

CLAY BRICK PRODUCTION

self-learning handbook



HOW TO START A MODERN BRICK BUSINESS

APRIL 2023



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01 PRODUCTION PLANNING

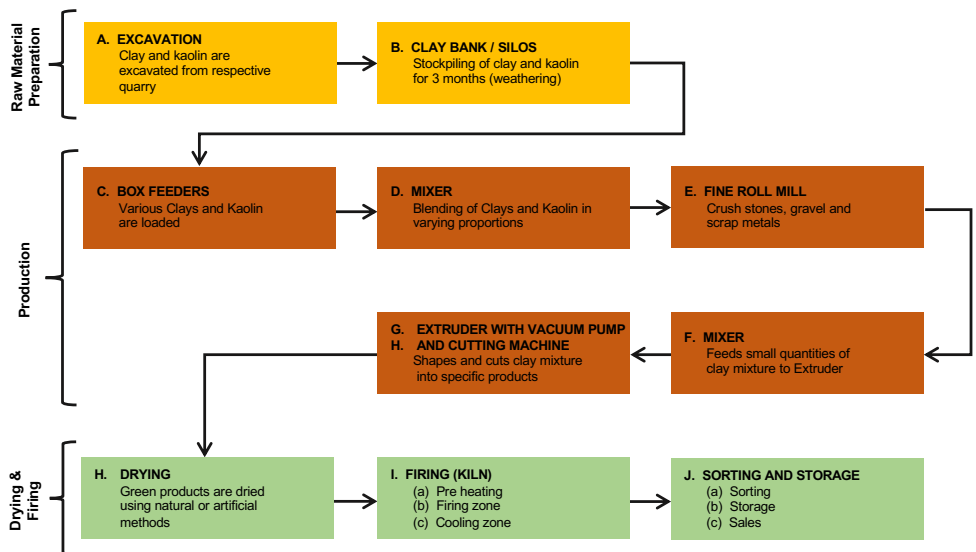
PRODUCTION PLANNING IN THE CLAY BRICK INDUSTRY

WHAT IS DEFINITION OF PRODUCTION PLANNING?

Production Planning is the administrative process that takes place within a manufacturing business and which involves making sure that sufficient raw materials, clay brick making machinery, staff and labour, and other necessary items are procured and ready to create finished products according to the schedule specified.

WHAT DO YOU MEAN BY PRODUCTION PLANNING?

Production planning describes in detail how a company's products and services will be manufactured. A production plan defines the production targets, required resources and overall schedule, together with all the steps involved in production of clay bricks and their dependencies, like roofing tiles and pavers etc.



Flow Chart of the Factory Clay Brick Manufacture

PRODUCTION PLANNING IN FIVE STEPS



In a Clay Brick Industry, Production Planning will be listed as:

- Sales providing the product requirement for the next three months based on customer forecast and present inventory.
- Out of the products requested to be produced, determine the priority of manufacture.
- Priority list should be based on the availability of raw material, die/mould and drying time required, Dryer Racks etc.
- Also, check if trained manpower is on site to produce the requirements.
- Keep rechecking the production schedule, so that it is flexible to adjust to new requests from the Sales Dept.

PRODUCTION PLANNING

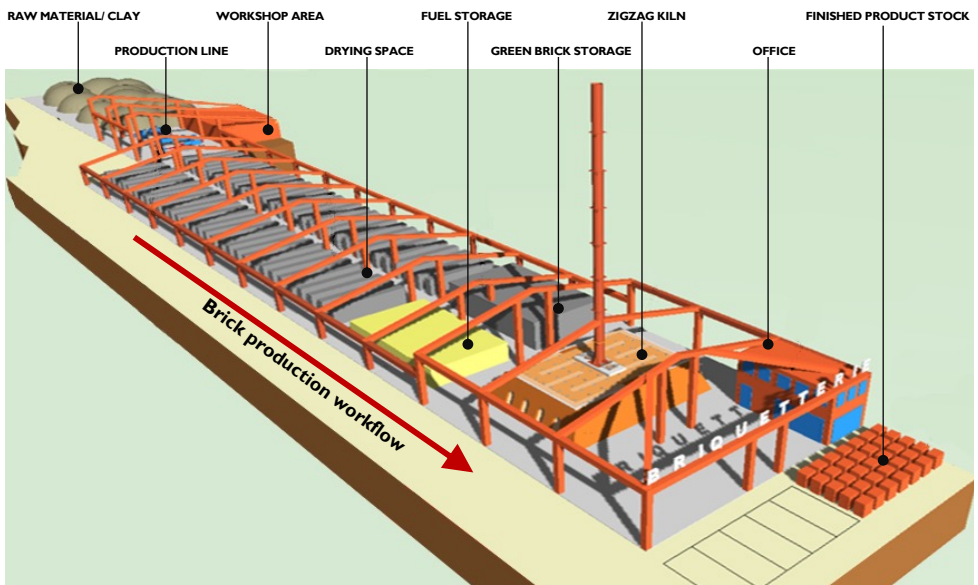
IT'S MEANING AND OBJECTIVE

Production is the most important activity of an enterprise, which includes the clay brick industry as well.

It occupies significant place in an organisation because other functional areas of management viz., financing, marketing, personnel revolve around it.

Production is concerned with transforming raw material into finished product with the help of energy, capital, manpower and machinery and is a very complex and tedious process, especially in a clay brick industry.

Model Layout plan for a brick factory



Model layout plan for a brick factory



PRODUCTION PLANNING

OBJECTIVES OF PRODUCTION PLANNING

- 1 To achieve coordination among various departments relating to production.
- 2 To make adequate arrangement of men, money, materials, machines and method relating to production.
- 3 To decide about the production targets to be achieved by keeping in view the sales forecast.
- 4 To keep production operation continuous.
- 5 To achieve desired share of the market.
- 6 To fix right type of man for right type of job.
- 7 To achieve the desired level of profit.
- 8 To make all arrangements to remove possible obstacles in the way of smooth production.
- 9 To achieve economy in production cost and time.
- 10 To initiate production on modern lines.
- 11 To operate the plant at planned level of efficiency.
- 12 To develop alternative plans in order to meet any emergency or contingency.

H.A. Harding, a well known authority on Industrial & Production Management, has nicely summed up objectives of production planning. In his words, the objective of production planning is to make sure that customers will be supplied their orders, on their delivery dates and also at the minimum overall cost by planning the sequence of activities.

PRODUCTION PLANNING:

Production Planning is the first function performed by the Production Manager.

Production Planning is concerned with thinking in advance what is to be produced, how it is to be produced and by what time should it be produced.

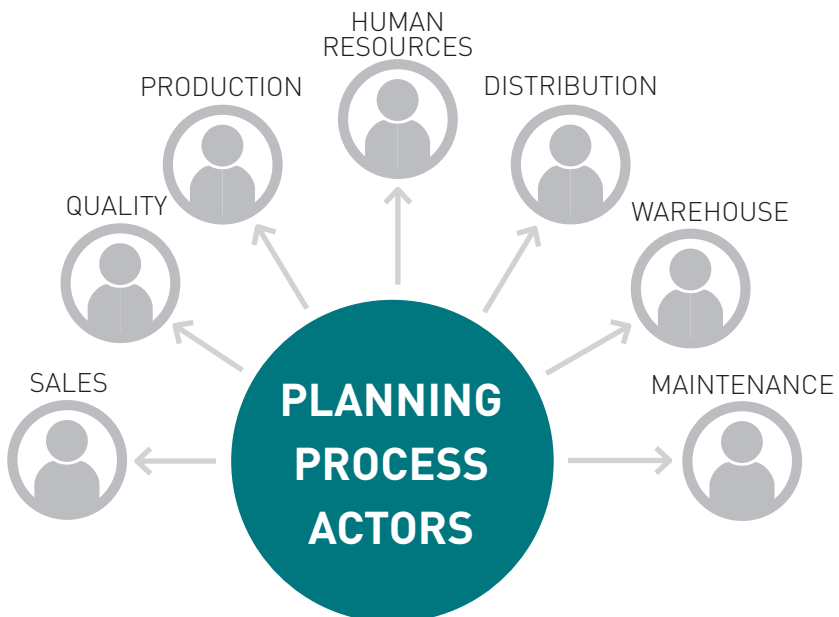
It is also concerned with deciding about the production targets to be achieved by keeping in view the sales forecasts.

PRODUCTION CONTROL:

Production planning cannot be properly achieved without an effective system of production control.

It is in fact concerned with successful implementation of production planning. It aims at completing production well in time and also with lesser costs.

A proper system of vv control ensures continuous production, lesser work-in-progress and minimisation of wastages.



PRODUCTION PLANNING

TASKS

1

MANUFACTURING PLANNING

Ensuring that the manufacturing facility is fully functional

2

MAINTENANCE PLANNING

The manufacturing facility is capable of producing the plant rated quantity without any breakdown

3

PROCUREMENT PLANNING

All raw materials, lubricants, machinery spares have been procured well in advance to avoid disruption in production

4

HUMAN RESOURCES PLANNING

In order to operate the machinery, trained operators/technicians are available

FACTORS AFFECTING PRODUCTION PLANNING:

A. Quality Control:

The Production Manager is also concerned with maintaining required quality of the product.

Quality control is concerned with controlling the negative variables which affect the ultimate quality of a product.

It is concerned with use of all the ways and means where by quality standards could be maintained.

B. Method Analysis:

There are many alternative methods for manufacturing a product.

