

Supply Chain Management and Manufacturing in Sugar Industry: A Study of Sugar Industry in Chhattisgarh (India)

Siddhant Soni¹, Prashant Chandravanshi¹, Vishesh Tiwari¹

1. National Institute of Technology Raipur (Mechanical Department).

Abstract

The present paper discusses the Supply Chain Management as a tool for improving the total quality management in process industries (Sugar Plant). Agro handling is an enormous area that covers exercises like farming, cultivation, and estate. It additionally incorporates different enterprises that utilization agribusiness contributions for assembling of eatable items. Sugar Industry is one such significant part in Agro preparing area. More prominent assignment and intensity in agro based enterprises require new types of co-appointment among ranchers and different offices to expand amount inside catchment territory. During the whole creation season, to amplify sugar creation with least overheads a decent organization of the multitude of components is needed to be set up. Sugar industry faces a ton of issues like absence of co appointment, breaks in supply of crude material because of characteristic catastrophes and numerous other such issues. To conquer these issues industry needs to have a legitimate store network the board. Sugar industry especially in Maharashtra is famous in the agreeable area. It is adding to almost @ 40% of all out public creation of sugar. The weight figures are @ 50-70 lakh huge loads of sugar each year[2].

Key words:

Sugarcane, supply chain Management, sugar Industry, production.

Introduction

The improvement in modern robotization and coming about intricacy of frameworks included, have made the dependability of machines and other gear, significantly more significant. This is particularly evident in the process ventures, which is portrayed by the extensive specific gear and severe natural contemplations. The sugar business is an enormous designing unit having ceaseless sugar creation for 24 hours in a day during pulverizing season. To address the current difficulties, it has become for sugar plant to present the Stockpile Chain The board for improving Absolute Quality Administration. Store network The executives is organization of offices and exercises that play out the elements of item advancement and obtainment of material from sellers, the development of materials between offices, the assembling of items and circulation of completed products to clients. It is an absolute framework way to deal with dealing with the whole progression of data, materials and administrations from crude materials providers through manufacturing plants to the end client. To endure and grow a suitable way of thinking of All out Quality Administration needs to be embraced.

The idea of All out Quality Administration is able to withstand the rivalry, carries soundness and accomplishes improvement with the need of the time. Store network the executives in sugar enterprises included a great deal of issues which will thus influence the profitability of sugar. The sugar ventures in India utilize just sugarcane as information, henceforth sugarcane have been set up in enormous sugarcane developing states like Uttar Pradesh, Maharashtra, Karnataka, Gujarat and Tamilnadu and

Andhra Pradesh. These six states offer over 85% of all out sugarcane creation in India. Uttar Pradesh and Maharashtra together offer over 57% of complete creation.

Elements Influencing supply of sugarcane

1. Environment Because of a dangerous atmospheric deviation there are continuous changes in the environment which thus influence the yield and nature of sugarcane
2. Specialized Absence of specialized information among ranchers in regards to development and collecting of sugarcane - Sugarcane creation
3. When there is more creation of sugarcane it will prompt more creation of sugar and the other way around.
4. Political elements This is main consideration influencing the stockpile of sugarcane as larger part of sugarcane ventures in western Maharashtra are overwhelmed by lawmakers and the political fight emphatically influence this industry.
5. Recuperation rate, Term of season, sugarcane usage for sugar creation is likewise another factor that influences the stockpile of sugar[1].

MAJOR PROBLEMS IN SUPPLY CHAIN OF SUGAR INDUSTRIES

Cane Creation

Around there, cost of creation including gathering, infield haulage, street transport, loss of throughput can add to costs at each connection in the store network esteem chain research gives a few drives to lessening this expense and improving the productivity of

inventory network, similar to the execution of GPS direction framework to help following while at the same time reaping, bunch cultivating, defense of collecting gathering to diminish cost of cultivators, overhauling the site to work with the assortment and examination of information from ranchers to help with agronomic and ranch monetary administration choices, consistently giving the most recent updates of market and climatic changes just as the prescribed procedures for improving sugarcane creation to the ranchers by leading workshops and extraordinary preparing project will likewise assist with improving the creation of sugarcane.

