

# Characteristics and Challenges of Brick Making Industry in Central Aceh, Silih Nara, Indonesia

N. Kolodziejek <sup>1,a</sup> and L. S. Tey <sup>\*2,b</sup>

<sup>1</sup> Asia Europe Institute, University of Malaya, 50603 Kuala Lumpur, Malaysia

<sup>2</sup> Faculty of Business and Accountancy, University of Malaya, 50603, Kuala Lumpur, Malaysia

<sup>a</sup>n.kolodziejek@gmail.com, <sup>\*b</sup>teyls@um.edu.my

**Abstract** – *This study presents traditional brick making in Central Aceh in Indonesia, specifically in Silih Nara sub district. According to official statistics Silih Nara since 2008 remains the poorest area of central Aceh. Traditional brick making is the biggest industry in the area besides agriculture. Previously no research has been conducted about bricks quality and brick yards development in sub district. Data from the research can be use in study of SMEs recovery after earthquake that hit Aceh in 2013. Due to reoccurring natural disasters in the area it is important to improve quality of bricks, which are used to rebuild dwelling houses and public facilities. This study describes methods of brick making in Silih Nara and quality of the bricks in order to recommend changes in production which can strength final product. Through SWOT analysis of brick industry, some recommendations were suggested for brick makers in Silih Nara and local government to improve bricks quality, industry sustainability. Copyright © 2016 Penerbit Akademia Baru - All rights reserved.*

**Keywords:** Brick Making, Indonesia, Silih Nara, Bricks Quality

## 1.0 INTRODUCTION

Traditional building materials play an important role in developing countries. Bricks, bamboo, wood and natural fibers are important building materials in both urban and rural areas of South East Asia (SEA) [1]. Weak construction and building materials put the lives of generations at risk when natural disasters such as earthquakes or hurricanes strike. The importance of studies about the brick making industry should not be underestimated. It should receive more attention [1].

Brick making remains a big business in SEA countries, such as Indonesia, Vietnam and Thailand. Majority of brick producers rely on traditional method in producing bricks. In some developing countries entrepreneurs could not afford modern changes because of limited capital [2]. Thus, traditional techniques of producing bricks are popular in Asia. It is very challenging to transition from traditional brick making to modern techniques [2]. Besides, the brick making industry is diverse within SEA. The diversity is not only defined by country borders but also between regions, districts or even villages. In Indonesia, the brick making industry differs between islands (i.e. Java and Sumatra), neighbouring districts and sub districts [3]. The industry may face different challenges across the country and region. Aspects of brick making in Silih Nara (Central Aceh of Sumatra, Indonesia) were not studied [4] [5]. There is no analysis about brick making small and medium enterprises (SMEs) in sub district neither from Regional

Disaster Management Agency (Badan Penanggulangan Bencana Daerah) or the Statistic office. Demand of bricks remains high in this area to rebuild the damaged house caused by 2013 earthquakes. Recommendations for efficient development of the Silih Nara brick industry and product quality are urgently needed.

Based on the above arguments, this study was carried out with four objectives:

1. To identify the input of brick industry and issue faced by brick industry in Silih Nara.
2. To describe traditional brick making method and brick quality issue in Silih Nara.
3. To identify the opportunities, threats, strengths, and weaknesses (SWOT) of brick making in Silih Nara.
4. To recommend how bricks quality and brick yards business can be improved in Silih Nara.

This paper is organized as: after the research methodology, the input of production of brick in Silih Nara was first presented in this paper. Second, the traditional brick making method and the brick quality of Silih Nara were then presented. It was followed SWOT analysis. And lastly, recommendations were provided to improve quality and efficiency of the brick making industry for that district.

## **2.0 METHODOLOGY**

We employed mixed method approach, interview and survey, in this study. It was a cross sectional and exploratory study since not much was known about the topic in Silih Nara. Data was obtained from primary and secondary sources. Qualitative data was analyzed with content analysis method. The unit of analysis of this study is the brick maker. All brick makers selected in the study were informed about purpose of the study. The study was conducted in June 2014 at Takengon in Central Aceh. Pictures of materials for brick making, working process, brick yards and kilns were taken during field work. For interview data, it was jot down during the interview and it was coded by using different coding process, open and axial coding, to identify the theme of the data.