Some methods are more economical than others.

The Production Manager should study all the methods in detail by analysing them in detail and select the best alternative out of them.

The process of selecting the best alternative is known as methods of analysis.

Methods of analysis are considerably helpful in minimising the cost of production and improving productivity of the concern.

C. Inventory Control:

The next important function to be carried by a Production Manager is to exercise proper control over the inventory.

He / She should determine economic order size, maximum, minimum, average and danger levels of materials so that problems of overstocking and under-stocking do not arise.

This also helps in minimising wastages of materials.

D. Plant Layout:

Plant layout is primarily concerned with the internal set up of a company in a proper manner.

It is related to orderly and proper arrangement and use of available resources viz., men, money, machines, materials and methods of production inside the factory.

In other words it is concerned with maximum and effective utilization of available resources at minimum operating costs.

E. Work Measurement:

Work Measurement methods are concerned with measuring the level of performance of work by a worker.

Time and motion studies techniques can be used for work measurement.

If a worker works below the level fixed by work-measurement techniques, his/her performance must be improved through positive or negative incentives.

F. Other Functions:

Apart from the above-mentioned functions, the Production Department also carries certain other functions viz., cost control, standardization and storage, price analysis and provision of wage incentives to workers etc.

FIVE P's OF PRODUCTION MANAGEMENT

THE FIVE P's

1

THE PRODUCT

Product is the link between production and marketing. It is not enough that a customer requires product but the organisation must be capable of producing the product.

As per the product policy of the organisation an agreement is reached between the various functions on the following aspects of the product:

Performance / Quality and reliability / Aesthetics and ergonomics

Quantity and Selling Price / Delivery Schedule

To arrive at the above, the external and the internal factors which affect the various aspects such as market needs, existing culture and legal constraints and the environmental demands should be given due consideration.

Thus the major policy decisions regarding variety of product mix is going to affect the producing system.

2

THE PLANT

The plant accounts for major investment (fixed assets)

The plant should match the needs of the product; market, the worker and the organisation. The plant is concerned with:

- Design and layout of building and offices
- Reliability, perfect, maintenance of equipment's
- Safety of operations
- The financial constraint

Plant layout deals with physical arrangement of plants and machineries within the selected site. The layout should be such that it should allow for smooth movement of men and materials with minimum back tracking. The type of the layout is dependent on production type, volume of demand, etc.

3

THE PROCESS

There are always number of alternative methods of creating a product. But it is required to select the one best method, which attains the objectives.

In deciding about the process it is necessary to examine the following factors:

- Available capacity
 - Manpower skills available
 - Type of production
 - Layout of plant
 - Safety
 - Maintenance required
 - Manufacturing costs
-

4

THE PROGRAMME

The programme here refers to the timetable of production.

Thus, the programme prepares schedules for:

- Purchasing
 - Transforming
 - Maintenance
 - Cash
 - Storage and transport
-

5

THE PEOPLE

Production depends upon people. The people vary in their attitudes, skill and expectations from the work. Thus, to make best use of available human resource, it is required to have a good match between people and jobs which may lead to job satisfaction.

The Production Manager should be involved in issues like:

- Wages / Salary administration
- Conditions of work/safety
- Motivation
- Training of employees

Thus, production management encompasses these 5 Ps.

The areas of 5 Ps are overlapping.

FUNCTION OF PRODUCTION MANAGEMENT

ACTIVITIES ORGANISATION AND EXECUTION

The activities of the production department of an organisation are grouped into two broad categories:

- 1** The activities that convert the available capital in to physical resources required for production
- 2** The activities that convert the physical resources in to salable goods and services

In carrying out the above activities, the production department must perform the following activities:

- A** Production of goods at the right time and in sufficient quantity to meet the demand
- B** Production of goods at minimum possible cost
- C** Production of goods of acceptable quality

PRODUCTION PLANNING EXAMPLE

TYPICAL EXAMPLE OF PRODUCTION PLANNING IN AN INDUSTRIAL BRICK PLANT

Clay/Kaolin requirements

Mix Ratio: Clay: **85 %** Kaolin: **15%**

Full Capacity of Plant: **100 tons** per day

Add: Loss of 5% broken: **105 tons** per day

To produce 100 tons/day salable product, we need to produce 105 tons/day

Out of 105 tons, Clay constitutes 85%: $105 \times 85\% = \mathbf{89.25 \text{ tons}}$

Out of 105 tons, Kaolin constitutes 15% : $105 \times 15\% = \mathbf{15.75 \text{ tons}}$

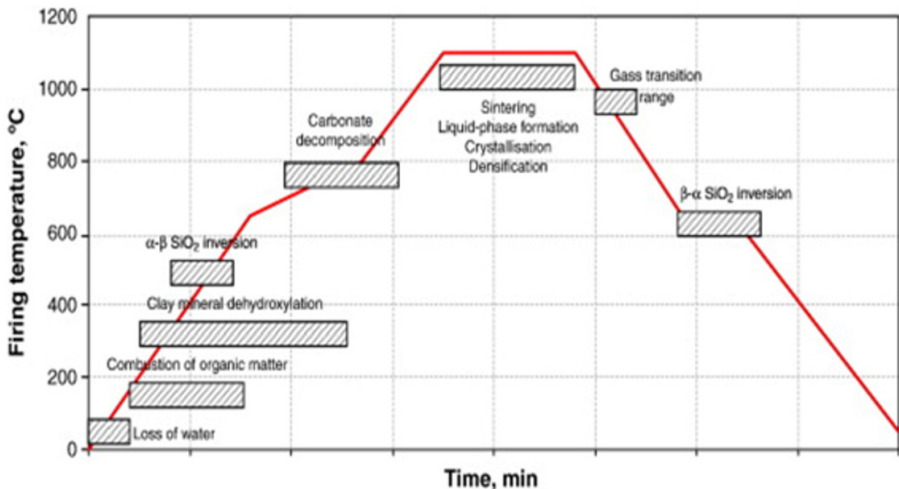
Clay Required is: **89.25 tons**

Add: Loss of Ignition @8.3%: $89.25 \times 1.083 = \mathbf{96.66 \text{ tons}}$

Add: Moisture Compensation @ 5.5%: $96.66 \times 1.055 = \mathbf{101.98 \text{ tons}}$

Kaolin required is: **15.75 tons**

On a dry basis: Clay Required: 101.98 tons, Kaolin Required: 15.75 tons



Typical firing curve for Clay Brick Firing

Financial considerations

Basis: 30 days @ 100 tons salable products

Reference Product: Brick 17.5 (25 x 17.5 x 9.5 cm)

Fired Weight: 4 kilos

Selling Price: RwF 400 each*

Cost Price: RwF 339 each*

Fired Production per day : 105 tons

Fired Production per day (in nos.) : $(105000/4) = 26,250$ nos.

Fired Production per month (in tons) : $105 \times 30 = 3,150$ tons

Fired Production per month (in nos.) : $26,250 \times 30 = 787,500$ nos.

Fired Production per year (in tons) : $3150 \times 12 = 37,800$ tons

Fired Production per year (in nos.): $787,500 \times 12 = 9,450,000$ nos.

Sale Value of Production / year: $9,450,000 \times 400 = \text{RwF } 3.78 \text{ Billion}^*$

Production Loss / year: $9,450,000 \times 5/100 = 472,500$ nos.

Actual Sale Value / year: $(9,450,000 - 472,500) \times 400 = \text{RwF } 3.591 \text{ Billion}^*$

Raw Material costs

Clay Cost per ton: RwF 1,250*

Clay Required per day: 101.98 tons

Clay Cost per day: $101.98 \times 1250 = \text{RwF } 127,475^*$

Clay Required per month: $101.98 \times 30 = 3059.4$ tons

Clay Cost per month: $3059.4 \times 1250 = \text{RwF } 3,824,250^*$

Clay Required per year: $3059.4 \times 12 = 36,712.8$ tons

Clay Cost per year: $36712.8 \times 1250 = \text{RwF } 45,891,000^*$

Kaolin Cost per ton: RwF 3500*

Kaolin Required per day: 15.75 tons

Kaolin Cost per day: $15.75 \times 3500 = \text{RwF } 55,125^*$

Kaolin Required per month: $15.75 \times 30 = 472.5$ tons

Kaolin Cost per month:	$472.5 \times 3500 = \text{RwF } 1,653,750^*$
Kaolin Required per year:	$472.5 \times 12 = 5,670 \text{ tons}$
Kaolin Cost per year:	$5670 \times 3500 = \text{RwF } 19,845,000^*$

Fuel requirements and cost

Coffee Husk required/day: 8 tons

Coffee Husk cost per ton: RwF 35,000*

Coffee Husk cost per day: $35000 \times 8 = \text{RwF } 280,000^*$

Coffee Husk required per month: $8 \times 30 = 240 \text{ tons}$

Coffee Husk cost per month: $240 \times 35000 = \text{RwF } 8,400,000^*$

Coffee Husk required per year: $240 \times 12 = 2,880 \text{ tons}$

Coffee Husk cost per year: $2880 \times 35000 = \text{RwF } 100,800,000^*$

Similarly, costs and requirements can be worked out for:

Power - Water - Maintenance - Workforce - Miscellaneous

*Prices updated to November 2022

02 INTRODUCTION TO CERAMICS

DEFINITION AND BACKGROUND

The word “Ceramic” is derived from the Greek work, “Keramos”, which means “Pottery”.

