TRADITIONAL CERAMIC KILN DEVELOPMENT MODEL

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ABSTRACT
The research is focused on the traditional ceramic kiln development model as an application of the local culture to improve the teaching/learning activity in ceramic firing technique. The object of the research was the traditional kiln model in the ceramic craft village of Bentangan, Wonosari Sub-district, Klaten Regency, and the traditional kiln model in Melikan village, Wedi Sub-district, Klaten Regency. The research activity was an effort to preserve creative industry-based local culture as well as to improve the model of traditional ceramic kiln development as an object of teaching/learning activity improvement for students in ceramic firing technique. Those two ceramic craft-based creative industry villages have optimally-developed potencies. One of them is the existing kiln development model. The specific target to gain in this research was the materialization of the traditional ceramic kiln development model as the application of the ceramic craft-based local culture in the teaching/learning activity improvement for the students on the ceramic firing technique. The research itself is a local culture application and additional instrument engineering in the form of traditional kiln development model. The methods applied in the research were observation, discussion, and operational work methods. Activities which were related to the research objects were, among others, direct observations on the ceramic firing technology in Bentangan village, Wonosari, Klaten and in Melikan village, Wedi, Klaten. Following the observations, a new design of the traditional ceramic kiln development model was designed.

Keywords: kiln development model, traditional kiln, ceramic firing

INTRODUCTION

In Indonesia, ceramic industry and craft is one of the fields capable of absorbing quite a number of workforces as well as having a bright prospect as one export producer that can become one of the foreign-exchange sources for the country. Informal education which studies the miscellanies of ceramic arts, especially on the design and product development, is opened by higher education institutions/ universities to answer the need of community. The course of the parties involved in ceramic world is not as bright as its prospects (Budiyanto and Gatot, 2008). The problem encountered by the industrial sectors is related to the production cost, which is hindered by the high cost of fuel needs. It caused several craft-persons and artists to engineer the kiln development model to reduce the cost. The same problem is also encountered by formal institutions which open ceramic class. They try to cut down the operational cost of education to provide adequate facilities for the teaching/learning activities. Formal institution activities need an immediate solution and have to be adjusted to the development of the ceramic design request, which should be supported by sufficient infrastructure for the teaching/ learning process. Also, that infrastructure should be able to counter weight the need acceleration of diverse students' assignments execution, in order for them to fulfill the competency expertise in the field of ceramic art.

One way out is by developing the traditional kiln model which has already existed in ceramic craft villages based on creative industry. The examples are ceramic kiln model in Bentangan village, Wonosari sub-district, Klaten and the kiln model in Melikan village, Wedi sub-district, Klaten regency. Those two models in two villages are processed and developed in such a way that they bring out the traditional kiln development model which can broaden the students' outlook in the teaching/learning process. Traditional ceramic kiln is ceramic kiln which uses woods and straw as its fuel. That kind of kiln is usually utilized by the craft-persons in the ceramic crafts village of Bentangan, Wonosari sub-district, Klaten regency and in the ceramic crafts village of Melikan, Wedi sub-district, Klaten regency. The traditional ceramic kiln is the kiln used to fire ceramic with the maximum temperature of 700°C. Ceramic that is fired in that kind of kiln is low-temperature fired ceramic, which has a terra cotta color. For the kiln to reach higher temperature, the kiln has to be design in such a way that it is able to absorb heat longer. The material that is used in the making of that traditional kiln also plays an important role. If the material used in the making of the kiln does not absorb the heat too much, the heat itself will be used in a maximum way in the firing process, and as such, it will be more efficient

The emerged problem is connected to the problems encountered by the industrial sectors which are related to the production costs of the firing process. Some craft-persons are hindered by that problem. Therefore, one way to solve the problem is by the engineering of local culture-based kiln development model. That way, the ceramic kiln model can be developed, yet it will still be oriented to the existing traditional ceramic kiln. A similar problem is encountered by formal institutions which open ceramic classes. The formal institutions attempt to cut down the operational cost of education to provide sufficient facilities for the teaching/learning activities. Formal institutions' activities need an immediate solution and have to be adjusted to the development of the ceramic design request, which should be supported by sufficient infrastructure for the teaching/learning process. Moreover, that infrastructure should be able to counter weight the acceleration of need for the execution of students' diverse assignments, in order for them to fulfill the competency expertise in the field of ceramic art.

