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# ROLE OF QUALITY CIRCLE IN FOOTWEAR INDUSTRY

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***ABSTRACT:*** ***In modern scenario, each and every industry works for introducing the term Quality in their respective products and services provided by them. According to variability of customer demands and desires, the industry needs to implement positive changes in production and manufacturing operations. Each industry needs to modify their services and products as the customer provisions because a customer friendly industry can grow at a much better rate instead of a profit based or production based industry.***
***Footwear industry is basically a combination of production based and profit based industry. In present era, footwear industry is developing slowly but steadily as they are adopting SQC techniques & tools like 5-S, Quality Circle, Kaizen Approach, Brainstorming, QFD, Ishikawa fishbone diagram, Pareto diagram etc. The Quality Circle Conception is one of the finest techniques for introduction of quality in each & every department of an industry. QCC helps to interrelate each and every department of an industry so that by collective suggestions and ideas from various sources can be used to enhance the quality in respective products and services offered by any industry.***
***For successful enhancement in the quality of any article, a better inspection approach helps more conveniently than any other technique. Some of the inspection approaches used in any industry are alike Sampling Inspection, Acceptance Inspection, 100% Inspection etc.***

## INTRODUCTION

### QUALITY CIRCLE HISTORY

The credit of QC origin goes to nation Japan. As soon as QC development takes place, more than 50 nations accepted it over the Ishikawa strategy. JUSE alone officially recorded more than 200000 QCs. QCC is responsible for origin of the concept TQM. Initially, Dr. Ishikawa supposed QCs dependence on parameters sole to society of nation Japan. But he imagined that QCs helps to do well in any nation that utilised the Chinese alphabet after looking at results of QCs implementation in nations South Korea and Taiwan.

As time passes away, the accomplishment of QCs from place to place in world led Dr. Ishikawa to an innovative decision i.e. QCs are successful as they are familiar to the autonomous nature of civilization. Dr. Ishikawa inscribed “Wherever they are, human beings are human beings” in a 1980

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introduction to the English paraphrase of the Koryo. QC is a participative management system in which workers provide suggestions & enhancements for the betterment of the industry.

## QUALITY CIRCLE CHARACTERISTICS

- QCs are group task.
- QC includes work performers instead of top management.
- QCs are truthfully participative.
- QC is not a procedure but it is a thinking.
- QC is approach from low-to-high management.
- QCs are not supervision focused but administration reinforced.
- QCs are not compelled or essential but voluntary.

QCs include minimum three members and maximum twelve members i.e. it is a small set of persons from all primary departments

## QUALITY CIRCLE STRUCTURE

For the successful implementation of QCs, a fundamental organisational structural framework needs to be built up.

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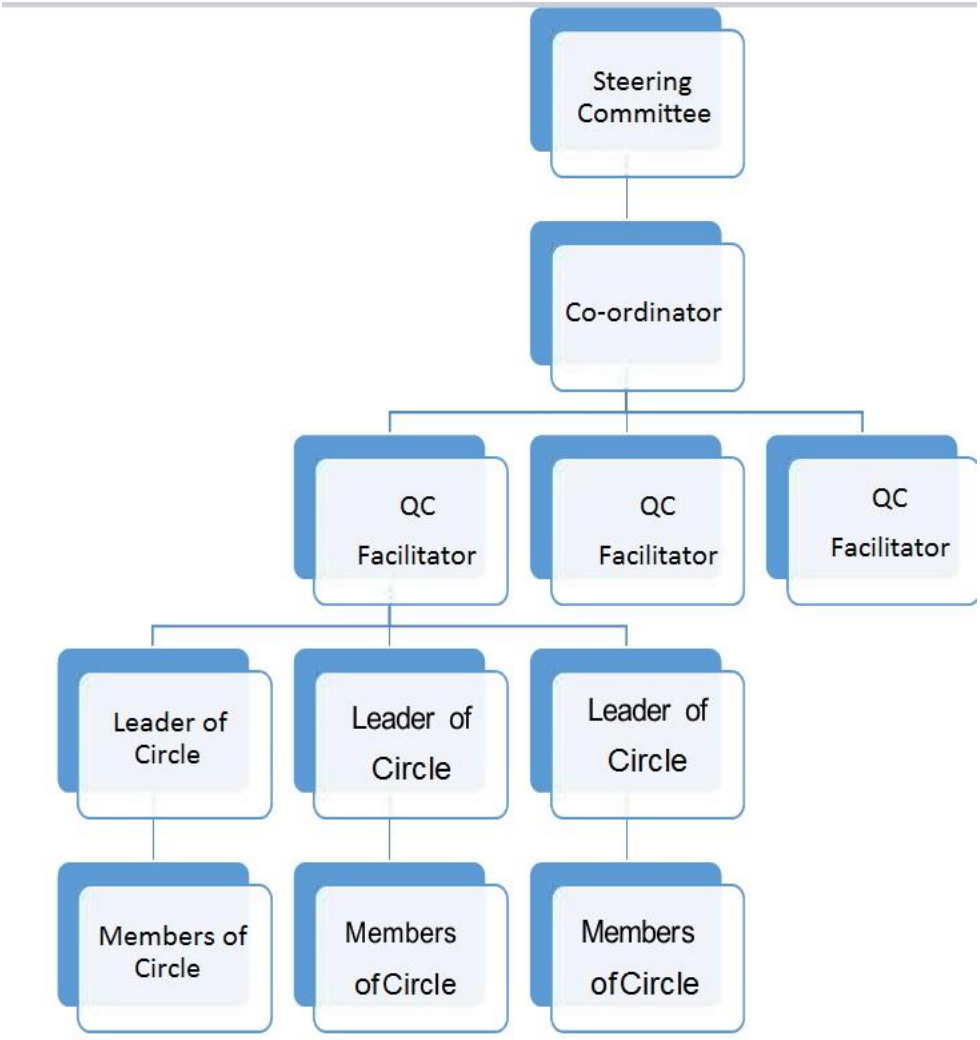


*Figure 3.1: Basic Model of Quality Circle Structure*

The QCs output will be efficient as well as effective if and only if the optimal organisation structure is built. Though the QC structure may fluctuate from organisation to organisation; but the basic model for framework is very much similar as Fig. 3.1 represents.

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The main components of a QC for any type of manufacturing industry includes: -

1) A Steering Committee
2) A Co-ordinator
3) Implementer
4) QC Leader
5) QC Members

**STEERING COMMITTEE / MANAGEMENT ROLE**

- Review progress on regular basis.
- Development of guidelines for performance evaluation of QC activities so that cost effectiveness monitoring becomes easy.
- Most commonly encourage the movement.
- Provide required resources time to time.
- Take into account ideas of QCs fairly & instantly.
- Announcement of official start-up of QC activities.
- Contribute to QCs model & structure advancement.
- Provide essential training to QC leader & members.
- Give opportunities to QC's to provide optimal solution & to implement them.
- Reward the contributions of QC facilitator & members.
- To make arrangement for external specialist help when needed by QCs.
- To convey decisions to QC's commonly in 2 weeks.

