

IDENTIFICATION OF THE POSSIBILITY TO REUSE THE CERAMICS GLAZED TILE WASTE AS A ECO FRIENDLY RAW MATERIAL FOR THE MANUFACTURING INDUSTRY IN SRI LANKA

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Abstract

According to industrial waste can be affected by the environment and human. Reason of that lots of companies concern about their benefits, Because of them not concern about environmental damage and life cycle of goods. Subsequently, ongoing years have seen rising social worry about the issue of waste administration by and large, and modern waste and waste from the development business specifically. This research is mainly considered to give the solution for ceramic glazed tile waste in Sri Lanka. Royal Ceramic Lanka PLC (RCLPLC), Lanka Tiles PLC (LTPLC) and Mack tiles Lanka, used as a case studies to find the data. The objective of this investigation is to study and analyzing these three ceramic tile factory waste (squaring dust and polishing dust) properties and discussing how to re-use the ceramic glazed tile waste as a raw material for the production industry in Sri Lanka. This study is analyzed in the three factors mentioned above manufacturing process, Properties of tile, Source of tile waste, Current Methods of tile waste recycle and ingredients of tile waste. Similarly, laboratory testing of waste effluent samples from the factory will identify the components involved. That waste can be used to produce sanitary ware or tableware, bricks manufacturing, water purification, and different type of concrete unit, it can be a long duration and high strength. The amount of silica present in the chemical constituents is relatively high and can be used to increase bond strength. Not only that but also it does not have any heavy metals so it's harmful to plants and animals, it can be used for conservation such as coral and algae.

Keywords: *Ceramic waste, recycled ceramic aggregates, squaring dust, coral*

1. Ceramic Industry

"The word Ceramic is derived from the Greek word 'Keramos' meaning 'potter' or 'pottery'. Keramos, in turn, was originated from a Sanskrit root – meaning 'to burn'. Hence, the word Keramos was to infer 'burned substance' or 'burned earth' (CERAMICS, 2010)". Archeologists have revealed human-made earthenware production that goes back to at any rate 24,000 BC. These earthenware productions were found in Czechoslovakia (Vandiver, Soffer, Klima, & Svoboda, 1989) and were as creature and human dolls, pieces, and balls. There are main three types of tiles are manufacturing in Sri Lankan tile industry. Ceramic tiles, Porcelain tiles and Red clay tiles.

The Island is endowed with raw materials used in the ceramic industry such as kaolin, ball clay, feldspar, silica quartz and dolomite. The excellent quality and purity of these materials which is available in abundance contribute to the high standards of the products. Domestic value addition has become an essential factor when exporting products utilizing duty advantages offered under trading arrangements.

Being over 60% value addition, the ceramic industry ranks high amongst the locally manufactured export products. Excellent quality and purity are the hallmark of natural resources in Sri Lanka. The Kaolin, Feldspar, Ball clay, Silica, Quartz, Dolomite that is used in manufacture of ceramic products are the best that can be found. This industry has some significant operational strength, including a highly skilled workforce, competitive labor costs, and excellent management at factory levels, state-of-the-art technology, research and development facilities, high ethical standards and confidentiality of design integrity, in contrast to Asian competitors. Sri Lanka's biggest purchasers of flatware and elaborate product are the United States and the UK. Other significant purchasers are Germany, Italy, Canada, Spain, Belgium, and Japan.

2. Identification of the Tile waste in Sri Lanka

The man is proceeding with industrialization, but the road is very badly marked. It has become a serious crisis that causes many of the environmental, health & psychological problems that it faces. Solid waste is the black spot in that human history or the next century that we all belong to. Environmental and living beings can be affected by industrial waste. Reason of them not concern about environmental

damage and the life cycle of goods. This is in the same situation in Sri Lanka it is, unfortunately, insufficient to focus on the Problem locally rather than other countries. This is because the ability to acquire modern Technology and the time it takes to reach the third world countries and the problem has increased as the time it takes increases. In Sri Lanka, ceramic waste has been very little focused. But it is becoming an environmental issue that has a long-term impact, because ceramic stocks in the world can survive over 2000 years without any decay

“In the recent classification of Chinese Ceramics found in Sri Lanka those from the period* of Tang dynasty’s (618-906 A.D) are listed as the earliest one (Flad et al., 2005)”.In the past, it was a domestic industry and used to manufacture several types of daily items. Today, a large range of products with a range of consumer needs have grown to include professions and profitable ventures. Late decades have seen a checked upsurge in fashionable and financial development, adding to improved personal satisfaction and prosperity for natives. Nevertheless, we tend to ought to not dismiss the method that every generation framework makes results and waste things which might influence the planet.