LITERATURE REVIEWS

All forms of arts and aesthetical expressions that are present and developed in every culture tend to differ, in style and expression, and each has its own unique characteristics (Kartika, 2007). Koentjaraningrat (1980) states that culture is the whole system of ideas, actions, and works of human being in community life. Other than the ceramic produced by craft-persons, one culture product found in pottery crafts-person community is the ceramic kiln itself. There are numerous forms of kiln made by ceramic craft-persons. Kiln is a vital instrument in ceramic industry. There are many types of kiln used in ceramic industry. The ceramic craft-persons commonly utilize village kiln to fire their products. The village kiln is usually made of bricks, cylindrical in shape or in the form of box. The top of the kiln is opened, and it is used to stack the ceramic produces made by the crafts-persons (Razak, 1992). The village kiln is also known as periodic updraft kiln. This kind of kiln has several advantages, some of which are as follows: Since it is made of bricks, its building construction is easy and inexpensive. It is also inexpensive and easy to maintain, and its operation is simple too. However, from the point of view of ceramic safety during the firing process in the updraft kiln, the fire can come into contact with the ceramic being fired, and as such, can damage the goods. Other shortages of the periodic updraft kilnare that the attained temperature is about 700°C; it is difficult to reach the temperature homogeneity; and it causes uneven maturation. Usually, the products that are near the fire experienced a lot of damages, since their maturation process occurred earlier than the product on the upper part of the kiln. Moreover, this type of kiln is also fuel consuming (Ponimin, 2010). Each kiln has its own construction characteristics, which are affected by the type of each kiln itself. Each kiln has basic structure to be met as a ceramic kiln requirement. Important parts of kiln are: kiln foundation, fire mouth, kiln roof, kiln floor, canal, chimney.

PROBLEMS STATEMENTS

The problems which will be raised in this study are:

1. Related with the problems that faced by the industrial sector related production costs are constrained because the combustion process, make some craftsmen and artists reduce costs by combust furnace engineering development models based on the local culture.
2. It is also faced by the formal institutions that operated ceramics class, which is try to reduce the operating costs of education to provide facilities for teaching and learning activities.

Activity on formal institutions requires an urgent solution, because it must adapt to develop ceramic design requests that should be supported with adequate facilities for teaching and learning process. In addition, the opened acces fasilities should be able to balance the acceleration of student project target to full fill for all of ceramic art competency.

METHODOLOGY

The research was a long sequence of recurrent meticulous experiments. It was divided into two stages; the first stage was the preparation and try-out phase and the second was the adjustment or stabilization of the first stage process and the product development (diversification). The research was located in two villages; Bentangan ceramic center village, Wonosari sub-district, Klaten, which is located about 25 km south of Solo and Melikan ceramic industry center, Wedi sub-district, Klaten, which is located about 50 km south of Solo. Each ceramic craft center village has the potency of its own specific traditional kiln. The still-utilized-traditional ceramic kiln in each craft village has its own characteristics. Those kilns were then developed to be a new finding for the traditional ceramic kiln requisite based on the local culture. That kiln model was expected to be able to support the ceramic students' teaching/ learning activities.Those two locations were expected to be able to complete the need for the data and information which would then be integrated to answer the problems related to the engineering of the traditional ceramic kiln. The location for the construction of the new kiln design was in the ceramic laboratory of the Study Program of Fine Art, the Faculty of Fine Art and Design, Sebelas Maret University. The research was executed in several consecutive sequences as follows:

(1) The technological study of the firing process and the construction of the traditional kilns located in Bentangan and Melikan villages: The stage was intended to compare the kiln constructions and the temperature stances in the pottery firing in the two villages of Bentangan and Melikan. The attainable maximum temperatures in the pottery firing in those two locations were acutely needed as a data to be analyzed meticulously. Moreover, the data on the length of the firing with the attainable maximum temperature were also considered in analyzing the problem. The constructions of those kilns in those two villages were vastly different, and as such, a more detailed description was required to be discussed in the following chapter.