Quantitative data was collected through survey. Survey questionnaire contains questions about: 1) materials used by brick maker, 2) production process, 3) capacity of brick firing, 4) workforce, and 5) management system. Data collected through survey was analysed by using Taro works software designed by Greeman Bank foundation. The sample for this research is limited to brick makers in Silih Nara sub district. This study was conducted in two villages, Genting Gerbang and Mulie Jadi, with biggest amount of brick yards in Silih Nara. All 33 operating brick yards in those villages were visited. Owners and workers of brick yards who could provide information were interviewed in Indonesian language. Secondary data were gathered from statistic office in Takengon and Central Aceh, Banks BTPN and Industrial Training Center in Banda Aceh.

## **3.0 THE INPUT OF BRICK INDUSTRY AND ISSUES FACED BY BRICK INDUSTRY IN SILIH NARA**

As shown in figure 1, the common raw resources needed to produce brick in Silih Nara include clay, sand, water and timber. The brick makers in Silih Nara buy clay and sand. Clay is bought

from hills in Mutiara or excavate it near their own brick yards, while sand is bough from Sekep. Excavated clay is never homogeneous. Small rocks, sticks debris from the clay same like roots might get into the mixture of sand and clay. Some of them are removed during premixing process. Before mixing, clay need to have high plasticity and bounding strength. Water shortage is a difficult for most of brick makers in Silih Nara. Rain water is available seasonally so during dry season those brick makers who has no access to well needs to buy water from suppliers. More than a half of brick makers in Silih Nara purchase water for production. Only 45% of brick makers depend on rain water. Way to store water differs in brick yards. Some of them has just ditch dig next to brick yard and water is store there. Other form is to dig a container in the ground and cover it with a plastic, so water won't soak into ground. One brick yard had more advanced concrete container with capacity for one tank of the water. One of the interview respondents who was born in Silih Nara informed that around 40 years ago water was still available in the village but irrigation system was destroyed by the landslide so the river is no longer reaching the area any more. Brick makers should check water absorption and salinity of the bricks to follow measurements of national standard in Indonesia.

Timber/wood is bought right before firing and often it is kept in a place reachable by a truck. They do not keep wood in cubic and do not prepare any special storehouses. Wood fuel is a major cost of brick production in developing countries [6]. As diagram of materials reveal show it is also the most expensive input for brick industry in Silih Nara. Very often brick makers do not know how many cubic of wood they need every year.

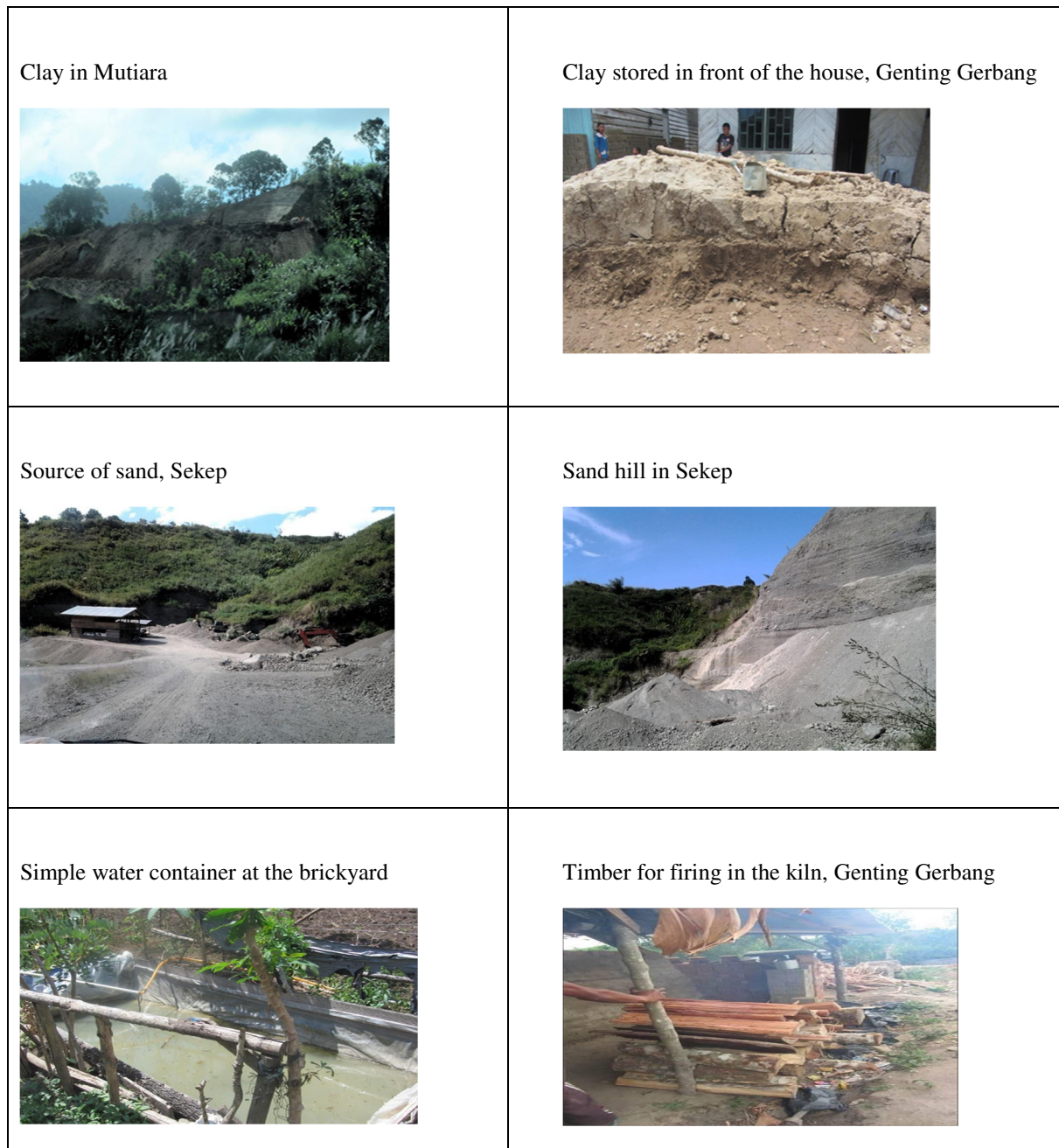
### **3.1 The Process of Brick Making:**

