# REDUCING NUMBER OF MISSING STITCHES DEFECT IN ROOTING PROCESS AREA AT TOY MANUFACTURING COMPANY, CIKARANG

**By**
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**A Thesis presented to the Faculty of Engineering President University in partial fulfillment of the requirements of Bachelor Degree in Engineering Major in Industrial Engineering**

**2017**

# THESIS ADVISOR
# RECOMMENDATION LETTER

This thesis entitled "**REDUCING NUMBER OF MISSING STITCHES DEFECT IN ROOTING PROCESS AREA AT TOY MANUFACTURING COMPANY, CIKARANG"** prepared and submitted by **Lestari My Oktaviani Ginting** in partial fulfillment of the requirements for the degree of Bachelor Degree in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a thesis fit to be examined. I therefore recommend this thesis for Oral Defense.

**Cikarang, Indonesia, January 25th , 2017**

**Anastasia L. Maukar, ST,. MSc., M.MT**

# DECLARATION OF ORIGINALITY

I declare that this thesis "**REDUCING NUMBER OF MISSING STITCHES DEFECT IN ROOTING PROCESS AREA AT TOY MANUFACTURING COMPANY, CIKARANG"** is, to the best of my knowledge and belief, an original piece of work that has not been submitted, either in whole or in part, to another university to obtain a degree.

**Cikarang, Indonesia, January 25th, 2017**

**Lestari My Oktaviani Ginting**

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# ABSTRACT

PT. X is the biggest toy producer in the world wide. In order to produce a toy, PT. X has two main departments which are Industrial Engineering (IE) Primary and Secondary. IE secondary is dealing with creating tha main body of the toy while IE Secondary is dealing with creating the final look along with packaging of the toy. One of main process at IE secondary area is rooting process. Rooting process is a process to attach hair yarn to toy head. Neverthless, a major defect occur during the process since 2006 that is missing stitches. This issue cause PT. X loss IDR 105,782,933/Month and extra additional 11 days for rework during production time. Thus, 100% inspection, standarization, regular inspection and operator's training are applied to overcome this issue through trial and experiments. As the result, PT. X is able to save IDR 8,922,933/month and no additional time needed for production process.

**Keywords:** *Toy Head, IE Secondary, Rooting Process, Hair Yarn, Missing Stitches, 100% Inspection, Standardization, Regular Inspection, Training.*

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF TERMINOLOGIES

| | | |
|---|---|---|
| 100% Inspection | : | A process which requires the inspection of each individual unit or output of a process. |
| ANOVA | : | Analysis of Variance, a statistical method in which the variation in a set of observations is divided into distinct components. |
| Defect | : | A physical problem that causes something to be less valuable, effective and healthy. |
| FAR Machine | : | Full Auto Rooting machine that was made and own by PT. X since 2006 and used for rooting process. |
| Fisher Comparison Test | : | A statistical test used to determine if there are nonrandom associations between two categorical variables. |
| Grooming | : | A process to create a hair style towards rooted head. |
| Hair Yarn | : | Raw material of toy head that used by PT. X for rooting and grooming process |
| Missing Stitches | : | Defect that occur in auto rooting process area at PT. X where the hair yarn does not attach perfectly on toy head, so that its easily pulled out |
| Pack Out | : | Term of production line in order to produce one complete toy that used raw material that have been produced separately in different department. |
| Packaging | : | A cover of toy head that aims to cover the toy head along with attached accesories. |
| Painted Head | : | Toy head which already given color on upper surface which has the same color with hair yarn. |
| Preventive Maintenance | : | Systematic inspection, detection, correction, and prevention of incipient failures, before they become actual or major failures. |

| | | |
|---|---|---|
| Weekending | : | A term that used by PT. X to represent the fifth day of the week by using date. |
| Rework | : | Correcting of defective, failed, or non conforming item during or after inspection. |
| Rooting | : | One of process at PT. X to attach hair yarn to toy head by using machine and auto machine. |
| Rotocast | : | A primary process of producing toy which proceed under Industrial Engineering (IE) primary and produce toy head by using machine. |
| Sampling Inspection | : | A statistical sampling that used to determine whether to accep or reject a production material in only few number out of total production |
| Sculpt | | A mother master of toy head shape that used at PT. X that will produce to be a lot of variants of toy head. |
| Scrap | : | A reject product that no longer can be used caused by major defect on the output. |
| SOP | : | Written procedure prescribed for repetitive use as a practice, in accordane with agreed upon specification aimed at obtaining a desired outcome. |

# CHAPTER I
# INTRODUCTION

## 1.1 Problem Background

PT. X is a multinational company that engages in creative industry which produces toys for kids. As the biggest producer in the worldwide, PT. X produces a lot of variants of toys. In order to produce toys, there are two main manufacturing departments called as IE (Industrial Engineering) primary and IE (Industrial Engineering) Secondary. IE Primary deals with creating the main body that consists of head, leg, main body, and feet. Meanwhile, IE secondary deals with rooting process which is adding hair yarn to the head of toys, grooming process which is creating hair style for toys, and packaging. Rooting and grooming process have used the head of the toy as the raw material that come from preceding department, which is IE primary.

In rooting process area, painted head and hair yarn are used as raw material. There are two main types of hair yarn, curly and straight with a lot of variants color and size. The using selection of hair yarn depends on the variety of the toy, which is given by Research and Development (R&D) department.

Currently, there are two methods that used to rooting head. They are manual rooting and auto rooting. Manual rooting is a method to rooting head by using the traditional machine and being operated by one operator for one machine. The second method which is auto rooting is a rooting process using an auto machine that only owned by PT. X. Currently, in auto rooting area one operator handle three machines since the operator are effortless rather than operator in manual rooting. There are 229 number of machines in PT. X.

Unfortunately, there is a major defect problem occurred in auto rooting process area yet until today management still has not found the right method to overcome. This problem is known as missing stitches. Missing stitch is a condition where hair yarn does not attach perfectly to painted head, so it easily removes from painted head. The percentage of the missing stitches defect is 96% of total production. The highest caused of missing stitches is the refraction of painted head does not spread evenly with the percentage of 56%. Currently, management takes two actions to overcome this issue which is doing rework or scrap toward all of those defects. Both of the action take time before the rooted head delivers to the next step. Other than that, if management decides to do rework, then an additional number of the operator should be paid to do this activity by using manual rooting machine, otherwise, if management decides to scrap the defects than the material will be wasted and meaningless. Management has to loss IDR 80,782,933 for rework and scrap within 11 days to do rework towards 40 toys.

In order to complete this action, there is eight number of the operator who are assigned to do a rework of missing stitches from auto rooting area, which means there is also eight number of manual rooting machine that is currently used to support the operators finish their job. Nevertheless, PT. X has not been defined any solution and method to help to reduce the number of a defect in auto rooting area, otherwise PT. X still maintain to do rework and scrap towards all of those defect.

In accordance with the issue that has been elaborate, this research will be focused on how to reduce the number of defect of missing stitches in the auto rooting process area. An improvement is expected able to reduce the number of defects which also as the way to reduce the amount of cost and eliminate rework time.

### 1.2 Problem Statement

The problem background which has issued on previous section leads into the following statement:

- How does the company reduce the number of missing stitches defect in auto rooting process area?

### 1.3 Problem Objective

This research is aimed at following statements below:

- To reduce the number of missing stitches defect in auto rooting process area

### 1.4 Scope

There are some scopes in this research due to the limitation of resources:

- The data were taken from September-October 2016
- The proposed system is only applicable in auto rooting process area

### 1.5 Assumption

There are several assumptions have to be made in order to support this analysis from the beginning until it is done:

- Production Run Rate for every toy is the same
- Operator's salary is IDR 5,000,000/month
- All rotocast machines are identic
- Rotocast machine capacity is the same
- Percentage of scrap is constant during September to November 2016

### 1.6 Research Outline

The structure of the research and its brief description is written as follows:

**Chapter I** **Introduction**

This chapter act as general illustration of the whole research which contains the background of the problem, problem statement, objectives of the research the scope and assumption of the study and the outline of this research

**Chapter II** **Literature Study**

This chapter consists of the previous study that related to the method adopted for the research which are quality tools, 100% inspection and statistical tools which is ANOVA and Fisher comparison pairwise test.

**Chapter III** **Research Methodology**

This chapter provides step by step conducted the research, which is doing initial observation then identify the problem, creating literature study, collect data needed and analyze the data and problem, and the last step is making a conclusion and recommendation for future research.

**Chapter IV** **Data Collection and Analysis**

This chapter consists of the data taken as well as the analysis of the data itself using the method adopted to solve the issues mentioned. An appropriate solution of the problem at PT. X is acquired from this chapter.

**Chapter V** **Conclusion and Recommendation**

This chapter contains the outcome of the research concluded and recommendations for future research.

# CHAPTER II

# LITERATURE STUDY

## 2.1 Fundamental of Quality

In 1983, Feigenbaum labeled a phase where production of goods and services was confined predominantly to a single person or a small group during the middle ages and up to the nineteenth century. Feigenbaum labeled this phase by Operator Quality Control Period. Since then, the development of quality has been growth significantly untill today. The growth of quality control is not only concern on the system, but also the software that simplify the user in accordance to analyze the system. Many engineers were involving themselves to develop quality on different aspects (Mitra, 2008)

A professor from Faculty of Science at the Universitat of Waterloo, Waterloo, Ontario Canada, David M. Dilts defined quality into five scopes, which are:

1. Customer based, which according to C.D Edwards, Quality consists of the capacity to satisfy want.
2. Manufacturing based, which H.L Gillmore state in his book Quality as the degree to which a specific product conforms to a design or specification.
3. Product based, that according to K.B. Leifler, Quality refers to the amount of the unprocess attributes contained in each unit of the priced attribute.
4. Value based, that was defined by R. A Broh that is Qualty is the degree of excellence at an acceptable price and the control of variability at an acceptable cost.
5. Transcendent, that mentioned by R.M Pirsig as Quality is netiher mind nor matter, but a third entity independent of the two, even though Quality cannot be defined, you know what it is.

Many other authors defined quality in various way that based on their field. In manufacturing and service sector, the main parties that defined the level of the quality that should be met is customer. So, the quality tools of an industries should be flexible based on customer changes, yet it always meet the satisfied point of the customer.

Quality has eight dimension that defined as a framework for thinking about the basic elements of product quality (Garvin, 1984). Those eight dimension area:

1. Performance

   Is a key indicator which refers to the primary operating characteristics of a product. Every industry sector has different standard performance which depends on output product. The connection between quality and performance is ambigous yet it is affected by semantics.

2. Features

   Features is a secondary characteristic that support the basic function of product. Just like performance, features involve objective and measurable attributes that the connection towards quality is affected by individual preference.

3. Reliability

   Reliabilty concern on measuring the probability of a products's failing within a specified period of time. The most common measures tools of reliabilty are Mean Time to First Failure (MTFF), Mean Time Between Failure (MTBF) and the failure rate per unit.

4. Conformance

   Conformance is a related dimension of quality which is the degree to which a products's design and operating characteristics match pre established standards. Internal and externals elements are involved in this dimension. Conformance is usually measure by the incidence of defect which is the proportion of all units that fail to meet standard requirement, so it needs rework or repair.

5. Durability

   Durability is a quality dimension that has both economic and technical dimension. Technical durability can be defined as the amount of use one gets from a products before it physically worsen. Durability becomes more complicated when repair is possible. Through this things, economis environment may simply have changed.

6. Serviceability

   Serviceability is the speed, courtesy and competence of repair which the object is the customer. Some variable of servicability measured objectively, while others is reflecting differing personal standards of what constitudes accepatable service.

7. Aesthetics

   Aesthetics is a subjective evaluation of quality dimension. Aesthtics is measured through how the products look, feel, sounds, tastes or smells which is clearly matter of personal judgment.

8. Perceived Quality

   Just like aesthetics, perceived quality is also an subjective evaluation which the object is customer. Not all of customer possess complete information about a products's attribute, so they have to often rely on indirect measures when comparing brands.

Thus, these eight quality dimensions cover a broad range of concepts. Some of dimensions involve measurable product attributes, others reflect individual preference. According to Frank M. Gryna, quality has a relationship on productivity, costs, cycle time and value.

There is term of quality control which refers as the process employs to meet standards consitently. The control is a feedback loop which available Figure 2.1.

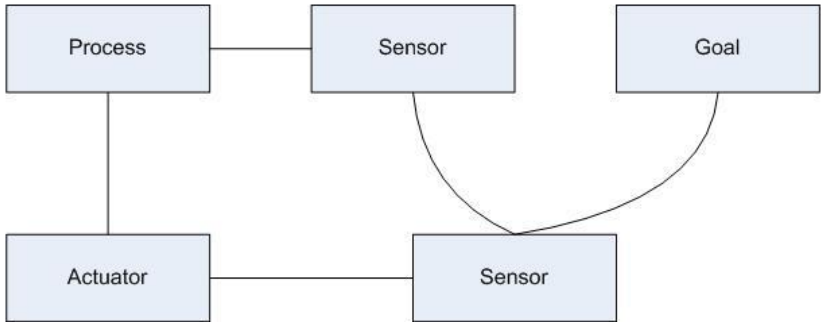



**Figure 2.1 Feedback Loop**

Figure 2.1. above shows the feedback loop of quality control. Control involves a universal sequence of steps as follows;

1. Choose the control subject
2. Establish mesurement
3. Establish standards of performance; product goals and process goals
4. Measure actual performance
5. Compare actual measured performance to standards
6. Take action on the difference.

The center activity of quality control is quality measurement. Quality measurement provides feedback and early warnings of problems. In operational quality planning, measurement quality help to identify the quatity of customer needs and product and process capabilities and measurement quality can motivate people, prioritze improvement opportunites and help in diagnosing causes.

There are several principles should be applied to identify and choose quality control subjects (Ghryna, 2007) which are:

1. Quality control subjects should be alligned and linked with customer parameters.
2. Defining quality control subjects for work processes starts with definging work
3. Quality control subjects should recognize both components of the definition of quality

4. Potential quality control subjects can be defined by obtaining ideas from both customers and employees
5. Quality control subjects must be viewed by thise who will be measured as valid

### 2.1.1 Continuous Quality Improvement

Quality fused in all aspects which are necessary to execute the business. The activities to ensure quality in each industry consist of three basic groups which are quality planning, quality control and quality improvement. Quality improvement take a neccesary role in business as the succesful quality improvement. (Juran & De Feo, 2010). There are seven basic quality tools which were claimed by Ishikawa in the 1960s. Those tools are;

- Flow Chart
- Pareto Diagram
- Check Sheet
- Control Chart
- Histogram
- Scatter Plot
- Cause and effect diagram

This seven basic tools are also comptible to be used to kaizen and Juan's approach to quality improvement. The application of these seven basic quality tools is appropriate with any other quality fundamental tools. According to EOQ, those seven basic quality tools are divided into two main parts which are data analysis and data acquisitions. Data analysis is including on cause and effect diagram, pareto diagram, flow chart and scatter plot. Meanwhile data acquistions are check sheet, histogram and control chart. The examples of each quality tools is shown in this figures below.