(2) The meticulous designing of the ceramic kiln concept design: Based on the first point analysis, temporary deduction on the kiln concept to be constructed was drawn, that was ceramic kiln which was more efficient than the present ceramic kilns in Melikan and Bentangan villages. The kiln would be used in the teaching/learning activities in the ceramic studio of Fine Art, Sebelas Maret University.

(3) The construction of ceramic kiln prototype: The prototype construction was really required as a medium to visualize the created kiln design. The prototype disclosed the constraints encountered in building the kiln construction.

(4). Ceramic kiln function and performance trials: After the prototype of the kiln construction was built, it needed to be tested. The result of the test demonstrated the strength of the kiln construction.

(5) The assessment of the ceramic kiln trials result: Following the ceramic kiln prototype assessment, its firing result needed to be tested

(6) **The performance analysis evaluation and ceramic kiln improvement:** The firing result test in the assessment stage enabled the evaluation of the kiln performance. The evaluation brought result which made the correction of the kiln construction possible, which in turn, would result in efficient kiln construction and the firing result with the maximum attainable temperature.

(7) **Making the research report.** The data analysis was carried out by using interaction as well as experimental analyses. The interaction analysis was performed since it was in line with ethical research and analysis interpretation, so that the data that were generated would be in harmony with the EMIC research. The interaction analysis was carried out to find out the common threads of the data that were already generated. The research analysis that was performed was an inductive one, which meant that all data conclusions were formed based on all information collected from the field. The analysis process was executed from the beginning of the research or since the data gathering, and it was compared with other data that were related to the objectives of the research. The data process consolidation and intensification were always performed in the form of cycle as verification.

According to Miles & Huberman, 1984, interactive analysis model has three analysis components, namely: data reduction, data presentation, and conclusion drawing or verification. The activities are performed interactively and the data gathering process is a cyclical process (Sutopo, 2006). Interpretation analysis was executed to draw conclusion out of several data sources, so that its result would be more objective. Interpretation analysis was performed in the research, the firing process technological assessment, and the construction of the traditional kilns which were existed in Bentangan and Melikan villages.

RESULTS & DISCUSSION

Prior to executing the core research activities in the forms of trials and testing, several points needed to be prepared to ensure smooth and correct process and the attained product would be optimum. The assessment stage covered the assessment of the used kiln model and the firing process temperature. The stage specified the result of the engineering of the kiln development based on the local culture as well as the cutting down of the operational cost of education in the teaching/learning activities. The technological assessment stage was divided into four phases as follows:

1. Kiln Model

The research took two examples of kiln model in Bentangan and Melikan villages. The Bentangan kiln model used by the craft-persons is classified into primitive/early kiln (*tungkuladang*). It was placed on open area. The villagers commonly used their field or yard to place the early kiln to fire their products. Nowadays, the primitive/early kiln has already undergone a little bit of change. In the past, early kiln did not have any roof. Now, a roof is added to the structure so that their products do not catch any rain when they do the firing activities during the rainy season.

a. Bentangankilm model

Bentangan village is a village located approximately 25 km on the south of Solo city. Bentangan villagers traditionally make their life out of lumps of clay. They fashion the clay into products, which upon drying, then fired. Those hand-made products are commonly known as *geroboh* (pottery). Patience and perseverance are required in the pottery making process. Working and fashioning a lump of clay into valuable products are Bentangan villagers' daily life. The pottery making process is not that simple. It goes through the process of clay processing, forming, and product drying. Once the products dried off, it is fired. Pottery firing is the final process prior to being marketed. The kiln in Bentangan village is primitive/early kiln. The Bentangan villagers commonly used their field or yard to place the early kiln to fire their products. Their pottery production covers a whole range of household utensils such as *anglo* (charcoal stove made of pottery), *keren*(wood fueled stove made of pottery), *wajan*(skillet made of pottery), *cowek*(mortar made of pottery), *kendhil*(pot made of pottery), *gentong*(water jar made of pottery/clay jar), and *padasan*(water jar made of pottery/clay jar, to contain water used for ablution). Usually, they fire the pottery in the morning and afternoon (Wahyuningsih, 2007).

Based on the field survey, herewith is the specification of the Bentangan kiln construction.

