Small Scale Foundries in Ghana: The Challenges

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Abstract

Small Scale Foundries (SSFs) have been in existence for several years in Ghana. The industry has created several jobs for the people of Ghana and has minimized the burden on government to find ways of disposing scrap metals generated within the country. While scrap metals are still being exported, the quantity exported has decreased as a result of recycling by foundrymen in producing various parts. The government of Ghana has not paid special attention to this industry. Nevertheless, individuals and private investors are heavily involved in producing several thousands of tonnes of castings annually generating revenue for the government through taxation as well as helping with metal waste disposal. Metal cast products are sold both locally and internationally to neighbouring countries. The industry is however faced with numerous challenges. These include quality issues due to lack of technical know-how, access to funding from both government and private financial institutions and foundry waste management. To promote this industry, government and private financial institutions must be encouraged to come on board. Policies must be established and proper training programme developed to improve and promote this technology. This could go a long way in reducing the high unemployment rate in Ghana.

Keywords

Ghana; Foundry; Challenges; Technology.

Introduction

Small and medium scale enterprises (SMEs) in Ghana can be grouped into urban and rural [1-3]. The urban SMEs can be subdivided into organized and unorganized. The organized ones tend to have paid employees with registered offices whereas the unorganized SMEs work in open spaces, temporary wooden structures or from home. The unorganized SMEs employ small number of workers and usually are not salary workers. These employees are mostly family members or apprentices. Small Scale Foundries (SSFs) in Ghana fall under the urban category and have both organized and unorganized structures.

Foundry is one of the ancient methods of metal shaping and includes processes such as melting of metals, manufacture of moulds, solidification, shakeout and fettling of the castings [4, 5]. Before the arrival of colonial masters, Ghanaians were using indigenous earthen pots for cooking and stones for grinding. The era of colonial masters saw the introduction of foundry products such as metallic pots, corn mill plates, bolts and nuts among others. The demands for these products have been increasing with time which has led to increasing cost of these imported products. This resulted in people coming together to find ways of producing these products locally. This move saw the birth of SSFs in Ghana.

Foundries in Ghana have contributed immensely to the growth of the national economy. It was not until 1957, just after Ghana's independence from the British, that the first SSF was establish in Ghana. Over the years, the numbers kept growing and unpublished results estimate over 50 foundry units scattered across the length and breadth of the country. Most of these foundry units are spread over two geographical areas: Kumasi metropolis in the Ashanti region and Accra-Tema metropolis in the Greater Accra region of Ghana. In Kumasi metropolis alone, the industry employs over 500 workers. SSFs in Ghana are mainly semi-production foundries. They cast products such as corn mill plates, cooking pots, automotive parts, manhole covers, and construction equipment items among others. The products are sold both locally and internationally to neighbouring countries such as Burkina Faso and Cameroon. It goes without saying that SSFs in Ghana serve as the threshold of industrial revolution. SSFs are profitability ventures, important job creation avenues, and major contributor to the nation's economy. However, the industry is faced with many challenges. They include quality of cast products as compared to their foreign counterparts, lack of proper quality control procedures resulting in lots of reworks during the manufacturing processes of the various components produced and improper foundry waste management among others. Foundry wastes are disposed of on site without proper characterization to ensure that they do not have any adverse effects on the environment. The Ministry of Trade and Industry is not supporting SSFs at present and accessing loans from private financial institutions is also a problem.

There has not been any work done to properly document and review the production technology of SSF, its characteristics and the challenges they encounter. It is the aim of this paper to bring to the fore the production technology of SSFs and challenges facing this industry in Ghana.

Material and Method

Two different types of survey were used to gather data: use of questionnaires and face-to-face interviews. The questionnaires were administered to foundrymen, entrepreneurs, wholesalers, retailers and foundry experts in the Kumasi and Accra-Tema metropolis. These two locations were selected due to the high number of foundries established in these areas. In all, 30 foundries and 9 retailers were visited. Both ferrous and non-ferrous foundries were considered. Data on the foundry operations, type of cast products, most patronized product, and target groups among others were captured. Personal observations were also made and recorded. Questionnaire was also administered to financial institutions and data such as interest rates and how to access loan facility for establishment of SSF, repayment period, and loan sealing were also captured. The response rate of the questionnaires was greater than 80%. Subsequent sections present some of the challenges facing SSFs in Ghana. The associated challenges have been grouped under seven sub-headings namely; human resource, raw materials, casting processes, quality assessment and management, pricing of cast products, access to finances, and environmental and health issues. Where applicable, graphical illustrations in the form of histograms have been presented to better clarify the results.