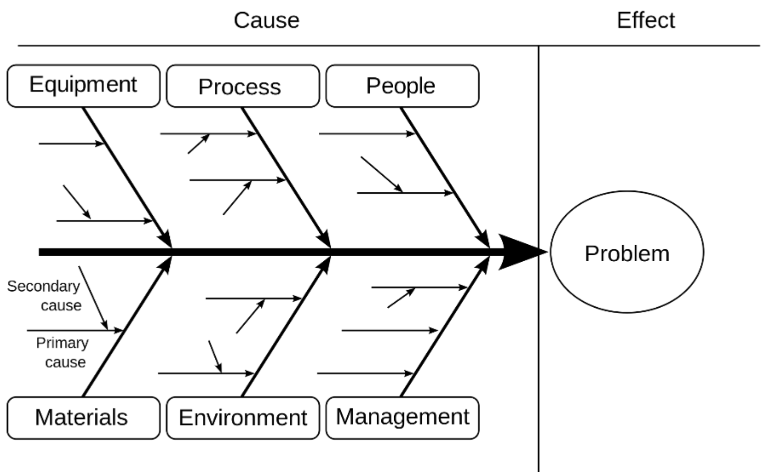



**Figure 2.2 Cause and Effect Diagram**

Figure 2.2 above shows the example of cause and effect diagram. Cause and effect diagram is also known as fishbone because its shape similiar with fish bone which first was developed by Ishikawa in 1943. Basically, cause and fish bone diagram use for identifying the list various causes that can be attributed to a problem (Mitra, 2008)

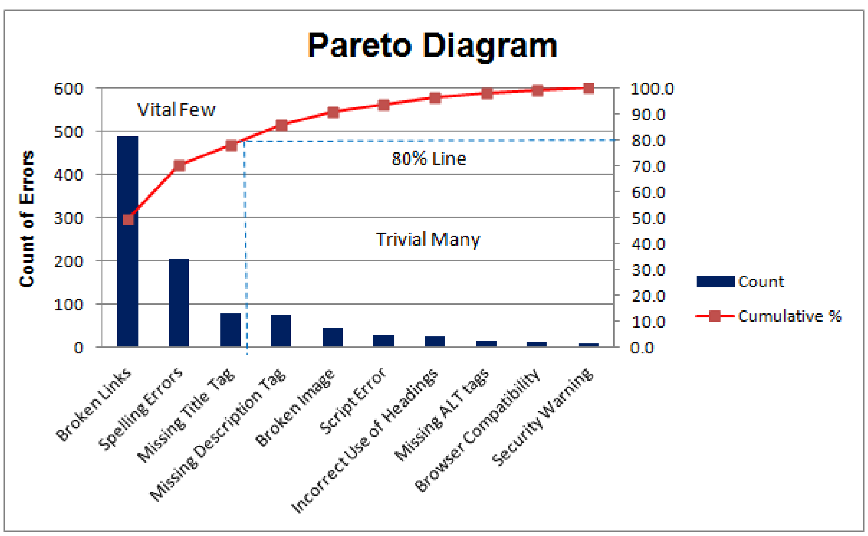



**Figure 2.3 Pareto Diagram**

Figure 2.3 above shows the example of Pareto Diagram. Pareto diagram is found by an Italian economist, Alfredo Pareto (1848-1923). He thinks that the wealth is concentrated in the hands of a few people. Pareto principle is the wealth which held by disproportianetly small segment of the population. Pareto diagram help to feature problems by arranging them in decreasing order of importance.

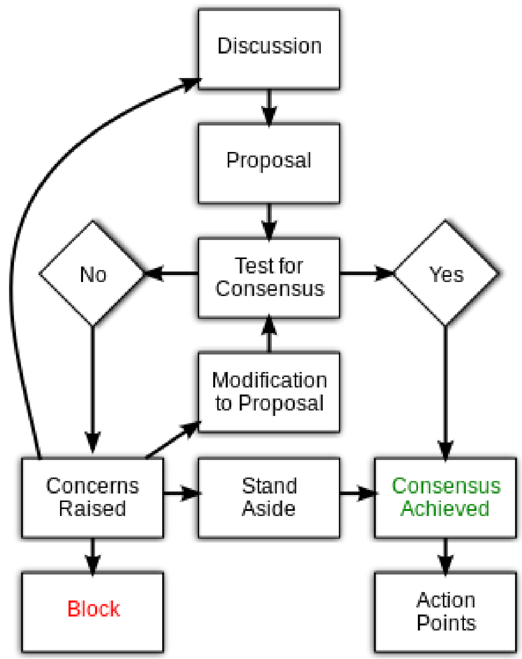



**Figure 2.4 Flow Process Chart**

Figure 2.4 above shows the example of flow process chart. Flowchart is used for manufacturing and service operations. Flowchart shows the continuity process of events in the process. Flow chart is used to identify the system which can defined bottlenecks, rebundant steps, non value added activites. Valuable process information is usually attain by the construction of flowcharts (Mitra, 2008)

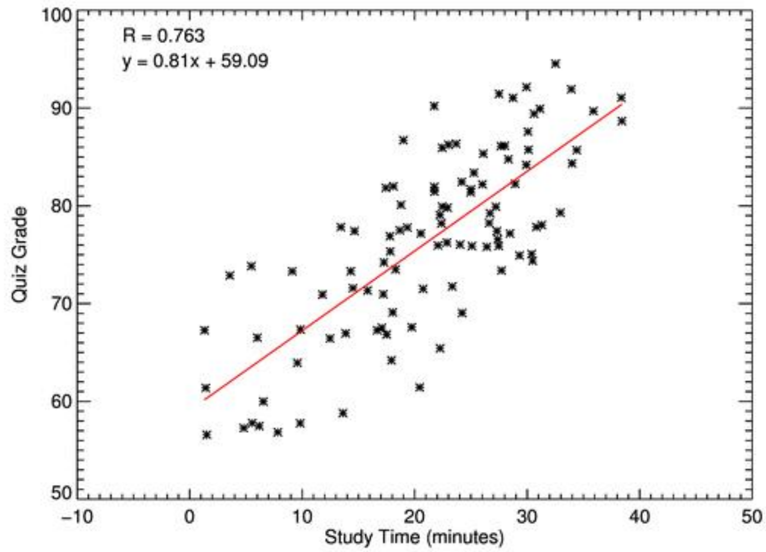



**Figure 2.5 Scatter Plot**

Figure 2.5 above shows the example of scatter plot. Scatter plot consists of plotting bivariate data to depict the relationship between two variables. Scatter plot helps to identify to decide how to set a controllable variable to achieve a desired level for the output characteristics (Mitra, 2008).

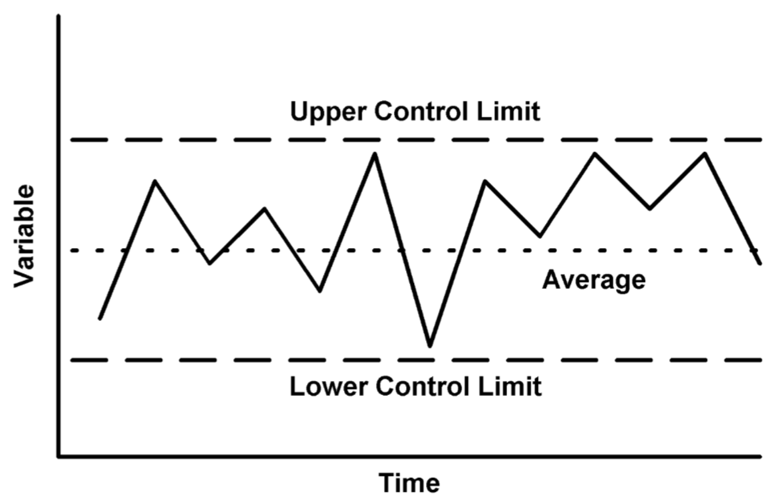



**Figure 2.6 Control Chart**

Figure 2.6 above shows the example of control chart. Control chart is one of statistical process control tool that often used to define whether manuafacturing or business is in state of. Control chart is also known as shewhart charts or process behavior charts. Control Chart was developed by Waltes A Shewhart in 1920 while he was working for Bell Labs.

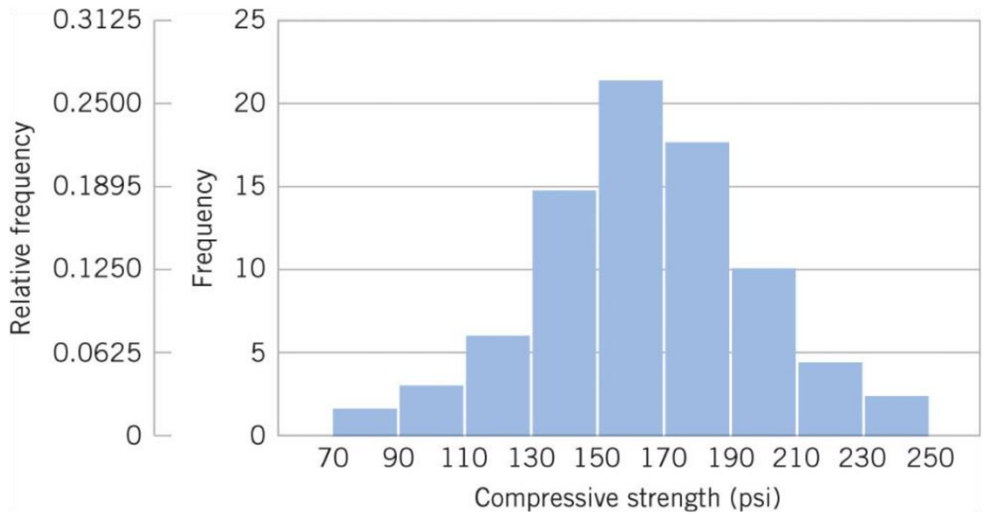



**Figure 2.7 Histogram Charts**

Figure 2.7 above shows the example of histogram charts. Histogram charts was introduced by Karl Pearson. Histogram heads for showing the representation of history of the distribution of numerical data. Actually, the term of histogram has no certain meaning where some said it is as histos while others said it is gramma. Karl Pearson himself derived the term from histos and change it into histogram.

**Motor Assembly Check Sheet**

Name of Data Recorder: Lester B. Rapp

Location: Rochester, New York

Data Collection Dates: 1/17 - 1/23

| Defect Types/ Event Occurrence | Dates | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | TOTAL |
| Supplied parts rusted | | IIIIIIIII | IIIII | IIII | II | | | 20 |
| Misaligned weld | | | III | | | II | | 5 |
| Improper test procedure | | | | | | | | 0 |
| Wrong part issued | | I | | II | | | | 3 |
| Film on parts | | | | | | | | 0 |
| Voids in casting | | | | IIII | II | | | 6 |
| Incorrect dimensions | | | | | | II | | 2 |
| Adhesive failure | | | | | | | | 0 |
| Masking insufficient | | | | | I | | | 1 |
| Spray failure | | | IIIII | | | | | 5 |
| TOTAL | | 10 | 13 | 10 | 5 | 4 | | |

**Figure 2.8 Check Sheet**

Figure 2.8 above shows the example of check sheet. Check sheet is the easiest way to gather data in a real time at the location where the data is produced and procced. Check sheet often called as tally sheet when it comes to quantitative data. According to Kaoru Isikawa in 1960s, check sheet has five identified uses in quality control, which are to check the shape of the probability distribution of a process, quantity defect by type, quantity defect by location, quantity defect by cause and to keep track the completion of steps in a multistep procedure.

All of those seven basic quality tools are applicable for another quality tools which depend on the purpose of the use of the tools itself. A good quality management will leads to succesful application on a day-to-day basis. Through a good leadership's company in applying quality policy and well documented quality management system, a company will help on how to show commitment of development and improvement of a quality (Socovic et al, 2008)

One of application of seven basic quality tools is through PDCA Cycle. PDCA sycle stands for Plan-Do-Check-Act Cycle.  The main purpose of PDCA cycle is lies in process improvement. It used to control continuous improvement. PDCA cycle is also known as Deming's quality cycle (Scholtes&J.L, 2003). Basically, Deming has four principle elements, which are Theory of System, Theory of Variation, Psychology and Theory of knowledge which has a good impact towards the cooperate based style of management that helps people simultaneously enjoy both of working and learning process (Kovach et al, 2011)

A PDCA cycle consists of four consecutive steps or phases, as follows:

1. Plan; denote as the first step of  PDCA cycle which focus on analyzing of what needs to be changed and improved that hold opportunities for change. A decision toward what action should applied is made in this step.
2. Do; The process of implementation of the action that was defined in Plan.
3. Check; In accordance with goals, policy, and requirements on products, controlling and measure of process and products is made in this step.
4. Act; is a process within the adoption or reaction to the changes to keep PDCA cycle through again.

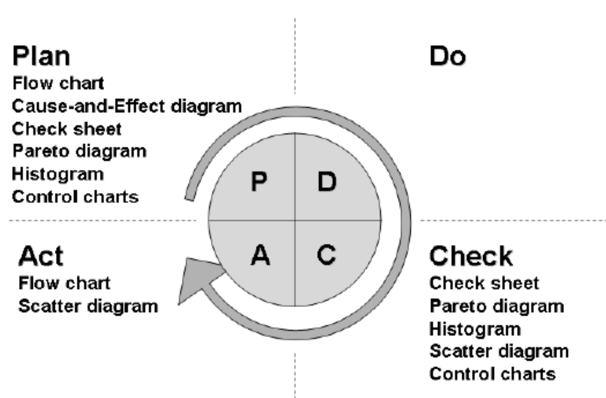



**Figure 2.9 PDCA Cycle within Seven Basic Quality Tools**

As shown in Figure 2.9 that three steps of PDCA cycle are compatible with seven basic quality tools. PDCA has more detail process when it is being implemented. Every step should be defined in the right way since it is a continuous phase of improvement. The complete application of seven basic quality tools in PDCA cycle is formed in the Table 2.1 below.

**Table 2.1 Seven Basic Quality Tools in Correlation with PDCA-cycle Steps**

| Seven basic quality tools | Steps of PDCA cycle | | | | |
|---|---|---|---|---|---|
| | Plan | Do | Check | Plan, Act | Check |
| | Problem Identification | Implement solutions | Process Analysis | Solutions Development | Result Evaluation |
| Flow Chart | X | | | X | |
| Cause and Effect Diagram | X | | X | | |
| Check Sheet | X | | X | | X |
| Pareto Diagram | X | | X | | X |
| Histogram | X | | | | X |
| Scatter Plot | X | | X | X | X |
| Control Charts | X | | X | | X |

As shown in Table 2.1, all of the seven basic quality tools can be used while PDCA cycle is implemented. A successful team work and effective solving daily quality problem can be defined by using seven basic quality tools. The implementation of this principle is a big stride forward which a company can take in order to change their statistic quality management to a dynamic one (Sokovic, 2008).

The implementation of seven basic quality tools is not only applicable to PDCA cycle, but also Six Sigma process. Six Sigma has various definition which authors defined as. According to Schroeder, et al, 2008, Six sigma is an organized, parallel meso structure to reduce variation in organizational process by using improvement specialist, a structured method, and performance metrics with the aim of achieving strategic objectives. The definition of six sigma from Linderman et al in the year of 2003 in a journal entitled Journal of Operation Management, the definition of six sigma is an organized and systematic problem solving method for strategic system improvement and new product and service development that relies on statistics (Allen, 2006).