**ROLE OF QC MEMBER**

- Contribute to apply solutions.
- Establish communal respect.
- Attend all meetings except when unavoidable.
- Contribute for finding optimal solution to current problem faced by industry.
- Acquire skills & knowledge for problem solving.

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- Complete training practices seriously with a receptive attitude.
- Suggest views, opinions & ideas without any hesitation & voluntarily in problem solving.
- Maintain focus at all times on objectives related to work / industry problems.

**ROLE OF QC LEADER**

- To make periodic meetings & ensure each individual participation.
- Support in data collection in relation with problems.
- Communicate QC suggestions to the QC facilitator.
- Interact among QC members & facilitator beside their own team members.
- Represent solutions / suggestions to management.
- Maintenance of all relevant meetings records.
- Ensure applicability of solution by the team members.
- Keep the information updated to QCs about status of previously submitted suggestions.
- Keep positive attitude in meetings & talk about how to be on track.
- Training QC members in group process & in the utilization of problem solving tools & techniques.

**ROLE OF FACILITATORS**

- Establish co-ordination in the work of several QC's via leaders.
- Serve as a resource to the QC.
- Make arrangements for expertise from external groups/agencies.
- Keep the QCs on track & enthusiastic.
- Acquire skills via training sessions.
- Try to transfer skills to QC's members.
- Effective transmission of proposals/solutions to management.
- Make a way for QC members training.
- Don't hesitate to provide feedback to QC members.

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- Provide feedback to the management.
- Budget Maintenance & keeping cost records.
- Support QCs to provide presentation to management.

**QUALITY CIRCLE PROCEDURE**

The fundamental goal of QC is simply the identification and solution of problem any industry faces during operation of production. QCs are not limited to manufacturing industries only. They are used for all kinds of industries where there is a scope of group based solution of task related problems. QCs are valuable for companies, schools, hospitals, universities, research institutes, banks, government offices, firms etc. i.e. any place where persons are in interaction in problem solving & enhancement of task. The QC members generally meet for one hour once a week. The initial meetings time is devoted basically for QC members training purpose.

The QC members will start execution on given problems after acquiring knowledge about techniques of ultimate problem solving and analysis of quality.

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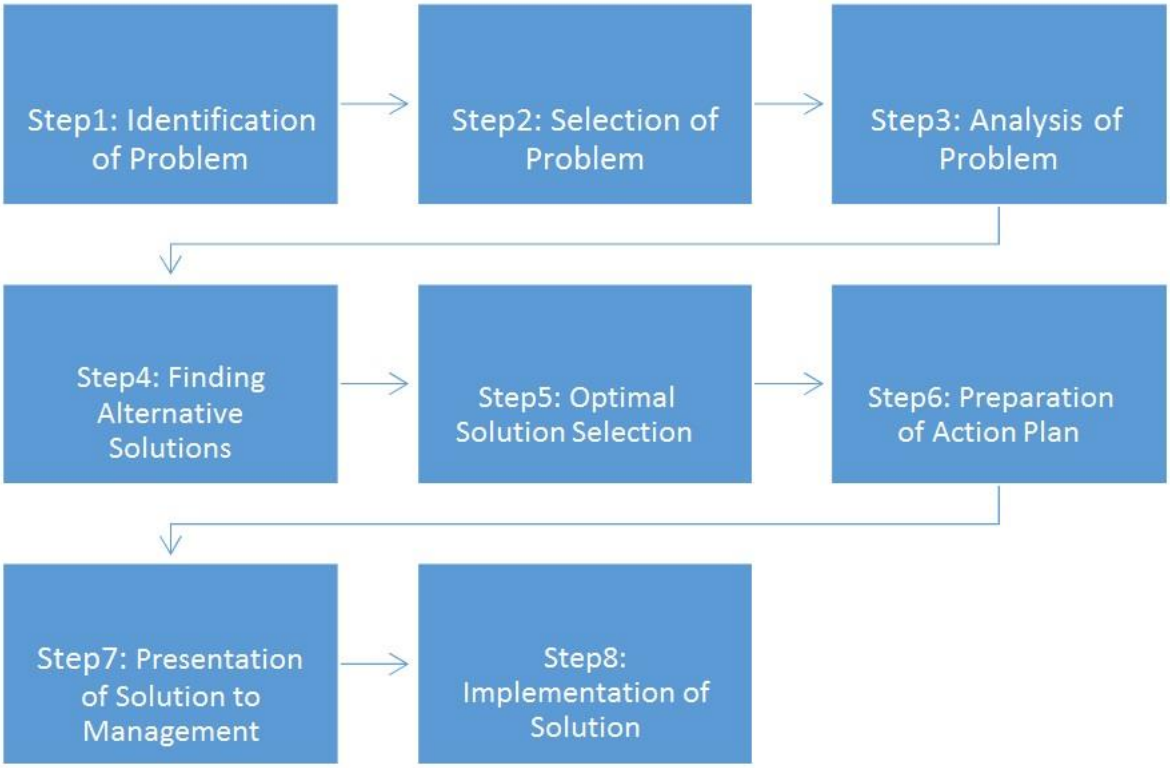


*Figure 3.2: Quality Control Circle Operation Step by Step.*

**OUTCOMES OF QUALITY CIRCLES**

- Controller and Quality Enhancement.
- Work life upgradation.
- Enhancement of entire performance.
- Self-development.
- Communal Progress.

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**BENEFITS OF QUALITY CIRCLES**

Any industry adopting the QC technique as the problem solving technique gets following benefits as output: -

- Endorse best production level along with quality-mindedness.
- Members gets self-development as well as mutual development.
- Generating unity in employees and team spirit.
- Enhanced motivation, pride feeling in respective work along with job satisfaction.
- Effective decrease in absenteeism & turnover of labour.
- Emerging a bond of belongingness for a specific industry.
- Reduction of wastage.
- Economical technique i.e. effective and efficient decrease in cost.
- Inspires staff members for training.
- Motivates staff employees for Leadership purpose so that a best leader can lead the whole team towards industry goals.
- Enhancement in safety work.
- Better identification of job correlated difficulties and optimal solution as output.
- Communication gap between staff members is effectively reduced.
- Optimal utilization of all available human resources potential.
- Moral of industry employees and their consciousness is significantly increased through appreciation of their individual specific activities.

