form of:

$TC_1 = f_1(x)$ and $TC_2 = f_2(x)$ (1)

Where :

TC1 & TC2 = a total amount set per time period, per project or per unit is used for each alternative 1 and alternative 2

x = an ordinary non-permanent factor that affects alternative 1 and alternative 2

Solving values for "x" is solved by equating functions:

$TC_1 = TC_2$ dan $f_1(x) = f_2(x)$ (2)

The "x" value gives the same cost for the alternatives considered and therefore shows a break-event point.

Formula used:

$TC(1) = CR(i)_1 + M + C_{(1)} \cdot t$ (3)

$CR(i)_1 = (P - S) \times D + S_{(1)}$ (4)

$D = \frac{i(1+i)^n}{(1+i)^n - 1}$ (5)

Where :

$CR(i)_1$ = Annual cost (IDR)

M = Annual tax value (IDR)

$C_{(1)}$ = Unit price value

D = Depreciation

t = Total production per year

P = Annual cash outflows (IDR)

S = Resale value (IDR)

n = Total number of periods

i = Discount Rate (%)

3 RESEARCH OBJECTIVES

The main objective of this study is to analyze the break-even point, the point at which total production costs equal income. The break-even point shows that the level of production has generated revenue equal to the production costs incurred, a case study of transporting clay as a raw material for small brick industries using Grandong. Grandong is a small truck, made from scrap metal waste, made by researchers and the community in Onembute District, Konawe Regency.

4 RESEARCH METHODS

Analyze break-even points, the point at which total production costs equal income. The break-even point shows that the level of production has generated an income equal to the production costs incurred. In this analysis, it is illustrated that there are 2 types of transportation of raw materials for small brick industries using transportation equipment made by researchers and the community, the first being Grandong (local name), a small truck produced and assembled, and the second is Dump truck.

The location of the study was in Onembute District, Konawe Regency, complete location map in Figure 1 and 2.