There is one of sig sigma method that defined as DMAIC (Tague, 2005). Below is the description for each method:

- Define; Improvement of project goals, goals based on cutomer needs and wants
- Measure; Current process and establish metrics to monitor the path to achievement of goals
- Analyze; Current process to understand problems and their causes
- Improve; Process by identifying and piloting solutions to problem
- Control; Improved process with standardization and on going monitoring

The using of seven basic quality tools in six sigma is shown in Figure 1.10 below:

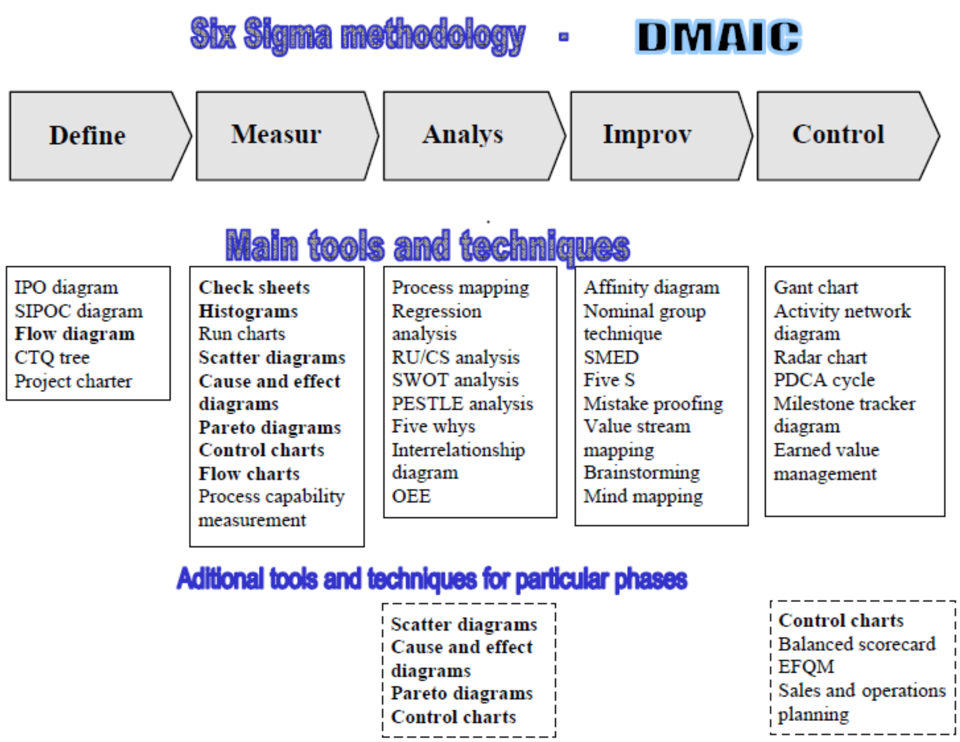



**Figure 2.10 Quality Tools and Techniques in DMAIC Methodology**

Figure 2.10 shows which tools are used in every phase of DMAIC. Every basic quality tool fit into each step of DMAIC. Additional tools and techniques also put in this diagram, and it can be seen in Figure 2.10 that except improve phase, the analysis and control have one more QC tools.

There are a lot of industries which can use six sigma as its method to solve any problem regarding to efficient and effectiveness. Montgomery and Woodall, 2008 mentioned in their book that a big company, such as in general electric, caterpillar, Bank of America have reported significant financial saving while implementing six sigma in their company.

The usage of seven basic quality tools is not limited on PDCA cycle and six sigma only. Every industry applies the seven basic quality tools among with quality continuous improvement. The combination between seven basic quality tools and quality continuous improvement could give a big power to especially for any manufacturing company, transactional or services process to reduces waste, non value added activities, cut time and defect. It could bring whether long term or short term result through the power of both combination (Socovic, 2008)

### 2.1.2 Quality Inspection

Term of inspection and test usually refer to manufacturing industries, which has several different terms. By way of example is checking, reconciliation, and examination. The main objective of inspection is to determine whether the product should be accepted. Product can mean a discrete unit. Product can also mean a service. According to Frank M. Gryna inspection planning is the activity of designating the stations at which inspection should take place and providing those stations with the means for knowing what to do plus the activities for doing it. Product acceptance involves the diposition of product based on its quality. This disposition involves several important decisions:

1. Conformance. Judging whether the product conforms to specification
2. Fitness for use. Deciding whether nonconforming product is fit for use
3. Communication. Deciding what to communicate to insiders and outsiders

During the quality inspections, there are two things that neeed to be classified. The first one is quality characteristics which derived from the specification.. The other one is defect which depend on the characteristics for output products of the company (Gryna et al, 2007). According to David M. Milts, generally there are five basic steps that must be completed during an inspection task:

1. Set up; obtain procedures or work instruction, items to be inspected, and equipment neede for inspection
2. Present; prepe item for inspection
3. Search; examine item for possible defecrs
4. Decide; compare potential defect against standards to determine if it exceed the standards
5. Respond; accept or reject the item based on the decision made in step four, mark the item as needed, and complete rewquires paperwork.

Frank M Gryna state that electrical, mechanical, nondectructive and chemical manufacturing are often use automated inspection in reducing costs, error rates, shorten inspection time, alleviate personnel shortages, avoid inspector monotony, and providing any other advantages. There are four economics inspection. They are;

1. No inspection; No inspection is applicable when there has already been a qualified laboratories inspection.
2. Small samples; Small samples can be adeauate if the process is inherently uniform and the order of production can be presevced. Small samples can also be used when the products is homogeneous due to its fluidity or to prior mixing operations.
3. Large samples; the actual sample size on two main variables which are the tolerable percentage of defects and the risks that can be accepted.
4. One hundred inspection; This technique is used the result of sampling show that the level of defects pressnt is too high for the product to go on to the users.

An economic evaluation of these elaternative requires a comparison of total cost under each one. Below is the term of proportion of inspection (Gryna, 1984)

N: Number of items in lot

N: Number of items in sample

P: proportion defective in lot

A; Damage cost incurred if a defective slips through inspection

I: inspection cost per item

$P_a$ : probability that lot will be accepted by sampling plan

A and I are sometimes denoted as $K_1$ and $K_2$ repectively.

Those term usually used on cost comparison between sampling inspection and 100% inspection. The formula is available on Formula 2.1 below.

$$Pb = \frac{I}{A} \quad \textbf{(2.1)}$$

Where Pb is the break event point of the lot size of the inspection. If the lot quality is less than Pb, it will much better to apply sampling inspection instead of 100% inspection. Meanwhile, if the $p$ is greater than $Pb$, 100% inspection is the best. There are several factors that impact visual inspection that can impact the performance, which are task, individual, environmental, organizatinal, social. Task is related to defect rate, standards, etc. Individual is related with, aptitude, personality, etc. Environmental related with loghting, noise, temperature, etc. Organizatonal involves in training job rotation, feedbcak, etc. And the last social is related with pressure, issolation, cmonsultation, etc (Milts, David M).

**2.2 Industrial Statistics**

Statistic first came from the latin word "staus" meaning "state which identified by the diplays of data and charts related to the economic, demographic, and political situations prevailing in a country (Johnson and Bhattacharyya, 2010)

Statistics is the branch of mathematics that transforms numberinto useful information for decison maker (Levine, 2011) According to Bowley statistic are numerical statements of facts in any department of enquiry place in relation to each other. Meanwhile accordint to Yule and Kendall, statistic means quantitative data affected to a marked extent by multiplicity of causes.

Statistic can be applied in any form and term which depend on problem background and objective itself. Eventhough the method that is used by manufacturing and business sector are different, but basically both of the principles are the same. There are several basic vocabulary that common used of statistic as follows:

1. Variable; is a things that being  analyzed when using statistical method
2. Data; are the differenet values associated with a variable
3. Population; consists of all the items or indviduals about which you want to draw a conclusion
4. Operational definitons: The meaningless variable unless corresponding variables
5. Sample; is the portion of a population selected for analysis
6. Parameter; is a measure that describe a characteristic of a population
7. Statistic; is a measure that describes a characteristic of a sample

**2.2.1 Statistical Tools**

There are a lot of statistical tools that used in common daily life in order to solve a problem. The usage of the tools is depend on the complexity of the data. Those statistical statistic including descriptive statistic, probabilty, normal distribution and other continuous distributions, sampling and sampling distributions , confidence interval estimation, hyphothesis testing and two sample test. The more complex statistical tools are ANOVA, chi square, simple linear regression, multiple regression, etc. Following statement are brief explanation of each basic statistic tools.

- Descriptive statistic

According to Mikki Hebl, descriptive statistic is number that used to summarize and describe data. There are two type of analysis in descriptive statistic which are centrak tendency, variation and shape of numerical variable and relationship between numerical variables. First analysis is including mean, median, mode, quartiles, range, variance, etc, and the second type is including covariance, coeffecient of correlation.

- Probability

Probabilty is a possibility of a numerci value from 0 to 1 as the representative of chance that particular event will occur (Berenson, et al, 2011). Bayes' theorem was used to revise previously calculation on probability based on new information. In probability calculation, there are simple probability, conditional probabilities and independent events.

- Normal Distribution and Other Continuous Distribution

According to David M. Levine, 2011, normal distribution is a common distribution that most matter in the business cycle. Normal distribution means that it is symmetrical and the mean and median are equal. It formed in bell shaped. Even normal distribution is common using on business cycle, it does not means that all of the distribution are normal. Continuous distribution is used when the data is not normal distribution.

- Sampling and sampling distribution

Sampling statistical procedure is used when there is huge number of population which is impossible to be analyzed. Then, pick up a small number of population is helpful to analyze the population. Furthermore, the result from sampling distibution is used to estimate characteristic of entire population. There are several method to select a sample, which rea simple random, systematic, strafied and cluster sampling (Figueiredo, 2011)

- Confidence Interval Estimation

There are two question appear when about to determine what equation to use for a particular situation (Berenson, et al, 2011) which are:

1. Are you constructing a confidence interval, or are you determining sample size?
2. Do you have a numerical variable, or do you have a categorical variable?

- Hyphothesis Testing

According to David M. Levine, a hyphothesis testing that concern on a single parameter has two type of data within different type of test. Numerical data is used t test hyphothesis for the mean, while categorical data is used Z test of hypothesis for the proportion. Thus, this is why it is important to know whether the data is involving on numerical variable or a categorical variable in order to define the test. In general, there must be $H_0$ and $H_1$ in order to run statistical test. The decision is whether to accept $H_0$ and reject $H_1$ or reject $H_0$ and accept $H_1$. To come up with this result, the decision is made based on used test and the result of the test.

- Two sample test

According to Mark L. Berenson 2011, two sample test is used when there is the difference between the means of two related sample. Selecting the test that is most appropriate for a given set of conditions and to criticaly investigate the validity of the assumptions underlying each of the hypothesis-testing procedures. Numerical data use t tests for the difference of the means of two independent populations, paired t test, F test for the ratio of two variances, meanwhile for categorical data is using Z test for the difference between two proportion.

Those points above could be mentioned as the basic quality tools that will be used for further analysis. By way of example, every statistical tools require hypothesis testing as the perimeter of test which data definitely has mean, median, variance, etc. Category data will help to find what statistical tools that will be used to prove hypothesis testing. The more complex statistical approach and often compatible with any kind of data is known as ANOVA (Analysis of Variance). There are two type of ANOVA, One-way ANOVA and two way ANOVA. The explanation of each topic is elaborated in the next sub chapter.

### 2.2.2 Analysis of Variance and Fisher LSD

Analysis of Variance is defined as analysis of variance used in analyzing experimental data that able to analyzed and determine if significance of the factors on the dependent data (Ahmed and Rashed, 2014). ANOVA allows to analyze and interpret observations from several populations. There are two types of ANOVA, which are One Way ANOVA and Two Way ANOVA. ANOVA often use term of groups, level and factor. Group means the general classification of data that being examined.

The groups are classified based on levels of a factor of interest. In ANOVA, total variation is subdivided into variation, which is due to difference among the groups, and variation that is due to difference within the groups. The explanation of each type is as follows.

One-way ANOVA is a procedure of ANOVA that use for completely randomized block design. The term of completely randomized design just the same with independent random sampling from several populations when each population is identified as the population of responses under a particular treatment (Johnson and Bhattacharyya, 2010)

There are several assumptions are made when performing analysis pf variance:

1. Data must be obtained from the population with normal distributon
2. Data must be obtained using a sampling method
3. The experiment must adopt a sampling normal distribution
4. Variance of data in each level of experimental process must be equal and independent

Since statistical test should have a hypothesis testing, One-way ANOVA has null hypothesis which is there is no difference in population mean, and alternative hypothesis is at least there is one difference means in population mean. The hypothesis testing of One-Way ANOVA is as follows;

$$H_0: \mu_1 = \mu_2 = \ldots = \mu_c$$

$$H_1: \text{Not all of } \mu_j \text{ are equal}$$

To perform an ANOVA test, there are several formulas that generally used in order to find out the result. Total variation is represented by the sum of squared total (SST). Since the assumption towards the other normal distribution of the data, then to calculate total variation by summing the squared differences between each individual value and the grand mean. Grand mean us the mean of all the values in all groups combined. Equation 2.2 shows the formula of total variation.

$$\boldsymbol{SST = \sum_{j=1}^{c} \sum_{i=1}^{n_j} ( X_{ij} - \bar{\bar{X}})} \quad \textbf{(2.2)}$$

Where,

$\bar{\bar{X}}$ = Grand Mean

$X_{ij}$ = *i*th value of i group

$n_j$ = number of values in group j

$n$= total number of values in all groups combined

$c$= number of groups

Sum of Squares among groups (SSA) is computed by summing the squared differences between the sample mean of each group, and the grand mean, weighted by sample size in each group. Equation 2.3 shows the formula of among group variation.

$$\boldsymbol{SSA = \sum_{j=1}^{c} n_j (\bar{X}_j - \bar{\bar{X}})^2} \quad \textbf{(2.3)}$$

Where,

$c$= number of groups

$n_j$ = number of values in group j

$\bar{X}_j$= Sample mean of group $j$

$\bar{\bar{X}}$ = Grand Mean

Within group, variation usually called sum of squares within groups (SSW) which measure the difference between each value and its own group and sums the squares of thesdiffernces over all groups. Equation 2.4 shows the computation of the within groups variation.

$$\boldsymbol{SSW} = \sum_{j=1}^{c} \sum_{i=1}^{n_j} \left( X_{ij} - \bar{\bar{X}} \right)^2 \qquad \textbf{(2.4)}$$

Where,

$\bar{X}_{ij}$= *i*th value in group *j*

$\bar{X}_j$= Sample mean of group j

During the calculation of ANOVA, degree of freedom is an important things on calculation. Degree of freedom for SST (total variation) is *n-1* , SSA (among group variation is *c-1* and the last SSW (within variation) is *n-c*. If each of these sums is divided of squared by its respective degrees of freedom, there are three variances which known as mean square. The equation below shows the computation of mean square.

$$MSA = \frac{SSA}{c-1} \qquad \textbf{(2.5)}$$

$$MSW = \frac{SSW}{n-c} \qquad \textbf{(2.6)}$$

$$MST = \frac{SST}{n-1} \qquad \textbf{(2.7)}$$

One way ANOVA is using Ftest as the tools to prove the result of hypothesis testing. Ftest statistic follows F distribution which has *c-1* degrees of freedom in the numerator and *n-c* degrees of freedom in the denominator.

$$F_{stat} = \frac{MSA}{MSW} \qquad \textbf{(2.8)}$$

As ANOVA has bell shaped graphic, there is a decision area on the graph which depend on t result of One Way ANOVA test. The decison rules is shown in Figure 2.11 below.