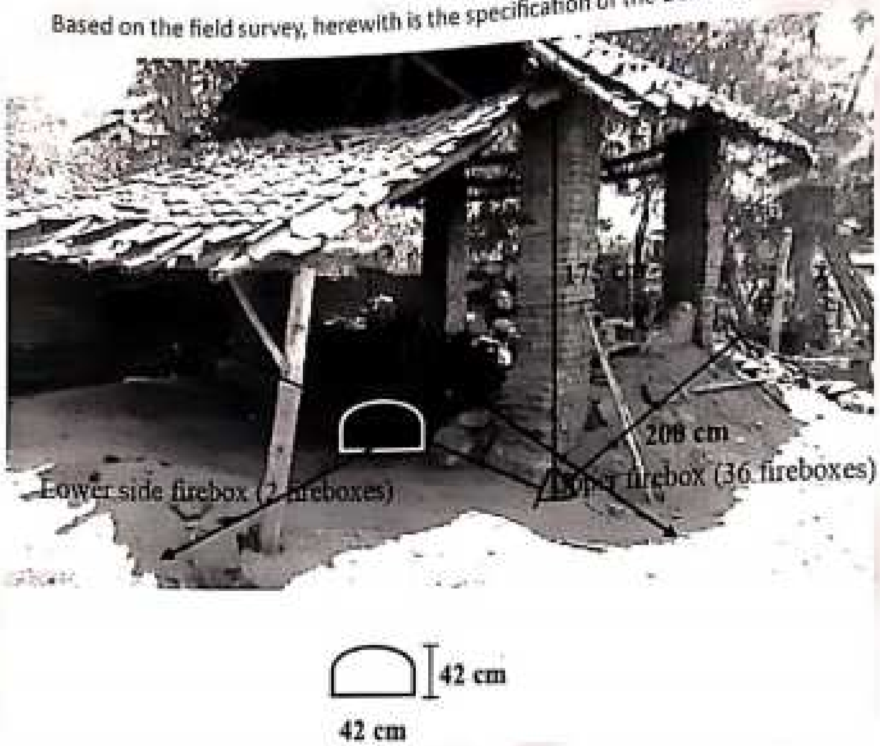


Fig. 1. Kiln model in Bentangan village. (Photo: Novita, 2014)

The kiln in Bentangan village is a somewhat improved early kiln (*tungkuladang*), with roof tiles and four supporting brick pillars. Those pillars' height is 1.75 m. It is roofed so that the fired ceramic will not get wet during rainy season and the firing process proceeds smoothly. The kiln dimension is 2 by 2.3 meters. The kiln construction possesses two fireboxes which dimension is 42 cm in height and 42 cm in width. There are 36 fireboxes, connecting the firing with stacks of fired potteries. The brick construction is arranged a bit tight, to allow the heat to spread evenly over the fired potteries. This kind of kiln construction allowed much thermal energy generated from the firing wasted.

2. Ceramic Kiln Model in Melikan Village

Melikan village, Wedi sub-district is one ceramic production center in Klaten regency. It is located approximately 50 km south of Solo city. The social, economic, and cultural condition of the Pager Jurang area offer a kind of beauty that is oriented to uniqueness that cannot be found anywhere else. Agrarian cultural nuance can still be found there despite the fact that Melikan is a ceramic production center. Melikan area is located at the foot of a hill. Every morning in every Melikan villager's home, very interesting rituals happen. In almost all households earning their living through making pottery, the villagers put out wet molded clay to dry under the sun in front of their house.The shapes are various; from *kendi* (water jug), *celengan* (piggy bank), and placenta container, to child's toys. Some of the crafts that they produce are *kendi* (water jug), *celengan* (piggy bank), pot, *kriuk* (pots to brew herbs made of pottery), *kendhil*(pot made of pottery), *wajan*(skillet made of pottery), *cowek*(mortar made of pottery), and *padasan* (water jar made of pottery/clay jar, to contain water used for ablution) (Wahyuningsih, 2014: 1)