Transportation

Sugarcane ventures are generally situated in provincial territories as sugarcane is the fundamental crude material utilized for assembling of sugar so the sugar businesses to decrease their transportation cost like to set up the enterprises close the of sugarcane creation regions, however the principle issue here emerges is that inappropriate street offices. Without dynamic vehicle booking, an ordinary sugarcane transport framework apparently shows unreasonable lining times enormous number of no stick stops, critical over brief and helpless vehicle use, an undeniable degree of coordination is needed between ranchers, collect project workers, transport workers for hire and factory directors to ensure the plant gets a constant flow of new stick. The improvement of bigger stick receptacles and a productive catching framework for the proficient vehicle of entire yield material will assist with lessening the transportation cost somewhat.

Warehousing

Subsequent to assembling and before circulation the sugar is put away in distribution centers which is

additionally called as stock, during this stockpiling a few issues may happen like here and there because of dampness sugar get changed over in strong solid shapes or might be ruined because of inappropriate taking care of. So appropriate consideration ought to be taken to keep up the stock in great condition. To take care of these difficult businesses ought to create warehousing at burning-through objections this empowers enterprises better evaluating and killing an excessive number of brokers, better Data Innovation and utilization of quantitative devices and strategies can be utilized for stock administration.

Government Approaches

Sugar has verifiably been delegated a fundamental product and has been controlled across the worth chain. The weighty guideline in this area misleadingly impacts the interest supply powers bringing about market unevenness. Detecting this issue, since 1993 the guidelines have been continuously facilitated. The key administrative achievements

Sugar has generally been delegated a fundamental ware and has been managed across the worth chain. The substantial guideline in this area falsely impacts the interest supply powers bringing about market unevenness. Detecting this issue, since 1993 the guidelines have been dynamically facilitated. The key administrative achievements include de-licensing of the industry in 1998 and the removal of control on storage and distribution in 2002 .However, policy still plays an important role in industries. There are various legislations regarding sugarcane procurement, sugarcane pricing, sugar sales, capacity and production, import and export.

Different Issues

Bungle, absence of coordination between ranchers, factory proprietors and merchants, absence of present day innovations as a significant number of the ventures actually depend on old advances are a few issues which should be revised for improving the productivity of inventory network.

Issue of Ranchers

1. A minimal Indian rancher is confronted with a few difficulties that outcome in yield and quality being second rate by world guidelines.
2. He needs admittance to data exact climate gauges and exceptional data on product market costs.
3. He needs admittance to the market and in this manner trapped in the endless loop of imperfect utilization of homestead inputs greater expense of credit and lower value acknowledge on his produce prompting irreplaceable pay for him[1].

Solution for these problems

1. Pre configured SAP solution
2. Web based cane management system
3. Add on utilities; smart card and SMS
4. ASM clean development Mechanism.

Manufacturing of sugar

- Production of sugar from sugar cane is a seasonal operation, depending on the availability of sugar cane, which lasts from October to May.
- Sugar can also be produced from beet, the production activity being limited to about 100 days in a year. As a result of its seasonal nature , sugar

industry presents peculiar problems for pollution control.

- sugarcane starts losing its sugar content as soon as it is harvested. It needs to be crushed immediately.
- sugarcane is bulky and heavy. Therefore, its transportation cost is high.

The sugar can be produced by many of the sources like Sugarcane, Sugar Beet, Maple, Palm, Coconut and Apple, but these sources are costly and their production is in negligible quantities except sugarcane and sugar beet. The main crop which is being used for production of Sugar all over the world is Sugarcane. In a nut shell, the process for sugarcane refining is carried out in following steps:

- Pressing of sugarcane to extract the juice.
- Boiling the juice until it begins to thicken and sugar begins to crystallize.
- Spinning the crystals in a centrifuge to remove the syrup, producing raw sugar.
- Refining the raw sugar by washing and filtering to remove remaining non-sugar

ingredients and color.