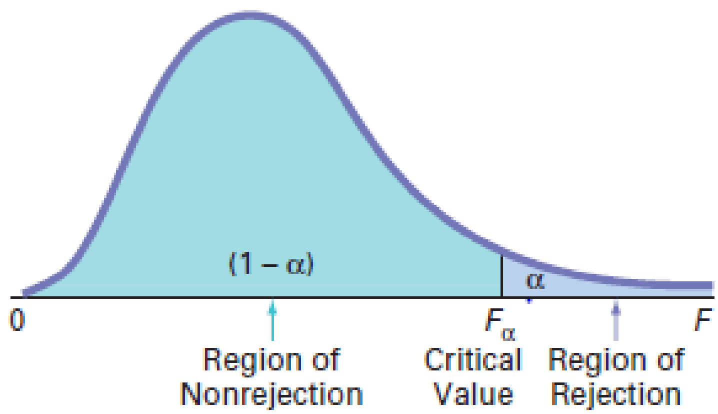



**Figure 2.11 Decision Rule in One Way ANOVA by Using Ftest**

Figure 2.11 above shows the rejection area of one way ANOVA by using Ftest. It can be seen that if Ftest is greater than Falpha, then null hypothesis is reject otherwise do not reject null hypothesis. Every different alpha will give different number of alpha. The summary of one way ANOVA computation is form in the Table 2.2 below.

**Table 2.2 One Way ANOVA Table**

| Source of Variation | Degree of Freedom | Sum of Squared | Mean Squared (Variance) | F |
|---|---|---|---|---|
| Among Groups | c-1 | SSA | MSA= $\frac{SSA}{c-1}$ | Fstat= $\frac{MSA}{MSW}$ |
| Within Groups | n-c | SSW | MSW= $\frac{SSA}{c-1}$ | |
| Total | n-1 | SST | | |

Table 2.2 above shows the summarize of computation of one way ANOVA that facilitate the user when conducting a statistica test. The table consist of the main formula of one way ANOVA which the detail is can be seen on previous equations.

After conducting one way ANOVA and analyzing the result, it can be seen whether the null hyphothesis is rejected or accepted. The problem is when the null hyphothesis is reject which means there is at least one mean difference among the groups, then it has to be proved. ANOVA features can not applied to seek which mean is different. Then another statistical test is conducted.

There are a lot of test that can be used to find out the result. Tukey Kramer is often used as a statistical tools regarding to the problem. Another compatible test is Fisher Least Significance Different which widely used in statistical modelling directional data (Figueiredo, 2011). Fisher pairwise comparison was first developed by Fisher in 1935 is called the least significance different (LSD) test that can be used only if the $H_0$ of ANOVA test is reject (Keselman & Burt Holland , 2010).

The formula for the least significant difference is:

$$LSD_{A,B} = t_{\frac{0.05}{2}.DFW}\sqrt{MSW\ (\frac{1}{n_a} + \frac{1}{n_b})} \qquad \textbf{(2.9)}$$

Where,

$t$ = Critical value from th t-distribution table

MSw = Mean square qithin, obtained from the results from ANOVA test

$n$ = number of scores used to calculate the means

By using Fisher LSD, it is able to show which mean of group is different among the others. Fisher’s LSD test can not use for multiple comparison. Fisher’s LSD compute the pooled SD from all the groups which gains power where compared with t test that only compute the pooled SD from only the two groups being compared.

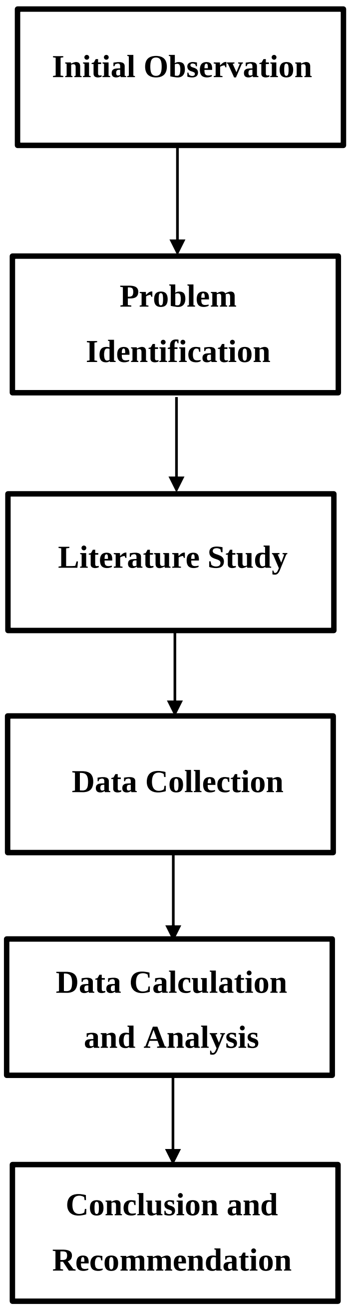
It should be noted that Fisher on 1935 Least Significant Difference procedure only provides Type I error protection via the level of significance associated with the ANOVA null hypothesis, that is, the complete null hypothesis. For other configurations of means not specified under the ANOVA null hypothesis all means but one equal and where the set of J 1 equal means is quite disparate from the one mean), the rate of familywise Type I error can be much in excess of the level of significance (Mahapoonyanont, 2010).

Both of ANOVA and Fisher Least Significance Different is able to use Minitab as the statistical software that facilitate the user when analyzing data. Running ANOVA and Fisher Least Significance Different in ANOVA, it will shows the complete result which leads to conclusion of the data.

Previous studies and research used as the literature study has been defined in this chapter. The fundamental procedure for doing 100% inspection and calculating ANOVA has also been acknowleged. After that, detail steps that should be done in finishing the research will be defined. Therefore, methodology of the research will be delivered in the next chapter.

# CHAPTER III

# RESEARCH METHODOLOGY




**Initial Observation:**

- Direct observation at auto rooting area
- Interviewing operators and respected section head

**Problem Identification:**

- Identified the problem by review rooted head for year of 2016
- Determine problem statement
- Define objective, scope, and assumption

**Literature Study:**

- PDCA Cycle
- 100% Inspection
- Analysis of Variance

**Data collection**

- Perform direct observation to production floor
- Gather all related data

**Data Calculation and Data Analysis**

- Analysis the root cause
- Analysis appropriate method towards the each root cause
- Comparison current situation and proposed improvement

**Conclusion and Recommendation**

- Conclusion
- Recommendation for future Research

**Figure 3.1 General Research Framework**

Figure 3.1 shows the step of doing this research. There are seven main processes that involve during this research, they are initial observation, problem identification, literature study, data collection, data analysis and conclusion and recommendation. The brief explanation of each step is listed below:

### 3.1. Initial Observation

The initial observation was started when by doing a direct observation to the production floor and learned everything that related to auto rooting process. Things that being observed are such as the area of auto rooting process, the design of the machine, the amount of the machine, components of the machine, flow process before and after the rooted head, raw material, the cycle time for each process, and including required safety equipment.

As the observation in auto rooting process area was started, it was discovered that one operator runs three machines with a different type of head of the toy. It was also found that there was a different cycle time for each toy which depends on the standard requirement for the long of hair yarn, type of hair yarn whether it is curly or straight hair and the color of the hair yarn.

According to the result of interviewing some operators, each of them already knows the criteria of missing stitches for the rooted head. They do it through visualization inspection for every rooted head right after they pulled out the head from the machine. If the output has no missing stitches, thus they put in on nearest basket around them and if it finds that there are missing stitches toward the rooted head, then they put it on the different basket. Rooted head without no defect will deliver to pack out to be produced along with another component, meanwhile rooted head with missing stitches will be reworked before it delivers to pack out. Also by interviewing the operators, it was confirmed that if the number of the defect is high, then another problem comes along. There is a lateness delivery to packing out because the operators who do rework unable to finish the rework on the same day due to the limitation resources they have.

In accordance with the issue stated above, the further observation was needed to overcome this problem. The observation then was focused on reducing a number of a defect in the auto rooting process area.

### 3.2. Problem Identification

After done doing the interview, then a review of all related data of auto rooting process of the year 2016 done. It is found that there is a high number of rework caused by missing stitches compared with other factors. Hence, PT. X need to do an improvement to overcome this issue in order to avoid the lateness delivery to packing out area and minimize the amount of cost should be paid.

Consequently, based on the problem issued on the paragraph above, there are some problems which require being solved and stated in a form of problem statement which written below:

- How does the company reduce the number of missing stitches defect in auto rooting process area?

Therefore, based on three problem statements above, the objectives of this research are written in the following statement below:

- To reduce the number of  missing stitches defect in auto rooting process area

### 3.3. Literature Study

After the problem is identified, literature study is provided to support the research conducted. The reference is come from textbooks, journal, e-books or website. Some of the literature study that used in this research are quality tools, 100% inspection, statistical tools and ANOVA and Fisher test. Basic knowledge used in this research is listed in the following paragraphs below.

1. Quality

Quality is the most critical point in any industries spesifically in manufacturing. Compay with the most satisfying quality will gain more customer to buy a product.

Quality aims to ensuring there is no defect occur towards a product trough some quality tools. This research is concern on seven basic quality tools which are pareto chart, fishbone diagram, check sheet, Flow Chart, scatter plot, histogram and control chart, In general, a manufacturing company would like to ensure the quality of product towards various kind of inspection. By way of example is sampling inspection and 100% inspection which become a highlight in this research.

2. ANOVA

Analysis of Variance (ANOVA) is a common statistical tools that widely used in many aspects. In manufacturing area, statistical tools can be used in order to define the most compatible paired between material as become a concern on this research. There are two types of ANOVA, which is One-Way ANOVA and two-way ANOVA. The difference of the usage depend on the statistical data. ANOVA come up with the result of whether to reject or accept null hypothesis. As a continuous analysis towards the result of ANOVA, there are another statistical tools that widely used to analyze data deeper. Some of those tools are Tukey Kramer and Fisher Least Different Significance tools. This tools is used specifically when the ANOVA null hyphothesis is rejected and to find out the difference among the groups that ANOVA can not do.

### 3.4. Data Collection

In this section, all data needed for this research is observed and collected. The data used in this research is mostly gotten from IE secondary department, interviewing the operators and some of supporting data from IE primary department. After all of the related data is collected, calculation of the data is executed.

Data that being collected to support this research are like the total output during period of reviewed, number of defect, procedure of auto rooting process number of machine and operator in auto rooting process, number of operator to do rework, type of painted head, variants of hair yarn, the pair of painted head and type of hair yarn and downtime machine and any other supporting data.

### 3.5. Data Calculation and Analysis

After all of the related data are collected, the next step is conducted which is data calculation and analysis. In addition, to calculate, analysis of the calculation is also thoroughly conducted. This phase is started from creating a fishbone diagram, as a visual way to present the cause and effect of missing stitches easier. After done on this step, a further step is continued by analyzing what treatment does appropriate for each caused.

In order to overcome the issue, some IE tools are adopted to overcome each sub-caused. It is found that there is two main treatment which applied to this research, they are continuous improvement through PDCA cycle along with 100% inspection and Analysis of Variance to find out the standardization between the type of head and type of hair yarn.

Finally, after the calculation of the data is done, analysis of the result is conducted. The analysis is done by comparing current condition in area of auto rooting process with proposed improvement through each variable in the area of rooting process.

### 3.6. Conclusion and Recommendation

In this section, conclusion and recommendation are going to be discussed. The conclusion will answer the research objectives. The recommendation for further research is stated in this section.

### 3.7. Detail Framework

To assist the reader in understanding the steps taken in the research with more clear and concise way, detailed framework will be included in this chapter (see figure 3.2 on the next page)

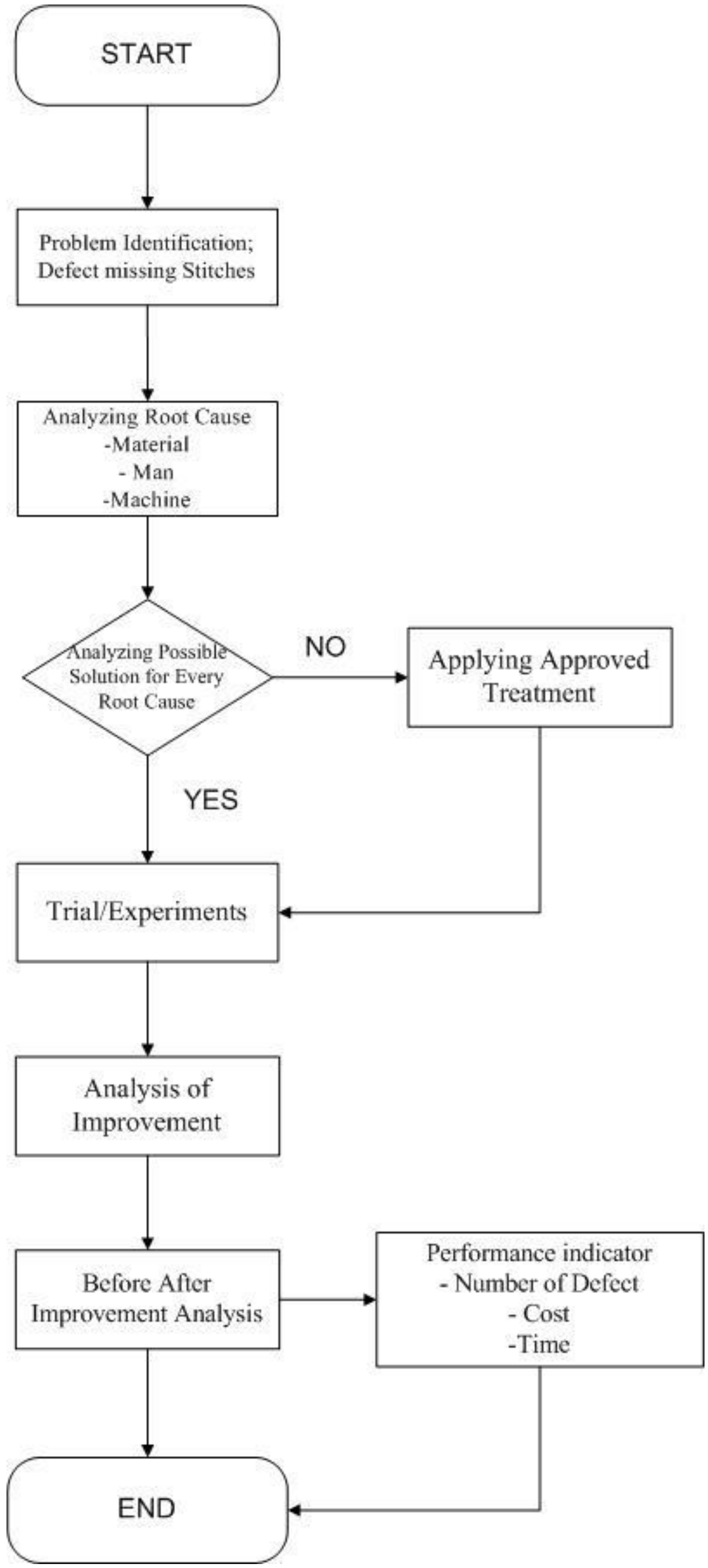



**Figure 3.2. Detail Research Framework**

# CHAPTER IV
# DATA COLLECTION AND DATA ANALYSIS

## 4.1. Initial Observation

To complete this research, there are some data that related to area and auto rooting process were collected. The data were gathered from initial observation, interviewing the operator and reviewing the entire data auto rooting by the year 2016.