**DE-MERITS OF QUALITY CIRCLE**

- Variations in control & system may become essential.
- After QC successful implementation, a time period of confusion may result because everyone will be doing experiment with new ideas, new skills and new roles.
- At the beginning of QCs, the whole productivity may decrease initially because the employees turn from their daily work to the task of organising themselves & undergoing training.
- A huge amount of money & time is needed for a new concept implementation i.e. essentially new

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& unproven in the industries context.

- The chances of happening mistakes increase at the beginning. Mistakes are inevitable as all staff members adjust to a new idea of doing tasks.
- Due to over-expectation of few members may result in disappointment and drop out because of their initial high excitation.
- QCs may threaten conventional authority structure. Threatened authorities are likely to resist & non-cooperate with the QC activities.
- Some members may feel uncomfortable with QCs as they are dependent on supervisor's instructions & directions for working.

## LITERATURE SURVEY

**Dr. S. Pougajendy et al. (2015)** paper entitled "A Study on Employees Participation in Quality Circle at Wheels India Limited – Padi, Chennai" suggests the different kinds of cooperation's present among the employees of a company. Some of the cooperation's are TQM, Economical, Authority equivalence, Entire curb, Employee or task committee, Collective committee and cabinet, Combined contracting, Work enhancement and growth, Proposal blueprint, QCs, Entitled groups, Partnership Cooperation etc. There are basically three types of managerial agreements such as Financial, Crew and civil. These agreements influence the employees of several firm's formulation and thus the employees need to submit their point of view. The financial agreements are mechanism of manufacturing, mechanization, closure, cut-backs and tie-ups. Similarly, the Crew agreements include task dissemination, hardship adjustment, relocations, betterment, degradation, hiring and electing. The civil agreements are time period of job, Well-being extents, Queries regarding job regulations and plan for each employee's security, fitness, roar restriction and hygiene working space. Cooperation generally means proportioning the opinion procedure capability along with the suggestions from the low level management including worker's, employee's etc. The employee's cooperation is basically the driving force for enhancement of efficient and effective development of any kind of organisation.

**Dr. Ravinder Kumar et al. (2015)** paper entitled *"Quality Circle: A Methodology to Identify Scope of Quality Improvement through Kaizen Approach"* describes the significance of Kaizen Technique in any manufacturing company. Kaizen Concept is now a days become one of the most significant tool for obtaining enhancement in the field of maintenance, quality, production operation etc. in the assumption of manufacturing organisation. Achievement of Kaizen is possible only through better completion done by group members working all together for achievement of Goal of any company. Hence, QC Concept is used which leads the enhancement on right track by application of group job. The present research paper concerns to an observational work of Kaizen Technique based upon the QCC in which huge literature is studied periodically. The results of the work signify that combination of QC concept and Kaizen Technique is an important tool for getting increment in production process, product and its quality in a manufacturing organisation. A case study discussion is present in the given research paper which concludes the witness of increment in quality of product for small scale company by implementation of QCC.

**Dr. Devendra S. Verma et al. (2015)** paper entitled *"Development of Quality Circles in an Organisation (A Case Study in Machine Shop of Tool Room, Indore)"* concerns with various QCs impacts. The present study/paper deals with various aspects of QC & how the productivity is to be enhanced by adopting QC in tool room, machine shop & related industries. The paper describes a case study of development of QC in a machine of tool room, Indore. The paper also presents comprehensive discussions of various features of QCs, improving the productivity, motivation towards work & the problem solving techniques.

**Dr. M. Nasir Zamir Qureshi et al. (2014)** paper entitled *"Escalating Productivity of Work Culture and its Customization through Quality Circles"* describes the vital role of QC in present scenario. In this competitive globalised era the roles of QC act as a management tool to improve the effectiveness of corporate culture. The concept encourages employees & worker's participation as well as motivates & promotes teamwork to contribute towards organizational effectiveness through group processes.

Japanese industry implemented Kaoru Ishikawa ideas for quality production in the 1960's. This helped to transform their products from one considered to be poor in quality to one of high quality. This drastic change has been noted in American & European Industries & attempts to emulate their successful techniques have occurred. One of these techniques is the concept of QCs. Now ever days' Indian economy is opening up & in a due course of time it will be fully globalised. Survival of most of the Indian companies will depend on the use of latest technology & development of human resource. Since Indians are hard-working, ethical, co-operative & the most important thing is that they are innovative. In this paper an attempt is to be made to develop the utility of QCs for achieving economy growth & certain policy measures have also been suggested for improving the QCs.

**Dr. Raj Kumar et al. (2014)** paper entitled *"Quality Circle: An approach to improve productivity and quality in Sugar industry"* concerns about popularity and effective impact of QCs as a productivity and quality enhancement technique. The productivity is a significant factor in sugar industry. QC helps to increase production level as well as product quality. There are a large number of research papers have been discussed regarding the QCC. In the present paper, some key Technical Parameters are considered to enhance the production rate of Sugar Industry by QC Concept implementation. Productivity enhancement is done by significant juice extraction from the Sugar Cane.

**Nida Shireen (2014)** paper entitled *"Quality Circle: A Fundamental Unit of Increase Profitability"* discusses the impacts of taking suggestions from each and every individual employee for solving a problem faced by an industry. QC is a methodology for increase in productive & participative problem solving interaction among the various kinds of personnel of an industry. It comprises of small cluster of personnel from all levels of the existing hierarchical structure within an industry. Many voluntarily are involved in the process of identifying, analysing & formulating solutions to various technical & manual related problems in daily work life. The main feature of QC is that the basic philosophy, preamble, time & budget allocation is expressed by the industry itself & the members of each circle & prepare the target achievement for desired result & resolve the course of work culture.

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The success of establish circle is totally depending on the organization's support & commitment for the formation of QC & essential knowledge about QC activities. QC have been effective tools for linking employees to the process of decision making in their work & growth increase their motivation to work & also increase productivity in any industry. The present study focus on general introduction of quality circle & its impact. It aims to determine the relationship between membership of circle & organization committee.

**Pramod Kumar (2013)** paper entitled *"Quality circle: An effective management tool (Implemented in small scale industries)"* deals with the reduction of cost by some modification in the production operations of small scale industries. The author has focused the importance of QC as a management approach to increase the effectiveness of production processes and also focuses on the enhancement's that can give the minimum rejection rate of the products. In this paper some data is collected by experimenting specially in the wire harness manufacturing industries for automotive vehicles. Here are some modifications by implementing these in the same industries the quality of the products can be increased. By adapting, the production operations can be made more significant and effective.