In rural area of Indonesia, bricks are prepared differently than in the modern brick factories. Brick making process consist of four steps. Firstly, necessary materials are obtained: (clay, sand, water, materials for firing), mixed and shaped into a brick. It is then dried and finally fired in the kiln (refer to figure 2).

#### **3.1.1 Mixing**

Clay as a raw material must be prepared and it has influence of end quality of the product. It is time and energy consuming process, but neglecting it can result in cracking and defects of bricks during drying. Firstly clay lumps has to be crushed. It unlock natural minerals in the clay so that material can be more plastic (disintegration of clay). In order to make it clay is firstly mixed with a shovel and this job is mostly performed by man. During this process clay is mixed with a little water, neatly sticks, roots and small rocks are being removed. Usually rural brick makers have limited funds to invest in mechanical preparation of the clay [7], so they rely mostly in hand operated equipment. In Silih Nara brick yard uses buffalos to mix clay. After that clay is mixed with buffalo in a round pot.

One buffalo is mixing clay, water and sand for around 3-4 hours to create coherent mixture. Buffalos are often rented by brick makers from the village. In Silih Nara brick makers do not use machines as hand tractors to mix clay but I could see it in other parts of Sumatra



**Figure 1:** The input of brick industry

<p>Mixing materials with buffalo Genting Gerbang</p> 	<p>Moulding Bricks</p> 
<p>Brick production machine</p> 	<p>Bricks are arranged after drying</p> 
<p>Small kiln in Genting Gerbang</p> 	<p>Brick arrangement in the kiln before firing differs in brickyards</p> 
<p>Wood ready for firing in the kiln tunnel</p> 	

**Figure 2:** The process of making brick

It is possible to add fuel waste such as saw dust, coffee or rice husks as admixture to the bricks but only to clay which has high shrinkage. The ratio of fuel for clay has to be found out by testing. Sand clays are completely unsuitable for such mixing with waste because it can increase water absorption and in the firing process added waste might cause lower compressive strength. Luckily, it was not observed in Central Aceh.

### **3.1.2 Moulding**

Shaping bricks is done manually. It is done by smashing lumps of the mixture into the wooden mold. The excessing clay is removed from the top of the mold by wire saw. In Silih Nara this process is mostly done with single mold. Bricks are then turned upside down and drying under the roof. Damage of edges or brick shape must not happen during this stage. Bricks are very malleable just after shaping.