Archaeological excavations have revealed some of the earliest pottery fragments, over 3000 years old. It is said that man initially hunted for his food, it was later that he started cooking. This was after the discovery of “fire”. For cooking, man needed a utensil to cook in, and that clay pot was the first ceramic product developed.

This clay was then put to many uses as the early man found to his benefit. He could shape clay into rectangular products to build walls. There’s an anecdotal incident quoted by historians, that in Mesopotamia, there occurred a massive fire, and it engulfed a pile of hand made bricks. When the fire died out, it was found that the bricks had developed mechanical strength and featured an “orange red” color. This was the first fired red clay brick coming into existence.

Ceramics was the basic tool of human development in those times. Excavations have shown figurines, glazed pottery etc.

Ceramics can be technically defined as an inorganic non-metallic solid comprising either metal or non-metal compounds that have been shaped by hand or machine, and then hardened by heating to high temperatures. They are usually very hard, corrosion resistant but brittle. They are associated with properties like: high melting point, high hardness, poor conductivity, high moduli of elasticity, chemical resistance and very low ductility.

Ceramics started as “Traditional Ceramics”, which is clay based, and can be categorized as, Stoneware, Earthenware and Porcelain. The clay composition used, type of additives and firing temperature determine the end product.

However, in the last hundred years, the ceramic domain has undergone a metamorphosis, where new ceramic materials are being created with unique properties that fit specific requirements. Consequently, a new branch of engineering has developed called “Materials Science”.

Nowadays, ceramic materials, not derived from clays have been developed. These advanced ceramics are used in high performance applications, viz. space, medicine etc.

Ceramics has been an inalienable part of history, where they were initially used to mould pottery objects like pots, and other hollow utensils. Originally, they were made from either pure clay or were blended with other materials such as silica, followed by a process of hardening and sintering with fire. Later, amorphous glaze coating was employed to create smooth, colored surfaces as well as to reduce porosity and increase mechanical strength.

Historically, the raw materials used in ceramics have been clay-like minerals, viz. Kaolinite. More recently, aluminum oxide, also known as alumina, has been widely adopted. Advanced ceramics embrace materials such as Silicon Carbide and Tungsten Carbide, both of which are recognized for their abrasion resistance making them useful in crushing equipment and mining operations. Advanced Ceramics can also be found in the medical, electrical, and electronics industries. As raw materials are finite in nature, the creation of synthetic sand for use in ceramics has been developed. Synthetic sand is sand that is deficient in clay, blended with bentonite or other clay-like material to make it suitable for molding.

While the domain of Ceramics is very vast, we shall in this presentation restrict ourselves to clay brick as a ceramic item.

Bricks are categorized for their usage:

- Load bearing walls
- Non-load bearing walls
- Insulating walls
- Cladding walls
- Cover walls

The selection of bricks is made from their usage point of view:

Normally the brick length is twice the width and the thickness is $\frac{2}{3}$ of the width.



CLAY BRICKS

ADVANTAGES, COMPOSITION AND CHARACTERISTICS

ADVANTAGES:

Let us here enumerate the advantages of clay fired bricks over competing alternatives:

- 1 FIRE AND MELT RESISTANT IN NORMAL CIRCUMSTANCES
- 2 NOT SUBJECT TO CORROSION OR RUST
- 3 DO NOT DISCOLOUR WHEN EXPOSED TO ULTRA VIOLET RAYS OF THE SUN
- 4 FIRED BRICKS WILL NOT ROT OR BE ATTACKED BY TERMITES
- 5 FIRED BRICKS WILL PROP UP INNUMERABLE DESIGN OPTIONS

COMPOSITION:

The basic chemical composition can be written as:



Other Oxide generally comprise Iron Oxide, which gives the orange colour to the clay bricks, usually up to 13%. The remaining would be Manganese / Magnesium Oxide and Calcium Oxide

How does the chemical composition impact clay bricks making?

- **SILICA:** Silica is an inherent part of the clay. Its role is to provide the basic shape of the chemical bond and prevents the brick from warping
- **ALUMINA:** Alumina provides the plasticity to the clay, which makes it to be moulded into shape and retain the new shape.
- **LIME:** It acts as a flux, and acting as a binder, lowering the maturing temperature for firing the clay brick.

HARMFUL INGREDIENTS:

What are the harmful ingredients in clay that can cause clay bricks to fail?

- **ORGANIC MATTER:** High Organic matter can play havoc with the quality of the bricks. lowering the mechanical strength. When a high black core is found upon inspection, that signifies that the organic matter had time to burn away.
- **ALKALI:** Alkalis can lower the firing temperature of the clay brick abnormally.
- **PYRITES:** Can cause the clay brick to lose its binding power.



Black core in brick

CHARACTERISTICS OF CLAY BRICK:

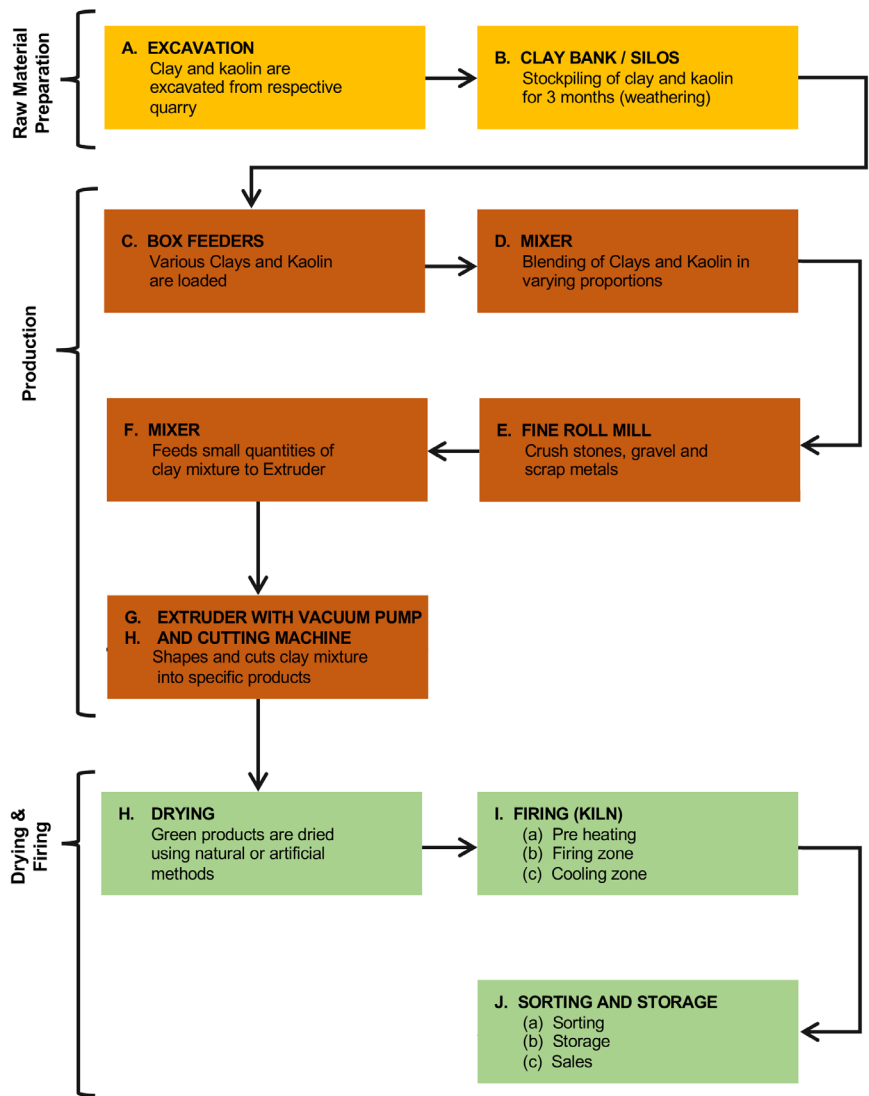
- **COLOUR:** A well fired clay brick will have a red to orange-red colour. This colour is dependant on the amount of Iron Oxide present in the clay.
- **APPEARANCE:** The clay brick should have sharp edges, crack-free and should respect the design dimensions.
- **FIRE RESISTANCE:** Clay bricks, depending upon their chemical composition, are fired in kilns at temperatures between 850° to 1050° C. With such high firing temperature, ordinary fire doesn't affect the brick strength. A brick masonry wall fails because of the intervening mortar joints. They are porous and can lower the strength of the wall in case of fire.
- **STRENGTH:** With such high firing temperature, clay bricks develop a high mechanical strength and can withstand high loads.
- **DURABILITY:** There are in existence centuries old buildings built with clay bricks, which exemplify the durability of clay bricks life.
- **WATER ABSORPTION:** When a clay brick is kept wholly immersed in water at room temperature, its weight should not increase beyond 14%. This is the suggested maximum absorption and it measures the brick porosity.
- **EFFLORESCENCE:** When the lime content in clay is high, it leaves a whitish powder on the surface, deteriorating the appearance of a brick wall.