- Crystallizing, drying and packaging the refined sugar.

Other by product

- 1.Ethanol
- 2.Manure
3. Baggas

Various department

- Administration Department
- Finance Department
- Cane Department
- Mechanical Department

MANUFACTURING PROCESS

(A) Washing, Cutting of Canes, Shredding

- Washing the sugarcane before processing i.e. removing dirty.
- Cutting operation is the first operation in industry.
- Cutters are mechanical equipment which is used to cut the canes into desired size.
- Shredder is used to remove leaves and undesired solid particles from cane.

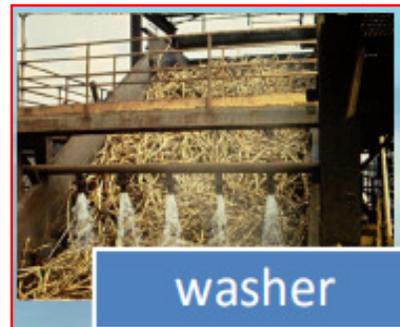




Fig-Shredder and canes



Fig-Crushing and Milling



Fig-Shredder and canes



Fig-Reverse carrier for raw material

(B) Milling

- Milling is process of crushing the sticks of sugar cane to extract the juice.
- The shredded cane is fed through a series of crushing mills to extract the sugar rich juice. Consists of three roller mills connected in series:
 - o Top roller
 - o Feed roller
 - o Discharge roller
- These used to extract the juice from crushing sticks.
- To make the mill process more efficient, the poor juices of the subsequent millings are reprocessed (mashing process) and hot water is applied in the last milling to increase the extraction.
- Bagasse is produce as a by product.



Fig- Lime addition on raw juice

(C) Clarification

- In clarification process sludge, mud, suspended & colloidal particles are removes by some chemical compounds.
- Raw cane juice are filled in clarifier (conical shape vessel), where

phosphoric acid, lime & sulphur dioxide are mixed with the help of agitator.

- When these chemicals are mixed, suspended and colloidal particles are collect in flock and resulting settled down.
- Neat and clean juice comes out from the upper section of clarifier, sludge and mud are collect in bottom and drainage to rotary filter.
- Calcium phosphate : as flocculent
- Lime & SO₂ : acts as bleaching agent
- CO₂ : acts as acidifying agent

(D) Filtration

Clarified mud from the clarifier further filtered in rotary filter. Mud & sludge are stick on the periphery of rotating drum by the action of suction. Solid cake removes from the drum by doctor blade.

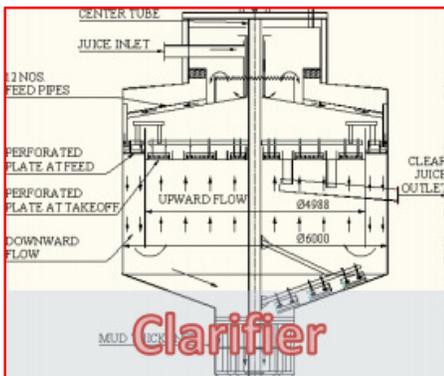
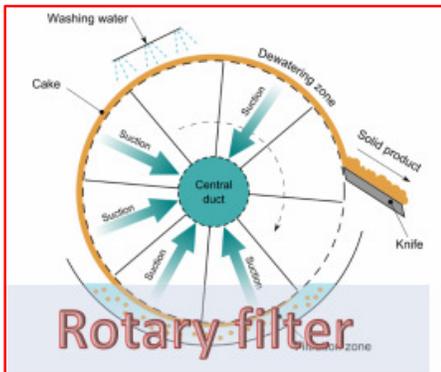


Fig- Colour after Lime addition on raw

(E) Boiling & Evaporation

- Evaporators are used in process industry to concentrate liquids.
- The operation is performed normally by use of low pressure, dry & saturated steam.
- The evaporator consist a heat exchanger in inner section .
- In the evaporator feed interred at upper section and concentrated thick liquor exit at bottom section.
- Multiple effect evaporator increase quality



Fig- Boiler Station 1



Fig- Boiler Station 2

Boiler Fittings and Accessories

➤ **Safety valve:** It is used to relieve pressure and prevent possible explosion of a boiler.