### **3.1.3 Drying**

Success in brick making depends strongly on uncontrolled factors such as weather, it is difficult to estimate time of production. The brick makers need to have practical experience to find the best drying method [7]. The importance of drying process should not be underestimated. Length of drying process depends strongly on wind and temperature. Drying of freshly molded bricks too fast or on strong sun often results in cracking or deformation [7]. In Silih Nara bricks are dried not on direct exposure onto the sun. Shaped bricks are put on the ground under the roof. During this stage bricks are arranged in way which makes it easy to calculate them. The most popular way is to put 5 bricks in one unit together. It allows to count bricks produced per day and the salary of the workers. Time of drying depends strongly on weather and is extended during raining season. In May and June when interviewed were conducted drying required 4-7 days. According to several brick makers during raining season it takes even up to 14 days to makes brick ready. Study shows that due to extended time of drying, the production of bricks decreases about 27 to 65 % [8]. When drying bricks shrinks and become more solid. Water is evaporating from the mix. Drying should be done with a minimum loss of the product. If green bricks still contain a lot water when they are placed in the kiln, then energy, and money, is wasted just to dry them [6]. After weathering for several days bricks are dense and can be put one on one another and build a wall of the brickyard. Brick makers need to be careful when arranging bricks so that they do not fall and break. In the brickyard where bricks are shaped by machine drying is more time consuming because bricks are often glue together and air is not getting easily through the gaps.

### **3.1.4 Frying**

Brick kilns can be classified into three categories: small with production <1 million bricks/year, medium 1–2.5 million bricks/year and large >2.5 million bricks [9]. In Silih Nara small kilns, so called clamp kilns are dominating similarly to other rural areas in developing countries [10]. In Central Aceh brick maker do not use the latest Vertical Shaft Brick Kiln or continuous type Bull Trench Kiln technology which appears in other developing countries of Asia [10].

Kilns in Silih Nara had quadruple or rectangular shape. Wall of the kiln is built of 2 rows of bricks. Depend on the width of the kiln, 2, 3 or more wholes are done for timber insertion in one of the walls. Some kilns also have holes for wood tunnels on the opposite side but it is rare. In some kilns the underpart is a little wider. Floor of the kiln can be concrete or is

simply a ground with sand or ash on the surface. A kiln with equal sides has a smaller cooling area than a rectangular one of the same volume because they have smaller walls surface and that reduce heat losses [6].

Heat is lost through the top, the walls and, to a lesser degree, the bottom of the kiln. Anything which reduces heat loss increases efficiency of firing. As it was found thicker scoving, plastering with mud, on clamps will help reduce losses as will using fired bricks in the outer layers. During firing brick makers in Silih Nara plaster top of the kiln with mud or clay, some alternatively cover top with old bricks which were damaged and could not be sold.

Arrangement of the bricks in the kiln has influence on how well bricks are fired. Amount and type of firing material are as well important. Placing fuel as close to the bricks as possible is most efficient. Placing some or all the fuel in the clay mix can be very efficient but one of Silih Nara brick makers use it in the mixture. Anything brick makers can do to reduce waste of heat will cut costs. In Silih Nara none of brick makers possess tools to measure temperature in the kiln. One brick maker estimate it based on flame color. Most of brick makers focus on keeping fire stable so that kiln temperature would not decrease during firing.

Kiln arrangement also allows counting of the bricks. Most of the time brick makers count layers of brick in the kilns and multiply with amount of bricks within one layer. High kilns can have up to 25 layers of bricks.

According to some authors firing of the kiln is the most important phase in the production of bricks [6] [11]. The temperature is critical factor for brick final quality [6]. The thermal efficiency of the firing in kilns is low. Firing in traditional kilns consumes lot thermal energy. Schilderman [6] calculated that for every 1,000 bricks which are fired 3 cubic meters of cut firewood is needed. In Silih Nara brick makers do not calculate cubic but trucks of fuel-wood per firing. One truck delivered to Silih Nara contain 5 cubic of wood (according to truck driver). It means that 25 000 bricks which is an average production per firing in Silih Nara each firing would require 75 cubic of wood much more than are really use – most of brick makers purchase 2 or 3 trucks of wood (15 cubic) to fired 25 000 bricks. Kiln site organization is imported to make firing process save. Wood should be storage enough far from the kiln to avoid accidental fire. In Indonesia wood is mostly store near brickyard or kilns because brick yards are not very spacious. Space is even more limited in mountain areas such as Silih Nara. Location for wood is often not planned and strict.

During firing process firstly bricks are losing all the water which did not evaporate during drying. It happens when bricks are heated to a temperature between 20°C and 150°C [11]. As the firing chemical changes starts to occur in a clay when temperature rises to 600°C, bricks color start to change as well as their hardness and durability. Above 900°C, vitrification is complete. All the elements of vitrification should be achieved to guarantee that brick will be resistant and hard. Final quality of the brick depends strongly on vitrification [11]. The temperature shouldn't be allowed to fall until firing is complete. The major loss from most kilns is due to too much cold air being drawn in [6].