Efflorescence seen in the brick

CLAY BRICKS PRODUCTION

FLOW CHART



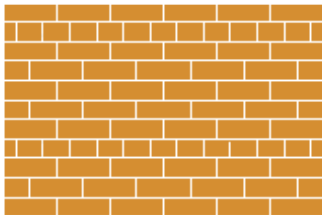
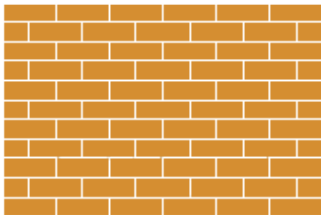
Flow Chart of the Factory Clay Brick Manufacture

CLAY BRICKS LAYING PATTERNS

BRICK WALLING LAYOUT

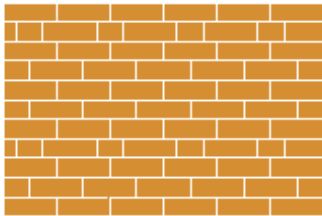
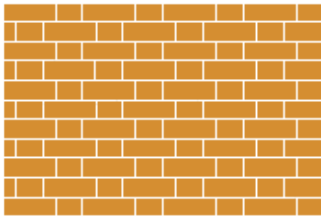
There are several ways of laying bricks and these have evolved over time. They can bring out the beauty of clay bricks when laid in different layout. Though in some patterns, the number of bricks used may be more than if they had adopted the most popular Stretcher Bond.

STRETCHER
BOND



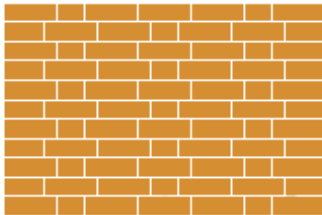
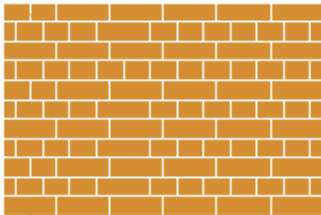
COMMON
BOND
(Full headers
every 6th course)

FLEMISH
BOND



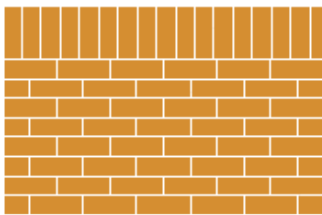
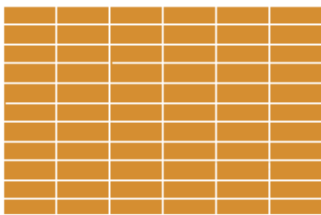
COMMON
BOND
(Flemish bond
every 6th
course)

DUTCH
BOND



GARDEN WALL
BOND

STACK
BOND



SOLDIER
COURSE
(On stretcher
bond)

03 MARKETING TECHNIQUES

CLAY BRICK INDUSTRY FUNDAMENTALS

BEGINNING:

Clay bricks have been known since time immemorial. Some of the archaeological finds have made us aware that clay bricks have been around for more than 7000 years. Initially started as just sun dried and manually shaped bricks. There's an anecdotal reference to Mesopotamia, wherein, the bricks kept out for drying were caught in a huge fire that engulfed the area. When the blazing fire died out, the people found that the sun-dried bricks had become mechanically strong, developed an orange colour, and that was the start of making fired clay bricks.

Handmade bricks gave way to bricks being produced using wooden moulds, so that the bricks had a uniform shape.

MANUFACTURING:

The clay brick making got a shot in the arm during the Industrial Revolution that swept Europe in the 18th century. As manufacturing started getting mechanized, clay brick making too saw a cataclysmic change happening. Manual making of bricks was being replaced by machine, called "extruder". Rapid changes started happening, leading to the current scenario, where robotics is used for clay brick making, especially in large scale plants.

FUEL:

Dry grass / firewood was the initial fuel to burn the bricks. As technology improved, newer fuels started being used for firing, starting from Bio-fuels (sawdust / coffee husk / bagasse / wood chips etc). Modern large sized clay brick plants use gas (CNG / LPG), while others use liquid fuel, such as Furnace oil, Kerosene Oil etc.

Over the last 50 years, the method of producing clay bricks has not had much change across the globe. The clay bricks are a significant basic material for all types of construction activities and make up about 10% of the total building material cost.

THE CONSTRUCTION MATERIAL MARKET:

Early types of construction provided minimal shelter from fire attack, wind and rain. At present, the definition of modern house has changed where every

aspect of lighting, climate and security could be under finger-tip control. With this development, there is a continuous demand for improved, more efficient and economical as well as environmental friendly construction materials such as fired clay bricks which in turn increase the demand for an automatic clay brick market.

The construction industry is the backbone of any economy and in Rwanda, it contributes to more than 10% of the GDP. Clay bricks are an important player of this industry. As construction industry grows, the demand for clay bricks will also increase, creating more job opportunities, both in the organized and unorganized sectors.

ALTERNATIVES:

Bricks we have to contend with alternative materials. While taking a tour of Central Business District (CBD) of Kigali City, we will notice that most high-rise buildings have a great deal of glass façades. There is also an increased use of plywood instead of walls. All these factors lead to drop in clay brick sales.

Though glass façade buildings for tropical countries are not ideal, architects are driven by customer demands, who wants a glitzy exterior, giving it a premium look.

Clay Bricks face a strong competition from alternatives like stones, AAC bricks, cement blocks, soil stabilized bricks etc, but their versatility, availability and price make them the first choice for any builder.

CURRENT BRICK PRODUCTION:

Being an environment friendly and a recyclable product, fired clay bricks are used extensively, where clay is easily available. Today we have scenarios where handmade bricks co-exist with large clay brick plants of capacity touching 1800 tons per day. But such scenarios present a different style of marketing their bricks.

Handmade bricks plants, with limited resources, have trouble accessing customers. These types of units are usually located in remote areas, and for them to transport their products to cities is very expensive. Most of such manufacturers bring their products to the road side and park it there, hoping that a customer passing by will buy them.

MARKETING STRATEGIES

TEXT

The Business Owner has to make a conscious decision to employ a Marketing Manager, who is not only skilled in selling but also is trained on the technical aspects of clay bricks and usages. Clay Bricks largely fall into three categories:

1 ROOFING

Roofing materials are in the form of clay roofing tiles. There are three different types of roofing tiles prevalent in the region, viz., Roman / Portuguese / Mangalore roofing tiles.

2 WALLING

This category constitutes the largest section, as it has a wide repertoire of products.

The mechanized clay brick producers have other challenges. Due to their large-scale production, they cannot keep their finished goods inventory within their factory premises, as there will be shortage of space. They need to have a thriving and formidable marketing strategy to keep pushing their goods out through robust sales.

Large producers have competitors within the immediate region and they have to contend with that. As mentioned earlier, hand made brick suppliers adopt a relatively low budget marketing strategy. They do not have spare funds and choose the easy way out.

For large manufacturing units of clay bricks, there are myriad ways to sell bricks, and we will individually dwell briefly on them:



Website:

In the digital world we live in, having the company's website is a must.

The company website should be developed by a professional and have all details of the products, technical information, i.e. measurements, number of bricks required per sqm, weight per piece, compressive strength, and water absorption.

There should be as many photos uploaded on the site of all the products that the

company manufactures, show laying pattern of bricks / blocks.

Some large companies even provide online sales / online payment to make it a seamless process.

Search engine optimization (SEO) is how you help customers find your site when they search on Google, Bing and Yahoo. By building your site the right way and optimizing your keywords, you'll drive more traffic to your page and generate more sales.



Architects & Civil Contractors:

The Marketing Manager of a clay brick company should have a list of architects and civil contractors operating within the city or jurisdiction that the company operates in. It is the architects who specify which building material to be used in a particular project.

Architects need to be briefed on the type of products available, for walling, for roofing, and for flooring, as well as the benefits of using Maxpan for storied buildings.

Some architects are die-hard proponents of clay bricks in their architectural designs, while others have to be made aware of the benefits of using clay bricks over competing products.

Civil Contractors are also another group that weigh heavy in the use of clay bricks. They too need to be approached and informed on the benefits of clay bricks. Perhaps, a training of using clay bricks would make the task of promoting clay bricks that much easier.



Print & Audio-visual Media:

In the electronic digital world, one has to take into account the mighty sway of print and audio-visual world that can assist in the promotion of products.

Advertisement inserts in newspapers, trade related magazines / journals are now standard forms of promotion of products.

While inserting advertisements in the print media, one must find out what is the readership level of the related newspaper etc. The higher the number, more the number of people who will see the advertisement.

In the audio-visual media, a slick video clip needs to be created for promotion of

clay bricks. This has a better appeal and far reaching impact than print media, as more real life experience can be shown.



Working towards achieving ISO certification:

ISO certification from authorized agencies will emphatically impact your clay brick in the eyes of a potential customer.

An ISO certification is viewed by the general public as a certificate of quality.

Therefore, clay brick companies must work towards getting certified for ISO and thereby enhancing their reputation.

This certification also puts an enormous onus on the company to maintain the product quality, which is actually win-win for all.

Government and large corporate buyers of clay bricks always look for companies having such certifications, as then they do not have to go through the process of testing the products. It is more or less; one can buy the products with eyes closed.



Working with Technical Schools:

Technical schools like architectural schools, department of Civil Engineering in engineering colleges are another avenue to promote clay bricks.

The marketing impact may not have an immediate impact, but these students at these faculties are going to be specifying clay products in the future. So, it is catching them young.

Inviting these students to your manufacturing facility will give a ring side view of the production process, which they can appreciate and later on in life can be canvassing for the usage of clay bricks in their projects.



Direct Sales / Walk In:

There is a group of customer that approaches the clay brick producer directly for bricks.

He / She is fond of clay brick products and wants to use them in their construction.

He /She takes the decision on the choice of the building material to be used and direct the civil contractor on what to use for the building material.

This group is generally walk-in customer and are a sizable lot.