To fashion the ceramic products, they, usually the craft woman, utilize the angled potter's wheel. The men work on the smoothing or finishing parts. Some craft-persons create flower pots, approximately half a meter in diameter. To create pot or pottery that big, they employ flat potter's wheel. Those kinds of product are usually made by men. Each rotating technique (angled and flat) has its own weaknesses and strengths. The angled potter's wheel can only fashion a small format pottery, about 40 cm in length and 30 cm in width. By employing this technique, a large number of quantities can be gained at a relatively short time. Also the technique and the earth gravitation make for an easy and untiring works. On the other hand, when operating the flat potter's wheel, it is heavier to haul the clay up. Its strength lay on the fact that it helps to fashion bigger forms of pottery such as *jombangan* (big vessel), *gentong* (big water vessel), or pot. They still employ traditional kiln for the firing process, with wood, straw, and wet leaves as their reduction fuel. The Melikan kiln can be cathegorized as open kiln, as there is only a wall surround it (Amboro, 2014). The following is the picture of the ceramic kiln in Melikan village, complete with its construction. Based on the field survey, the detailed construction of the kiln in Melikan village is presented below:

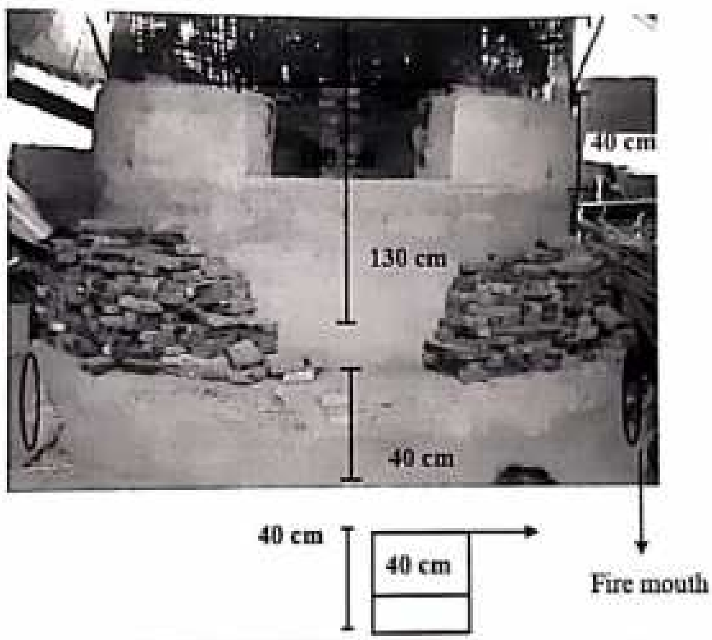


Fig.2. The CeramicKiln in MelikanVillage. (Photo: Wahyuningsih, 2014)

That ceramic kiln in Melikan village is a cylindrical open kiln. Its construction is equipped with roof and sturdy pillars to give a shade. The roof is for the rain season, so that the fired ceramic does not get any rain, and the firing process can proceed smoothly. Specifically, the size of the ceramic kiln construction in Melikanvilllage can be depicted as follows: a cylindrical kiln, its height is 1.7 m and its diameter is 2.5 m. There are two fire mouths in the kiln, each is 40 cm in height and 40 cm in width. There are 46 fire holes, connecting the fire stokes with the stacks of potteries being fired. Its brick construction is a bit close-fitting, and thus is able to spread the heat to the fired pottery evenly. When it is compared to the construction of the early (field) kiln, the construction of the cylindrical kiln enables the energy that is used to fire to concentrate and not much energy is wasted.