Results and Discussion

Human Resources

Most of the foundry units owned and managed by individual families. **Figure 1** shows the distribution of the educational background of the foundrymen. Out of the 60% response rate, about 44% of them had no formal education, 33% have had some education up to the junior high level, 11% up to the senior high level and the remaining 11% have had some form of technical education.

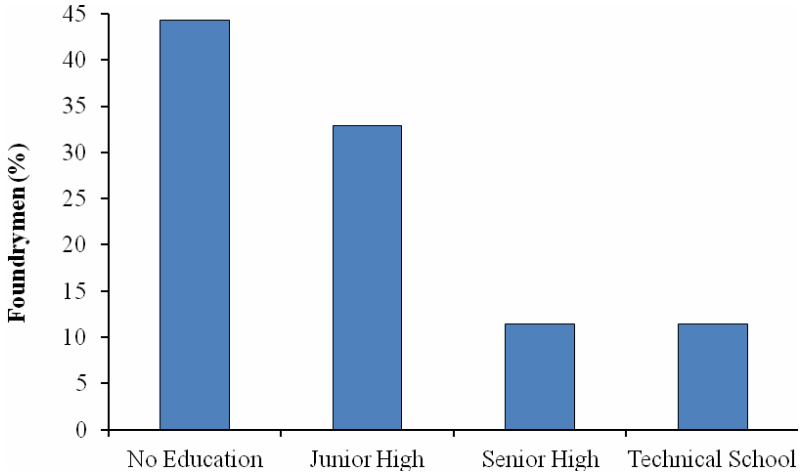

Figure 1. *Educational background of foundrymen*

The high level of illiteracy suggests the difficulties foundrymen could face when it comes to adaptation to new trends in the foundry industry. Personal interviews with some of the entrepreneurs indicated that some are aware of the new trends in technology. However, they are constrained by lack of technical know-how and funding. This translates to defects in cast products such as misruns, cold shots, blowholes and rough finishing. With no accounting skills, foundrymen also lack proper bookkeeping and hence financial management is a major concern. Lack of proper bookkeeping also hinders their chances of getting financial support from private financial institutions. It must be mentioned here that Kumasi Polytechnic Institution (a tertiary institution in the Kumasi metropolis) has been running Higher National Diploma in Foundry Technology since 1997. The department has trained over 400 foundry technologists out of which only two have been able to establish their own foundry units. The reason for this trend is largely due to access to investment capital.

Most foundrymen are members of the Ghana Foundry Association (GFA). This association organizes workshops inviting skilled resource persons at least once a year to assist members deal with some of their quality issues and operational difficulties. Sponsorship for these workshops comes from two organizations namely, the United Nations Industrial Development Organisation (UNIDO) and Japan International Co-operation Agency (JICA). The training has impacted positively on the operations but more can be done by other stake holders to improve the ever changing demands in foundry practices. Additionally, JICA in 2006 sponsored six members of Ghana Foundry Association to Malaysia to study the development of foundry in the country. The intent was to return and transfer knowledge and skills to foundrymen in SSFs. However, this was not realized due to one of two reasons. First, the members who were sent had little educational background on foundry technology and therefore had difficulties assimilating the technology within their short stay (less than 4 weeks) in Indonesia. Secondly, government did not support them financially on their return.

The Ghana Foundry Association could also consider organizing workshops for foundrymen in the areas of bookkeeping and financial management.

Raw Materials

Almost all the raw materials used by foundrymen are obtained locally. For ferrous castings, the materials range from discarded vehicle engine blocks, rims of trucks, shafts, cast-iron corn mill plates and general cast iron products. For nonferrous castings, sources of raw material include copper products and aluminium scraps from Volta River Authority (VRA) and from aluminium dealers. Even though the government of Ghana has put an embargo on the exportation of ferrous metal scraps from the country, scrap dealers are still exporting ferrous metal scraps. This is because revenue from exportation of metal scraps are more than what local foundrymen are willing to pay for the same quantity. This leads to metal scraps supply shortages to the SSFs affecting smooth operation of foundries.