These impacts might happen anytime within the item's life-cycle, within the case of between the underlying periods of effort crude materials, the amendment, and generation stage, among item dispersion or once the top the client should discard things that square measure nevermore needed. This issue is winding up progressively intense because of the developing amount of modern, development and decimation squander produced in spite of the measures which have been taken lately at Sri Lankan Community, national and provincial dimensions went for controlling and directing waste administration, as per manageable advancement strategies and the Kyoto Protocol(Juan et al., 2010).

In Sri Lankan context, tile waste disposal method is very harmful to the environment. That type of waste does not reach the environment, because ceramic products are produced from natural material containing and processing of dehydration and controlled firing at a temperature between 700C and 1200C(Juan et al., 2010) It is called fired clay. There is no known proper way to dispose or recycle ceramic waste. All country have use to the private sector and try to filing abandoned mines, filling low land and things like that(Koyuncu, Guney, Yilmaz, Koyuncu, & Bakis, 2004).

The recent boom in the construction industry in Sri Lanka has created a huge demand for the tile industry. Therefore, the capacity of tile factories has increased and the flow of imported tiles has increased rapidly, and tile manufacturing plants have been operating all year. Producing a wide variety of waste during their manufacturing process, and are seen to be reused to some degree.

The tile manufacturing process can be mainly divided into two parts, the before and after kiln. In this case, the before kiln stage is the process that goes before the oven and the after kiln is burned in the oven. The raw material that was discarded before the killing is returned to the production process. Tile related problems in the country as well as in the world are the impact of the waste caused by burned tiles. Tile pieces and tile squares that cannot be used during this after-killing process are disposed of as tile waste, resulting in approximately 20 tons of garbage being generated daily in Sri Lanka(Dissanayake, 2015).

There is very few research done in Sri Lanka and there are no practical applications to date. This ceramic tile waste can have a major impact on the environment in short term as well as long term. Most of the workers who work at tile factories are at risk of respiratory illnesses due to exposure to ceramic tile waste. The accumulation of this waste in the vicinity of the factory has also caused problems for people living in the surrounding areas during the winds and rainy season. This has a tremendous impact on living beings. The use of ceramic waste to reclaim various mining sites and marshy areas does not grow plants. Although it does not cause much chemical damage, it has become a major environmental problem due to the accumulation of air, water and destruction of plant cover on the earth.

3. Important of the Study

In the world, industrial waste is used repeatedly, and the classification is often inherited in some regions or countries such actions are largely done by government and government licensed privet companies. In

developed countries such as Japan, rigorous environmental laws will guide these companies. However, developing countries have a very low level of focus on industrial waste management. The inadequacy and ineffectiveness of legal system in Sri Lanka had a great negative impact on waste management. The information and solutions obtained from this study can be used for other ceramic tile manufactures in island. In Sri Lanka, it will be able to utilize the following ceramic solid waste and other waste management methods similarly. Therefore, this study will help to make solid waste management with ecosystems and make necessary legislation for future activities. But it is very important to look at how much products can be tailored to Sri Lankan production process.

4. Scope and limitations

Ceramic tiles were the dominant place in the ceramic industry and contributed too many foreign exchanges and employment opportunities in Sri Lanka. There are three main makers commanding the earthenware tiles industry in Sri Lanka in particular, Royal Ceramic Lanka PLC (RCLPLC), Lanka Tiles PLC (LTPLC) and Mack Tiles Lanka. This research is intended to consider how the identification of the possibility to reuse the ceramic tile waste as a raw material for eco-friendly design. It is hoped that by examining the chemical compounds present in the samples, they will be better understood for the select production process. Sieve analysis dry test, Density, viscosity and Residue calculate is help to identify what is the physical properties of waste materials.