➤ **Water level indicators:** They show the operator the level of fluid in the boiler, also known as a sight glass, water gauge or water column is provided.

➤ **Bottom blowdown valves:** They provide a means for removing solid particulates that condense and lie on the bottom of a boiler. As the name implies, this valve is usually located directly on the bottom of the boiler, and is occasionally opened to use the pressure in the boiler to push these particulates out.

➤ **Continuous blowdown valve:** This allows a small quantity of water to escape continuously. Its purpose is to prevent the water in the boiler becoming saturated with dissolved salts. Saturation would lead to foaming and cause water droplets to be carried over with the steam - a condition known as priming. Blowdown is also often used to monitor the chemistry of the boiler water.

➤ **Flash Tank:** High pressure blowdown enters this vessel where the steam can 'flash' safely and be used in a low-pressure system or be vented to atmosphere while the ambient pressure blowdown flows to drain.

➤ **Automatic Blowdown/Continuous Heat Recovery System:** This system allows the boiler to blowdown only when makeup water is flowing to the boiler, thereby transferring the maximum amount of heat possible from the blowdown to the makeup water. No flash tank is generally needed as the blowdown discharged is close to the temperature of the makeup water.

➤ **Hand holes:** They are steel plates installed in openings in "header" to allow for inspections & installation of tubes and inspection of internal surfaces. ➤ Steam drum internals, A series of screen, scrubber & cans (cyclone separators).

➤ **Low-water cutoff:** It is a mechanical means (usually a float switch) that is used to turn off the burner or shut off fuel to the boiler to prevent it from running once the water goes below a certain point. If a boiler is "dry-fired" (burned without water in it) it can cause rupture or catastrophic failure.

➤ **Surface blowdown line:** It provides a means for removing foam or other lightweight non-condensable substances that tend to float on top of the water inside the boiler.

➤ **Circulating pump:** It is designed to circulate water back to the boiler after it has

expelled some of its heat.

➤**Feedwater check valve:** A non-return stop valve in the feedwater line. This may be fitted to the side of the boiler, just below the water level, or to the top of the boiler.

➤**Top feed:** A check valve (clack valve) in the feedwater line, mounted on top of the boiler. It is intended to reduce the nuisance of limescale. It does not prevent limescale formation but causes the limescale to be precipitated in a powdery form which is easily washed out of the boiler.

➤**Desuperheater tubes or bundles:** A series of tubes or bundles of tubes in the water drum or the steam drum designed to cool superheated steam. This is to supply auxiliary equipment that doesn't need, or may be damaged by, dry steam.

➤**Chemical injection line:** A connection to add chemicals for controlling feedwater

Controlling draft

Most boilers now depend on mechanical draft equipment rather than natural draft. This is because natural draft is subject to outside air conditions and temperature of flue gases leaving the furnace, as well as the chimney height. All these factors make proper draft hard to attain and therefore make mechanical draft equipment much more economical.

There are three types of mechanical draft.

✓Induced draft

This is obtained one of three ways, the first being the "stack effect" of a heated chimney, in which the flue gas is less dense than the ambient air surrounding the boiler. The denser column of ambient air forces combustion air into and through the boiler. The second method is through use of a steam jet. The steam jet oriented in the direction of flue gas flow induces flue gasses into the stack and allows for a greater flue gas velocity increasing the overall draft in the furnace. This method was common on steam driven locomotives which could not have tall chimneys. The third method is by simply using an induced draft fan (ID fan) which removes flue gases from the furnace and forces the exhaust gas up the stack. Almost all induced draft furnaces operate with a slightly negative pressure.

✓Forced draft

Draft is obtained by forcing air into the furnace by means of a fan (FD fan) and ductwork. Air is often passed through an air heater; which, as the name suggests, heats the air going into the furnace in order to increase the overall efficiency of the boiler. Dampers are used to control the quantity of air admitted to the furnace. Forced draft furnaces usually have a positive pressure.