These customers may have had previous experience of using clay bricks / or travelled abroad and seen clay bricks used in buildings and homes, and want to adopt similar construction style for their personal project.



Construction Division:

It is observed that large to mid sized clay brick manufacturing units have a construction division.

The construction division buys clay bricks from their sister group company, viz., the clay brick facility and uses the products in their building projects.

This is a win-win strategy for both the manufacturer and the buyer. The buyer is the construction division, who buys from the seller, which is clay brick producer. So, both parties are happy, as the buyer gets clay bricks easily and ahead of others, and the seller gets sales in the bargain.

This move is being widely adopted and has garnered success.



Sales through Depots or Agents:

When the clay brick manufacturer is situated in the city and there is possibility of sales happening in other cities, where quality bricks are not available. This is a potential opportunity for sales, which should be seized for sales growth.

Depending upon what level of sales is possible, the clay brick manufacturer could open a sales depot in the other city or if sales are not too high, then to appoint sales agents.

So, opening a sales outlet in a strategic location makes a good business sense.

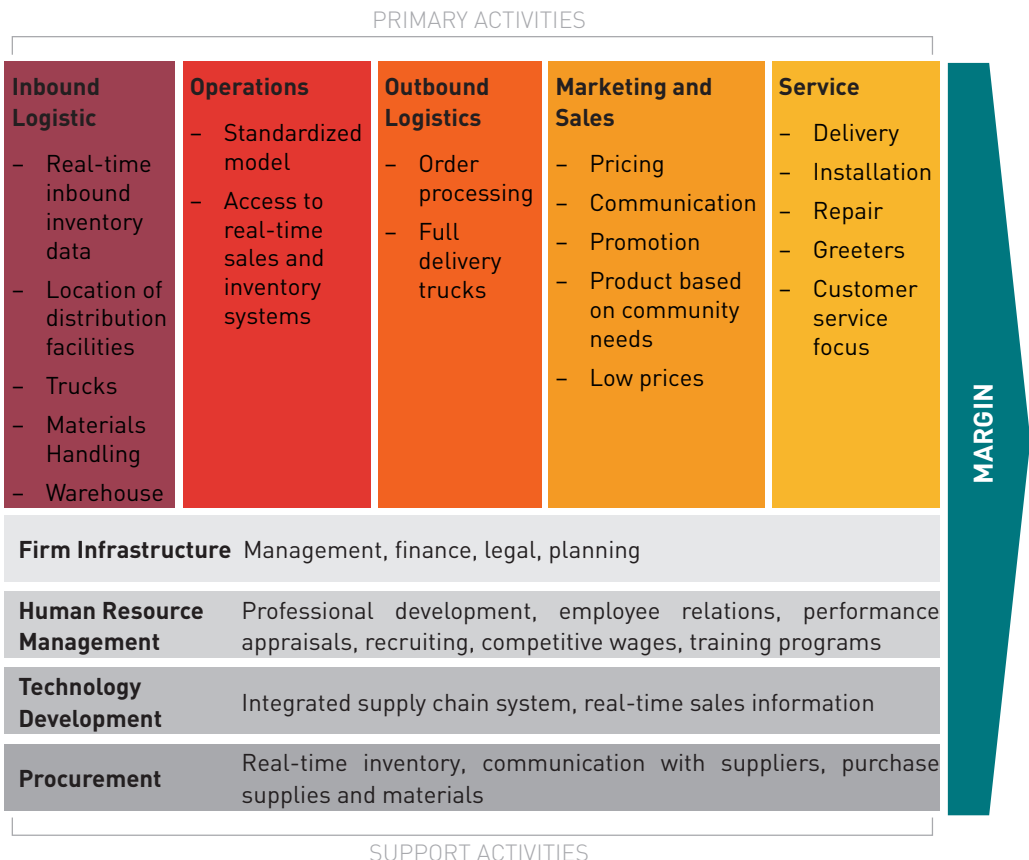
If the sales are intermittent, then appointing a sales agent is appropriate, as costs are low. It is based on commission on sales generated.

04 VALUE CHAIN

THE CONCEPT OF VALUE CHAIN

Value Chain as a concept was first described by the eminent Harvard School professor Michael Porter in 1985, in his book, “Competitive Advantage: Creating & Sustaining Superior Performance”. A value chain analysis is when a business entity describes the full chain of its business activities in the creation of a product or service – from the initial receipt of the raw materials and through processing to final product and onto the customer. It identifies its primary and secondary activities and sub-activities and evaluates the efficiency of each stage.

A **VALUE CHAIN ANALYSIS** can show the linkages, dependencies and other aspects.



Value Chains streamline the processes that take a product from concept to market. The integral linkages are supported by both structure and effective communication between direct, indirect, and support components. Direct activities like hiring and training human capital are further supported by indirect activities, like record keeping and Quality Control.

In order to evaluate the value chain model, the following ten cost drivers help in acknowledging the scope for improvement.

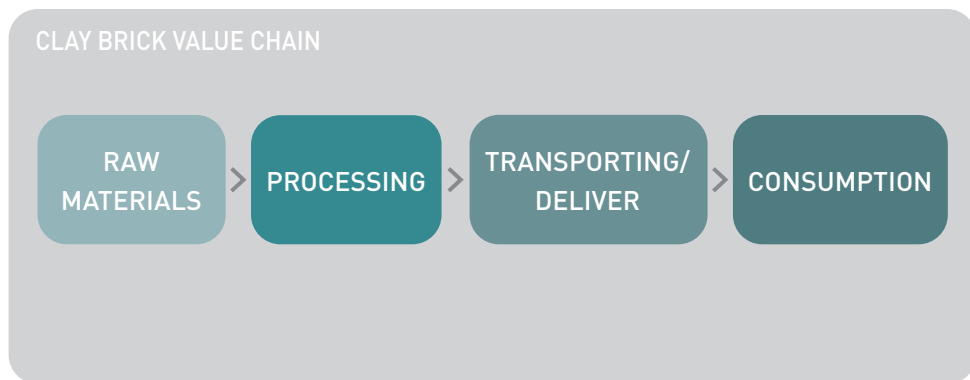
- 1 **ECONOMIES OF SCALE:** A realistic analysis of the demand, cost analysis for the demand size, whether it is within the country or across the borders.
- 2 **LEARNING:** Activities that alter the efficiency or improvement, such as scheduling, use of asset, plant layout.
- 3 **CAPACITY UTILIZATION:** A plant is at its most efficient capacity when the rated capacity and plant output are matching.
- 4 **LINKAGES AMONG ACTIVITIES:** Identifying areas of cross-functional improvement through coordination and optimization.
- 5 **INTER-RELATIONSHIPS AMONG BUSINESS UNITS:** Opportunities to share information and resources.
- 6 **DEGREE OF VERTICAL INTEGRATION:** Identifying areas of joint integration or, in some cases, de-integration.
- 7 **TIMING OF MARKET ENTRY:** Driven by economic or global conditions and competitive position in the marketplace.
- 8 **FIRM'S POLICY OF COST OR DIFFERENTIATION:** Identified value integrated into the process.
- 9 **GEOGRAPHIC LOCATION:** This would include wages, climate and raw materials availability.
- 10 **INSTITUTIONAL FACTORS:** These would include taxes, unions and regulations.

Factors that Influence Competitive Advantages:

- A. Competitive rivalry within the clay brick industry
- B. Threat of new market entrants
- C. Bargaining power of customers
- D. Bargaining power of suppliers
- E. Threat of alternate products

VALUE CHAIN IN THE CLAY BRICK INDUSTRY

FROM RAW MATERIAL TO FINAL CONSUMER



Value Chain definition in a clay brick industry is explained as how the products reach the final consumer from raw material or from the initial stage of a product to an intermediate stage and then supplied to the final consumer.

RAW MATERIALS: The brickworks value chain starts with the mobilization of the inputs which are required for the production of bricks. Clay, labour, kaolin, coffee husk and land are the main inputs.

PROCESSING: Immediately after this mobilization phase, the second stage is manufacturing bricks, which includes the activities like mixing homogeneous clay mix with water, shaping clay via a mould/die, drying the wet bricks and arranging them in a kiln, fire them and store them.

TRANSPORTATION: The burnt bricks are transported either directly to the final customer or through intermediates like agents / dealers. The final consumers are private citizens or contractors building projects like commercial buildings, housing, etc. The question of governance occurs when the players along the value chain act according to rules set by others, like Government, NGO, labour unions and Human Right forums etc. These are governed in two ways: outside agencies (external governance) or from within (internal governance). It is clear how different players impact the chain from raw material to finished goods.

During this process, the brickworks have to face the environment laws of the land, to reduce pollution and land degradation.