Foundries do not have documented process to evaluate, review and select suppliers for their raw materials. This affects reproducibility of products since chemical composition of the melt would differ from one charge to another. Metal scraps supplied are left in an open space and are not labelled and could cause a problem of charging ferrous and nonferrous metal scraps into copula furnace, if careful monitoring system is not put in place. Metal scraps are sorted based on experience by foundrymen and are quantified by visual inspection when charging into the copula furnace.

Another major challenge is the access to quality foundry coke. Coke is used by foundrymen as a source of fuel in the melting of metal scraps in copula furnaces. Ghana does not have coal deposits and therefore does not mine coal. Importation of foundry coke is one option for these SSFs. Nevertheless, the high cost involved makes it difficult for majority of the foundrymen to choose this option. Foundrymen therefore rely mostly on remnants of coal used by Volta Aluminum Company Limited (VALCO) to fuel their furnaces [6]. Recently, when VALCO shut down operations for some months, SSFs had to rely on coke supplies from Nigeria which increased their cost of production thereby affecting product prices. The type of coke received by foundrymen from VALCO comes in various grades and sizes. The coking potentials of two grades of coke have been investigated by Andrews et al. [6]. It was found that the volatile matter and ash contents of both grades were not satisfactory. This leads to increased generation of foundry waste. It has therefore become necessary to manage foundry waste being generated properly to minimize its impact on the environment. The limited sources of coke have created monopoly in coke pricing and this has affected the industry in recent times. There are times that foundries do not operate due to lack of coke. Oil is an alternative source of fuel but it is expensive for the SSFs. In place of the copula furnace, an electric furnace can be used. However, these furnaces are expensive and the utility tariffs

in Ghana are so high that SSFs cannot afford. In an attempt to solve this problem, work is currently underway to find alternative sources of fuel for use by the SSFs in Ghana.

Casting Processes

The flowchart of the various stages in the casting process is shown in Figure 2. Detailed production processes are not discussed in this paper but can be found elsewhere [4, 5]. However, emphases are made on areas where SSFs face challenges. About 60% of foundries use sand moulds whereas 30% use permanent moulds and 10% use graphite moulds.