**Shantanu Kulkarni et al. (2013)** paper entitled *"Quality Circle to Improve Productivity"* explains the various forms of Quality Circle Approach along with how increments can be done by supporting training of QCC in Chemical organisations. The present research paper also discusses an equivalent debate of distinct appearance of QC Approach, Quality Enhancement Class as well as team of Project/Task Class. A case study of a chemical corporation using the concept of QC is well explained in this research paper which is clearly visible for the performance of QC Perception.

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## Footwear Nomenclature

The naming of various components of footwear article of type EVA Floater needs to be done with the knowledge of some common terms used in any footwear industry. The nomenclature of footwear articles is possible only by knowing its various parts.

The common terms used for various parts of a footwear articles in a footwear industry is as follows: -

**(1). EVA: -** An artificial composite organic polymer required for preparation of soles of a footwear article in a footwear industry. EVA delivers softening to the base of foot and it's shaping is effortlessly done using the action of heat and pressure.

**(2). Insole: -** A generally softened component of the footwear article on which the foot completely rests on inside a footwear article.

**(3). Outsole: -** The bottom most part of the foot shoe of a footwear article that comes in direct contact with the ground surface.

**(4). Vamp/Upper: -** The forward-facing of a footwear shoe's upper central visible portion.

**(5). Throat: -** The key opening of a footwear shoe spreading from the vamp to the ankle.

**(6). Top line: -** The opening in the upper portion of a footwear shoe which is used as entrance gate for the foot to enter into the shoe. A special type of adhesive layered fabric tape is most often used to strengthen the top line between the upper portion and top most edge of a footwear shoe.

**(7). Midsole: -** The layer that lies between the outsole and the insole for shock absorption, is the midsole.

**(8). Heel: -** The rear portion at the bottommost of a footwear article is the heel. It cares the heels of the feet. Heels of a footwear article are often finished from the same material as the sole of the footwear article.

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*Figure 1.1 EVA Flotter's*

**(9). Sole:** The exterior bottommost part of a shoe is the sole.

**(10). Last:** A metal, wood or plastic form utilized to generate the profile of a footwear article.

## RAW MATERIAL FOR EVA FLOTTER

The raw material used for the Footwear Industry include a variety of Chemical's for the manufacturing of footwear articles. The footwear article selected for dissertation work is EVA Flotter manufactured by RFL, Plant No.6 situated at Bahadurgarh, Haryana. EVA Flotters are manufactured by a number of Indian Footwear Industries but none of them can compete with RFL products.

The different combinations in different proportion are selected for different footwear articles. Some of the Chemical names & their physical appearance is listed in table below: -

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*Table No. 1.1: - Different Chemicals for Raw Material*

| Serial Number | Chemical Name | Physical Appearance |
|---|---|---|
| 1.) | Zinc Stearate | White Powder |
| 2.) | Stearic Acid | Light Brown |
| 3.) | ADC 5A06 | Orange Powder |
| 4.) | ADC-A14D | Orange Powder |
| 5.) | Di Cumyl Peroxide | White Sugar Form |
| 6.) | Finamold MR | Cream Crystal |
| 7.) | Plastaid-943 | Reddish White Powder |
| 8.) | Titanium Dioxide | White Powder |
| 9.) | PEG-4000 | White Flake Form |
| 10.) | Zinc Oxide (Active) | Yellow Powder |
| 11.) | Calcium Carbonate | Super White Powder |
| 12.) | Talcum Powder | Super White Powder |
| 13.) | EVE (21 – 28 %) | Transparent White Beads |
| 14.) | LDPE 1020FA20 | Transparent White Beads |
| 15.) | Engage | Transparent White Beads |
| 16.) | P.E Wax | Cream Crystal Form |
| 17.) | EVA (18%) | Transparent White Beads |
| 18.) | Sodium Carbonate | White Powder |
| 19.) | Thinner | Colourless Liquid |
| 20.) | Silicon Emulsion | Viscous Milky White |
| 21.) | DOP | Oily Liquid Form |
| 22.) | Carbon Black | Fine Black Powder |

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| | | |
|---|---|---|
| 23.) | Nitrile Rubber | Brown Yellow in Pale Form |
| 24.) | HSD (Diesel) | Light Liquid Form |
| 25.) | Organic Colour | Fine Colour Powder |
| 26.) | DOA | Oily liquid Form |
| 27.) | EVA Coupling | Creamish Yellow |
| 28.) | Finalux G-101 | Liquid Form |
| 29.) | AC Polythenewax 400 | White Granular Form |
| 30.) | A-C 6A | White Powder |
| 31.) | EVAMOLL | Liquid Form |
| 32.) | PVC Resin | White Powder |
| 33.) | Stab. MTS-120 | Liquid Form |
| 34.) | LDPE | White Granular Form |
| 35.) | Micro Crystalline Wax | Cream Hard Crystal |
| 36.) | Stab.4610 | White Powder Form |
| 37.) | U.V Tex (OB-2) | Light Yellow Powder |

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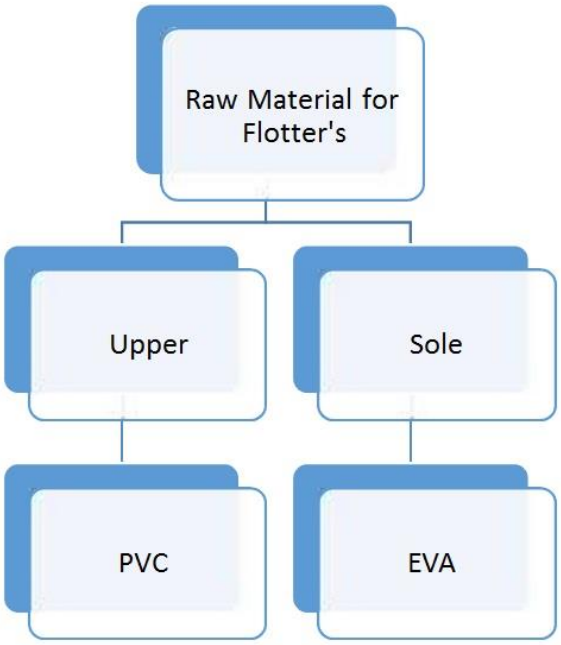


*Figure 1.2 Raw Materials for EVA Flotter's*

Figure 1.2 depicts that EVA Flotter's are made up in two distinct portions such as upper portion and sole portion. The upper portion is made up of PVC raw material while the sole portion is made up of EVA raw material.