5. Research Objective

This study aims to re-use ceramics glazed tile waste as an environmentally friendly sustainable solution and to consume the best of natural resources as well as expected to achieve some specific objectives such as, identify how ceramic glazed tile waste produce in Sri Lanka, identify the physical properties of ceramic glazed tile waste, What are the economic feasibility and existing methods of ceramic glazed tile waste reusing and also study the possibility of reusing ceramic glazed tile waste as a new material for the Sri Lankan society.

6. Research Methodology

6.1 CASE STUDY ONE: ROYAL CERAMIC LANKA PLC : HORANA

This is due to the fact that the rocell Horana factory is a large and ceramic glazed tile manufacturing company which generates tile waste during dry squaring, wet squaring and tile polishing. Both dry squaring and wet Squaring plant are operational there. Most of the waste is generated through these, we can consider this factory as a good sample.

6.2 CASE STUDY TWO: LANKA TILES PLC : HANWELLA

Lanka tile Hanwella Factory is the only factory that manufactures floor tiles and uses only two types of wet squaring and polishing. The factory, Lank Tiles they use water for the tile squaring and the polishing, because of that those waste are in the wet form. There generate various kinds of Wastes in like Ceramic powders, Tile pieces, Sludge and glazed. Among those, there is a considerable amount of wet squaring wastes and polishing wastes.

6.3 CASE STUDY THREE: MACK TILES LANKA : BANDARAGAMA

The Tile Factory at Bandaragama is the only tile manufacturing factory in Mac tile which currently produces no polished glazed tile and only dry squaring is used for tile squaring. So those wastes can't use back in the manufacturing process. For these experiments, used 4 samples from those because the process use in each factory is different from each other. Those samples are as follows,

6.4 ABOUT WET TILE SQUARING PLANT - (ROCELL / LANKA TILE)

Water is used for this process. Water diluted wastes are drained to large tanks. Alum ($Al_2(SO_4)_3$) is added to accelerate the waste depositing speed. After that those are discarded by filling to large bags.

Fine particles in the water are extracted by sending them through the filterers. They are used again after the wastewater treatments. Those filtered particle waste are like the gray mud and they tend to form cubes when they are dried. They are so much like the ordinary lime form the outer appearance.

6.5 ABOUT DRY TILE SQUARING PLANT - (ROCELL / MACK TILE)

Water is not used here for the squaring. This is like the dust and is generated through the compound chambers and form the large scale vacuum cleaners. These waste can differ according to the factory and tiles produce at the moment. This waste is like a white fine powder, more like cement. Samples are used to identify the chemical composition and other chemical properties of the waste.

6.6 ABOUT TILE POLISHING PLANT - (ROCELL / LANAKA TILE)

Aforementioned waste is generated through by cutting off the edges of the tiles for the finishing and also generated from polishing the glaze for the shine. So there are special characteristics for these wastes. This is done with using the water and drained to the tanks as mentioned before. In those factories, those polishing waste and Squaring waste are collected to the same tanks. Therefore those two are considered as one.

7. Case Studies and Data Analysis

7.1 CASE STUDY 1 : ROYAL CERAMIC LANKA PLC

Sample 01: Dry Squaring Waste Plant (8 - RSQ)

The squaring plant uses small tiles, such as 30 "x 30", 40 "x 40", which are not polished. Squaring these tiles in closed chambers. This process is done in a dry environment, where the amount of waste removed is very low compared to wet squaring. Due to the small size of the tile, the amount of waste produced is relatively small. It is stored in a factory underground chamber where a large quantity of bags are collected and then stored in the company premises. It was started a few months ago and currently disposes of about 3 tons of waste powder per day. With the expansion of manufacturing activities this amount may increase in the future. The ceramic tile waste here is dry. The distinctive characteristic of this powder is its fine white powder. Such features can be seen here.