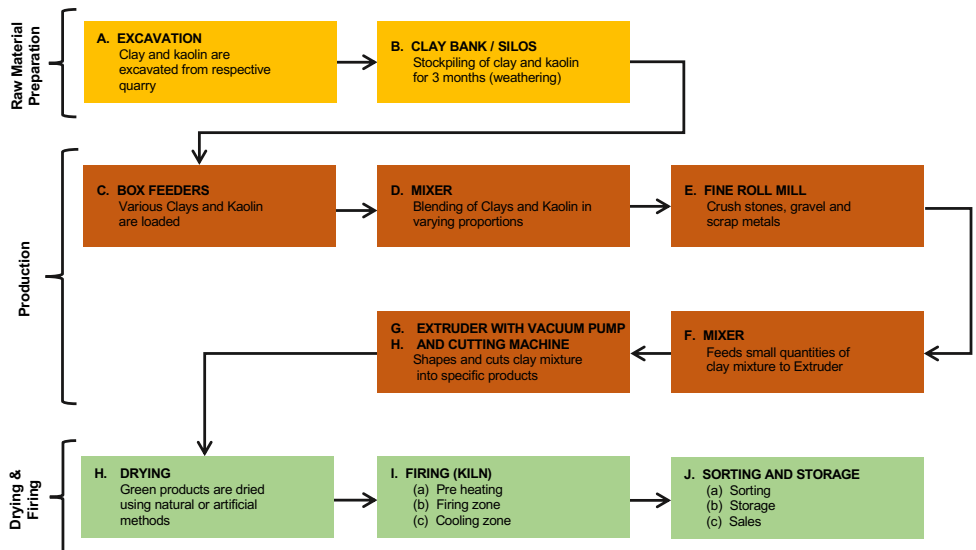
CONSUMPTION: The final stage of clay brick is consumption. It begins with the examination of minimum quality standards of clay bricks through the methods of quality control, like random checks of dimension tolerance, strength, colour and water absorption.

05 PLANT LAYOUT

PLANT LAYOUT MEANING

Plant Layout is a floor plan for streamlining, determining and arranging the designed clay brick machinery whether established or contemplated, in the best and optimum place, to permit the quickest flow of material, at the lowest cost and with the minimum handling in processing the product, from the receipt of raw material to the shipment of finished product.

It involves a most efficient and economical arrangement of machines, materials, personnel, storage space and all supporting services, within the available floor space.



Flow Chart of the Factory Clay Brick Manufacture

OBJECTIVES

OF THE PLANT LAYOUT

- 1 EFFICIENT UTILIZATION OF FLOOR SPACE, HORIZONTAL AND VERTICAL
- 2 ENSURE WORK PROCESS FROM FIRST TO FINAL POINT WITHOUT DELAY
- 3 PROVIDE FOR ENOUGH PRODUCTION CAPACITY
- 4 REDUCE MATERIAL HANDLING COSTS
- 5 REDUCE HAZARDS TO PERSONNEL
- 6 UTILIZE LABOUR EFFICIENTLY
- 7 INCREASE EMPLOYEE MORALE
- 8 REDUCE ACCIDENTS
- 9 PROVISION OF SUPERVISION AND CONTROL
- 10 PROVIDE EMPLOYEE SAFETY AND HEALTH
- 11 ALLOW EASE OF MAINTENANCE
- 12 ALLOW HIGH UTILIZATION OF MACHINE / EQUIPMENT
- 13 IMPROVE PRODUCTIVITY
- 14 TO MINIMIZE THE COST OF PRODUCTION
- 15 BETTER INTER-DEPARTMENTAL RELATIONSHIPS

PLANT LAYOUT

DETERMINANT , PRINCIPLES AND FACTORS

DETERMINANTS OF PLANT LAYOUTS

1. Type of Product: size / shape / quality
2. Type of Process: technology of operations: manual / mechanized / robotic
3. Volume of Production: Possibility of increasing capacity at a later date

PRINCIPLES OF PLANT LAYOUT

MINIMUM MOVEMENT: material and men should be moved over minimum distances; saving cost and time of transportation and material handling.

SPACE UTILIZATION: all available space should be effectively be utilised, both horizontally and vertically.

FLEXIBILITY: layout should be flexible enough to be adaptable to changes required by expansion or technological development.

INTERDEPENDENCE: interdependent operations and processes should be in close proximity to each other to minimize product travel.

OVERALL INTEGRATION: all the plant facilities and services should be fully integrated into a single operating unit to minimize cost of production.

SAFETY: there should be in-built provision in the layout design to promote safety and comfort of workers.

SMOOTH FLOW: the layout should be so designed as to reduce work bottlenecks and facilitate uninterrupted flow of work throughout the plant.

ECONOMY: the layout should target to achieve economy in terms of investment in fixed assets.

SUPERVISION: an ideal layout should facilitate overall supervision of the workers.

SATISFACTION: it should boost employee morale by providing maximum work satisfaction.

FACTORS INFLUENCING PLANT LAYOUTS

FACTORY BUILDING: The nature and size of the building determines the floor space available for layout. While designing the special requirements, e.g. kiln location, its positioning should be such that it has easy access to fuel supply, ease of loading and unloading bricks and in close proximity to the Finished Goods Yard.

NATURE OF PRODUCT: Some products are large sized and some are small sized, so the plant should be able to handle both types with ease.

PRODUCTION PROCESS: In line with clay brick manufacturing, the layout should be such that there is no hindrance in the workflow.

TYPE OF MACHINERY: Machinery siting should follow the process flow to enable smooth movement of materials. There should not be a back and forth movement of the raw materials, as it wastes time and precious money.

REPAIRS & MAINTENANCE: Machines should be so sited / arranged that adequate space is available between them for movement of equipment and people required for repairing the machine and even for its easy removal for major repairs.

HUMAN NEEDS: Adequate arrangement should be made for cloakroom, washroom, lockers, drinking water, toilets and other employee facilities, proper provision should be made for effluent disposal, if any.

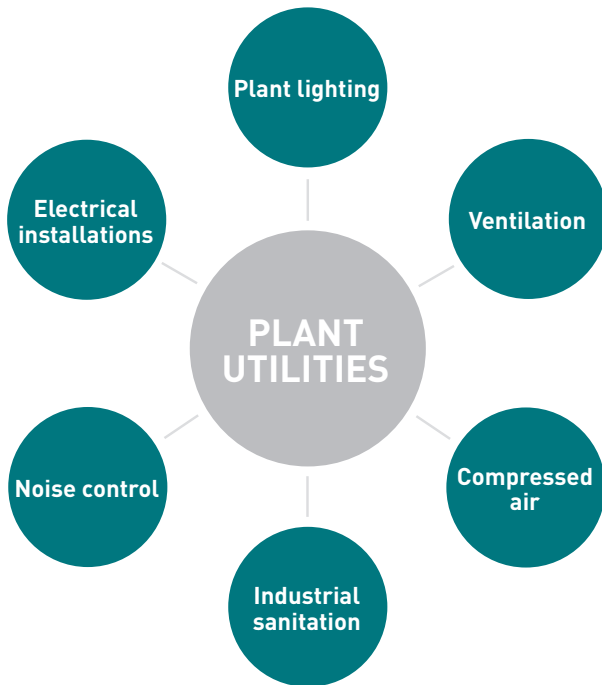
PLANT ENVIRONMENT: Heat, light, noise, ventilation and other aspects should be duly considered, e.g., kiln location should be away from Preparation and Shaping Areas to avoid heat and fumes from the stack.

MANAGEMENT POLICIES: Management policies should be a guiding principle to ensure safety of human life and machines.

PLANT UTILITIES

MINIMUM REQUIREMENTS

The types of plant facilities and services are as follows:



Plant Lighting

Adequate lighting is necessary for a worker to perform his/her job with ease and accuracy. According to global standards a minimum of 14 to 18 lumens of illumination is considered adequate.

IMPORTANCE OF GOOD ILLUMINATION:

- Ease of seeing / reduced eye strain
- Improved quality of work
- Better utilization of floor space

-
- Good housekeeping
 - Improved employee morale / Better supervision / Flexible layout

THERE ARE TWO MAJOR SOURCES OF LIGHTING:

- Daylight naturally received from the sun. Roof skylights or clearstoreys can provide natural lighting during daytime.
- Artificial light as illumination through artificial means. Types of artificial general lighting is provided by fixtures, luminaires or grid system placed ten feet above the work area. The lighting is provided uniformly over the whole work area in sufficient intensity to satisfy the requirement of the general manufacturing conditions within it.

Ventilation

Ventilation is concerned largely with engineering techniques for controlling air currents within the plant and for introducing outdoor air in a pattern and on a scale that is adequate to maintain satisfactory indoor air quality.

IMPORTANCE OF VENTILATION:

- Protection of the health of the workers
- Meets legal requirements

TYPES OF VENTILATION:

- General Ventilation, to keep the working conditions at acceptable comfort levels and to keep the air quality within the safe and acceptable limits.
- General Exhaust Ventilation: It is a system for preventing the contamination of factory air by withdrawing the contaminant at its source into a duct system for discharge to the outside.

Industrial Sanitation

Sanitation refers to control of the spread of infection and other detriments to the health of employees. Occupational disease caused by the industrial process leads to employee's dissatisfaction and labour turnover.

- Supply of potable water
- Disposal of waste and effluents
- Provision of food which is free from contaminants
- Elimination of insects and rodents

- Provision of personal services
- Good housekeeping

Noise Control

Noise is unwanted and unpleasant sounds.

ELEMENTS:

- Impairs the hearing of the employees
- Results in Noise Control Methods and nervousness
- Vibration causes damage to machinery and equipment
- Bad working environment

NOISE CONTROL METHODS:

- Control by absorption / source / ear protection

Electrical Installations:

If there is a transformer on the factory site, it should be suitably fenced.

The substation grounding is chosen to provide a low resistance path while the surrounding ground is filled with a crushed stone layer to provide high resistance so that the fault currents flow into the ground but not along the ground. The benefits of the gravel layer are:

1. To minimize step potential and touch potential voltages.
2. Avoid pooling of inflammable oil etc. on the substation ground in case of any spillage of insulation oil from the equipment. This also avoids spreading of fire from one equipment to the other in the substation.
3. To slow down the evaporation of moisture in the



Fenced power transformer

earth's upper layers.