✓Balanced draft

Balanced draft is obtained through use of both induced and forced draft. This is more common with larger boilers where the flue gases have to travel a long distance

through many boiler passes. The induced draft fan works in conjunction with the forced draft fan allowing the furnace pressure to be maintained slightly below atmospheric

(F) Crystallisation

In the field of engineering crystallization process considered as mass transfer operation.

- Purest form of substance is obtained.
- The object of the process is usually the recovery of the solute (crystals) from the solvent.
- Process consist 3 major events:
 - Clustering
 - Nucleation
 - growth

(G) Separation / Centrifugation

- Separate sugar from molasses /mother liquor
- Centrifuge operates at 100-1800 rpm
- Molasses pass through perforations
- Sugar crystals are washed with 85°C water
- Raw sugar and molasses produced

(H) Refining and Filtration

- A sugar refinery is a refinery which processes raw sugar into white refined sugar.
 - Refining process consist of 4 step ;
 - Affination - dissolving off some surface impurities
 - Carbonatation - removing further impurities that precipitate from solution with calcium carbonate
 - char filtration - removing further impurities with activated carbon
 - Recovery - using a vacuum process (see salt recovery).
- The liquor left over from the preparation of white sugar

and the washings from the affination stage both contain sugar which it is economic to recover.



Fig- Clarification and defecation Chamber



Fig- Clarification and defecation Chamber

(I)Drying

- Drying is very essential mass transfer operation in processing sugarcane into sugar.
- The wet raw sugar from centrifuges goes to rotary drier to remove the water from the wet sugar to reduce moisture content to 0.5-2%; using hot air at 110°C which flow counter currently with sugar.



Fig- Filtration Chamber 1



Fig- Filtration Chamber 2

(J)Storage and Packing

- packing is final process of sugar manufacturing process.
- Containers opaque, airtight, moisture/odor proof
- Glass canning jars or cans for liquid sugars

Factors affecting sugar storage

- Temperature
- Moisture
- Quality of sugar
- Light
- Grain size and distribution
- Compression

BY-Product (Molasses)

The history of the Word 'molasses' ('Melasse' in German and Dutch) is not mentioned in Etymological dictionaries since it is quite definitely and clearly derived from the Romanic languages.

The term 'molasses' is applied to the final effluent obtained in the preparation of sugar by repeated crystallization. The amount of molasses obtained and its quality (composition) provide information about the nature of the beets (local conditions of growth and effects of the weather) and the processing in the sugar factory, such as the efficiency of the juice clarification, the method of

crystallization during boiling, and the separation of the sugar crystals from the low-grade massecuite. If the concept molasses is to be strictly defined it is necessary to distinguish between theoretical and practical molasses. The *theoretically final molasses* is a mixture of sugar, nonsugars and water, from which no saccharose crystallizes under any conceivable physical and technically optimum conditions, with no regard to time. If relatively more favourable conditions for crystallization are maintained (low water content, low temperature, long crystallization time, thin layers of the syrup film) the crystallization might be so extended that with intensive centrifugation of the molasses a quotient (Q) of 49 would be attainable. Q represents the percentage of sugar in the total solid content of the molasses. The lower the purity or purity coefficient, the more closely a syrup approaches theoretical molasses. Unusual specimens of molasses, produced in experimental studies, have quotients from 45 to 50. The *practically obtainable molasses* is the end syrup from which, with maintenance of the technical conditions promoting crystallization, no significant additional amounts of saccharose can be recovered by further concentration. In this sense molasses with purity quotients above 64 are no longer true molasses they are crystallisable syrups. The objective of the sugar industry is to produce molasses whose purity is as low as possible. Commercial molasses ordinarily have a quotient around 60, *i.e.* approximately 48 % sugar is present in molasses whose solids content is 80%. (Q denotes purity quotient of molasses; S is sugar content; T represents dry substance.) Efforts to understand and master the conditions leading to exhausted molasses are as old as the sugar industry itself. Since the formation of molasses and the problems of crystallization of sugar are closely related, a clear understanding of the influences of the nonsugar substances on the crystallization of the saccharose from aqueous solutions simplifies the study of the formation of molasses.