In Silih Nara, brick makers do not measure or control temperature of firing. Increasing insulation, particularly of clamps which can be covered with a thicker layer of mud, offers

a potential saving without a big cash spending. Firing is finished by cooling a kiln and exiting bricks. Cooling kiln is often done with use of rice husks. Husk are spread on the top surface which makes flames goes up from the wood in the tunnels. During cooling heat sometimes cause damages of corrugated roofs above the kilns. Cooling should not be too fast so that cool air which enter kiln do not crack the bricks. Bricks can be stronger if the kiln will be cooling down slowly [11]. In Silih Nara man are responsible for firing kilns and opening them after firing.

More than a half of the kilns in Silih Nara has firing capacity from 25 000 to 50000 bricks and most of brick makers owns one kiln. It is possible to find kilns with smaller capacity than 25 000 bricks or used irregularly. To build the kiln is main expense of starting business and this work is done by qualified kiln builder. Brick makers who wish to increase production hire more people instead of expanding their kilns (mostly due to limited space). Kilns can be used for many years. Most of the kilns in Silih Nara has tunnels for wood just on the front wall but models witch holes on the both sides can be seen. In Silih Nara some kilns were damaged during earthquake in 2013, brick makers rebuild them or build new kilns. Old kilns are demolished but several of them are still placed in the brick yards. Most of the brick yards in Silih Nara have rectangular shape.

## **3.2 SWOT Analysis of Brick Industry in Silih Nara**

### **3.2.1 Strengths**

Majority of brick makers in Silih Nara employ simple production technique which allows to recruit workforce easily. Brick making brings better income than any other industry in the area and generate jobs for both genders. Brick making can easily engage all family members. Strength of the industry is also that it helps in Central Aceh recovery after the earthquake.

### **3.2.2 Weaknesses**

The main weaknesses of the industry are: 1) quality of the bricks and 2) lack of skilled labour/manager. Poor quality of the product might cause customers turn to other sellers or to alternative building materials. Inferior quality of the mixture increase costs of firing and cause easy breaking of the bricks. Size of bricks do not meet national required standard. Some of the brick makers believe that quality of the bricks depends only on materials and are sure that all brick yards in the area produce similar quality. Brick makers in Silih Nara test bricks mostly do it by checking it surface, sound and color after firing. Two brick makers explained that bricks in Silih Nara would not be dark red due to pale color of clay. Many brick makers decide to fire bricks for the second time if brick looks white. All brick makers who fired bricks for the second time were convinced that it improves strength of the brick. In fact second firing has harmful influence on the quality which was tested by Build Change during BBM project in West Sumatra in 2013[13]. Some of interviewed brick makers dropped fired bricks or throw them to test it strength and see whether they cracks.

Genting Gerbang had more advanced testing method to compare quality of bricks from Silih Nara and Bireuen (neighbor district which also produce bricks). To test strength of the bricks, brick makers arranged them in a layers and drove through them by motorcycle, afterwards they checked whether bricks were cracked or broken. During field research we did not witness such testing. Simple test of the bricks were performed in the Build Change Office.



Skilled or educated labour rarely happen in the brick making in Silih Nara. Out of all the brick maker interviewed only one brick maker attended two-week industrial training in Banda Aceh and had experience from brick yards in Java. Provincial Department of Industry and Trade informed, and Industrial Training Center in Banda Aceh do not offer trainings for brick makers. Though the institutions offered tools to brick makers to modernize production.

In fact simple way of producing bricks makes job possible for both genders and people in various age. It is easy to find workers for the kilns. Role of labour efficiency in small brick yards has been studied [10]. Citizens of Silih Nara either works in agriculture or brick making industry. Sometimes it makes hiring workforce for brickyards during harvest time more difficult. Since all the population in Silih Nara is Muslim during fasting month workforce is also limited. Workforce includes all age groups; teenagers, adults and elderly people work in brick yards of Silih Nara. One older woman shape bricks also with her grandchildren.

Division of labour by gender in brick making could be seen. Man and young boys are responsible for obtaining clay and mixing it with water, arranging bricks and bringing them in and out of the kiln, watching the firing process. If brick yard has a truck man are drivers. Woman mostly mould the bricks and setting them to dry. In 48% of brick yards women were majority. Woman working performance play big role in disaster recovery [8].