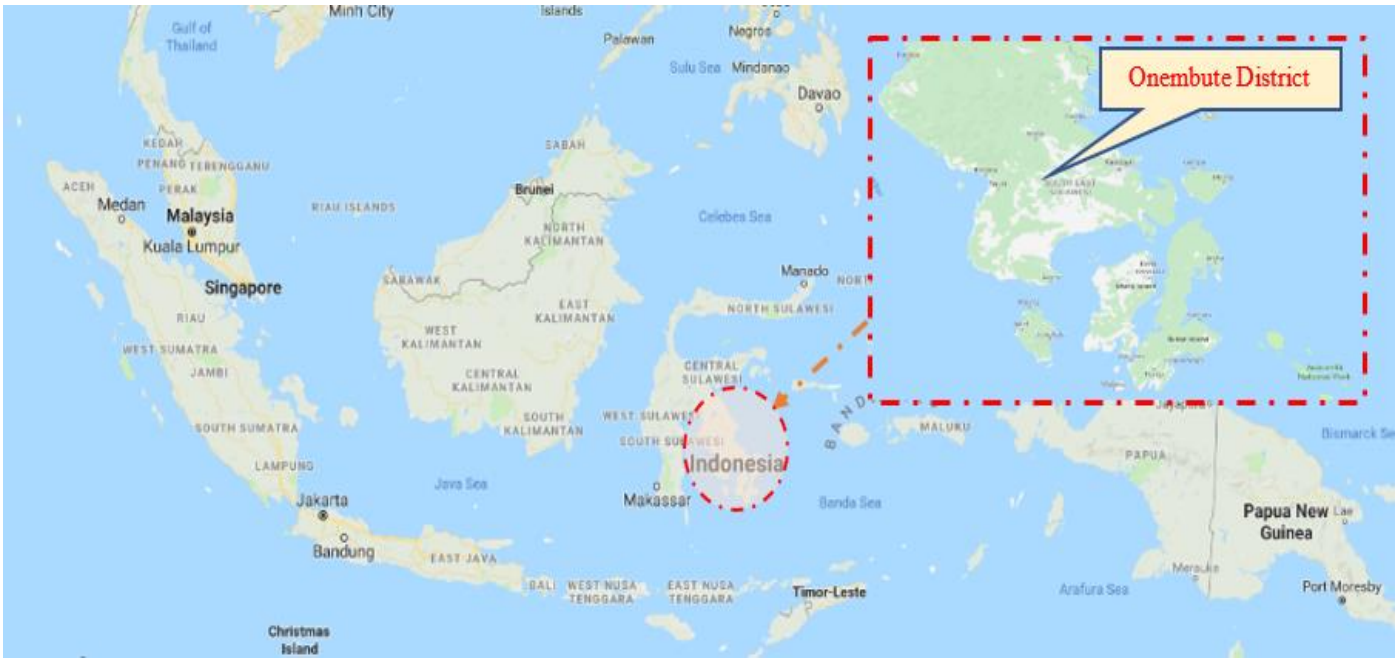

Fig.1. Research Map

Fig. 2. Map Details of the small brick industrial area of Onembute District

5 RESULTS

In the break-even analysis on the transportation of raw materials for clay in small industries, bricks in Onembute Subdistrict will analyze two types of equipment between Grandong based on Appropriate Technology and Dump Truck, with this in detail, as follows:

5.1. Rent Equipment Analysis.

This analysis will look for how much the rent value of each of the two tools, with the description in table 1 as follows:

TABLE 1
Equipment Rent Analysis

No	Description	Code	Quantity		Unit	Information
			Grandong	Dump-Truck		
A	General					$D=\frac{i(1+i)^n}{(1+i)^n-1}$
1	Power	Pw	40	100	HP	
2	Capasity	C	3	8	Ton	$R=\frac{(L-R)D}{O}$
3	Economics period	n	5	5	Years	
4	Operating Hours/year	O	2,000	2,000	Hours	$I=\frac{2\%\ R}{O}$
5	Local value	L	40,000,000	435,000,000	IDR	
6	Discount rate	i	10	10	%	F = (0.125-0.175) Ltr/HP/ Hoursx P x Fp
7	Tax	T	10	10	%	
8	Fuel prices	Fp	10,000	10,000	IDR	Luc= (0.10-0.20)Ltr/HP/ Hours x P x Lp
9	Lubricant prices	Lp	50,000	50,000	IDR	
B	Direct Cost					$Ws=\frac{(6.25-8,75)L}{O}$
1	Residual value 10%.Lp	R	4,000,000.00	43,500,000.00	IDR	
2	Depreciation (Capital factor)	D	0.26380	0.26380	IDR	$Sp=\frac{(12.5-17.5)L}{O}$
3	Direct cost:					
	a. Return on capital	R	4,748.35	51,638.36	IDR	
	b. Insurance and Others	I	40.00	435.00	IDR	
	Subtotal (B)	2	4,788.35	52,073.36	IDR	
C	Indirect Cost					
1	Fuel	F	60,000.00	150,000.00	IDR	
2	Lubricant	Luc	30,000.00	75,000.00	IDR	
3	Workshop	Ws	1,500.00	16,312.50	IDR	
4	Sparepart	Sp	3,000.00	32,625.00	IDR	
	Subtotal(C)	3	94,500.00	273,937.50	IDR	
C	Total cost					
1	Total = (B) + (C)	To	99,288.35	326,010.86	IDR	
2	Tax 10% x To	Tx	9,928.84	32,601.09	IDR	
	Total cost	Tot	109,217.19	358,611.94	IDR	

Based on the calculation results in table 1, it can be seen that the value of rental of Grandong equipment is IDR 109,217.19/hours and Dump Truck is IDR 358,611.94/hours.

5.2. Productivity and coefficient analysis

This analysis is going to look for the value of productivity and coefficients of each of the two tools, with the description in table 2 as follows:

IJSER

TABLE 2
Productivity and coefficient analysis

No	Description	Code	Quantity		Unit	Information
			Grandong	Dump-Truck		
1	Hauling distance	L	2	2	Km	
1	Transport capacity	V	2.6	5.2	Ton	$Ct2=\frac{L}{v1}x\ 60$
2	Efficiency Factor	Ef	0.8	0.8	-	
3	Soil density	D	1.3	1.3	Ton/M^3	$Ct4=\frac{L}{v2}x\ 60$
4	Loaded average speed	v1	20	30	Km/Hours	
5	Average speed is empty	v2	30	50	Km/Hours	$Q=\frac{(V\ x\ Ef\ x\ 60)}{(D\ x\ Ct)}$
6	Cycle time					
	- Time to fill up	Ct1	60	60	Minute	$Co=\frac{1}{Q}$
	- When transporting	Ct2	6	4	Minute	
	- Unloading Time	Ct3	60	5	Minute	
	- Time back	Ct4	4	2.4	Minute	
		Ct	130	71.40	Minute	
7	Production Capacity	Q	0.74	2,69	M^3/Hours	
8	Coefficient	Co	I,3542	0.3719	Hours	