The many studies along these lines can be divided fundamentally into two categories.



Fig- Sugar classifier and packing machine used in Sugar plant of Chhattisgarh (India)



Fig- Sugar classifier and packing machine used in China

(i) Mechanical theory of molasses formation

This old theory is based on the decrease in the rate of crystallization which depends on the speed with which the dissolved sugar molecules are transported out of the liquid on to the crystal surface as well as on the rate at which they are built into the crystal lattice.

(ii) Chemical theory of molasses formation

This theory is based on the mutual solubility influences in the system: water sugar, salts or non sugar components. In many studies of the influence of the non sugar components on the solubility of sucrose, pure substances or mixtures of pure substances have been employed, but they did not always correspond to the complicated relationships prevailing in molasses. The use of ion exchangers made it possible to start these investigations directly on molasses. It has been found that nitrogenous materials have practically no effect with respect to the sucrose solubility; potassium and sodium have considerably stronger molasses-producing properties than calcium and lithium. Because of the economic significance of the composition of final molasses there is great permanent interest in the sugar industry in being able to calculate beforehand the amount of molasses that may be expected, *i.e.* at the time of delivery and processing of the beets.

Method of prevention of some issues

1. First of all it is required to make proper standard for differentiating sugars as A, B & C. Apart from size and weight color and structure of sugar must be taken into account. There is also need of developing a system which is semi or fully automatic. There are devices which are used in small scale production, the principle of these devices can be used for modifying the currently used separation and packing system. We can use centrifugation, color inspection and X-ray sensitive device to classify and separate sugar. We also require robotic arms which can pick and drop package automatically.

2. The old burning system should be either given to any private power producing company or it should be modified such that the power produced by it can be used in the ethanol plant or it should be modified such that it can take

both coal and baggas as fuel simultaneously.This will reduce the overall loss of the plant due to modification .

3.Sugarcane crisis occurs due to big difference in FRP & SAP.Centarl government sets the fair price for retailing. But market price is set by state government which is not executed in the actual market due to polittiical interruptions.As a result of which there is nearly no profit to the sugarcane farmers and also to the plant owner.Our sugar can't be exported on other countries since we are producing sugar of higher cost than major sugar producing countries. So there is surplus of around 9 million tonnes.We can only use this sugar for buffer stock. Sugarcane crisis can only be solved by using proper inventory control and demand forecasting. In this way we can avoid surplus production.But it is not sufficient without a proper policy from the side of government.Government can make policy for setting SAP or can interrupt directly in deciding market price of sugar.



Fig- Coal carrier which was used many years ago but is degrading day by day. This shows that we are having waste of resources due to modification in any unit of plant. Government has no plans to make use of such heavy machines properly.



Fig- Coal carrier side view

Conclusion

In the sugar business the board of production network is changing extensively because of the regularly troublesome market climate. Geographic Data System(GPS) and Worldwide situating system(GPS) are utilized broadly in area, site determination, land use arranging, climate science, transportation framework, shipping organizations presently track their tracks through GPS innovation. In vehicle route framework, vehicle area framework, crisis vehicle organization and traffic the board are utilizing GIS and GPS for their worth chain. Notwithstanding this viable correspondence all through the world had conveyed virtual universe of e business, e joining, online business, e promoting, e obtainment. Present day sugar enterprises are needed to receive every one of these actions for improving the proficiency of their store network the executives.

Supply Chain Management is a systematic approach to improve the total productivity of the sugar industries by optimizing the timing, location and quantity of material flow from sugar cane to sugar at consumer's site using IT infrastructure and interacting with all the related intermediates and that is expected approach for implementing TQM philosophy to improve organization. SCM and TQM are the ways to cost optimization one all along the chain while other related to total business, but both starting from customer order to the delivery of goods to him.

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