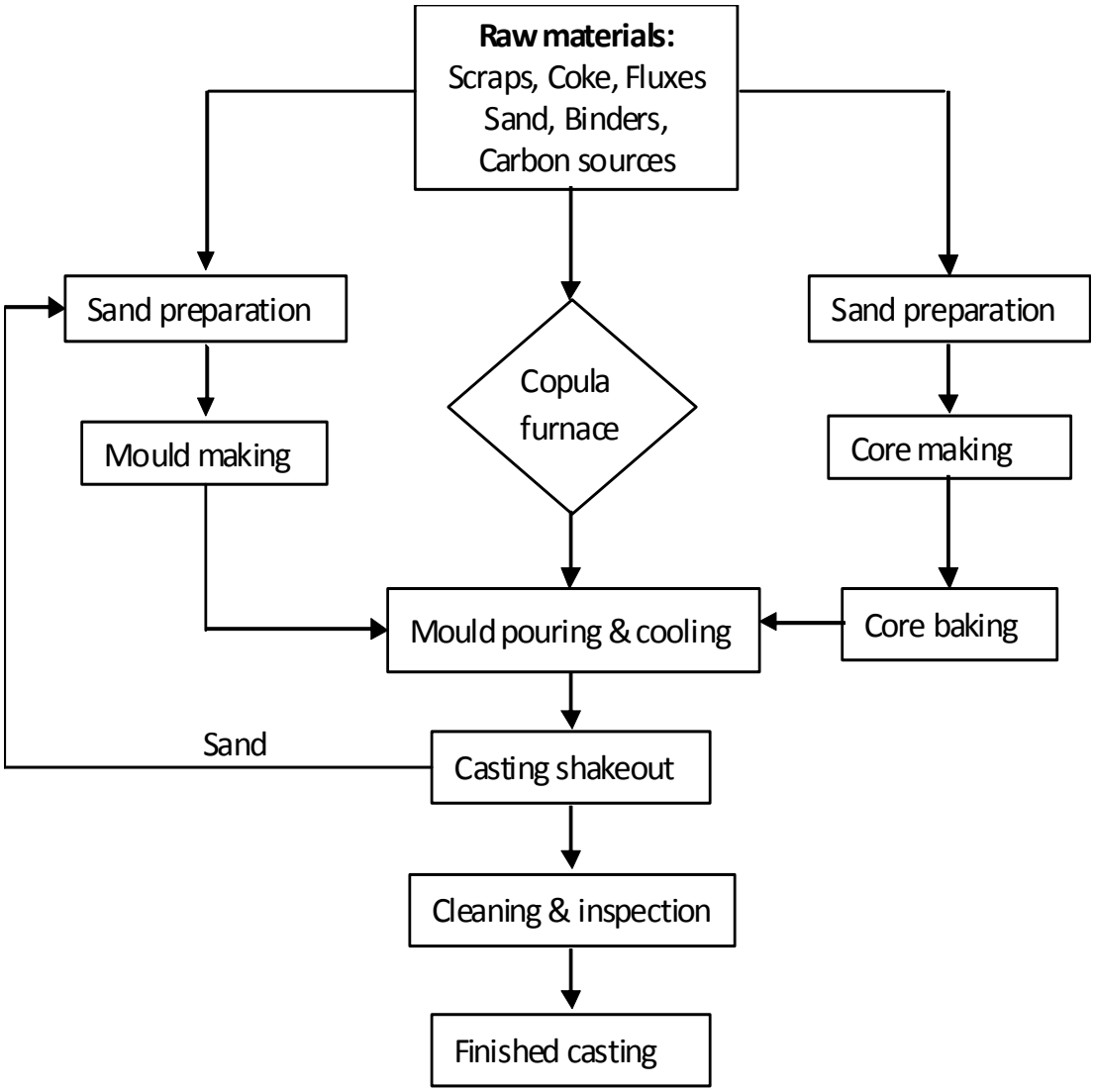

Figure 2. *Flow chart of a typical casting processes*

Green moulding sands used by SSFs are produced by mixing virgin silica sand with clay or organic chemical binders (e.g. bentonite). Carbonaceous additives, such as crushed

bituminous coal, are added to green sands to produce a reducing atmosphere during casting, while cellulosic additives (e.g. wood flour, cob flour, pecan shells, oat hulls, and rice hulls) are used to absorb moisture and prevent expansion defects [7]. There is no device for measuring the moisture content of the sand mould. Foundrymen use their hand to feel the texture of the sand and tell from experience whether the sand has enough moisture content and therefore suitable to be used to make moulds. This indigenous way of determining the moisture content is subjective and could vary from one person to another. Workers prefer the sand mould to the others because of its reusability and permeability. There are large deposits of sand in Ghana and this is easily accessible to foundrymen. The sand after a period of 6 to 12 months is disposed of after the sand start to show signs of weakness and subsequent problems in castings. Once again this is by trial and error means.

A pattern is simply the duplicate of the component which has to be manufactured by casting process. About 60% of foundries used solid patterns. This could be one of two reasons. First, is the simplest of all patterns and is used to make simple shapes. Secondly, current products on the market do not require other patterns such as split patterns, gated patterns, and sweeping patterns which require skilled labour to produce. About 70% used metal patterns which are the same products to be cast. The reason for using metal patterns is because they last longer than the other pattern types although it is expensive. About 20% use wood and 10% use wax patterns, respectively. Wood patterns are easily worked into shape but warps easily and sometimes they are burnt by the molten metal. Most patterns used by SSFs are bought from specialized pattern makers. The pattern makers design the patterns themselves and charge a fee for that. Some SSFs have also employed pattern makers. However, because they have learnt this through trial and error means, patterns are not given the correct tolerances for contraction after solidification of melts.

Cupola furnaces are the most commonly used melting furnaces by SSFs in Ghana. Melting in cupola furnaces is the most energy intensive operation in a foundry unit. For the nonferrous foundries, crucible furnaces are usually used. About 70% use cupola only whereas 20% use only crucible and 10% use both. These furnaces have been improvised since entrepreneurs do not have money to buy energy efficient copulas. Improvised furnaces have been poorly designed and have been constructed from heat dissipating materials which lead to higher energy loses. The general level of awareness among them about energy conservation is low. It is therefore necessary that proper training and demonstration be given to foundrymen to motivate them to use energy efficient cupolas. Furnaces are also relatively small in size and therefore can only handle small quantity of melt at a time. Refractory brick liners used in copula furnaces are also expensive for the SSFs. Foundrymen therefore rely on refractory rejects from Wahome Steels and Tema Steel (all in Ghana) to line their furnaces. This increase wear rate of the bricks generating high amount of waste sand at foundry sites.