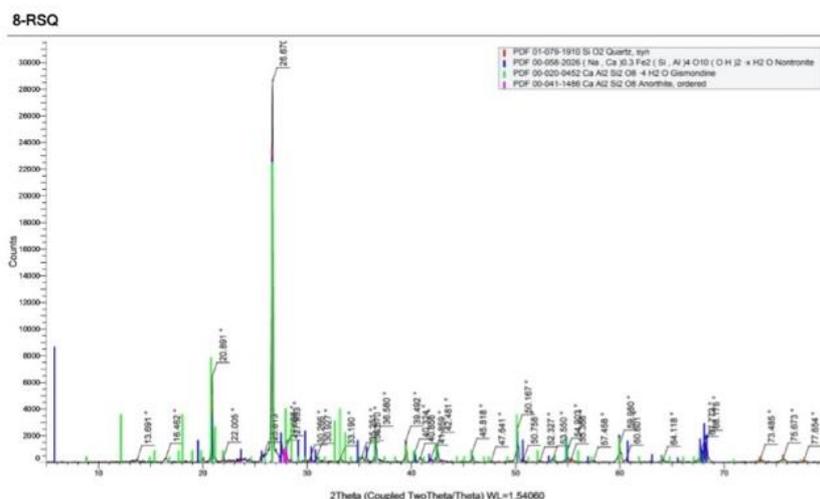


Figure 1 X-ray Powder Diffraction (XRD)

Table 1 Sieve analysis test

Standard Values		Detail	Scale
500 µm	30	The remaining powder on the filter	0.76 g
425 µm	40	The remaining powder on the filter	0.40 g
300 µm	50	The remaining powder on the filter	0.60 g
250 µm	60	The remaining powder on the filter	0.75 g
180 µm	80	The remaining powder on the filter	2.30 g
125 µm	120	The remaining powder on the filter	2.70 g
	fine	Powder passing through the filter	92.43 g

Table 2 Physical property of waste

Detail	values
Density	1.6
viscosity	-
Residue	2.11 g

Sample 02: Wet Squaring Waste Plant + Polishing Plant (9- RSQ+P)

This is other tile squaring plant in rocell Horana complex. The water that is removed from the plant and the polishing plant is dumped in large pools away from the factory. The constituents of the ceramic west of the water, which come into the pools, use alum to quickly deposit the bottom. There are five pools, one after the other, where the water passes through. The ceramic waste powder is deposited in the bottom of the pool with the action of alum. The difference is that the weight of the constituent c

Components changes as they move from the first pool to the last pool. The heavier particles are deposited in the first pool and the lighter ceramic particles are deposited in the last pool. The final pool sends the remaining ceramic water through the filter press to separate the ceramic and water from it. The treated water is directed to the water treatment plant and used for other purposes, such as squaring and polishing. Ceramic tile waste that is removed from these pools is placed in large courtyards and inside the premises. These ceramic tile waste have different characteristics than dry squaring waste, which are grayish liquid depending on the aggregation and the action of the alum.

Among the highlights found here

- The appearance of a gray liquid
- Made of clay and sand particles of various sizes
- Although tile squaring and chemicals are not used, but small chemicals percentage are used in the polishing process. A quality check of the above samples will help to understand which products are best for what type of product range.

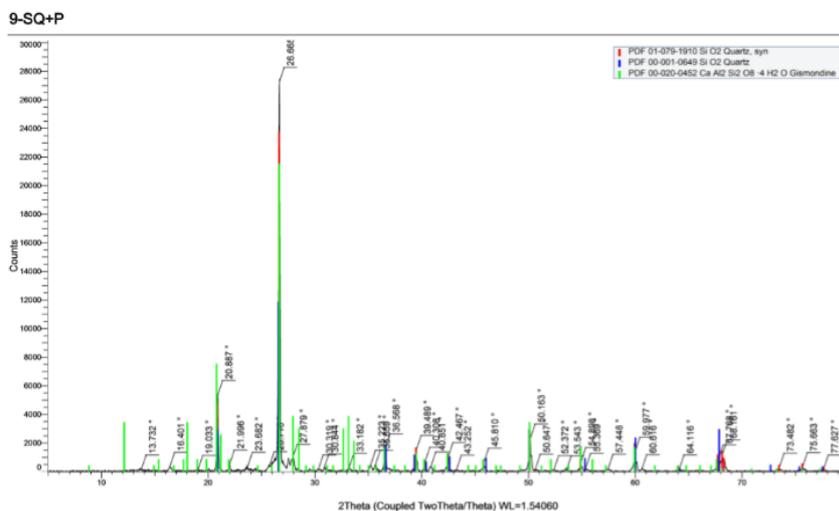


Figure 2 X-ray Powder Diffraction (XRD)