Initial observation was begun in September 2016. The very first step and routine activity during the observation were about to know the required raw material and the flow process of auto rooting itself. Thus, it is known that there are two main materials needed in rooting process, they are hair yarn and painted the head. In fact, there are a lot of variant for both of materials. The variant of each material is listed in the Table 4.1 below:

**Table 4.1 Head Toy Material Specification**

| Items | Material Type | | |
|---|---|---|---|
| | Hair Yarn | | Painted Head |
| Type | Straight hair and Curl hair | | Oval, Round, and Silkstone |
| Size | Straight hair | All straight hair yarn has the same size | Big, Middle, and Small |
| | Curly hair (Diameter) | Tiny, Small, Medium | |

As it can be seen in Table 4.1 above, there are two main items that differentiate hair yarn and painted head as the raw material of rooting process. Size, type, and color for each material depend on R&D department, which located in the USA. The using for each material is different that depend on the type of toy.

If it is straight hair, no additional process needed before it delivers to auto rooting process. Meanwhile if the head uses curly hair, then the hair yarn has to be delivered to curling process and then after done, it is ready to be used in the curling process.

Before entering rooting process, there are several steps needs to be passed by the raw material, as represent in this Figure 4.1 below:

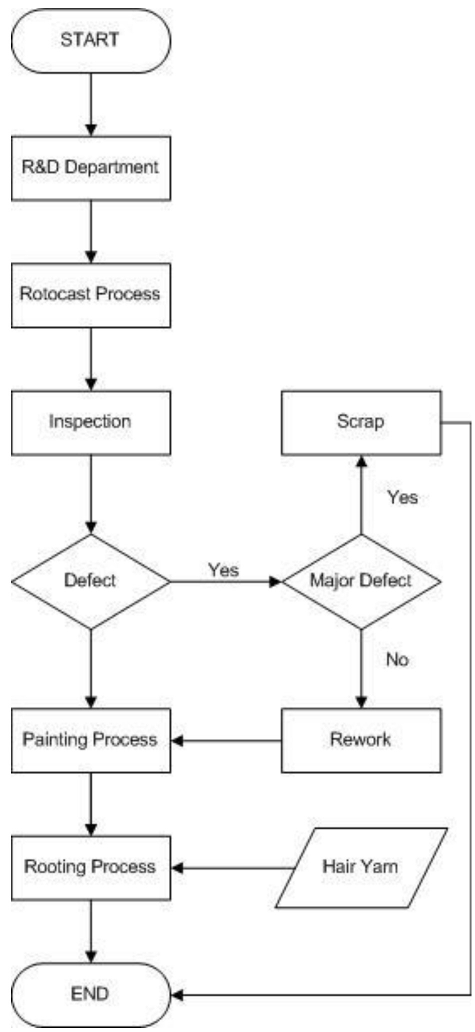



**Figure 4.1 Flow Chart of Head Toy Material**

Figure 4.1 above shows flow chart process of painted head before it is entering the rooting process. The process started from a roto-cast process which is the first process of creating a head for every toy. During the roto-cast process, there is an existing inspection which is done by QC Department from IE primary department.

The sample inspection is held by QC department. Three heads are being inspected per machine per toy per hour. The standard evaluation if this inspection is the weight of each head. Every head has different standard weight, which depends on the type of head that must be checked by the inspector.

If those three samples are approved, or in other words the samples meet the standard requirement of the head, thus it can directly deliver to the next process which is painted the head. Painting head means coloring the upper head's surface of the toy. Usually, the color is matched to the color of hair.

Otherwise, if those three samples are not meet the standard requirement of the head, there are two choices to be made. Whether the head of the toy will be scrapped or rework. Scrap means the head no longer can be re-used, usually because the shape of the toy is not proper or there is a fateful defect on the head. Rework means the toy still can be re-used by fixing the problem. If the head still can do rework on it, it will redeliver again to the production floor to be reproduced. After done, those heads deliver to painting process and then deliver to rooting process.

### 4.1.1 Sampling Inspection in Rotocast Area

In the previous section, it is already explained that there is an existing sample inspection which done by QC primary. Further observation was conducted to know the detail any related thing toward the inspection, which was done by observing, and record all of the related data towards the inspection. Below is the current layout of roto cast process that located in the area of IE Primary

#### 4.1.1.2 Layout Rotocast

In roto-cast area, there are 25 machines which are divided into two types, seventeen manual machines and eight automatic machines. The manual machine is operated by the operator while automatic machine uses robotic system and the operator only works for loading raw material and unloading output. PT. X set two spaces for rotocast area. Layout of rotocast can be seen in Figure 4.2.

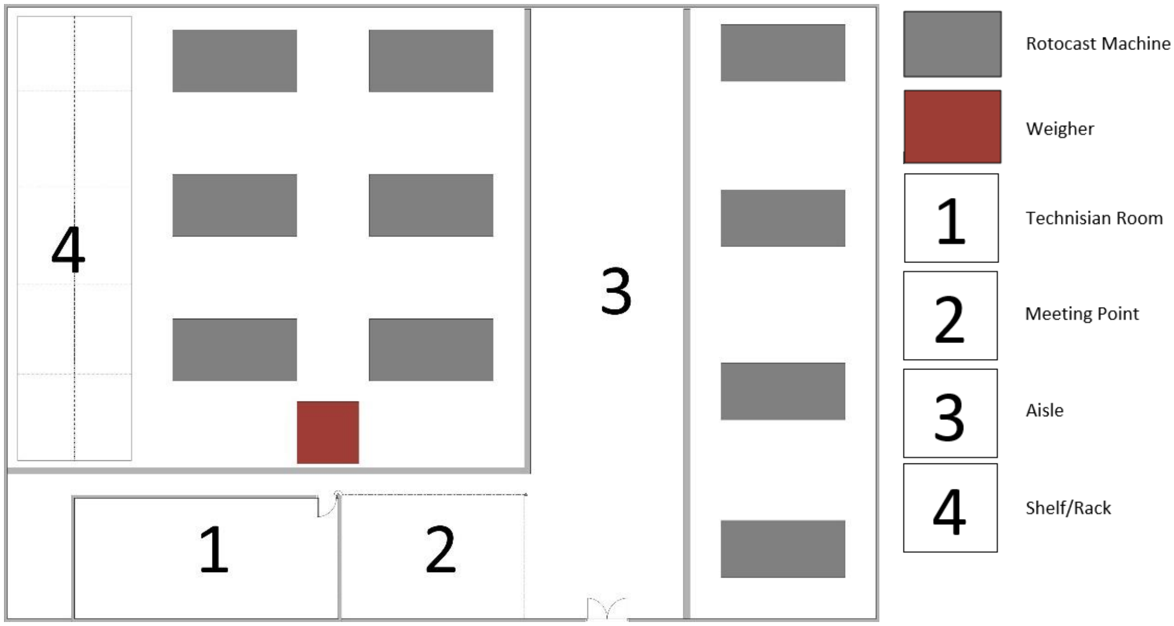



**Figure 4.2 Layout Rotocast Area**

Figure 4.2 above present layout one of room available for roto cast area (more clear figure is available in Appendix 1). In this area, there are ten machines that being used every day for five days and three shifts per day. The real dimension of whole rotocast area is 220.75 cm X 189.80 cm. Figure 4.2 above has a scale on 1:20.

Rotocast machine has two cycles time for one hour which has loading and unloading machine is about twenty five minutes per cycle time. There are 50 output that being produced for each cycle time means there are 100 output that being produced for one hour. In sampling inspection, three of this output are being tested which the detail is elaborated in the next section.

As it can be seen from Figure 4.2 above, flow information to do an inspection is provided which is weighted head in roto-cast process. When operator put in the raw material and machine process it and after twenty minutes it is done, the operator needs to move the output to empty boxes that are provided on their side and they continue to input the raw material for another time. These output for each machine for every hour have to be weighted while the weigher is located in between warehouse and machine. Digital weigher is being used to ensure the accuracy of the result. Later all data is recorded into one file that being used for analyzing and reviewing data.

### 4.1.2 Rework Auto Rooting Process

During the observation, it is found that there are two options to be made when the output of auto rooting is a defect, whether it is rework or scrap. As this observation is focus only in missing stitches as the highest defect that occurs in auto rooting process, it is found that mostly defect of auto rooting goes to rework.

The criteria of defect that will rework are if there is no other damage that occurs to the head toy other than missing stitches otherwise, it will become scrap. Other damage in toy head means if the needle is broken thus it possible to hit the painted head which leads to the safety issue if the ear is ripped due to machine error, or any other factors. Rework auto rooting is done by using manual rooting machine.

#### 4.1.2.1 Layout Rooting Process

As there are two types of rooting, which are manual rooting and auto rooting and both of this method is located in the same area. Basically, it does not take much time to deliver rework auto rooting to rework process area. Layout for rooting process is provided in Figure 4.3.

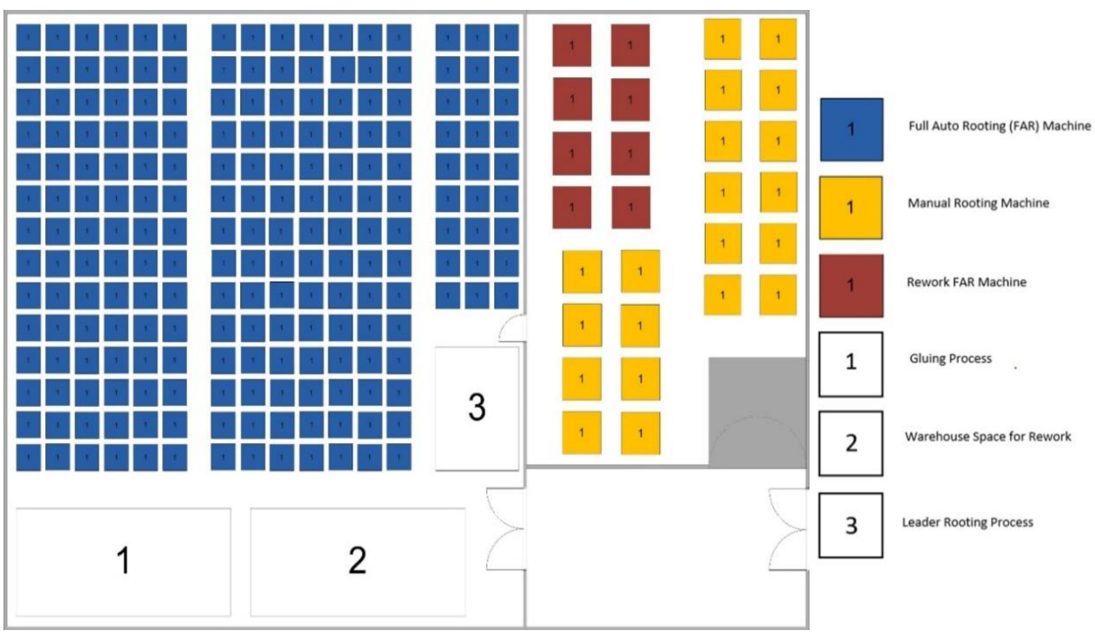



**Figure 4.3 Layout Rooting Process**

Figure 4.3 above shows the whole layout for the rooting process (more clear figure is available in Appendix 2). The dimension of whole area rooting process is 422.95 cmX 385.54 cm. Figure 4.3 above has a scale on 1:42. There are 229 machines of auto rooting and 28 machines of manual rooting which eight machines is used for rework. Actually, not all of auto rooting machine is used for the production process. During the observation which is in September-November 2016, there were only 130 machines that being used. The other will be used when it comes to peak season which there is a high number of market demand.

### 4.1.3 Variation of Painted Head

There are a lot of type of painted head that being produced in PT. X. Basically, the head type come from R&D department which give the document that consist of complete part of the toy and explanation for each part. Referring to this document, PT. X through IE Primary will produce the type of head based on the schedule.

In order to produce the toy head, PT. X has to refer to the head sculpt. Head sculpt is the prime shape of the head, means that one sculpt can be transform into any design of head that later on used as toy head. Toy head that has it sculpt will have the same size and same shape of eye, nose, ear and mouth. The difference is on the face design, part line of rooting, grooming style and the amount of stitches on rooting process, which prevail to different type of toy.

In this observation, there are 40 different type of toy head that being observed and reviewed all related data. Those 40 toy heads are being observed regarding to the the type of sculpt and toy head that summarized in the Table 4.2 below.

**Table 4.2 List of Sculpt for Each Toy**

| No | Sculpt Type | Toy Head | No | Sculpt Type | Toy Head |
|---|---|---|---|---|---|
| 1 | B58 | II | 21 | DMD | Z |
| 2 | B58 | KK | 22 | DNV | DD |
| 3 | CFF | B | 23 | K83 | N |
| 4 | CFF | D | 24 | K83 | T |
| 5 | CFF | F | 25 | K83 | LL |
| 6 | CFF | L | 26 | K83 | C |
| 7 | CFF | Y | 27 | K83 | G |

**Table 4.2 List of Sculpt for Each Toy**

| No | Sculpt Type | Toy Head | No | Sculpt Type | Toy Head |
|---|---|---|---|---|---|
| 8 | CFF | NN | 28 | N549 | O |
| 9 | CFF | I | 29 | N954 | W |
| 10 | CFF | J | 30 | PY2 | GG |
| 11 | CFF | R | 31 | PY2 | HH |
| 12 | CDH | P | 32 | PY2 | JJ |
| 13 | CHD | CC | 33 | T74 | EE |
| 14 | CHW | X | 34 | V05 | Q |
| 15 | DGY | FF | 35 | V05 | V |
| 16 | DKB | AA | 36 | V05 | U |
| 17 | DKR | E | 37 | W39 | MM |
| 18 | DLT | A | 38 | W91 | M |
| 19 | DLT | H | 39 | W91 | S |
| 20 | DMD | K | 40 | Y77 | BB |

As it can be seen on Table 4.2 above among 40 types of toy head there are only 20 type of sculpts which are B58, CFF, CDH, CHD, CHW, DGY, DKB, DKR. DLT, DMD, DNV, K83, N549, N954, PY2, T74, V05, W39, W91 and Y77. As mentioned before that there the major different of each sculpt are the size, hardness and thickness and face shape. This sculpt will be processed into different types of toy. The using of type of hair yarn will elaborated in the next chapter.

### 4.1.4 Variation of Hair Yarn

There are two types of hair yarn that being used by PT. MI which are curl hair yarn and straight hair yarn. Basically, these two types come from the same variants of hair yarn. The difference is curl yarn is passed one process that is known as curling process whereas straight hair yarn is being curl by using machine with different size of diameter according to type of toy that will be produced. There are five types of hair yarn that currently used by PT. X which are PP, KB, KF, NS and HA.

Each of hair yarn has similar look but it also has difference that can only be identified by aesthetic inspection through touching the structure of hair yarn. Table 4.3 below provide the basic different of each hair yarn.

**Table 4.3 Information of the Variants of Hair Yarn**

| No | Hair Yarn | Explanation |
|---|---|---|
| 1 | PP | Dense structure |
| | | Slippery; Hard; Sharp |
| | | Has the biggest denier |
| | | Require one spool when it is in used |
| 2 | KB | Rough; Slippery |
| | | Because of its structure, it is often used as curly hair yarn. |
| 3 | KF | Rough; Slippery |
| | | Has smaller denier than PP, but bigger than the others |
| | | Require two spool when it is in used |
| 4 | NS | Smooth; Oily |
| | | Require two spool when it is in used |
| 5 | HA | Smooth; Slippery |
| | | Because of its structure, it is often used as curly hair yarn. |

As it can be seen in Table 4.3 above that all variants of hair yarn have similar criteria. However, it is known that not all of hair yarn requires the same amount of spool when it is used which depends on the thickness of hair yarn. Also, in Table 4.3 above it state that only KB and HA that often use as raw material to be delivered to curling process since the structure is appropriate to be curled. All of selected hair yarn and painted head come from Research and Development (R&D) department, which located in USA then deliver to all department at PT. X Indonesia. Each toy may consist of single color or multicolor within different type of hair yarn also.