Quality Assessment and Management

Quality in this work has been defined in terms of fitness of cast material for purpose. Thus, material confers bulk properties that are largely reproducible between one piece of metal and another, determined by the microstructure associated with the selected composition, casting conditions and heat treatment. These properties could be affected by some types of disseminated defect, arising from impurities introduced in the raw materials or during the foundry process. There are lot of concerns when it comes to quality issues in SSFs in Ghana. This has lead to lot of reworks and defects in cast products. There are no laid down procedure for developing, documenting and controlling the entire casting process, including foundry engineering, such as gating, risering, pattern design and pour temperature. Procedures do not include a "change control process" that analyse and address any changes to the casting processes for their effect on the end product. Majority of the foundries visited do not have specific melting and pouring procedure for each alloy group. The foundrymen determine completion of melting by examining the colour of the torch (on the furnace) during melting and also by experience with time interval. Temperatures are not controlled or cannot be monitored with the improvised furnaces. Procedures are not in place to check chemical composition of the melt prior to releasing the melt for pouring. Foundries visited do not have a process for reviewing repetitive casting defects in order to make improvements to their casting process and foundry engineering which will improve the acceptability of the final product.

Most foundry units have limited capacity to evaluate the technology they are currently using and make changes as and when needs be. This is due to lack of technical know-how and this has affected the quality of cast products. Since SSFs typically want to minimize first-cost, a higher initial cost of optimizing operational technology and organizational structure become barriers to adoption of new technology. The Ghana Foundry Association could set up a monitoring body to monitor the quality of products on the market. This could inform their decision on what kind of topics to treat during workshops organized for the foundrymen.

Pricing of Cast Products

Survey conducted in Kumasi and Accra-Tema metropolis indicated that metal casting industry is very profitable. For instance, it is estimated that the annual gross income of producing impellers is about US$ 50,000 whilst that of mill plates is about US$ 150,000 per foundry shop. Metal castings mostly produced include milling plates, impellers, gears, gratings and general equipment parts. Figure 3 shows the percent patronage of these parts. Patronage of milling parts was found to be the highest (44%). This is because neighbouring countries (Burkina Faso, Cameroon) import mill plates from Ghana. General equipment parts were found to enjoy 28% patronage, followed by impellers (10%), gears (10%) and gratings

(8%). The industry does not have a common pricing method. For the foundries visited, 10% consider labour as the deciding factor, 20% follows the association price, 20% considers the quantity of raw materials used while 50% takes into consideration both the labour and quantity of raw material used. Prices of cast parts are generally lower than imported ones hence neighbouring countries prefer to purchase from Ghana. The pricing of foundry products must be looked into to regulate prices on the market.

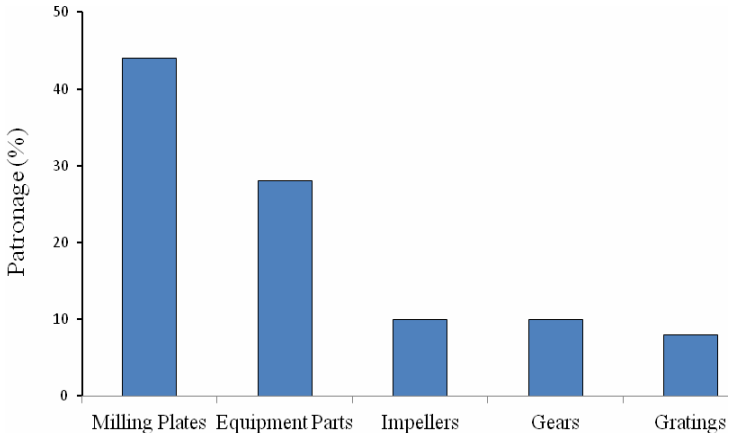

Figure 3. *Patronage of foundry products in Ghana*

Access to Finances

Finance has been identified in many business surveys as one of the most important factors determining the survival and growth of SMEs in both developing and developed countries [8-10]. It is important to understand the economics involved in establishing a SSF in Ghana so that problems can be envisaged and investors would know when to expect returns from their investments. Establishing a foundry business requires capital for purchasing equipments, construction of buildings, buying or renting of premises among others. The ultimate success of a foundry operation depends upon sound capital budgeting decisions. It goes without saying that financial management systems continue to be of importance to business success.