3. **Temperature of the Firing**

   a. The Firing in BentanganVillage

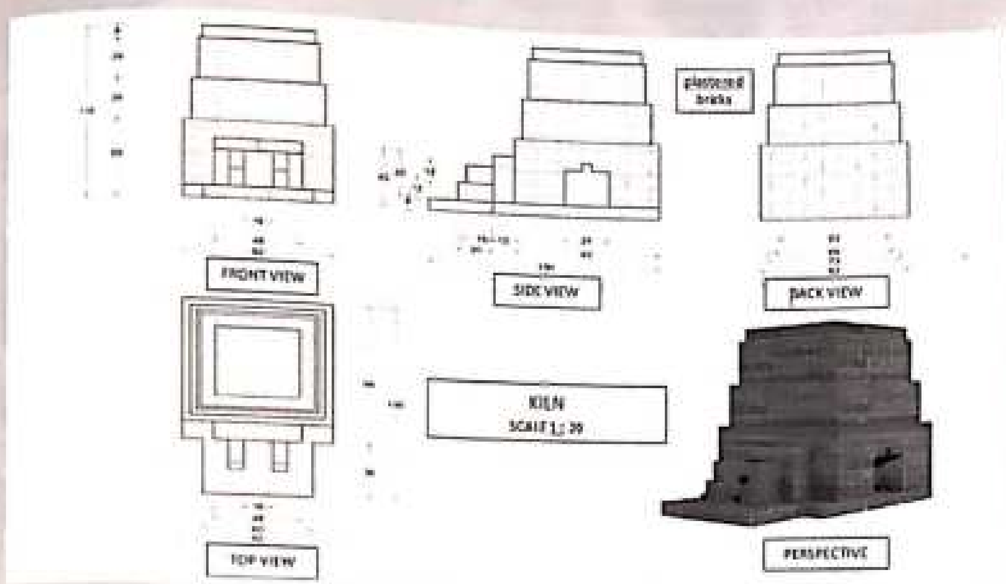
   In this firing process, a meticulous observation of the firing process was executed. The firing monitoring was done every ten minutes. By recording the result of the firing and the fuel disparity in that ten minutes, it was expected to discover the behavior of the fire meticulously, as well as to clearly monitor the recording of the firing results, both the fire behavior and the fired goods. Ceramic firing in Bentangan village occurred fast, more or less two hours. When the fire was lit up, the temperature was around 32^{0}C. The temperature count and fire behavior were monitored every ten minutes. At the time of the try out, the goods being fired was pottery in the form of *keren* (wood fueled stove made of pottery) and *cowek*(mortar made of pottery). The maximum result of the temperature that was reached in the firing in Bentangan village was 690^{0}C.

b. The firing in Melikan village

In the firing process in Melikan village, a meticulous observation of the firing process was also executed. The firing monitoring was done every ten minutes. By recording the result of the firing and the fuel disparity during the ten minutes, it was expected to discover the behavior of the fire meticulously, as well as to clearly monitor the recording of the firing results, both the fire behavior and the fired goods. Ceramic firing in Melikan village took place for about 17 hours. When the fire was lit up, the temperature was about 29^{0}C. The temperature count and fire behavior were monitored every ten minutes. At the time of the try out, the goods being fired was pottery in the form of bowl, frying pan, and cauldron. Small fire was lit up for ten hours until the temperature reached 63.6^{0}C. The maximum result of the temperature that was reached in the firing in Melikan village was 672^{0}C on the twelfth hour. After the twelfth hour, the fire was put out and the smoking or reduction using wet leaves began. The leaves commonly used in the reduction process were those from the rain tree, *Munggur/Trembesi* (*Samaneasaman*). The smoking was executed for four hours. That four hour smoking resulted in the distinctive colored pottery products; gleaming black like copper. After the fire was put out and the smoking process completed, the acquired temperature was 151.1^{0}C.

4. Development of the Traditional Ceramic Kiln

After studying the kiln models which exist in Bentangan and Melikan villages, the following stage is the process of creating the kiln based on those two kiln models in those two villages. That modified kiln construction can be viewed below: The height of the kiln is 116 cm; its length is 130 cm; and its width is 82cm. There are two circulation holes, namely: the fire mouths at the front of the kiln and the air circulation hole on the left. The dimension of the fire mouth is 46cm x 16cm x 40cm. The dimension of the air circulation hole is 25cm x 24cm. The kiln construction can be observed in the picture below:



After the making of the kiln construction finished, the next stage was the making of the ceramic kiln prototype. The phases were:

1. The material mixing process;
   The material used in the kiln construction is stones that can withstand fire and a mixture to cement those fire resistant stones. The mixture is made of Pacitan clay, fire resistant brick grog, kaolin, and feldspar, the ratio being 2:2:1:1.
2. The mixture mixing process
   In the mixture mixing, a precise mixture formula was needed in order to be able to cement the clay into the fire resistant bricks perfectly. The water needed should also be measured according to the soil plasticity to ensure a perfect plasticity.
3. The kiln base making process
   After the clay and grog mixture were mixed perfectly, the next step is the making of the base of the kiln. Fire resistant bricks were stacked alongside to form a rectangle.
4. The kiln making process
   After the base, the kiln wall was built. By arranging the fire resistant bricks and cementing them with the clay mixture, the bricks were stacked up until it resembles a miniature of a temple..