Afterward, data of 40 toys being reviewed on the combination between type of hair yarn and head type are shown in Table 4.4 below.

**Table 4.4 List of Toy Number and Hair Yarn**

| No | Toy Head Type | Hair Yarn Type | Total Color | No | Toy Head Type | Hair Yarn Type | Total Color |
|---|---|---|---|---|---|---|---|
| 1 | A | PP | Multi Colors | 9 | I | HA | Single Color |
| 2 | B | KB | Single Color | 10 | J | HA | Single Color |
| 3 | C | KF | Single Color | 11 | K | HA | Multi Colors |
| 4 | D | NS+KB | Multi Colors | 12 | L | KB | Single Color |
| 5 | E | NS | Multi Colors | 13 | M | NS | Multi Colors |
| 6 | F | KB | Single Color | 14 | N | HA | Single Color |
| 7 | G | KF | Single Color | 15 | O | HA | Multi Colors |
| 8 | H | HA | Single Color | 16 | P | HA | Single Color |

**Table 4.4 List of Toy Number and Hair Yarn (Continued)**

| No | Toy Head Type | Hair Yarn Type | Total Color | No | Toy Head Type | Hair Yarn Type | Total Color |
|---|---|---|---|---|---|---|---|
| 17 | Q | HA | Single Color | 29 | CC | HA | Single Color |
| 18 | R | KB | Single Color | 30 | DD | PP | Multi Colors |
| 19 | S | NS | Multi Colors | 31 | EE | NS+KF | Multi Colors |
| 20 | T | KF | Single Color | 32 | FF | HA | Single Color |
| 21 | U | KB | Single Color | 33 | GG | NS | Single Color |
| 22 | V | KB | Single Color | 34 | HH | KB | Multi Colors |
| 23 | W | HA | Multi Colors | 35 | II | HA | Multi Colors |
| 24 | X | PP | Multi Colors | 36 | JJ | HA | Multi Colors |
| 25 | Y | NS | Multi Colors | 37 | KK | KF | Multi Colors |
| 26 | Z | HA | Multi Colors | 38 | LL | KF | Multi Colors |
| 27 | AA | HA | Multi Colors | 39 | MM | NS | Single Color |
| 28 | BB | HA | Multi Colors | 40 | NN | KB | Single Color |

As it can be seen on Table 4.4 that most of the toy using HA as its hair yarn. It is also known that there are toys that have two different types of hair yarn in one head for multicolors by way of example which is toy head type D and EE, but there are also possible to toy for having only one hair yarn eventhough it is multi colors. After receiving master data from R&D Department, IE Secondary department usually will make a program of auto rooting and create a prototype in piloting process to identify any problem that occur during piloting process.

### 4.2. Problem Identification

After done in initial observation, the next step is problem identification. Problem identification is including defect, variation of hair yarn, sampling inspection and rework at auto rooting area. The explanation of each category is elaborated in this section below.

During the observation, it is found that there are several types of defect that occur in auto rooting area. To continue this observation, analyzing and reviewing data of auto rooting in September-November 2016 and 40 different toys are being observed within the total output and total the most defects that often occur in auto rooting process area. The data is formed in the Table 4.5 below.

**Table 4.5 Number of Output and Defect Auto Rooting in September-November 2016**

| No | Toy Head | Total Output | Number of Defect | | | | | | | | Total Defect |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MLn | O | T | BN | BW | MS | PL | S | |
| 1 | A | 1,408,982 | 25 | 0 | 100 | 11 | 45 | 560 | 0 | 33 | 649 |
| 2 | B | 102,681 | 0 | 110 | 760 | 202 | 63 | 1,536 | 0 | 26 | 2,798 |
| 3 | C | 100,306 | 0 | 4 | 0 | 8 | 11 | 431 | 0 | 49 | 499 |
| 4 | D | 87,539 | 0 | 5 | 350 | 100 | 80 | 427 | 0 | 294 | 1,347 |
| 5 | E | 82,824 | 6 | 0 | 13 | 24 | 0 | 425 | 0 | 10 | 483 |
| 6 | F | 70,831 | 0 | 0 | 869 | 35 | 0 | 1,258 | 0 | 33 | 2,338 |
| 7 | G | 65,579 | 0 | 30 | 345 | 28 | 0 | 289 | 0 | 47 | 909 |
| 8 | H | 62,976 | 0 | 2 | 289 | 10 | 0 | 638 | 0 | 20 | 1,007 |
| 9 | I | 59,079 | 0 | 23 | 1,090 | 1,006 | 15 | 1,581 | 0 | 33 | 5,708 |
| 10 | J | 58,023 | 0 | 11 | 698 | 885 | 47 | 1,456 | 0 | 50 | 4,417 |
| 11 | K | 57,097 | 46 | 6 | 425 | 74 | 2 | 585 | 0 | 29 | 1,727 |
| 12 | L | 55,950 | 0 | 2 | 568 | 19 | 25 | 923 | 2 | 7 | 2,245 |
| 13 | M | 54,889 | 0 | 0 | 769 | 152 | 11 | 585 | 0 | 9 | 1,663 |
| 14 | N | 51,245 | 0 | 42 | 798 | 865 | 99 | 749 | 0 | 85 | 2,856 |
| 15 | O | 44,405 | 0 | 0 | 0 | 8 | 0 | 528 | 0 | 6 | 542 |
| 16 | P | 39,021 | 0 | 0 | 89 | 4 | 0 | 300 | 0 | 3 | 396 |
| 17 | Q | 35,862 | 0 | 0 | 345 | 248 | 0 | 843 | 0 | 43 | 1,676 |
| 18 | R | 34,823 | 10 | 7 | 890 | 16 | 16 | 1,008 | 0 | 57 | 2,461 |
| 19 | S | 30,669 | 0 | 0 | 2 | 2 | 0 | 104 | 0 | 30 | 138 |
| 20 | T | 30,160 | 0 | 0 | 245 | 16 | 18 | 720 | 0 | 125 | 1,190 |
| 21 | U | 29,275 | 0 | 0 | 413 | 3 | 0 | 560 | 0 | 17 | 1,389 |
| 22 | V | 28,454 | 0 | 0 | 658 | 270 | 0 | 362 | 0 | 16 | 1,498 |
| 23 | W | 27,713 | 0 | 15 | 659 | 196 | 0 | 580 | 0 | 0 | 1,585 |
| 24 | X | 27,200 | 16 | 0 | 759 | 50 | 49 | 758 | 0 | 49 | 1,865 |
| 25 | Y | 27,038 | 0 | 2 | 112 | 54 | 331 | 1,031 | 0 | 280 | 1,915 |
| 26 | Z | 26,238 | 0 | 0 | 485 | 66 | 21 | 755 | 0 | 43 | 1,685 |
| 27 | AA | 24,981 | 0 | 0 | 92 | 14 | 18 | 356 | 0 | 10 | 503 |
| 28 | BB | 23,360 | 0 | 0 | 91 | 22 | 36 | 506 | 0 | 49 | 704 |
| 29 | CC | 21,479 | 0 | 0 | 0 | 10 | 16 | 174 | 0 | 9 | 209 |
| 30 | DD | 19,104 | 0 | 0 | 0 | 4 | 7 | 260 | 0 | 0 | 271 |
| 31 | EE | 17,939 | 0 | 0 | 85 | 6 | 0 | 380 | 0 | 14 | 538 |
| 32 | FF | 15,670 | 0 | 206 | 528 | 20 | 241 | 901 | 0 | 190 | 2,585 |
| 33 | GG | 15,044 | 17 | 0 | 268 | 101 | 554 | 532 | 0 | 1,420 | 3,072 |
| 34 | HH | 14,152 | 17 | 0 | 659 | 669 | 248 | 1,819 | 0 | 264 | 4,581 |
| 35 | II | 14,395 | 23 | 112 | 214 | 278 | 351 | 930 | 0 | 302 | 2,417 |
| 36 | JJ | 10,695 | 0 | 1 | 754 | 791 | 29 | 1,412 | 0 | 46 | 3,742 |
| 37 | KK | 10,147 | 0 | 4 | 125 | 141 | 50 | 716 | 0 | 32 | 1,068 |
| 38 | LL | 6,331 | 20 | 10 | 450 | 272 | 272 | 914 | 0 | 374 | 2,522 |
| 39 | MM | 1,837 | 0 | 46 | 432 | 154 | 444 | 476 | 0 | 481 | 2,138 |
| 40 | NN | 650 | 0 | 0 | 825 | 3 | 131 | 448 | 0 | 121 | 1,711 |
| Total | | | 180 | 638 | 16,254 | 6,837 | 3,230 | 28,816 | 2 | 4,732 | 2,985,003 |

Table 4.5 above shows the amount number of each defect that often occur at auto rooting process area. Those eight defects are MLn (Mold Line), O (Others), T (Tangled), BN (Broken Needle), BW (Broken Wall), MS (Missing Stitches), PL (Part Line) and S(Scrap). Actually during the observation it is known that those defect might be has relation each other. For instance like broken needle defect which is caused by tangle hair yarn, where tangle hair yarn also could possible to cause missing stiches, thus overcoming missing stitches issue has two options which are rework or scrap.

During the observation, it is found that there is not only tangled hair yarn which cause the missing stitches, but also other related external factor whether it is from the machine error or even human error. Table 4.6 below provide the information of the percentage of each total defect.

**Table 4.6 Total and Percentage of Total Output**

| No | Type of Defect | Total Defect | Percentage Defect Out of Total Output | Percentage Defect Out of Total Defect |
|---|---|---|---|---|
| 1 | Mold Line | 180 | 1% | 0.25% |
| 2 | Others | 638 | 2% | 0.91% |
| 3 | Tangled | 16,254 | 56% | 23.23% |
| 4 | Broken Needle | 6,837 | 24% | 9.77% |
| 5 | Broken Wall | 3,230 | 11% | 4.61% |
| 6 | Missing Stitches | 28,816 | 96% | 40% |
| 7 | Part Line | 2 | 0% | 0% |
| 8 | Scrap | 4,732 | 16% | 6.76% |
| Total Output | | 2,985,003 | | |
| Total Defect | | 69,949 | | |

Table 4.6 above shows the total of 40 toys has the same period of production running yet it has different number of defect. It can be seen from Table 4.6 above that the highest amount of defect goes to missing stitches that has 39.62% out of 69,949 total defect, then following tangle which has number at 23,23% out of total defect. Broken needle in the number of 9.77%, scrap in the number of  out of production, broken wall at 4.61%. Then the rest of defect which are others, mold line and part line only has 0.91%, 0.25% and 0% out of total production. Pareto chart is made to shows the difference among all of defect shown as Figure 4.5.

Figure 4.5 above shows Pareto chart of defect auto rooting in September-November 2016. As it can be seen that the highest number of defect goes to missing stitches which have 46.5% from amount of output in the auto rooting process. The second highest number of the defect is tangled which has 27.3% from the overall output of auto rooting process, then followed by a broken needle in 11.5% of output, scrap 7.9% of total output, broken wall in 5.4%.

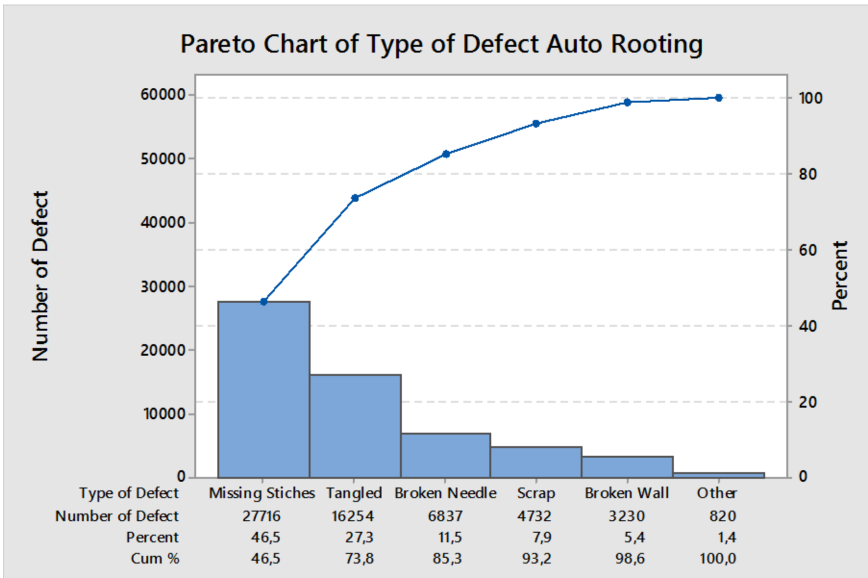



**Figure 4.4 Pareto Chart of Defect Auto Rooting in September-November 2016**

From Figure 4.4 above, it can be seen that the significant difference number of defect happened to other defect which only has 2% defect of total output, mold line in 1% number of total output, and part line which only happened in number of 2 among 2.985.003 of total output, which can be considered that there is 0% of defect part line in auto rooting in September-November 2016. Thus, by seeing this current situation it is identified that missing stitches has been the biggest issue in auto rooting stitches that occur not also on the latest three months but since many years ago when full auto rooting machine was developed which is around the year of 2006. Hence, any other further identification, analysis and improvement will be focused on missing stitches only.

Actually, not all of missing stitches does occur in a major defect condition. Some of rooted head just loose ten up to twenty hair yarn during the process. Yet, it still considered as defect that need to be rework. Figure 4.6 below shows the major defect that occur at rooted head.


**Figure 4.5 Example of Missing Stitches Defect in Auto Rooting Process**

Figure 4.5 above is an example of missing stitches that occur in auto rooting process which classified to major defect. If missing stitches does occur to the rooted head, there are two options will be chosen, whether it is rework or scrap. An operator who runs the machine makes the decision. If it is rework, then it will be sent to rework area which done by another operator by using the manual machine. If it is scrap, then the rooted head no longer can be used.

During the observation, a test is conducted in order to know the highest cause of missing stitches. Throughout 60 samples of three different toys, it is found that painted head in the number of 56% cause the highest percentage of missing stitches, while the rest which is 44% is caused by tangle hair yarn. Thus further analysis is conducted in order to find the proper treatment of this case which explain in the next chapter.

### 4.3 Analysis Current System

After collect and review all of related data in this research, then the next step is analyzing all data. In this research, data analysis is about analyzing the root cause of missing stiches in every possible aspect, thus proposed action and improvement will be defined later. Data analysis is elaborated as following below.

#### 4.3.1 Inspection Time and Cost Allocation

As mentioned in early chapter that there is a sample inspection which is the responsible of QC from IE Primary. The average time that needed by one operator to weighted one head is three minutes as two minutes go to weigher from machine area, one minutes to weigh the head and record the data. Since operator immediately took three of the samples, then the total average time that needed by one operator is five minutes. There are 5 operators that being assigned to weigh the sample.

There are 25 existing machines in Rotocast. One operator has to handle five machines. These machines are being operated based on the type of toy. There is no existing specific calculation of number to weigh. Thus, during observation, below is the simple calculation to calculate time for sample inspection;

Assume that there are five toys that being produced in a day, thus total time for one operator to weigh the three of the heads are 17 minutes. Thus five operator means need 85 minutes that calculated from 17 minutes multiplied by five operators. Assume that there are five toys that being produced in a day, means that the overall time needed for doing this inspection is 425 minutes or equal to seven hours a day.

Meanwhile, as mentioned before that there are five operators who currently checking the painted head which by doing sample inspection. Thus, based on average amount of wages in PT. X, each operator has to pay IDR 5.000.000 per operator per month which means IDR 25.000.000 per month has to be paid for the operator who is assigned as an inspector in roto cast area.