One of respondents hires workers from islands of Bali and Lombok which could be sign of demand for workforce. Salaries depends on the amount of job which should be done. Woman moulds the bricks which is the most time consuming duty. Due to low salaries (35 000 IDR per day if done 1000 bricks in Silih Nara) people are not motivated and are careless, owners admit that complain might cause workers leave the brick yard. For several interviewed entrepreneurs workforce is the first factor to develop business and makes it bigger. As it was found by Bala [10] in small scale industry people use similar technology so improving labour skills and efficiency can be important for higher returns and competitiveness. In brick making capacity depends on people productivity it is than important how workers are motivated. Daily production of bricks by each person influence tempo of all finalizing firing. One person can mold per day maximum 1000 bricks. Due to lack of educated manager, brick makes do not calculate they revenue and do not know how to adjust price of their products and how to seek for capital to develop their business. Lack of accounting unable to calculate loss from production and proof that brickyard is creditworthy. During harvesting in coffee plantations and in fasting month production decrease in Silih Nara. Since only cash transactions are accepted brick makers cannot attract contracts with big companies that offers installment buying. In addition, not all brick makers perform quality tests in Silih Nara.

<i>Internal</i>	<i>Strength</i>	<i>Weaknesses</i>
	<p>S1. Production near natural resources</p> <p>S2. Family business continuity</p> <p>S3. Simple techniques can be learned fast – low costs of training</p> <p>S4. Work for both genders</p> <p>S5. Contacts with middleman and other brick makers makes it easy to obtain customers</p> <p>S6. Easy available workforce due to lack of other work opportunities in the area</p> <p>S7. Income is higher in comparison with agriculture in the same household</p> <p>S8. Husk and ashes from agriculture available in the area</p>	<p>W1. Production decrease during Ramadan</p> <p>W2. Rental costs of land, buffalo and tracks</p> <p>W3. Uneducated and unskilled labour</p> <p>W4. Low capital to launch the business</p> <p>W5. Poor quality of final product</p> <p>W6. Lack of equipment to measure temperature during firing</p> <p>W7. Lack of machinery use in production or expensive technology</p> <p>W8. Lack of specify plans of business development</p> <p>W9. Lack of adequate accounting books</p> <p>W10. Weak safety conditions</p> <p>W11. Poor quality materials</p> <p>W12. Time consuming production</p> <p>W13. Lack of marketing activities and branding</p> <p>W14. Lack of systematic management</p> <p>W15. Old kilns cannot be easily modernized</p> <p>W16. Lack of space for develop business on own land</p>
<i>External</i>	<i>Opportunities</i>	<i>Threats</i>
	<p>O1. Trainings with NGOs to improve quality</p> <p>O2. Local government try to multiple molding blocks</p> <p>O3. Constatnt high demand for the product, higher after natural disasters</p> <p>O4. National standard to follow</p> <p>O5. Government assistance to rebuild the damaged houses. Increase the demand for bricks in the area</p> <p>O6. Available rice, saw dust and palm husks as alternative firing materials or mixture content</p> <p>O7. Research and study development about brick making</p>	<p>T1. Weather conditions extend production process</p> <p>natural disasters like regular earthquakes damage production site</p> <p>T2. Cost of registering business</p> <p>T3. People rebuild more often wooden houses in the area and demand might decrease</p> <p>T4. Competitiveness of cement producers</p> <p>T5. Brick factories may start to compete</p> <p>T6. Government uses different materials for big investments, brick making is neglected no standard controls</p> <p>T7. Landslide next to the kiln</p> <p>T8. Loss of timber supplier due to lack of permission</p> <p>T9. Growing costs of firing materials</p> <p>T10. Competitors from neighbor areas</p>

**Table 1:** SWOT analysis of brick making industry in Silih Nara

### **3.2.3 Opportunities**

Main opportunity for brick makers in Silih Nara relates to current high demand for bricks in the area. Brick yards can still increase production because clients and workforce are easy to find. Brick makers who excavate their own hills can become suppliers for others and break monopoly of external providers. NGO in the area might provide trainings and help brick makers develop their business and improve quality of the product. Investing in truck or car in cooperative can create higher mobility to business. Opportunity of creditability can growth when brick yards will legally register. Proximity to rice fields and various agriculture waste gives an opportunity to add organic waste to the mixture or firing material - it is than a chance to stop firing bricks for the second time and improve compressive strength of the product. Brick making is the biggest and still growing industry in Silih Nara, Aceh.