**MANUFACTURING PROCESS OF FOOTWEAR ARTICLE**

Every footwear industry has mostly 4 departments in which a broad-minded path is tracked for producing finished footwear articles. These are: -

- ✓ Clicking or Cutting Department
- ✓ Closing or Machining Department
- ✓ Lasting & Making Department
- ✓ Finishing Department & the Store Room

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**Clicking or Cutting Department**

In this department, the topmost portion of the footwear article or the "upper" is completed. The clicking operator is given membranes of leather, typically cow leather but not limited to this kind of leather. By means of metal band knives, the employees cut out fragments of several profiles that will yield the arrangement of "uppers". This process desires a high level of ability as the luxurious leather has to be wasted at the minimum level probable. Leather might also have several imperfections on the surface such as pointed wire scrapes which wants to be sidestepped, so that they are not utilized for the uppers.

**Closing or Machining Department**

In this department, the component fragments are sewn collected by extremely skilled machinists so as to yield the completed upper. The work is separated in phases. In early phase, the fragments are sewn collected on the flat machine. While in the later phase, when the upper is no elongated flat and has become three-dimensional (3-D), the machine called post machine is utilized. The sewing surface of the machine is raised on a pole to permit the operative to sew the 3-D upper. Numerous edge actions are also finished onto the leather for generous of a good-look to the completed upper. At this phase only, the orifices are also introduced in order to put up the shoelaces in the finished footwear article.

**Lasting & Making Department**

The finalized uppers are moulded into a profile of foot through the help of a "Last". Last is a malleable shape that pretends the foot profile. It is later detached from the completed footwear article to be utilized additional in making extra footwear articles. Primarily, an insole to the bottommost of the last is devoted. It is only a provisional accessory. Sometimes, regularly when welted footwear articles are mass-produced, the insole has a spoke devoted to its underneath edge. The upper is overextended & moulded over the last and devoted to the insole rib. Later the process completes, a "lasted footwear article" is attained. Now, the welt- a band of leather or plastic- is sewn against the footwear article over the rib. The upper & all the extra material is trimmed off the joint. The sole is then involved to the welt & both are tacked collected. The heel is then devoted which completes the "production" of the footwear article.

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This completes the process for heeled footwear articles. When a flat footwear article is in the creation, there are significantly rarer operations. The insoles in such situation is flat & when the uppers are 'lasted', they are pasted down to the surface of the innermost side of the insole. The portion of the upper, that is pasted down, is then roughed by a wire brush to take off the smooth texture finish of the leather. This is done since rough surface grips adhesive to give a robust bond.

The soles are frequently cut, completed & prepared as a distinct constituent so that when they are pasted to the lasted upper, the result is a complete & finished footwear article. Soles can also be pre-moulded as a discrete section out of several synthetic materials & again pasted to the lasted upper to complete the footwear article

**Finishing Department & the Store Room**

The finishing of a footwear article depends on the material used for production of it. If finished of leather, the sole edge & heel are trimmed & buffed to provide a smooth finish. To provide them a good-looking finish & to confirm that the edge is water-resistant, they are stained, shined and polished. The bottommost of the sole is regularly casually buffed, stained & polished and dissimilar kinds of designs are patented on the surface to provide it a craft completed look. Thus, finally a "finished footwear article" has now been finished.

For store room action, a core sock is fitted into footwear article which can be of any length - full, half or quarter. They generally have the producer's particulars or a brand tag whichever applicable. Depending on the resources of materials utilized for the uppers, they are then cleaned, polished & sprayed. Laces & somewhat tags that might have to be devoted to the footwear article, such as footwear article care directions, are also involved. The footwear articles, at latter, get wrapped in cartons.

**Production Process of EVA Flotter's**

Compounding Section: - EVA is prepared separately from specific chemicals addition in constant proportion of its monomer units. PVC is also prepared from its corresponding materials in proper proportion from its monomer units. The compounding section gives input of EVA section and PVC

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section. Both the EVA & PVC are in granular form initially. Both the upper production and sole production moves in parallel direction.

PVC Section: - Sometimes it is also called as PVC compound as it relates all machines and operations for upper part production. The PVC raw material is subjected to PVC injection M/c. PVC is a multipurpose thermoplastic material that is utilized in the production of thousands of upper portions for footwear products. Injection Moulding is an important process to manufacture PVC Moulded Articles - a manufacturing process that injects PVC resin into a metal mould by pressure. This process is best suited for production of three- dimensional structures i.e. Construction Fittings.

The trimming operation is the shearing of excess material from the headed configuration of complex shapes so as to obtain the final design and specifications. It is done to remove the extra material from the upper portion of footwear article that is being made by PVC injection M/c.

**EVA Section: -**

The material from combining section is provided firstly to the Kneader M/c of EVA compound. A kneader reactor (or kneading reactor) is a machine that makes a specialty of mix and kneading substances, significantly those with high viscosity. The kneading reactor is a horizontal mixing machine with 2 sigmas or Z-type blades

These blades are driven by separate gears at completely different speeds, one running 1.5 times quicker than the other. The reactor has one powerful motor and a speed reducer to drive the 2 blades. The kneader reactor sometimes has a W-type barrel with a hydraulic tilt that turns it and a heating jacket outside.

After this, the provision of kneader output is connected to Extruder M/c as its input. The extruder will turn solid plastic into a consistent soften through the heating, pressure, and shear then the melt is conveyed to the next process. The soften includes mix master-batch and alternative additives, blending resin, and so smash in the production process. The finished soften should be homogeneous on the concentration and temperature. The pressure should be giant enough to viscous compound extrusion.

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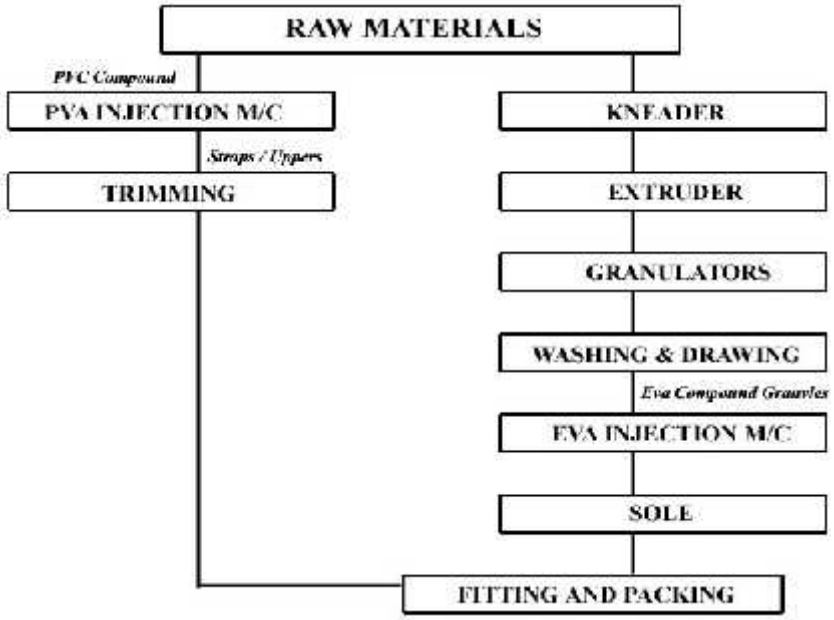


*Figure 1.9 EVA Flotter Production Process*

After completion of extruder machine, its output is equipped to Granulator as input. A plastic granulator is a machine used for size reduction, a necessary step in plastic utilization. Plastic granulators have the ability to quickly break down plastic products like plastic bottles, crates, drums, and films into small, uniform pieces referred to as "regrinds" or "flakes". In some cases, this perhaps the only step needed before it is reused in manufacturing new plastic products.
For the most half, however, utilization of plastic scrap needs much more resources in sorting and separation, size reduction, washing, and pelletizing.