The next step was the try out of the kiln function and performance. The phase was carried out to find out how good is the function of the kiln that was made as scientific development. Several points needed to be considered in the try out, namely: the firing process, the kiln durability, and the fire behavior. The testing process in that firing process used wood and coconut shells as its fuel. This developed kiln was projected to fire ceramic using woods as its fuel, as wood is still easily found near Sebelas Maret University campus as well as sold by several wood seller near Sebelas Maret University area. So are the coconut shells that can be taken freely from several iced young coconut drink sellers. They need only to be dried under the sun prior to be used as a fuel alternative. The kiln function try-out was needed since prior to be used in standard firing, the kiln should be totally dry. The fire resistant bricks and the cementing clay mixture should really be dried, without any water content inside its walls. That is so as not to hinder the absorbance of the heat energy during the ceramic firing. As such, it is hoped that the heat energy will really be focused on the fired ceramic alone. The ceramic kiln durability can be observed from the kiln performance try out. The result of the try out is that the kiln can be used to fire ceramic properly, as fit to its volume capacity. The volume capacity of this developed kiln is 0.8m³. Out of the function and performance try out, it can be concluded that the design of the developed kiln is suitable and that the kiln can work well in conformity to the operational standard of traditional ceramic kiln. The next step is the testing of the ceramic kiln try out stage. In this case, the firing process was executed slowly for eight hours. At the beginning, the noted temperature was 28.03°C. The temperature noting was taken every ten minutes in order to find out the track records of the fire behavior in the kiln intensively. In that firing process, on reaching the temperature of 100.43° C, the temperature of the fire can be raised stably. On reaching 200° C, the kiln started to evoke embers and at the temperature of 225.2°C the fire temperature was raised. The noted maximum temperature was 632.2°C. During the try out process, there was no major obstacle; the wall of the kiln leaked several times and needed to be plastered. The hot air coming out of the stove was caused by the drying cement. The wall plastering used the fire resistant grout mixture to maximally reduce the heat, so that the heat energy will not be wasted and can be used maximally in the firing. The kiln tests were executed in two firing. The first firing reached up to 766.4°C, which was reached for 5 hours and 5 minutes. The second firing reached 850°C for 7 hours and 5 minute. The temperature recordings were made every ten minutes to discover the increasing temperature in the above kiln area and below kiln area, temperature discrepancy, the average temperature, and the estimated temperature turnover in the middle of the kiln. It can be concluded that this developed kiln can be utilized as an alternative ceramic kiln, which has already meet the operational standard of the traditional ceramic kiln. The standard temperature reached in a traditional kiln is about 600°C. The temperature reached by this developed traditional kiln is 850°C. The kiln construction is sturdy. The fuel used is wood, so that it is more efficient and economical than the kiln which fuel is gas.

Fig.4. The perspective of the kiln model (Photo: Amboro, 2014)

CONCLUSIONS

The problems encountered by the industrial sector are related to the production cost which is hindered by high fuel cost. It causes several craft-persons and artists to reduce the cost by engineering the kiln model development. Similar problem is also faced by formal institutions which open ceramic class. They also try to reduce the operational cost of education to provide adequate facilities for the teaching/learning process. Activities in formal institutions need a solution, since it should conform to the development of the ceramic demand while also adjust to adequate infrastructure for the teaching/learning process. Also, those infrastructures should be able to cope with the acceleration of the needs of various students' assignments to fulfill the competency expertise in the ceramic art field. Based on the research the following conclusions are drawn: 1) the engineered developed kiln based on the local culture can reduce the cost of firing. Both the ceramic craft-persons and the formal institution can apply this developed kiln. 2) Moreover, in formal institution especially in ceramic classes, the engineered developed kiln can reduce the operational cost of education in order to provide adequate facility for the teaching/learning process. Hopefully, this research will trigger the spirit to execute researches related to kiln development. It is also expected that the future researches will be more innovative; in the design form, effectiveness, and efficiency, so that in can be employed more optimally for the research run.

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