Based on table 2, the coefficient for Grandong is 1.3542 hours and for the Dump Truck the value is less than 0.3719 hours, this means that the Dump Truck in the process of transporting clay raw material works faster than Grandong, but then we will describe in more detail.

5.3. Unit Price Value Analysis

The unit price analysis referred to is the unit price of transporting clay materials for small brick industries, how much is the unit price of m3 from the quarry up to the working ward where the bricks are processed, as shown on map image 2. And will be explained in detail in table 3 as follows:

TABLE 3
Unit Price Value Analysis

No.	Discription	Unit	Cofficient	Unit Price (IDR)	Total (IDR)
1	2	3	4	5	6
1	Drandong	Hours	1.3542	109,217.19	147,898.28
2	Dump Truck	Hours	0.3719	358,611.94	133,358.82

Based on table 3, it can be explained that the value in column 4 is taken from the Co value of 1.3542, the value in column 6 is taken from the Total value of IDR147,898.28 and column 6 is the product of clause 4 and column 5 so that the unit price is obtained with a value of IDR133,358.82, as well as the value of the Dump Truck.

5.4. Break Even Point Analysis

To analyze Break Even Point, we will use the manual or by hand method, but will still be assisted with Spreadsheets, why is that, because Spreadsheets will also directly create the graph.
Next in detail and detail will be explained in table 4 as follows:

TABLE 4
Break Even Point Analysis

TC_A (Grandong)	TC_B (Dump Truck)	Information
P = IDR45,000,000.00 (Annual cash outflows)	P = IDR435,000,000.00 (Annual cash outflows)	$D = \frac{i(1+i)^n}{(1+i)^n-1}$
S = IDR35,000,000.00 (Resale value)	S = IDR348,000,000.00 (Resale value)	
i = 12% (Discount Rate)	i = 12% (Discount Rate)	
n = 5 years (Total number of periods)	n = 5 years (Total number of periods)	
M = IDR0.00 (Annual tax value)	M = IDR2,500,000.00 (Annual tax value)	
D = Depreciation	D = Depreciation	
C_A = IDR147,898.28 (Unit price value)	C_B = IDR133,358.82 (Unit price value)	
t = Total production per year (?)	t = Total production per year (?)	
$CR(i)_A$ = Annual cost	$CR(i)_B$ = Annual cost	
= (P – S) x D + S (i)	= (P – S) x D + S (i)	
= IDR6,0594,277.86	= IDR65,894,646.68	
TC_A = $CR(i)_A$ + M + C_A. t	TC_B = $CR(i)_B$ + M + C_B. t	
= IDR6,0594,277.86 + IDR147,898,28.t……(1)	= IDR68,394,646.68 + IDR133,358.82. t……(2)	
IDR6,0594,277.86 + IDR147,898,28.t = IDR68,394,646.68 + IDR133,358,82.t		
IDR133,358,82 - IDR147,898,28 = IDR6,0594,277.86 - IDR68,394,646.68		
$t = \frac{(IDR62,335,368.82)}{(IDR14,539.46)}$		
t = 4,287.32		

Based on table 4, the break-even point is obtained at the value of 4,287.32, this means that the break-even point is worth 4,287.32 m^3 of raw material, and to make a graph using data as shown in figure 3, as follows:

	A	B	C	D	E
1	Discription		Drandong (A)	Dump Truck (B)	Information
2	Annual cash outflows (IDR)		40,000,000.00	435,000,000.00	
3	Resale value (IDR)		32,000,000.00	348,000,000.00	
4	Annual tax value (IDR)		-	2,500,000.00	
5	Unit price value (IDR/m^3)		147,898.28	133,358.82	$D=\frac{i(1+i)^n}{(1+i)^n-1}$
6	Total number of periods		5	5	
7	Discount Rate (%)		12		
8	D = A/P.i.n			0.2774097	
9	M^3	$CR(i)_A$	$TC_{(A)}$	$CR(i)_B$	$TC_{(B)}$
10	0	6,059,277.86	6,059,277.86	65,894,646.68	68,394,646.68
11	10		7,538,260.64		69,728,234.84
12	100		20,849,105.68		81,730,528.29
13	500		80,008,417.00		135,074,054.75
14	800		124,377,900.49		175,081,699.59
15	1000		153,957,556.14		201,753,462.82
16	2000		301,855,834.43		335,112,278.95
17	3000		449,754,112.72		468,471,095.09
18	5000		745,550,669.29		735,188,727.36
19	D =(C7/100*(1+C7/100)^D6)/(((1+C7/100)^D6)-1)				
20	$CR(i)_A$ =(($C$2-$C$3)*$C$8)+($C$3*$C$7/100)				
21	$TC_{(A)}$ =$B$10+$C$4+($C$5*A11)				
22	$CR(i)_B$ =(($D$2-$D$3)*$C$8)+($D$3*$C$7/100)				
23	$TC_{(B)}$ =$D$10+$D$4+($D$5*A10)				

Fig. 3. Break Even Point with the help of Spreadsheets

Based on the content of the spreadsheets in figure 3, the value of Depreciation or D in cell D8 is formulatext = (C7/100*(1+C7/100)^D6)/(((1+C7/ 100)^D6)-1), the value of CR (i) A in cell B10 is formulatext=(($C$2-$C$3)*$C$8)+($C$3*$C$7 /100), TCA value in cell C10=$B$10+$C$4+ ($C$5*A11), CR (i) B in cell D10 =(($D$2-$D$3)*$C$8)+($D$3*$C$7/100) and TCB in cell E10=$D$10+$D$4+($D$5*A10). This mathematical model will form a graph as in Figure 4, as follows:

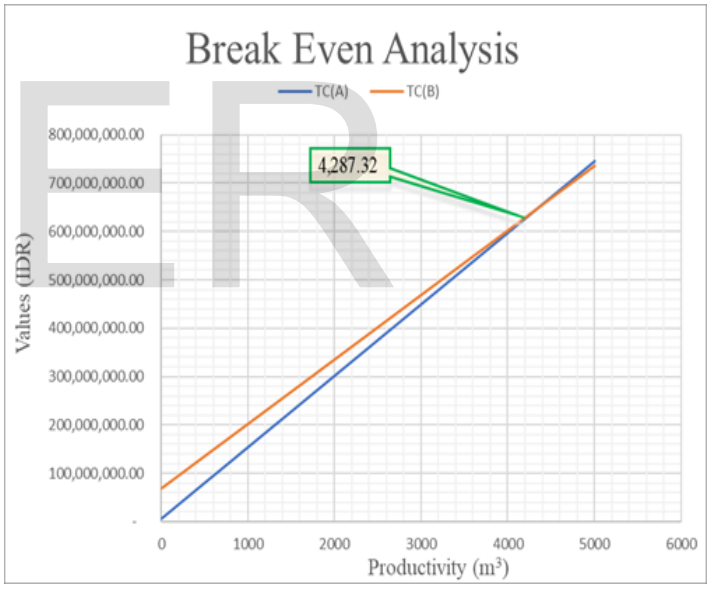

Fig. 4. Break Even Analysis

Based on Figure 4, the Break Even Analysis graph occurs intersection of 2 (two) lines.

5.5. Grandong Types and Specifications

Grandong is a carrier of clay raw materials for small brick industries as in figure 6, made by researchers and the community, all materials use old iron waste as in figure 7 to 9 with the principle of using Appropriate Technology. This carrier is very suitable for use in rural and inland areas either in groups or individually, which will be useful to help humans and participate in infrastructure development in a region.

Fig. 5. Dump Truk

Fig. 6. Grandang

Fig. 7. Scrap metal waste (pick up)

Fig. 8. Scrap metal waste (Truck)

Fig. 9. Scrap metal waste

The principle of Appropriate Technology in modern times like today is still very relevant and very desirable because it is simpler and cheaper and does not require high technology and spare parts do not depend on imported products.

Grandong specifications as follows:

a) Frames and chassis are made from waste car trucks or other types of Pick Up cars.
c) Tubs made of wood.
d) The main driving machine uses a 22 HP Diesel engine.
e) Diesel fuel.