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*Figure 1.10: Granulators*

In a plastic granulator, cutting knives are mounted on an open rotor spun to high speeds by an electric motor. This rotor is cased during a cutting chamber wherever stationary knives are mounted. As the plastic scrap enters this cutting chamber, the rotating knives come into contact with the stationary knives cutting the plastic into little pieces. A large screen with many holes is placed at the bottom. The plastic will continue to mix and be cut by the knives until it is small enough to fall through this screen. Hence, by adjusting the size of the holes, one can control the size of the cut shreds. After completion of granulator, washing and drawing operations are performed if necessary.

Single color EVA foam injection moulding machine is provided with 2 full-automatically efficient injectors, high-performance mould clamping system and computer system. Exploitation EVA as raw material, the injection moulding machine will manufacture soles and various kinds of EVA foaming products.

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**EVA Injection M/c features**

**1. Injection System**

With a potentiometer, it will calculate material quantity accurately in PLC and computer systems. Single color EVA foam injection molding machine applies linear rails and the motor drive which realizes immediate braking function to promise rapid movement of infectors. The location machine will measure the correct location with rotary encoder.

**2. Mould Closing System**

One color EVA injection moulding machine works rapidly in mould-opening and mould- closing procedures and its mould closing system is assured to proceed in an exceedingly tight unit. it's designed in low operation height to provide further height for mould opening, making it versatile to use totally different moulds.

**3. Controlling System**

Single color EVA foam injection molding machine applies human-computer interaction interface and bit screen on basis of windows operation system. It realizes period controlling in material rotate speed, injection amount, infection time, injection temperature, sulfuring time and productivity. In PLC and computer controlling system, the machine is functionally clear and operationally easy.

**4. Oil hydraulic system**

This machine applies proportional control valve to regulate oil pressure and flow.

**5. Others**

According to ergonomics, single color EVA foam injection molding machine is designed in low operation height. aside from this, mould thickness adjusting is stepless to accommodate moulds in thickness of 100-260 millimeter. It uses a singular way to produce rubber material or EVA material.

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*Figure 1.11: EVA Injection M/c*

Now Sole is ready in EVA section while upper is ready in PVC section. So both upper and sole are supplied to Fitting & Packaging Section. The Sequence of operations performed on a production line are as follows: -

- ✓ Stud Fitting
- ✓ Round Trimming
- ✓ Window Trimming
- ✓ Logo Pasting
- ✓ Rubber Burr Cleaning
- ✓ Applicator Application (Solvent)
- ✓ Runner Cutting
- ✓ Final Quality Check
- ✓ MRP Pad Printing
- ✓ Tag Fitting
- ✓ Polybag Fitting
- ✓ Inner Box Packing
- ✓ MRP Label Pasting
- ✓ Dispatch to Outer Area

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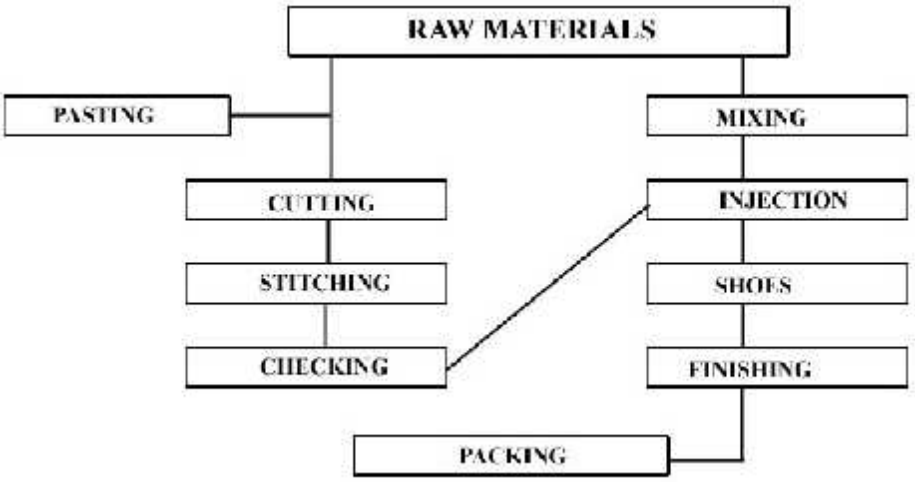


*Figure 1.12: Different Operations performed in Footwear Industry*

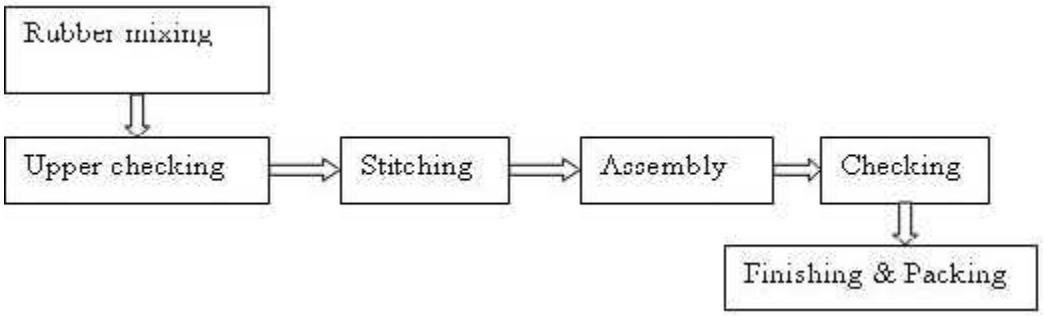


*Figure 1.13: Flow Chart for Manufacturing footwear articles.*

**Two Sample t test**

2-Sample t determines a confidence interval & does a hypothesis test of the difference between two population means when SD's are unknown & samples are drawn independently from each other. This method is based on the t-distribution, and for small samples it works best if the data were drawn from

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distributions that are normal or close too normal. To perform a 2-sample t-test, the two populations must be independent; in other words, the observations from the first sample must not have any bearing on the observations from the second sample. The 2-sample t-test also works well when the assumption of normality is violated, but only if the underlying distribution is not highly skewed. With non-normal and highly skewed distributions, it might be more appropriate to use a nonparametric test. Use this analysis to find if the means of two independent groups differ & secondly to find a range of values that is likely to include the difference between the population means.