Table 3 sieve analysis test: 9- RSQ+P

Standard Values		Detail	Scale
500 µm	30	The remaining powder on the filter	3.10 g
425 µm	40	The remaining powder on the filter	2.50 g
300 µm	50	The remaining powder on the filter	3.30 g
250 µm	60	The remaining powder on the filter	2.30 g
180 µm	80	The remaining powder on the filter	5.90 g
125 µm	120	The remaining powder on the filter	7.30 g
	fine	Powder passing through the filter	75.80 g

Table 4 Physical property of waste: 9-RSQ+P

Detail	values
Density	1.6
viscosity	-
Residue	6.82 g

7.2 CASE STUDY 02: LANKA TILES PLC (LTPLC) HANWELLA

Sample 03: Wet squaring, polishing and glazed line waste (5 – LFP)

This also operated as the rocell and Squirring waste and polishing waste are collected separately draining through sewage. But the capacity is relatively low and when it exceeds the limit it enters to the main tanks. Ceramic waste is collected there. The special thing here is that glazed waste also collected here in the same tank. In 18/19 6900mt of filter cakes are released from here.

That equivalent to 75% of the total generated waste. This waste is like a muddy look. Most of the waste is deposited in the sewage because there is a considerable distance from the tanks. Color is white or gray and grace adds muddy color to it. Here waste is not reused in the manufacturing process and waste generated through filter press is stored separately. Damaged tile pieces are crushed to tiny pieces and give them to another factory for the making of the Wall block bricks. The little amount of filter cake is also used and most of the filter cake is used in the landfill of the ball mining centers.

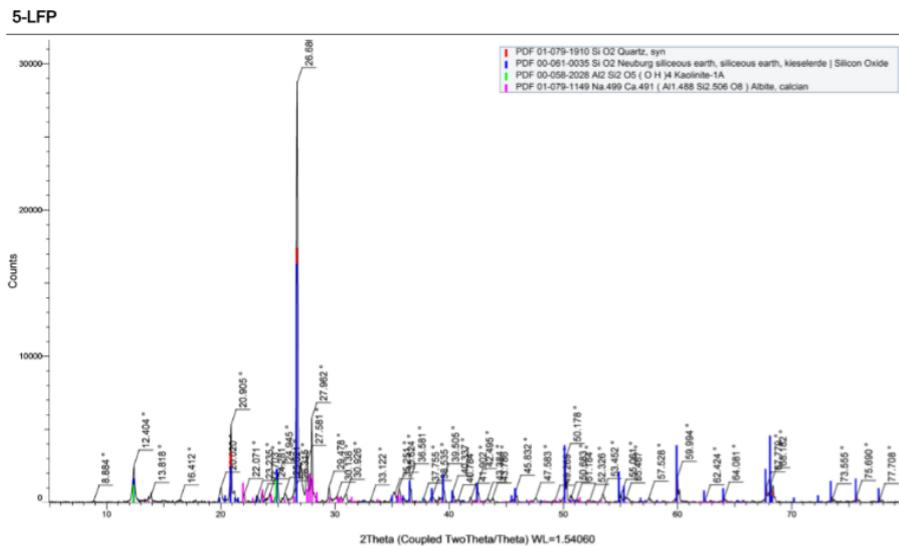


Figure 3 X-ray Powder Diffraction (XRD)

Table 5 Sieve analysis test: 5-LFP

Standard Values		Detail	Scale
500 µm	30	The remaining powder on the filter	33 g
425 µm	40	The remaining powder on the filter	11.1 g
300 µm	50	The remaining powder on the filter	20 g
250 µm	60	The remaining powder on the filter	5 g
180 µm	80	The remaining powder on the filter	9 g
125 µm	120	The remaining powder on the filter	6.6 g
	fine	Powder passing through the filter	11.6 g

Table 6 Quality of waste: 5-LFP

Detail	values
Density	1.61
viscosity	-
Residue	1.64 g

7.3 CASE STUDY 03: MACKSONS TILES LANKA BANDARAGAMA

Sample 04: Dry squaring waste plant (1 – MSQ)

The sample in this method is similar to the Rocell dry squaring waste. The factory does not use a wet squaring plant and does all the squaring through here. Also, the Rocell Company uses an open workspace for their large scale tiles. The discarded ceramic powder is placed in an adjacent yard. Approximately 6 tons of waste is generated per day. The external features are similar to sample 1.