### 4.3.2 Rework Time and Cost Allocation

In the previous section, it stated that there are a lot of missing stitches defect in auto rooting process, which is 28,816 among 2,985,003 of output towards 40 different toys. During the observation it is found that there is 10.924 rooted head was scrap and the rest which are 17,892 is rework. Condition of scrap that happened to missing stitches is different with scrap that listed in Table 4.2. Scrap in defect auto rooting machine caused by the different long of the hair yarn between all the stitches, condition where the hair yarn is out of the mold line, and the stitches of toy head is too close each other. This condition is checked by operator.

Total required time needed to finish the rework is 11 days. This number comes from average calculation from rework process. It is recorded that there is 8 operators who does rework toward defect rooted head, and each of them in general is able to finish 200 rooted head each day. Then 17,892 divided by 1,600 is equal to 11.18 days, which means that it takes around 11 days for management to finish all of those rework. As the remarks of this calculation is there are not only 40 toys that being produced for three months. As it can be seen in previous Figure 4.3 that there are eight machines that being used by auto rooting machine team management to do rework towards all of the defect product from auto rooting process.

Actually, manual rooting machine has a similar look with a sewing machine, manual rooting machine is being operated by one operator, means also that there are eight operators per month who are assigned to do rework in a normal season. Thus, by referring to this situation, PT. X has to pay IDR 40.000.000/month towards all of the operator who does rework of defect auto rooting machine.

Meanwhile for scrap product, PT MTI loses IDR 11,200 per toy head. This costs an accumulation for all process that the head been through and creating like rotocast process, painting process, and rooting process. The accumulation cost also includes the raw material, depreciation machine, salary of the operator and the other related cost toward the rooted head. Thus, in the amount of 10,924 defects scrap, PT. X lose IDR 122,348,800 for the raw material of head toy itself for three months which is September-November 2016. Assume that amount of scraps is all equal for latest three months from September-November 2016, thus PT. X must pay IDR 80,782,933/month.

### 4.3.3 Analysis of Current Maintenance in Auto Rooting Machine

As auto rooting machine is the main tool in the process, PT. X currently has a Preventive Maintenance (PM) check list for Full Auto Rooting Machine (FAR). Current PM FAR schedule will be conducted every day with six machines per day. In 229 number of FAR machine, means that one machine will have PM checked for once in six weeks. PM check list is available on table which inspected by FAR's technician and approval from production supervisor or section leader at auto rooting area. Current format of PM check list FAR machine is provided in Figure 4.6 below:

**PM CHECK LIST - FULL AUTO ROOTING**

M/C No :
Date :
Shift :

Mekanik :
Kpk :
Mulai :
Selesai :

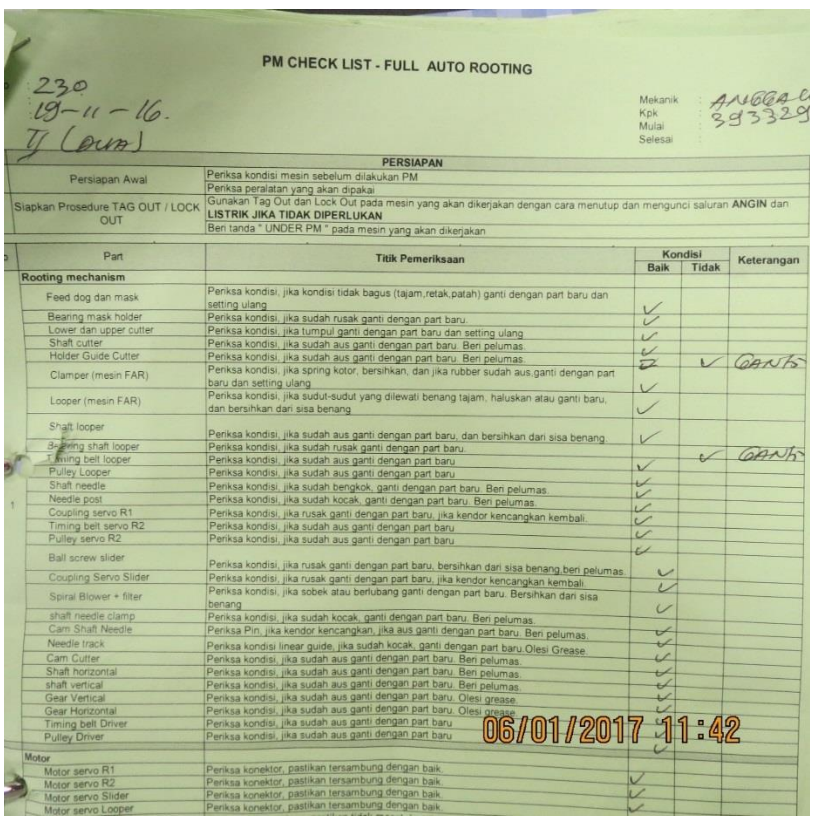
| No. | PERSIAPAN | |
|---|---|---|
| 1 | Persiapan Awal | Periksa kondisi mesin sebelum dilakukan PM |
| | | Periksa peralatan yang akan dipakai |
| 2 | Siapkan Prosedure TAG OUT / LOCK OUT | Gunakan Tag Out dan Lock Out pada mesin yang akan dikerjakan dengan cara menutup dan mengunci saluran **ANGIN** dan **LISTRIK JIKA TIDAK DIPERLUKAN** |
| | | Beri tanda " UNDER PM " pada mesin yang akan dikerjakan |

| No | Part | Titik Pemeriksaan | Kondisi | | Keterangan |
|---|---|---|---|---|---|
| | | | Baik | Tidak | |
| | **Rooting mechanism** | | | | |
| | Feed dog dan mask | Periksa kondisi, jika kondisi tidak bagus (tajam,retak,patah) ganti dengan part baru dan setting ulang | | | |
| | Bearing mask holder | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| | Lower dan upper cutter | Periksa kondisi, jika tumpul ganti dengan part baru dan setting ulang | | | |
| | Shaft cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Holder Guide Cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Clamper (mesin FAR) | Periksa kondisi, jika spring kotor, bersihkan, dan jika rubber sudah aus,ganti dengan part baru dan setting ulang | | | |
| | Looper (mesin FAR) | Periksa kondisi, jika sudut-sudut yang dilewati benang tajam, haluskan atau ganti baru, dan bersihkan dari sisa benang | | | |
| | Shaft looper | Periksa kondisi, jika sudah aus ganti dengan part baru, dan bersihkan dari sisa benang. | | | |
| | Bearing shaft looper | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| | Timing belt looper | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Pulley Looper | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Shaft needle | Periksa kondisi, jika sudah bengkok, ganti dengan part baru. Beri pelumas. | | | |
| 1 | Needle post | Periksa kondisi, jika sudah kocak, ganti dengan part baru. Beri pelumas. | | | |

**Figure 4.6 Current Preventive Maintenance Check List-FAR**

Figure 4.6 above shows the form of PM check list-FAR which actually has more listed variables to be checked. Form is available on Bahasa and it include the machine number, date, shift, mechanic (technician), KPK (identity number of the technician), time to start and finish to check the machine condition. There is also a preparation instruction before start the PM check list. Complete PM Check list-FAR is available on Appendix 4.

In PM check list-FAR, column part is divided into major part in machine, then each part is given the information about the checking point of the part. Technician has to put a mark on the column number three and four as the sign of part condition whether it is in good or not good condition based on explanation from column number two while in the last column there is remark column to give any remarks towards the condition of the part. Figure 4.7 below shows the form that filled put by FAR technician.


PM CHECK LIST - FULL AUTO ROOTING

: 230
: 19-11-16.

Mekanik :
Kpk :
Mulai :
Selesai :

| PERSIAPAN | |
|---|---|
| Persiapan Awal | Periksa kondisi mesin sebelum dilakukan PM |
| | Periksa peralatan yang akan dipakai |
| Siapkan Prosedure TAG OUT / LOCK OUT | Gunakan Tag Out dan Lock Out pada mesin yang akan dikerjakan dengan cara menutup dan mengunci saluran **ANGIN** dan **LISTRIK JIKA TIDAK DIPERLUKAN** |
| | Beri tanda " UNDER PM " pada mesin yang akan dikerjakan |

| Part | Titik Pemeriksaan | Kondisi | | Keterangan |
|---|---|---|---|---|
| | | Baik | Tidak | |
| **Rooting mechanism** | | | | |
| Feed dog dan mask | Periksa kondisi, jika kondisi tidak bagus (tajam,retak,patah) ganti dengan part baru dan setting ulang | ✓ | | |
| Bearing mask holder | Periksa kondisi, jika sudah rusak ganti dengan part baru. | ✓ | | |
| Lower dan upper cutter | Periksa kondisi, jika tumpul ganti dengan part baru dan setting ulang | ✓ | | |
| Shaft cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | ✓ | | |
| Holder Guide Cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | ✓ | GANTI |
| Clamper (mesin FAR) | Periksa kondisi, jika spring kotor, bersihkan, dan jika rubber sudah aus,ganti dengan part baru dan setting ulang | ✓ | | |
| Looper (mesin FAR) | Periksa kondisi, jika sudut-sudut yang dilewati benang tajam, haluskan atau ganti baru, dan bersihkan dari sisa benang | ✓ | | |
| Shaft looper | Periksa kondisi, jika sudah aus ganti dengan part baru, dan bersihkan dari sisa benang. | ✓ | | |
| Bearing shaft looper | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| Timing belt looper | Periksa kondisi, jika sudah aus ganti dengan part baru | | ✓ | GANTI |
| Pulley Looper | Periksa kondisi, jika sudah aus ganti dengan part baru | ✓ | | |
| Shaft needle | Periksa kondisi, jika sudah bengkok, ganti dengan part baru. Beri pelumas. | ✓ | | |
| Needle post | Periksa kondisi, jika sudah kocak, ganti dengan part baru. Beri pelumas. | ✓ | | |
| Coupling servo R1 | Periksa kondisi, jika rusak ganti dengan part baru, jika kendor kencangkan kembali. | ✓ | | |
| Timing belt servo R2 | Periksa kondisi, jika sudah aus ganti dengan part baru | ✓ | | |
| Pulley servo R2 | Periksa kondisi, jika sudah aus ganti dengan part baru | ✓ | | |
| Ball screw slider | Periksa kondisi, jika rusak ganti dengan part baru, bersihkan dari sisa benang,beri pelumas. | ✓ | | |
| Coupling Servo Slider | Periksa kondisi, jika rusak ganti dengan part baru, jika kendor kencangkan kembali. | ✓ | | |
| Spiral Blower + filter | Periksa kondisi, jika sobek atau berlubang ganti dengan part baru. Bersihkan dari sisa benang | ✓ | | |
| shaft needle clamp | Periksa kondisi, jika sudah kocak, ganti dengan part baru. Beri pelumas. | ✓ | | |
| Cam Shaft Needle | Periksa Pin, jika kendor kencangkan, jika aus ganti dengan part baru. Beri pelumas. | ✓ | | |
| Needle track | Periksa kondisi linear guide, jika sudah kocak, ganti dengan part baru.Olesi Grease. | ✓ | | |
| Cam Cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | ✓ | | |
| Shaft horizontal | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | ✓ | | |
| shaft vertical | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | ✓ | | |
| Gear Vertical | Periksa kondisi, jika sudah aus ganti dengan part baru. Olesi grease. | ✓ | | |
| Gear Horizontal | Periksa kondisi, jika sudah aus ganti dengan part baru. Olesi grease. | ✓ | | |
| Timing belt Driver | Periksa kondisi, jika sudah aus ganti dengan part baru | ✓ | | |
| Pulley Driver | Periksa kondisi, jika sudah aus ganti dengan part baru | ✓ | | |
| **Motor** | | | | |
| Motor servo R1 | Periksa konektor, pastikan tersambung dengan baik. | ✓ | | |
| Motor servo R2 | Periksa konektor, pastikan tersambung dengan baik. | ✓ | | |
| Motor servo Slider | Periksa konektor, pastikan tersambung dengan baik. | ✓ | | |
| Motor servo Looper | Periksa konektor, pastikan tersambung dengan baik. | | | |

06/01/2017 11:42

**Figure 4.7 Result of PM Check List-FAR**

Figure 4.8 above shows the result of PM check list-FAR that was done by one of technician at auto rooting area. As can be seen that technician only put a sign in column three and four, while in the last column technician put a remarks regarding to the condition of each part.

### 4.3.4 Analysis of Hair Yarn Type and Painted Head

As mentioned before that there was an issue occur at PT. X when there is unmatch type between hair yarn and painted head that leads to high number of missing stitches defect, so that management have to change the design of the hair yarn into curl as the first design was straight hair yarn. Surely this action takes time because management has to wait the approval from R&D Department. Referring to this situation, an analysis towards 40 the hair yarn and painted head is conducted. The result of analysis is formed in the Table 4.7 below:

**Table 4.7 List of Toy Head Type, Hair yarn Type and Percentage of Defect**

| **No** | Sculpt | Toy Head Type | Hair Yarn Type | % of Defect | **No** | Sculpt | Toy Head Type | Hair Yarn Type | % of Defect |
|---|---|---|---|---|---|---|---|---|---|
| **1** | B58 | II | HA | 38% | **21** | DMD | Z | HA | 45% |
| **2** | B58 | KK | KF | 67% | **22** | DNV | DD | PP | 93% |
| **3** | CFF | B | KB | 0.5% | **23** | K83 | N | HA | 26% |
| **4** | CFF | D | NS+KB | 32% | **24** | K83 | T | KF | 61% |
| **5** | CFF | F | KB | 0.54% | **25** | K83 | LL | KF | 36% |
| **6** | CFF | L | KB | 41% | **26** | K83 | C | KF | 86% |
| **7** | CFF | Y | NS | 0.54% | **27** | K83 | G | KF | 32% |
| **8** | CFF | NN | KB | 26% | **28** | N549 | O | HA | 94% |
| **9** | CFF | I | HA | 0.28% | **29** | N954 | W | HA | 37% |
| **10** | CFF | J | HA | 0.33% | **30** | PY2 | GG | NS | 17% |
| **11** | CFF | R | KB | 0.41% | **31** | PY2 | HH | KB | 0.40% |
| **12** | CDH | P | HA | 55% | **32** | PY2 | JJ | HA | 0.38% |
| **13** | CHD | CC | HA | 83% | **33** | T74 | EE | NS+KF | 61% |
| **14** | CHW | X | PP | 41% | **34** | V05 | Q | HA | 50% |
| **15** | DGY | FF | HA | 0.54% | **35** | V05 | V | KB | 24% |
| **16** | DKB | AA | HA | 71% | **36** | V05 | U | KB | 44% |
| **17** | DKR | E | NS | 88% | **37** | W39 | MM | NS | 22% |
| **18** | DLT | A | PP | 38% | **38** | W91 | M | NS | 35% |
| **19** | DLT | H | HA | 67% | **39** | W91 | S | NS | 75% |
| **20** | DMD | K | HA | 0.5% | **40** | Y77 | BB | HA | 72% |

Table 4.7 above provide the data percentage of defect along with the usage of hair yarn for each sculpt and each type. As can be seen that there is find a various different number of defect for each toy head even within the same sculpt and hair yarn. By way of example, toy R and toy L are using the same type of hair yarn and both of this toy basically has the same sculpt. But, there is a huge number of defect that occur in both of toys. Toy R has only 0.41% defect, meanwhile toy L has 41% of defect.