For 2-Sample t, the hypotheses are:

Null hypothesis

| | |
|---|---|
| $H_0: \mu_1 - \mu_2 = \delta_0$ | The difference between the population means ($\mu_1 - \mu_2$) equals the hypothesized difference ($\delta_0$). |

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**Alternative hypothesis**

Select one:

| | |
|---|---|
| H1: $\mu 1 - \mu 2 \neq \delta 0$ | The difference between the population means ($\mu 1 - \mu 2$) does not equal the hypothesized difference ($\delta 0$). |
| H1: $\mu 1 - \mu 2 > \delta 0$ | The difference between the population means ($\mu 1 - \mu 2$) is greater than the hypothesized difference ($\delta 0$). |
| H1: $\mu 1 - \mu 2 < \delta 0$ | The difference between the population means ($\mu 1 - \mu 2$) is less than the hypothesized difference ($\delta 0$). |

MINITAB 2017 Work: - Descriptive Statistics: Initial Imperfections, Final Imperfections

| Variable | N | Mean | SE Mean | StDev |
|---|---|---|---|---|
| Initial Imperfections | 15 | 1605 | 124 | 480 |
| Final Imperfections | 11 | 1429 | 121 | 402 |

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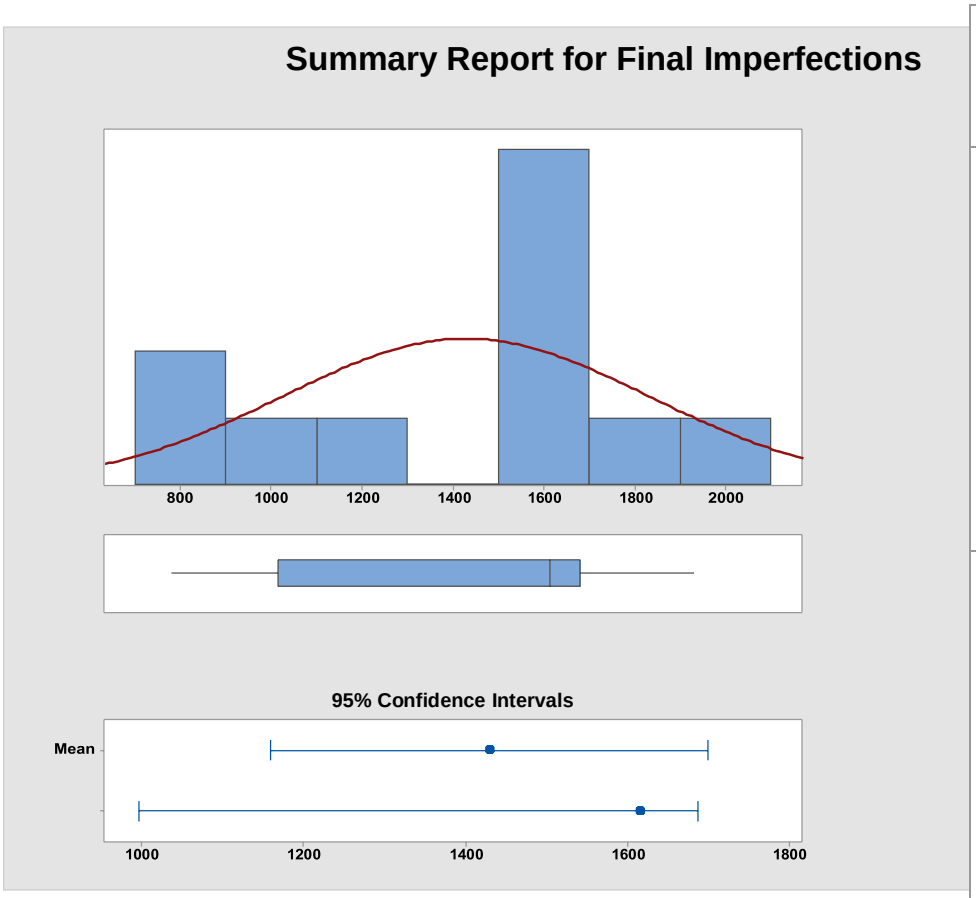


| | |
|---|---|
| **Anderson-Darling Normality Test A-Squared** | **0.75** |
| **P-Value** | **0.035** |
| **Mean** | **1428.5** |
| **StDev** | **402.1** |
| **Variance** | **161693.7** |
| **Skewness** | **-0.728792** |
| **Kurtosis** | **-0.985551** |
| **N** | **11** |
| **Minimum** | **780.0** |
| **1st Quartile** | **1014.0** |
| **Median** | **1614.0** |
| **3rd Quartile** | **1680.0** |
| **Maximum** | **1932.0** |
| **95% Confidence Interval for Mean** | **1158.4 1698.7** |
| **95% Confidence Interval for Median** | **996.2 1686.9** |
| **95% Confidence Interval for StDev** | **281.0 705.7** |