### **3.2.4 Threats**

As shown in Table 1, the main threats for brick making industry in Central Aceh relates to pricing of materials due to high bargaining power of suppliers. High demand for the bricks is cause by last big earthquake which strike Central Aceh in 2013. There are many new entrepreneurs in the industry and it's becoming more competitive. Weather conditions and natural disasters are threat for the brick yards and natural resources as clay are not renewable. Threat of substitute building materials (wood and batako blocks) is moderate but SMEs are not protected by cooperatives. Environment pollution is another threat to Silih Nara. Excavating hills in search for clay and clearance of trees for firing are two biggest environmental concerns in brick making industry in Silih Nara, Aceh. The finding is in line with [12]. A considerable amount of firewood can be saved if suitable agriculture, forestry and industrial waste can be utilized during bricks production.

## **4.0 RECOMMENDATIONS ON IMPROVING THE PERFORMANCE OF BRICK INDUSTRY IN SILIH NARA**

Table 2 shows some recommendations on how to improve the performance of brick industry in Silih Nara. Quality of bricks and business management can be improved in Silih Nara. It is recommended to control mixture to eliminate cases of brick breaking because of stones and lumps. Search for more sustainable production is recommended. Brick makers could invent more effective way to collect rain water, some brickyards can invest to build water containers. Organic wastes from agricultural production should be added to mixture in order to support ding of bricks. Temperature of firing bricks should be measured and future kilns should be designed with equal walls to reduce heat loss. Bricks should not be fired for the second time because it worse quality and increase firing costs. By improving arrangement or firing process they can save money for next operations.

	<b>Strength</b>	<b>Weakness</b>
<i>Opportunities</i>	<p><b>SO</b></p> <p>S2.O7, Business can be continue by experience family members and in time their experience go with newest scientific findings about industry</p> <p>S3.O1 short simple training can be completed with NGO when new workers are hired, part of effort can be delegate to NGO</p> <p>S3O3 Newcomer fast start to bring feasible profit, no internship necessary before hiring</p>	<p><b>WO</b></p> <p>W1O3, By hiring more workers during Ramadan highest stock in the brickyard would be possible, it is competitive advantage because most of brick makers decrease production in fasting month and has lower sales afterwards</p> <p>W2O5 Materials can be obtained from land of customer whose awaiting money from aid thanks to this resources near brickyard would last longer and costs of materials would be reduce in production</p> <p>W3O1, Workforce can get good and certified training from NGOs</p>
	<p><b>ST</b></p> <p>S4T3 Brick making remains job for both genders, in case of wooden construction man are working, brick making can remain field for women entrepreneurs after natural disasters</p> <p>S8T9 Ashes and husks from fields and plantations can be added to mixture and improve firing , those materials can substitute timber to lower the operation cost</p>	<p><b>WT</b></p> <p>W11 and W5 T6 Government should execute the standard that is set for Indonesia</p> <p>W12 T1 Government should provide technology and trainings to enhance production process.</p>

**Table 2.** SWOT Matrix of brick industry in Silih Nara

Brick makers may consider to register their business and cooperative to become creditworthy. Legalization of brickyards will empower them in relations with suppliers and government. Entrepreneurs should initiate marketing actions to build their brand. By hiring more workers during Ramadan brick yard can generate high stock, it would be a competitive advantage for producers.

Besides, construction sector represents a complex industrial environment [14]. Government and policy makers could address weaknesses and threats of the industry by executing national quality standard of the bricks to enhance the safety of the houses built. It is crucial step to grow safety of houses in Central Aceh. Since brick yards in Silih Nara lack accurate equipment for testing it is recommended to control bricks and support SMEs in achieving required standard. Instead of offering multiple moulding bricks government should focus on improving quality of building materials. Brick makers should receive certain incentives for registering business and industrial trainings should be renew in Banda Aceh. Policy makers should consider supporting brick making SMEs after natural disasters to respond to high demand for building materials. Awareness about bricks quality should be increase among population. Natural environment especially forest should be better protected from illegal lodging. In addition, policy makers might provide training in Total Quality Management (TQM) to enhance the quality of management system and product produced [15, 16]. According to recent study, latest technology can help to enhance the efficiency of heat generation and consumption [17, 18, 19, 20]. Brick makers might consider to adopt the latest technology to enhance the brick drying process.

In addition, NGOs may play their role in providing training to local brick makers to enhance their environment conscious as well as to improve the effectiveness and efficiency of the brick production process.

## **5.0 LIMITATIONS AND FUTURE RESEARCH DIRECTION**

This study is a cross sectional study. It only reflects the current brick industry in Silih Nara, Aceh. It does not show the evolution of the brick industry in this area. Future study may conduct a longitudinal study to investigate the evolution of the brick industry in Silih Nara, Aceh. It will provide more insight on the speed and the scale of the development of brick industry in Silih Nara, Aceh.