4. To restrict entering of snakes and other reptiles as the surface would be inconvenient to crawl.
5. To avoid growth of plants and weeds in the substation yard to some extent.
6. 20 to 25mm size gravel is generally used rather than bigger size stones to facilitate movement of persons and equipment in the substation yard.



Insulated diesel power generator

CONTROL PANELS

1. All Control Panels should be well ventilated and neatly wired with adequate insulation.
2. Only authorised personnel to open and work on the panel.
3. No naked busbar or naked wires to be seen anywhere in the plant.
4. Appropriate type of fire extinguisher is available close to the control panels.
5. All circuit breakers / Control Gear to be of rated capacity as per demand of the equipment.
6. It would be appropriate to have Lightning system installed.



Electrical control panel

06 PREVENTIVE MAINTENANCE

DEFINITION

Maintenance serves to protect the Factory Owner’s investment in a number of ways, preserving an asset (a machine etc.), in order to enable its continued use and function above a minimum acceptable level of performance, over its design or service life without unforeseen renewal or major repair activities.

GENERAL REASONS FOR MAINTENANCE:

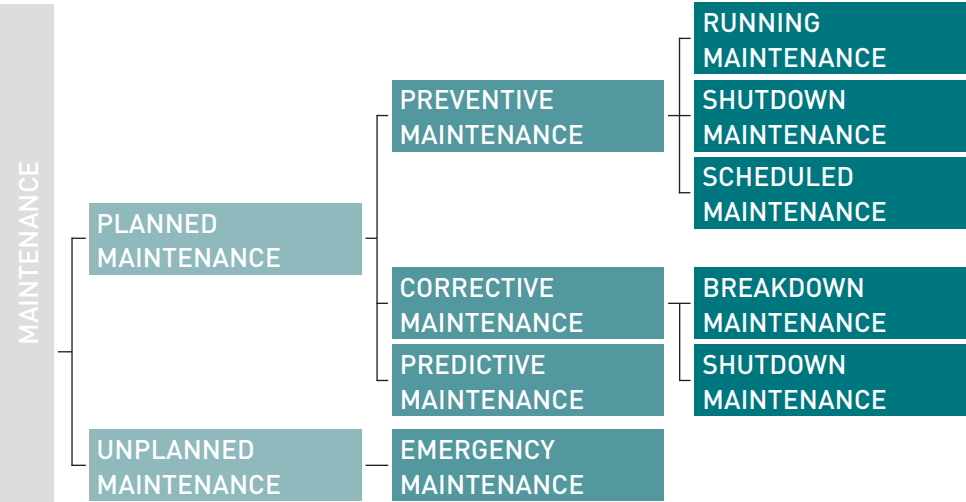
PHYSICAL INTEGRITY to keep the assets in good working order so as to minimize disruptions and downtimes.

RISK MANAGEMENT: to keep the assets in a state of good repair for the business progress and growth.

AESTHETIC PRESERVATION: to keep the assets from deteriorating in appearance and becoming unsightly.

RESPONSIBLE STEWARDSHIP: to ensure that the assets achieve their full potential service life.

DUTY TO MITIGATE: to prevent unnecessary damage to assets and prevent premature failure.



WHY IS PREVENTIVE MAINTENANCE IMPORTANT?

- The purpose of preventive maintenance is to try to keep the equipment in optimum working condition and to help prevent any unplanned downtime due to breakdowns. Because components start to wear over time, replacing items prior to failure can cost far less than the potential consequences of failure while in service. At times, the failure could be because of faulty design.
- Some people see maintenance as an expense and it can often be one of the first departments to suffer from cuts during difficult times, however, this is very much false. Preventing problems from occurring will almost always be far less than the costs you will incur due to actual failures.



Damaged clay extruder in need of repair

REACTIVE
MAINTENANCE



ALLOW ASSETS TO RUN TO
FAILURE

PREVENTING
MAINTENANCE



PREVENTING PROBLEMS
BEFORE THEY OCCUR

PREDICTIVE
MAINTENANCE



PREDICTING PROBLEMS
TO INCREASE ASSETS
RELIABILITY

TYPES OF PLANNED MAINTENANCE

TEXT

1 PREVENTIVE MAINTENANCE

Preventive Maintenance is conducted to keep equipment working and / or extend the life of the equipment.

Example: an individual bought an incandescent light bulb. The manufacturing company mentioned that the life span of the bulb is 3 years. Just before the 3 years, the individual decided to replace the bulb with a new one.

RUNNING MAINTENANCE:

A Preventive maintenance sub-category is Running Maintenance which includes those maintenance activities that are carried out while the machine or equipment is running.

Example: Lubrication, adjustment of nuts & screws, tightening of loose nuts and bolts.

SHUT DOWN MAINTENANCE:

Which is a set of preventive maintenance activities that are carried out when the production line is in total stoppage situation.

These are performed generally after three or six months or as demanded by the operation.

These involves the inspection of the plant items which are known to wear out or suspected to occur

SCHEDULED MAINTENANCE:

Scheduled Maintenance is any variety of scheduled maintenance to an object or item of equipment.

Specifically, Planned Maintenance is scheduled to be carried out by a competent and suitable agent, to ensure that an item of equipment is operating correctly and to therefore avoid any unscheduled breakdown and downtime.

An example of Planned Maintenance is car maintenance. After so many kilometers or miles the oil should be changed, parts replaced etc.

2

CORRECTIVE MAINTENANCE

In this type of maintenance, actions such as repair, replacement, or restore will be carried out after the occurrence of a failure in order to eliminate the source of this failure or reduce the frequency of this occurrence.

It also includes the different types of actions like typical adjustment or redesign of the equipment.

The difference between Corrective Maintenance and Preventive Maintenance is that for Corrective Maintenance, the failure should occur before any corrective action is taken. It is of two types: breakdown maintenance and shutdown maintenance

BREAKDOWN MAINTENANCE:

It is an emergency based policy in which the plant or equipment is operated until it fails and then it is brought back into running condition by repair.

The Maintenance staff locate any mechanical, electrical or any other fault to correct it immediately.

It is feasible for the small factories where:

- There are few types of equipment.
- Machine and equipment are simple and does not require any specialist.
- Where sudden failure does not cause any serious financial loss.

SHUT DOWN MAINTENANCE:

Which is a set of preventive maintenance activities that are carried out when the production line is in total stoppage situation.

These are performed generally after three or six months or as demanded by the operation.

These involves the inspection of the plant items which are known to wear out or suspected to occur

3

PREDICTIVE MAINTENANCE

Predictive Maintenance tends to include direct measurement of the item.

Example: the operator has the opportunity to observe the bulb operation daily. After two years, the bulb starts flickering. The individual predicts at that time that the bulb is going to fail very soon and decides to change it for a new one.

THE MAINTENANCE PROBLEM

GENERAL CLASSIFICATION OF MAINTENANCE PROBLEMS

A. Mechanical Failure

- Worn out bushes and bearings and other moving parts
- Fatigue of machine parts
- Creep of material at high temperatures
- Excessive forced vibration, misalignments etc.

B. Thermal Failure

- Overheating of the component
- Lack of lubrication
- Inadequate cooling

C. Chemical Failure

- Highly corrosive fluids containing abrasive particles
- Failure of protective linings like glass, rubber etc.

D. Electrical Failure

- Failure of Control Gear / Switch gear
- Electrical insulation failure

The following are five things to be considered when developing an effective Preventive Maintenance Plan:

1 Get the Right People on the Maintenance Team

- Without knowledgeable people to prepare the plan, there will be chaos.
- Skilled and experienced people need to be involved in developing and preparing the Maintenance Plan.

2 Set Goals for the Preventive Maintenance Plan

- Every company is unique in terms of its operation, resources and industry.
- When setting specific goals, these factors should be kept in mind since the scope of a PM plan is largely dependent upon the size and structure of a company.

3 Collect Detailed Information on the Equipment

Before a preventive maintenance program can be initiated, it is important to becoming familiar with company equipment as well as establish a baseline on its usage.

To do this, the make, model and serials numbers of each piece of equipment need to be documented along with all maintenance guidelines as well as specifics on installations, repairs and parts replacement.

Once this is done, the functioning of a piece of equipment should be assessed. To do this, machine downtime, meantime-between-failure (i.e., amount of time between repairs), the cost of parts replacement, the amount of time spent by technicians, the technician's response time and percentage of parts deliveries made on time all must be established. Utilizing this information, it is then possible to calculate the average cost of one hour of downtime.

The above data will form a baseline from which a Preventative Maintenance program can later be evaluated.

4 Create the Preventive Maintenance Schedule

Based on prior equipment maintenance history, maintenance standards for individual assets, inspection times, technician availability, equipment location and production downtimes.

Keeping these factors in mind ensures optimal maintenance with minimal operations disruption.

5 Monitor costs, performance and adjust as needed

Once in place for several months, PMs should be monitored by evaluating associated cost/benefit effects. While keeping in mind that results may vary depending on conditions or changes within the company's activities, Maintenance Managers may choose to adjust PMs as needed with the goal of further improving overall operations efficiency.

WHAT IS A CHECKLIST & ITS IMPORTANCE?

A checklist is basically a list of items required, points to think or the things needed to be done. The primary usage of a quality checklist is to make sure that all the important aspects are covered. People use a printable checklist to help them ensure that they don't forget something.