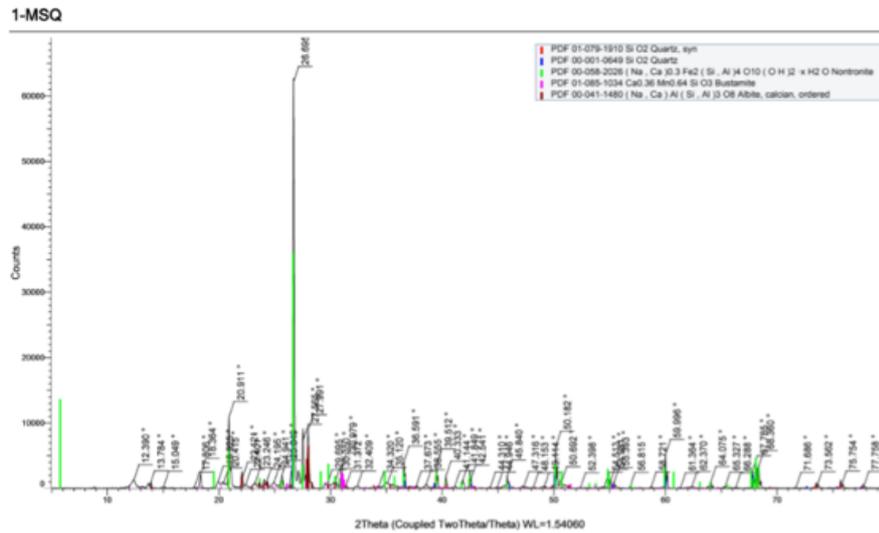


Figure 4 X-ray Powder Diffraction

Table 7 Sieve analysis test: 1-MSQ

Standard Values	Detail	Scale
500 µm	30	The remaining powder on the filter
425 µm	40	The remaining powder on the filter
300 µm	50	The remaining powder on the filter
250 µm	60	The remaining powder on the filter
180 µm	80	The remaining powder on the filter
125 µm	120	The remaining powder on the filter
	fine	Powder passing through the filter

Table 8 Quality of waste: 1-MSQ

Detail	values
Density	1.61
viscosity	-
Residue	1.64 g

8. Conclusion and Recommendation

Ceramic tile factories in Sri Lanka produce waste products such as ceramic powder, ceramic glaze, and sludge and there is no mechanism to deal with that waste locally. Every factory had been made an effort to provide a better solution, but there arises a requirement of a common solution to dispose of these wastes. This is not only important for countries like Europe, India, China who are the giant in the manufacturing field of ceramic but also for Sri Lanka which is an island where there aren't many factories are situated and this is being a very severe problem in the long run because this ceramic waste will decay for many years and will not be added to the environment. Tile fragments were not considered in this study. The main focus has been on squaring and polishing waste.

To simulate the interest, to re-use the ceramic waste, it should be cheaper to re-use than dispose of. Tile pieces are often used after a process of remaking. But due to the powdery nature of tile-squaring, it can be used to manufacture other products profitably. Although there are advanced techniques for waste management in the world, those are not properly utilized in Sri Lanka. Reusing the maximum amount of waste without damaging the quality of the tile can prevent the wastage and by utilizing other waste in more suitable industries, we can maximize the use of natural resources as well as protect the environment. XRD testing can make it clear that it does not contain any harmful substance for the

environment and organisms. Durability, strength, and heat resistant properties of this ceramic powder make it ideal for producing economically important products.

According to many other study references, these are being used in concrete mixing. Also, the amount of waste removed from dry squaring is subtle. These can be used to create small ceramic products manufactured under ceramic casting. It can also be used with concrete as well as tar for road construction. Tile pieces can also be used for this purpose, but the sharp edges of the tiles can damage the vehicles traveling on the road after the deterioration of tile and cement.

This ceramic waste has the potential to cover a large area of production. In addition to this, for further experiments, some field investigations are being carried out to use this waste for the growth of marine organisms. Within a short period of two months, we could observe a variety of algae appeared on it. The burnt ceramic powder which is the disposal of the ceramic squaring and polishing plants has a high potential to be used in a new manufacturing process with the use of proper methodologies and new experiments to minimize the environmental damages. That waste can be used as an ecofriendly material for environmental conservation project.



Figure 5 after 1 month



Figure 6 after 2 month



Figure 7 after 6 month

9. Reference

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