### **ACKNOWLEDGEMENT:**

Equipment and transportation of this research were provided by Build Change Indonesia. [www.buildchange.org](http://www.buildchange.org).

## **REFERENCES**

- [1] Food and Agriculture Organization of the United Nations FAO, (1993) Status and development issues of the brick industry in Asia, Field Document No 35, Bangkok.
- [2] E. Gomes, I. Hossain, Transition from traditional brick manufacturing to more sustainable practices, Energy for Sustainable Development 7 (2) (2003) 66-76.

- [3] O.F. Nur, Analisa sifat fisis dan mekanis batu bata berdasarkan sumber lokasi dan posisi batu bata dalam proses pembakaran, *Journal Rekayasa Sipil* 4 (2) (2008) 1-14.
- [4] K. Laswi, Pengaruh peneambahan abu sabut kelapa pada pembuatan batu bata tanpa pembakaran terhadap kuat tekan dan porositas, Universitas Negeri Gorontalo, 2014.
- [5] R.I. Safitri, Peranan industri batu bata terhadap tingkat kemiskinan rumah tangga petani pengusaha batu bata di desa Sitimulyo Kecamatan PIYUNGAN Kabupaten Bantul, Universitas Negeri Yogyakarta, 2012.
- [6] Schilderman, T. (2008), Ten rules for energy efficient, cost effective brick firing, A guide for brick makers and field-workers, *Practical Action*, (2008).
- [7] G. Merschmeyer, Wall building. Technical brief, Energy Saving Brick making, Germany, GATE, 1999.
- [8] P. Sawitri, E. Hartoanto, Sariyati, Female workers in post disaster recovery case study: access, empowerment and opportunity in Bantul Yogyakarta, Indonesia, *Delhi Business Review* X, 10 (2) (2009), 27-34.
- [9] T. Narafu , H. Imai, Y. Ishiyama, D. Kusumastuti, W. Wuryanti, K. Shirakawa, M. Kinoshita, Experimental Study on Confined Brick Masonry in Indonesia, Lisboa, WCEE, 2012.
- [10] S.M.H. Bala, Labour Productivity, Energy Intensity and Economic Performance in Small Enterprises: A Study of Brick Enterprises Cluster in India, *Energy Conversion and Management*, 47 (6) (2006) 763-777.
- [11] A. Beamish, W. Donovan, W. Village-Level Brickmaking, Germany, GATE, 1993.
- [12] B.A. Margono, P.V. Patapov, S. Turubanova, F. Stolle, M.C. Hansen, Primary forest cover loss in Indonesia over 2000–2012”, *Nature Climate Change*, 4 (2014), 730-735.
- [13] Elsa, BBM Final Project Report, Build Change, [www. Buildchange.org](http://www.Buildchange.org), 2013.
- [14] A.R. Abdul Hamid, D.M. Clarence Botiti and S.R. Mohandes. Managing the Delayed completion on Construction Project. *Journal of Advanced Research in Business and Management Studies*. 1 (1) (2015), 14-24.
- [15] Tey, Lian Seng and Ooi, Tech Loon. Exploring the Barriers and the Level of TQM Implementation in Malaysian Construction Industry. *Research Journal of Applied Sciences, Engineering and Technology*, 7 (16) (2014), 3419-3424.
- [16] A.R. Firend. Contextual Examination of TQM Practices and Competitive Advantage in the Malaysian Manufacturing Sectors. *Journal of Advanced Research in Business and management Studies*. 1(1) (2015), 1-4.
- [17] Nor Azwandi Che Sidik and Rizalman Manat. Recent Progress on Lattice Boltzmann Simulation of Nanofluids: A Review. *International Communication in Heat and Mass Transfer*. 66 (2015), 11-22.

- [18] Omer A. Alawi, Nor Azwadi Che Sidik, H.A. Mohammed, S. Syahrullail. Fluid Flow and Heat Transfer Characteristics of Nanofluids in Heat Pipes: A Review. *International Communications in Heat and Mass Transfer*. 56(2014), 50-62.
- [19] Nor Azwadi Che Sidik, H.A. Mohammed, Omer A. Alawi and S. Samion. A Review on Preparation Methods and Challenges of Nanofluids. *International Communication in Heat and Mass Transfer* 54 (2014), 115-125.
- [20] H.K. Dawood, H.A. Mohammed, Nor Azwadi Che Sidik, K.M. Munisamy and M.A. Wahid. Forced, Natural and Mixed-convection heat transfer and fluid flow in Annulus: A Review. *International Communication in Heat and Mass Transfer*, 62 (2015), 45-57.