The items in a checklist are listed according to its level of priority similar to a to-do list. The use of checklist has become increasingly popular—from factory operations to complex medical operations.

07 QUALITY CONTROL

IN THE CLAY BRICK INDUSTRY

WHAT IS QUALITY CONTROL ?

A system of maintaining standards in manufactured products by testing a sample of the output against the specification.

QUALITY CONTROL

vs

QUALITY ASSURANCE

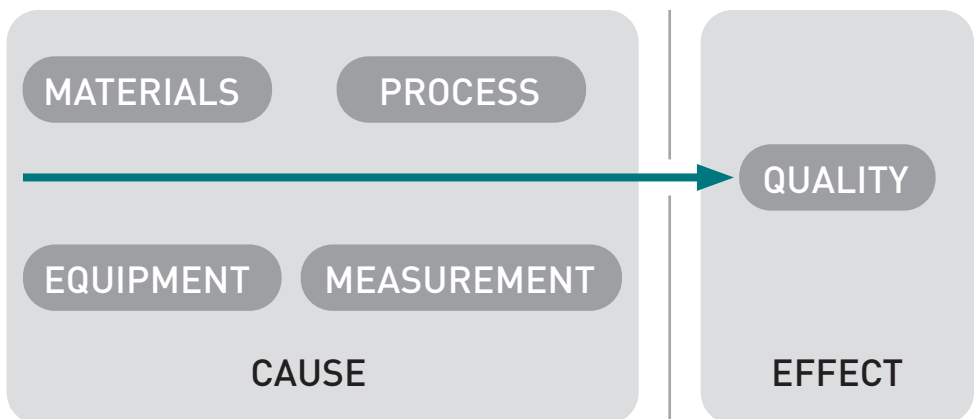
Quality Assurance is aimed to avoid the defect, whereas Quality control is aimed to identify and fix the defects.

Quality Assurance provides assurance that the quality requested will be achieved, whereas Quality Control is a procedure that focuses on fulfilling the quality requested.

Quality Assurance is a proactive measure, whereas Quality Control is a Reactive measure.

Quality Assurance requires the involvement of all team members, whereas Quality Control needs only a testing team.

Quality Assurance is performed before Quality Control.



QUALITY STANDARDS

RWANDA and EAST AFRICA

CASE1: The **Rwanda Standard BOARD (RSB)** has developed a quality specification for Burnt Clay Bricks under RS 359:2009, which is adopted from East African Standards, EAS 54:1999

The Standard tests the bricks for:

- dimensional tolerance
- compressive strength
- water absorption
- efflorescence

Some Important Formulae (useful in a Quality Control exercise)

Moisture Content (%)	$= \frac{(\text{Wet Weight} - \text{Dry Weight}) \times 100}{\text{Dry Weight}}$
Dry Shrinkage (%)	$= \frac{(\text{Wet Length} - \text{Dry Length}) \times 100}{\text{Wet Length}}$
Fired Shrinkage (%)	$= \frac{(\text{Dry Length} - \text{Fired Length}) \times 100}{\text{Dry Length}}$
Total Shrinkage (%)	$= \frac{(\text{Wet Length} - \text{Fired Length}) \times 100}{\text{Wet Length}}$
Loss On Ignition (%)	$= \frac{(\text{Dry Weight} - \text{Fired Weight}) \times 100}{\text{Fired Weight}}$
Water Absorption(%)	$= \frac{(\text{Weight soaked in water for 24 hrs} - \text{Fired Weight}) \times 100}{\text{Fired Weight}}$

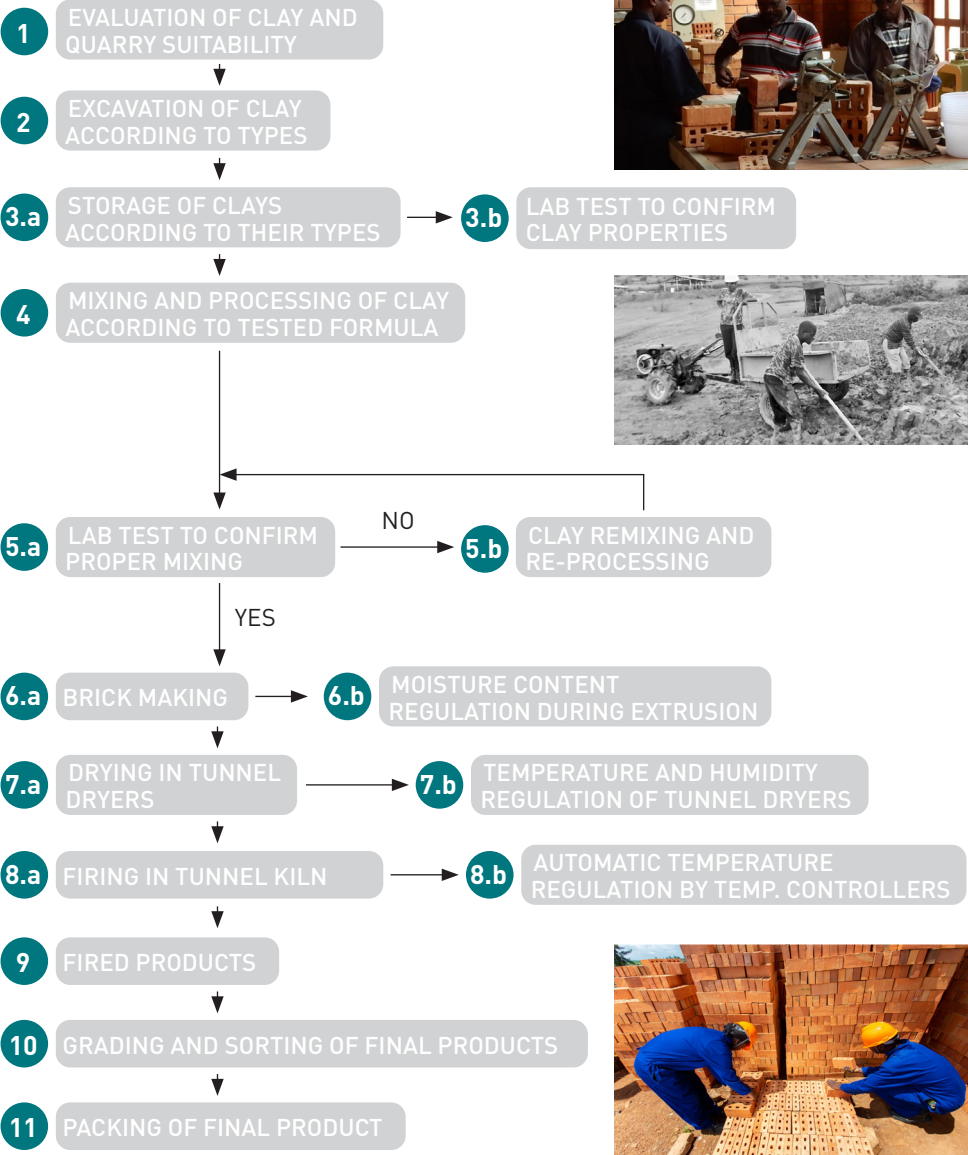
QC CHECKLIST

EXAMPLES OF QUALITY CONTROL CHECKLISTS

S. No.	Testing Station	Test Description	Periodicity	Test to be carried out at
1	Clay quarry	Test the clay for suitability for clay brick manufacturing, LOI/Granulometry/Shrinkage/Other usual tests	Once a quarter	BMC
2	Clay mix ratio	If the brickwork is using a two or more components in their raw material mix, then to ensure that the ratio is being followed	Every visit to brickwork	Respective brickwork
3	Roller mill	It was noticed at all Brickworks that clay dropping onto the Roller Mill is occurring at the center, whereby the shell wear out is happening in the center. With the heavy wear out, the clay simply passes through the roller shells without any grinding action. A suitable jig be developed to ensure that the clay falls evenly across the width of the roller shells	Every visit to brickwork	Respective brickwork
4	Moisture content at the extruder	Moisture content at the extruder mixer	Every visit to brickwork	Respective brickwork
5	Vacuum level	Those brickworks having a vacuum pump attached to the extruder to ensure that the pump is operating efficiently	Every visit to brickwork	Respective brickwork
6	Extruder	Check the extruded column is exiting uniformly across the entire face. Ensure the cores are aligned.	Every visit to brickwork	Respective brickwork
7	Cutter	Check the weight of the brick. If the weight has started to increase, inform brickwork that the die needs to be worked upon to reduce weight of extruded product. Check for sizing. Check for rectangularity, Check tension of cutter wire	Every visit to brickwork	Respective brickwork
8	Drying	To ensure that dried products being sent to the kiln have moisture content less than 2%. To train the Brickwork staff on arranging the bricks for drying	Every visit to brickwork	Respective brickwork
9	Kiln	Ensure optimum loading into the kiln chamber. Ensure proper arrangement of brick loading into the chamber to ensure uniform firing across the height and width of the loaded chamber. Most brickworks do not have any means of measuring temperature inside the kiln. Brickworks need to be informed that without proper measuring of the temperature, there will be repeated firing quality issues occurring.	Every visit to brickwork	Respective brickwork
10	Fired bricks	Bricks to be tested as per Rwanda Bureau of Standards (RBS), RS 359:2009 for sizing, water absorption, crushing strength, efflorescence	Every visit to brickwork	Respective brickwork and BMC

FLOW CHART

QUALITY CONTROL IN BRICK MANUFACTURING



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