Besides being able to lift clay raw materials, it can also use other materials such as wood and other needs in brick production.

5.6. Summary of Break Even Analysis

Based on the results of the Break Even Analysis using Drandong in Onembute District, Konawe Regency. A full summary will be explained in table 4. The following:

TABLE 4
Summary of analysis results

No.	Discription	Grandong	Dump Truck	Unit
1	Break Even Value	4,287.32	4,287.32	m^3
2	Load capacity	2	4	m^3
3	Number of working days / month	22	22	day
4	Number of working months /year	12	12	Month
5	Total Trip / day	8.12	4.06	Trip/day
6	Rounding	8	4	Trip/day

Based on the 4 table in number 2 Drandong the transport capacity is only 2 m^3 and the Dump Truck is 4 m^3, conditions in the field like that, for number 3 the number of working days per month is all the same, using 22 working days per month, number 4 also, the number of working months per year both use 12 months of work per year. The final result is the number of trips per day for Grandong 8.12 and the Dump Truck 4.06 trips/day rounded up to 8 and 4 trips/day.

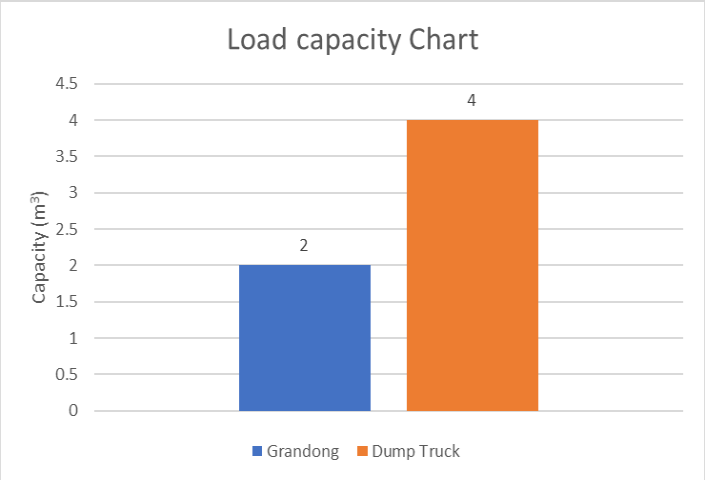

Fig. 10. Load capacity chart

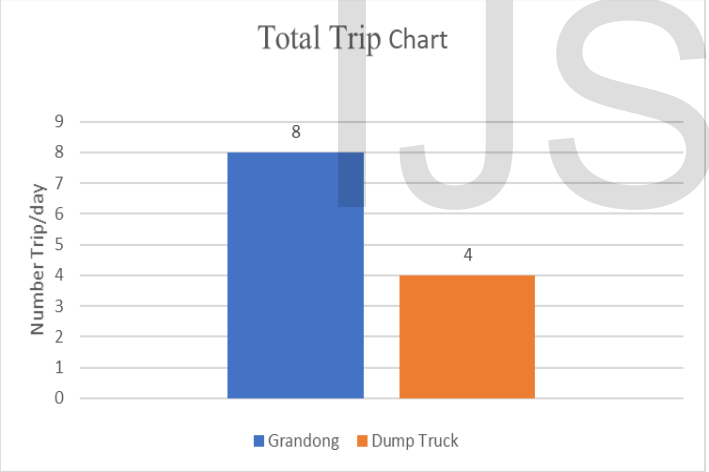

Fig. 11. Total trip chart

5.7. Research limitations and suggestions for further research.

Further research suggestions and creative ideas:

a) Design and analysis of material transport of rows using cable-way in mountainous areas.
b) Design and analysis of transportation of construction materials using cable-way in weir and dam projects.
c) Design and analysis of transportation of construction materials using an offshore cable-way building project.
d) Design and analysis of transportation of agricultural products using rural cable-way and plantations.
e) Design and analysis of row transport of small industrial material using rail-way.

6 CONCLUSION

The conclusion that based on the results obtained is as follows: Break Even Point analysis results in real use of alternative row material transporters (Grandong) in rural areas or in this case Onembute District, it is strongly recommended to use Grandong.