*Figure 5.10: Basic Statistics of Final Data*

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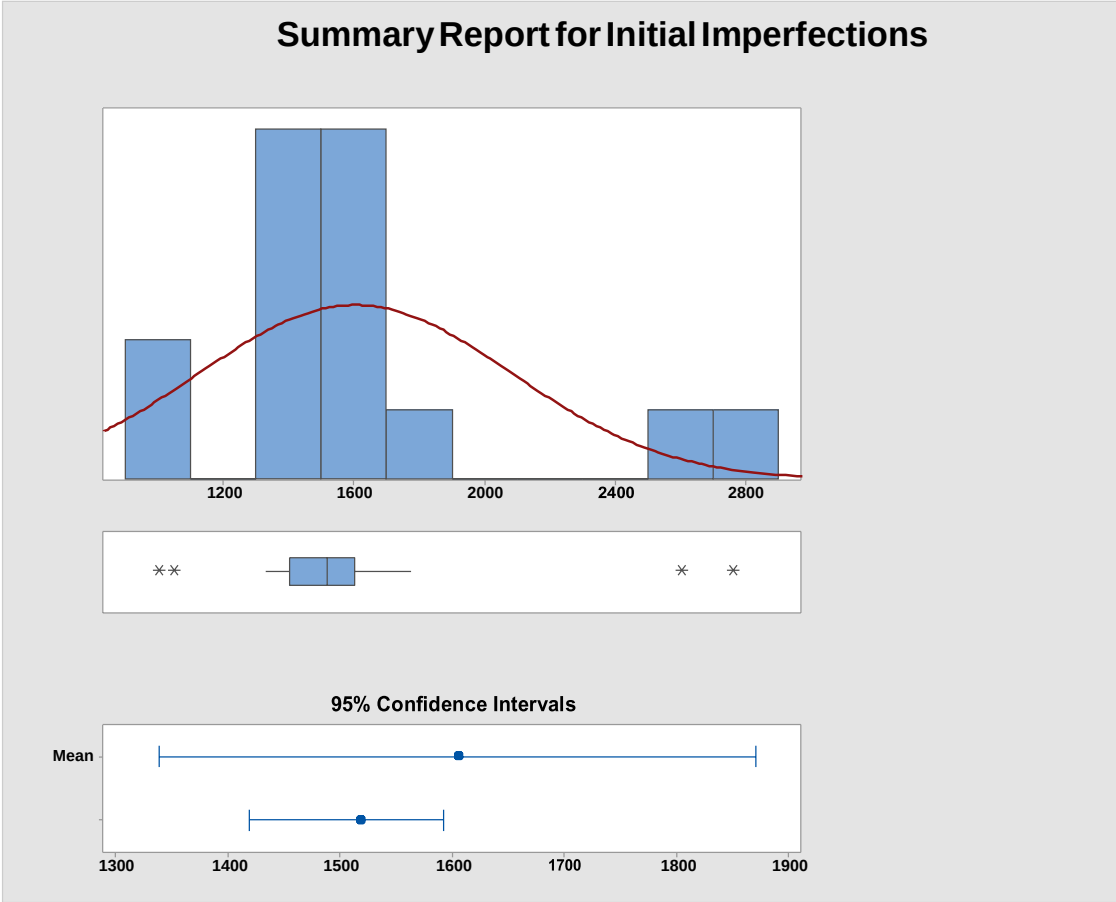


| | |
|---|---|
| Anderson-Darling Normality Test A-Squared | 1.42 |
| P-Value | <0.005 |
| Mean | 1605.2 |
| StDev | 480.5 |
| Variance | 230862.2 |
| Skewness | 1.56821 |
| Kurtosis | 2.43841 |
| N | 15 |
| Minimum | 1002.0 |
| 1st Quartile | 1404.0 |
| Median | 1518.0 |
| 3rd Quartile | 1602.0 |
| Maximum | 2760.0 |
| 95% Confidence Interval for Mean | 1339.1 1871.3 |
| 95% Confidence Interval for Median | 1419.7 1593.0 |
| 95% Confidence Interval for StDev | 351.8 757.8 |

*Figure 5.11: Basic Statistics of Initial Data*

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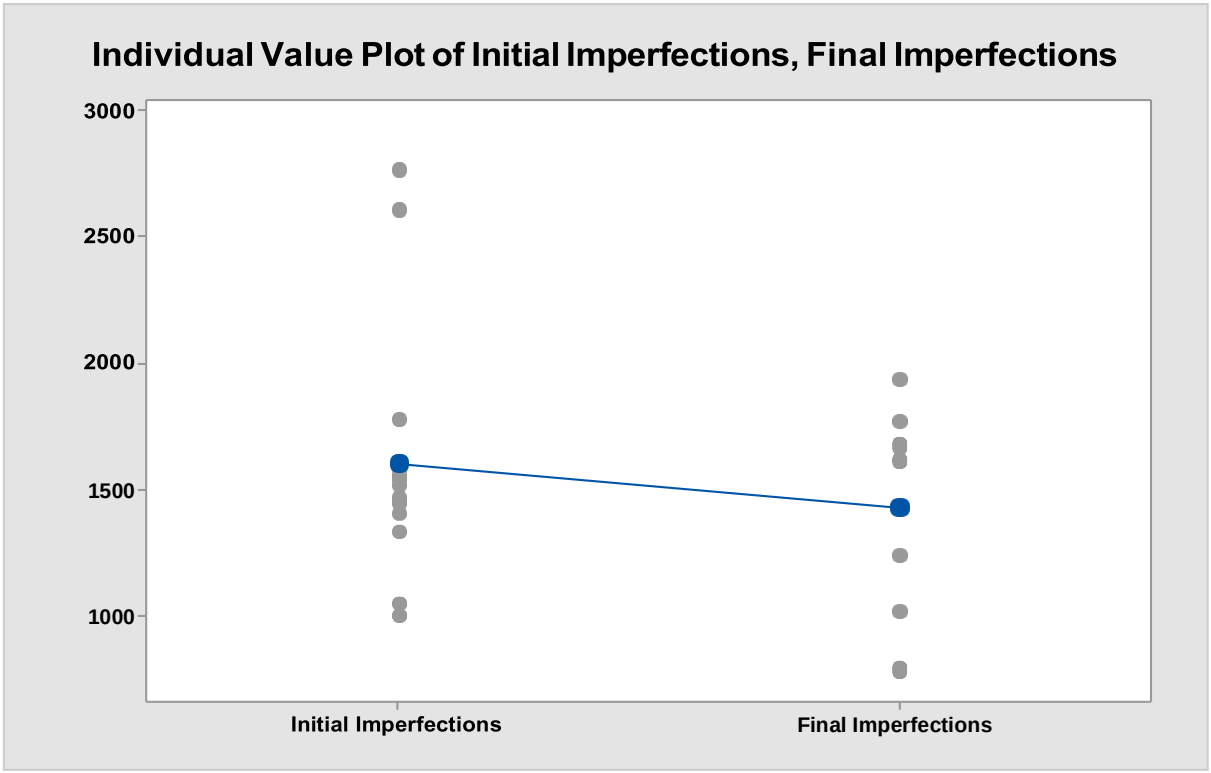


*Figure 5.12: Representation of decrease in footwear articles imperfections*

The present research case study for a Footwear Industry is designated for advancement of Quality in footwear articles by classifying the kinds of imperfections arises during manufacturing process. The imperfections in footwear articles are basically classified into two types B and C respectively. The footwear articles with classification of type B suffers from the minor imperfections also

known as Non-Critical imperfections. At last, type C footwear articles undergoes the Critical imperfections or sometimes called as Major imperfections during the manufacturing process. All the footwear articles under the category of type C imperfection must be recycled to introduce more content of quality so that the footwear articles will be more and more customer friendly. By the enhancement of quality in footwear articles through the introduction of concept 100 % inspection in Production department, the footwear industry will earn more profit by improving the number of footwear articles sold.

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