The initial capital investment is undoubtedly the driving force for the foundry business. Various financial institutions exist in Ghana that offer assistance (both financial and technical) to small and medium scale enterprises (SMEs) to develop and expand their businesses. These institutions may be government owned or private. The government owned institutions include Ministry of Trade and Industry, National Board of Small Scale Industries (NBSSI), Commercial Bank, and Ghana Regional Appropriate Technology Industry Service (GRATIS). In 2004, the government established Venture Capital Trust Fund (VCTF) with the aim of providing investment capital to SMEs for the development of promotion of venture

capital financing. The Minister in charge of Finance and Economic Planning in 2007 Budget mentioned full tax exemption to private investors for 10 years [11]. This was supposed to serve as an incentive for investors to come to Ghana to promote the government's accelerated growth strategy.

There are over 20 banks in Ghana with the major banks being Ghana Commercial Bank, Standard Chartered Bank (Gh) Ltd., Barclays Bank (Gh) Ltd., Trust Bank, Zenith Bank, Uni Bank, Standard Trust Bank, Rural Bank, Agricultural Development Bank, International Commercial Bank, Amalgamated Bank, Ecobank Ghana Ltd., CAL Bank, and Stanbic Bank. More private banks are being established every now and then. Even though there are so many banks in a small country like Ghana, it was realized during the collection of data that majority of these banks are conservative in their lending policies, especially to SMEs. Information gathered on loan facility schemes are summarized as follows:

1. Private financial institutions do no support start-up businesses.
2. Average interest rate on loans is pegged around 28% with repayment period ranging from 1 – 5 years depending on the business venture.
3. Individuals must have fixed assets that could be used as collateral for the money they borrow.
4. In some cases, borrowers must have an account with the bank to be able to assess the loan facility.
5. Average loan sealing for SMEs is pegged around US$ 25,000. However, this amount could be adjusted depending on the nature of business.

The importance of SSFs getting access to funding cannot be overemphasized. Access to finance could allow SSFs to undertake productive investments to expand their businesses and to acquire the latest technologies, thus ensuring their competitiveness in the global foundry industry. Lack of functioning financial systems in the country has seriously undermined the microeconomic fundamentals of a country, resulting in lower growth in income and employment. For instance, preliminary survey carried out in the Ashanti region, where majority of the SSFs are located indicated that poor finish of products is one of the major challenges facing this industry. This is because foundries lack skilled people to cast products to near net shape and size. This has negatively affected the exportation of their cast products. People have been trained in foundry technology at Kumasi Polytechnics but cannot practice due to financial constraints. It goes without saying that government can intervene to implement financial policies that could facilitate access to finance. Government must therefore formulate policies that will promote loan acquisition from private financial institutions to promote this industry. Government of Ghana can also invest in SSFs by organizing workshops and training programmes that would improve foundrymen technical

know-how. This industry has the potential to reduce unemployment rate in the country, if these challenges could be addressed.

Environmental and Health Issues

Foundry workers are reported to be exposed to various hazards such as heat, metal dusts, fumes, silica, polycyclic aromatic hydrocarbons (PAH), molten metal and machinery. Research has indicated that there have been increased rates of lung disease, both malignant and non-malignant [12]. High temperatures of the furnaces have been associated with heart disease, usually in population settings [13]. Foundry workers may also be at increased risk of cardiac problems due to their exposure to carbon monoxide from combustion of foundry coke [14, 15]. The foundries visited in Accra-Tema metropolis were found to be neater compared to foundries in Kumasi metropolis. The foundries in Kumasi were characterized by dirty floor from moulding sand, lack of proper infrastructure like toilet and offices and poorly laid out foundry sites. The copula furnaces lack emission control systems that capture dust coming from the furnaces to prevent air pollution. The copulas have no spark arresters to arrest the sparks as the scraps are melted. These put the workers at high risk and leave the workers exposed to health hazards. Majority of the work force do not wear personal protective equipments (PPEs) and therefore the need to modernize the existing foundries to meet ISO 9000 standards. The foundry wastes (both solid and gas) are disposed on site without any proper characterization to determine their effects on the environment. It is therefore important the government implement measures to minimize the health hazards of foundrymen as well as those working around foundry sites.

Conclusions

SSFs are profitable ventures and can serve as a source of employment to graduates who cannot obtain jobs in Ghana. However, the realization of this venture is hampered by getting the necessary financial support from financial institutions since it is capital intensive. The foundry industry has advanced over the years with improved technology for proper quality control. The new technology comes with additional cost and therefore access to funding is inevitable for the growth of SSFs in Ghana.

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