Based on the results of the study, to transport clay raw materials to small brick industries using alternative transportation equipment in rural or inland areas, it is strongly recommended, especially equipment based on Appropriate Technology and local assemblies, this is due to spare parts, waste of scrap metal is quite a lot and human resources for operators and technicians are quite available and able to handle them, this type of equipment is still very much needed for small industry activists in rural areas.

ACKNOWLEDGEMENTS

Special thanks to Prof. DR. Ir. H. Andi Bahrun, MSc. Agric as the Rector of the University of Sulawesi Tenggara, who has provided much guidance, encouragement, motivation and the motto that is known for being creative and innovative.

REFERENCES

[1] V.M.Sathianarayanan, R.Arivazhagan, and V.Balakumar, "Project On Innovation And Implementation Of Composite Brick," *Int. J. Pure Appl. Math.*, vol. 119, no. 7, pp. 1145–1150, 2018.

[2] J. Collinson, *Brickwork and Bricklaying*. Marlborough: The Crowood Press Ltd, 2012.

[3] M. A. Saleem, S. M. S. Kazmi, and S. Abbas, "Clay Bricks Prepared with Sugarcane Bagasse and Rice Husk Ash - A Sustainable Solution," *Int. Conf. Adv. Sustain. Constr. Mater. Civ. Eng. Syst.*, vol. 120, pp. 1–12, 2017.

[4] J. Lissenden, S. Maley, and K. Mehta, "An era of Appropriate Technology : Evolutions , oversights and opportunities," *J. Humanit. Eng.*, vol. 3, no. 1, pp. 24–35, 2013.

[5] R. K. Watile and S. K. Deshmukh, "Interlocking Brick For Sustanable Housing Development," vol. 2, no. 2, pp. 58–64, 2014.

[6] R. S. Bridger, *Introduction to Human Factors and Ergonomics Fourth Edition*, 4th ed. New York: Taylor & Francis Group, 2018.

[7] E. F. Schumacher, *Small is Beautiful*. 2006.

[8] Mc Grow Glencoe, *Appropreate Technology for Sustainable Living*. New York: Hill Companies, 2001.

[9] C. Berlin and C. Adams, *Production Ergonomics: Designing Work Systems to Support Optimal Human Performance*. London: Ubiquity press, 2017.

[10] M. Helander, *A Guide To Human Factors And Ergonomics*, 2nd ed. New York: Taylor & Francis

IJSER

Group, 2006.

[11] M. Ridha, "Comparison of the Costs and Time of Using Tower Crane Heavy Equipment and Crane Cars in Surabaya Hajj Hospital Project," 2011, doi: 10.11606/issn.1984-5057.v9i2p4-15.

[12] K. Heinze, *Cost management of capital projects*. New York: Taylor & Francis Group, 2017.

[13] C. . . and H. . J. . Bartlett. J.W, *Information Technology Project Management, Seventh*, vol. 19, no. 1. Boston: Course Technology, 2014.

[14] Rostiyanti, *Alat Berat Untuk Proyek Konstruksi*. Jakarta: Rineka Cipta, 2008.

[15] Sunaryo, L. M. M. Rahmat, and Arsetyo, *Alat Berat Filsafat Teori dan Aplikasi*. Makassar: Nas Media Pustaka, 2019.

[16] Sunaryo, A. Bahrun, Magribi, and E. Sukotjo, "Productivity Analysis and Efficiency of Transportation Clay Raw Materials in Small Brick Industries using Grandong Based on Appropriate Technology," *Int. J. Sci. Eng. Res.*, vol. 10, no. 8, pp. 550–559, 2019.

[17] L. Blank and A. Tarquin, *Engineering Ekonomi 7 Edition*. New York: Mc Graw Hill Book Company, 2012.

[18] Sunaryo, A. Bahrun, Magribi, and L. Hatani, "Financial Feasibility Analysis of Concrete Casting Using Mini-Cranes in Coastal Areas and Small Islands," *Int. J. Sci. Eng. Res.*, vol. 10, no. 7, pp. 527–536, 2019.

[19] Sunaryo, Haryono, H. Wijaya, and Kasmarudidn, "Financial Feasibility Analysis of Kendari-Toronipa Tourism Destination Road Development," *Int. J. Sci. Eng. Res.*, vol. 10, no. 11, pp. 601–608, 2019.

IJSER