### 4.3.4 Analyzing Root Cause

Analyzing root cause of missing stitches was begun from knowing the components that are used for the process of auto rooting itself. The outline of the process is man, material and machine. Each of this component have secondary component. To analyze the root cause of each aspect in detail, one of seven quality tools is used which is fishbone diagram. Fishbone diagram of missing stitches can be seen in Figure 4.9 below.

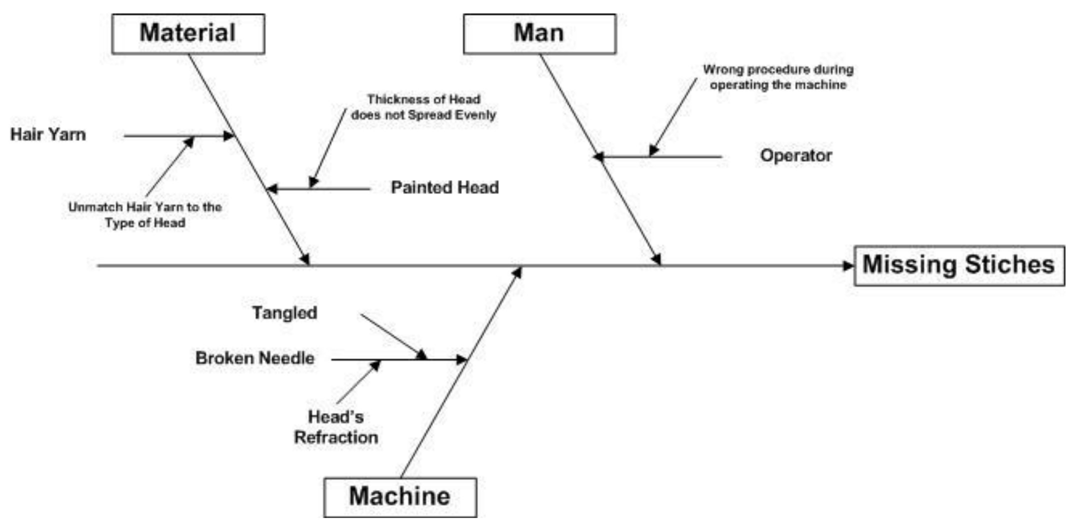



**Figure 4.8 Fishbone Diagram of Root Cause of Missing Stitches**

Figure 4.8 above shows the fishbone diagram of root cause of missing stitches in auto rooting machine. Figure 4.8 above consists of the main cause of the problem within each secondary cause. As can be seen that there are three main causes of missing stitches, they are material, man and machine wit each secondary cause. The brief detail explanation will be elaborated below.

The first cause of missing stiches is material in two aspects which are painted head and hair yarn. The caused of painted head means the thickness of the painted head does not spread evenly. The correlation between this case and missing stitches is if at certain area of the painted head has different thickness than the others, means that the refraction of the area will different than the others. This case will cause the needle can not go through the head at all, so that there will be no hair yarn on the painted head or known as missing stiches. Actually, for current system it has been set that there is a sample inspection as responsibility of IE Primary at rotocast process as the first step of creating toy head. This sample inspection is obtained for every hours per toy per machine in amount of three heads. IE primary will weight those three samples based on the standard requirement of each toy that already determined by quality department in accordance to the basic data from Research and Development (R&D) department. Each toy has different standard requirement of weight.

Basically, weighing toy head is related to the refraction of the head. PT. X found that a certain refraction could be met at certain weight of toy head. This decision was made because there is no proper way to check the equality of the refraction at overall surface of toy head unless only aesthetic way. Thus, PT. X find a way to meet the closest matter to overcome this issue which is weigh the toy head was selected through sample inspection. This sample inspection is actually proper to roto cast process itself but it brings another problem to the next process which is rooting process.

Another cause from material that is hair yarn where it is found unmatched type or variants of hair yarn to the type of painted head. A case was occur when there is a high number of missing stitches at one type of toy head even it still on piloting process. After analyzing he root cause, it is found that the hair yarn of the head was to smooth, while the head is so hard. Thus, there are two options to overcome this issue at that time, the first one is changing the type of the hair yarn or the second one is changing the design of the hair yarn that currently was straight. Management decided to changing the design of the hair yarn to curl hair yarn after got approval from research and development department that located in USA.

The second main cause of missing stitches is machine. At machine, it has only one secondary cause which are broken needle. Broken needle caused by tangled and head's refraction. Tangled is a condition where the hair yarn is crumpled and often occur in curly hair yarn. Eventually there already put a sensor for tangled hair yarn but tangled hair yarn might be occur after the hair yarn pass the sensor or occur when it is on process of hair yarn making. If the hair yarn is tangled, it can cause broken needle. In a simple way actually it does not really matter, but since there is a pressure from the machine to the hair yarn, thus the hair yarn caused broken needle.

Broken needle also caused by the refraction of the head that already elaboraed in previous case which is material. Thus the correlation between these two things is if the refraction of the toy head is too hard, thus the needle will be broken and when it is broken then it will be caused missing stitches.

For needle of the machine itself, management has not set yet the exact schedule of changing the needle. Eventually there is a maintenance system of the machine including the needle itself, yet the inspector only checking the condition of the needle without considering any schedule of changing the needle.

The last main cause of missing stitches is man which is the operator who operate the machine. PT. X as the biggest producer toy in the worldwide needs big amount of operator to support the management system. With the exception of the operator who responsible to work in the line production and finish the whole part of the the toy, there are operators who work only at the certain area of the production. One of the example is operator at auto rooting process. As known that there are 130 machines that being operated among 229 machines. Actually there are no problem if the machines are only used for 130, but when it comes to the peak season, PT. X often use all of the machine to meet the market demand. By adding number of active machine to be used, means that additional operators are needed.

In current system, PT. X usually take the operator from another process area except from line production itself. This case could lead to defect of missing stitches at auto rooting area because the operator is untrained yet. The operators do not understand yet about the procedure, the right step and the process of auto rooting itself. Thus, some of them will be caused the missing stiches or known as human error.

Based on the explanation above, it can be concluded thatto overcome this issue, it can not the treated by the same treatment since there are three main causes of this prolem and each of this cause has different problem background. Below is some approaches formed in Table 4.8 that might possible to be executed to overcome this issue.

**Table 4.8 List of Proposed Improvement**

<table>
<tr><th>No</th><th colspan="2">Root Cause</th><th>Improvement</th><th>Execution</th></tr>
<tr><td rowspan="5">1</td><td rowspan="5">Material</td><td rowspan="2">Painted Head</td><td>Fixing molding machine at rotocast process</td><td>No</td></tr>
<tr><td>100% inspection</td><td>Yes</td></tr>
<tr><td rowspan="3">Hair Yarn</td><td>Changing type of hair yarn</td><td>No</td></tr>
<tr><td>Changing type of painted head</td><td>No</td></tr>
<tr><td>Standardization</td><td>Yes</td></tr>
<tr><td>2</td><td>Machine</td><td>Broken Needle</td><td>Regular Inspection</td><td>Yes</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Man</td><td rowspan="2">Operator</td><td>Recruit new worker</td><td>No</td></tr>
<tr><td>Training existing workers</td><td>Yes</td></tr>
</table>

In accordance to table 4.8 above, it can be seen that there are several possible improvements towards each root cause in order to reduce number of missing stitches defect at auto rooting process area. By way of example, in order to overcome the issue that come from painted head there are two proposed improvements that can be executed which are fixing molding machine at rotocast process or doing 100% inspection. Doing 100% inspection at rotocast are is being choosen because fixing molding machine is no longer the area of IE secondary. Mean while there are three options which are proposed in order to overcome this issue. They are changing both of the hair yarn and type of head when a certain problem just occur and creating a standarization for hair yarn and head toy. The decision is made toward standarization between hair yarn and toy head to avoid any problem that migh be happened.

As the machine only has one root cause which is broken needle, yet actually the brokem needle caused by the material also, then an improvement is made towards the inspection of the needle which is doing regular inspection. And the last one is man which means operator, and there are two options are proposed they are recruit new operator and training existing machine. The decision is made towards the second one, since the first one will increase the cost that should be paid by PT. X. In order to execute those selected proposed improvements, the proper way is being formed in the Table 4.9 below:

**Table 4.9 Method List of Executing Proposed Improvement**

| Root Cause | | Selected Proposed Improvement | How to Execute |
|---|---|---|---|
| Material | Painted Head | Doing 100% Inspection | Operator Weigh every single output from rotocast area by operator and make a SOP. |
| | Hair Yarn | Standardization | Creating a standard pair between toy head and hair yarn |
| Machine | Broken Needle | Regular inspection | Doing a regular inspection by changing needle FAR machine once in a two weeks and make a SOP. |
| Man | Operator | Training existing workers | Conducting a training towards the exchange operator from other department and make module training |

From Table 4.9 above, it can be seen the way to execute the selected proposed improvement. Before implementing the proposed improvement, those methods will pass trial and error stage in order to analyze the result. The detail of the way to execute the improvement along with each analysis will be discussed in the next sub chapter.

### 4.4 Proposed Improvement

In previous chapter, it already discusses the most proper improvement towards the issue of missing stitches that form in Table 4.8 and explain briefly in Table 4.9. Thus, the more detail step and explanation from proposed improvement is elaborated below.

### 4.4.1. Proposed Improvement in Material

Refering to Table 4.8 and Table 4.9 in previous section, it state that the final decisions in material are doing 100% inspection towards the head at roto cast process before it delivers to painting process then rooting process and the second one is creating a standarization between painted head and hair yarn. The detail and steps is elaborated below;

#### 4.4.1.1. Proposed Improvement on Painted Head

As mentioned before that 100% inspection is conducted to overdome the issue through painted head. 100% inspection is a process that rarely used in common manufacturing company, since it takes a big effort to be executed. In this case, executing 100% inspection is done through PDCA cycle as the perimeter of the continuous improvement. The background to decide doing 100% inspection is because there are high number of defect that occur in auto rooting area and it is found that 56% of defect caused by toy head. As rotocast process is the first process of producing toy head, thus a big concern goes to the output.

In current system, five operators assigned to weight toy head in rotocast area. These five operators are able to handle 17 manual machines in rotocast area and doing sample inspection for three sample of the output per hour. Thus, in 100% inspection also applied for manual machines only since.

Executing 100% inspection in rotocast area means adding number of operator, tools and time as the main major milestone of the improvement. The detail procedures and additional number of operator is explaining in the next sub topic.

**A. Procedure of 100% Inspection**

As mentioned that there is only the output of manual machine that being inspected. In one machine there are two cycle time per hour per machine and each cycle time produce 50 output, means that there are 100 output that need to be weighted.

In this case, 100% inspection is done in a four simple ways for the operator. Figure below represent the main procedure of doing 100% inspection in rotocast area.

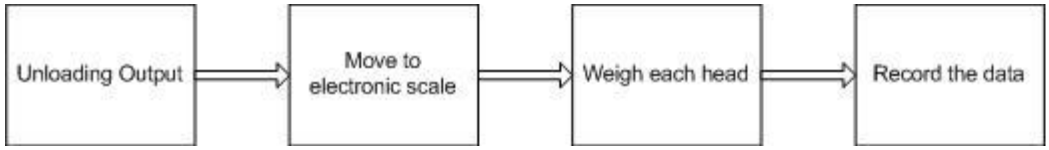



**Figure 4.9 Procedure for Doing 100% Inspection**

In Figure 4.9 above, it can be seen that there are four main process in doing 100% inspection towards the output of rotocast process The detail is elaborated in these points below:

a. Unloading Output

The first thing that should be done in doing 100% inspection is taking off all of the output or known as unloading output from the machine and put it into nearest available basket. There will be two unloading activities in one machine as there are two cycle time for each.

b. Move to the electronic scale

After unloading all output of rotocast process, then move it into electronic scale which available in one side of the machine. Move the output to available basket. In this step, operator who assigned to do this work have to ensure that all output of the machine will be moved to the electronic scale.

c. Weigh each of the head

This is the the keynote along all of the steps, which is weighted each head one by one and ensure that the weight for every single head meet the standard requirement for every toy. If the head meet the standard requirement, then the operator put it on the nearest available basket around them, otherwise if the head does not meet standard requirement, thus put it on another basket.

Since PT MTI own an electronic scale which allow the user to set standard weight, so it will be easier for them to separate the good product and reject product without any waste movement.

d. Record all of data

The last step is that record the amount of head, whether it meets the standard weight requirement for each toy or not. Operator has to ensure that the none of the output is missed to be checked. If there is any head that does not meet the standard requirement, then consider it as rejection. Thus, record the result in provided form as a database for management. After checking all of toy, move it to the storage in the left side of rotocast area.

Additional information, there will be a different operator who executes each procedure Operator number one is responsible only to unloading and move the output and move the result of 100% inspection. This operator must be mobile in whole rotocast area. While operator who do process number three and four is just staying to weight and record the result of 100% inspection.

As there is an activity of recording data in the last process of 100% inspection, thus a form is needed in order to help the operator record the data easily. The form should be designed simply to prevent wasting time when fulfill the form. The form should consist of main data that facilitate the user to manage the data well and help to do any improvement toward the result of 100% inspection through PDCA cycle. The form will be used to monitor the result of 100% inspection which will be evaluated by management system.  The sample design of form 100% inspection is available on Figure 4.10

**FORM 100% INSPECTION ROTOCAST PROCESS**

Date : Toy # : Leader :

Shift : M/C # : Operator :

| Phase Sequence | Output | Good Product | Reject |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**Figure 4.10 Form 100% Inspection of Rotocast Process**

Figure 4.11 above shows the sample design of form 100% inspection of rotocast process. In the first two rows, it shows the identity for date and shift, toy number and machine number and there is also the identity of the leader section and the operator. While in the first column there is a phase sequence which shows number of cycle time of machine. The output of the rotocast product should be written in the second column, then the amount of good product and reject is written in the next column. Through this simple design, the operator and the managements will be easier to see, record and evaluate the data.

Since the operator will need a guideline to do their work, a Standard Operational Procedure (SOP) is made to facilitate the operator doing their job. Setting aside SOP will prevent the operator doing wrong move in their job. The SOP will put in side of the operator and it is provided in Bahasa. SOP for doing 100% inspection is available on Appendix 03.

### B. Additional Number of Operator and Time Calculation

As there will be a whole inspection towards the output of the rotocast, then additional number of operator should be considered. Based on the procedure above, it can be concluded that 100% inspection require 17 operators who work to weight the toy head from rotocast machine.

In step number two it is known that the operator should be mobile to unload and move the output. Then, to do this work for 17 machine, which divided into two areas, 100%, inspection require 2 operators that will be assigned to do this work. Those two operators are placed in different rotocast area.

For estimated time calculation by refer to current situation which is operator only needs 60 second in average to weight the toy head, then in proposed system to do 100% inspection in one machine per hour which produce 100 output. Means that operator needs 100 minutes or equal to 1.67 hours to finish the work of two cycle of one machine in one hour. While the operator who assigned to unload the output will suit themselves to the process of rotocast area through 100% inspection.

#### 4.4.1.2 Proposed Improvement in Hair Yarn

Refering to Table 4.8 that explains briefly of a proposed improvement and also refer to Table 4.9 that provides the number of missing stitches defect towards the toy head which has the same sculpt, which the most proper improvement towards the data is creating a standard between the toy head through the sculpt and the hair yarn.

In order to execute this action, a test sample analysis is made towards the same toy head as reviewed in order to get a significant result. This research is conducted for five times experiments per sculpt per toy head per hair yarn at ten samples of each test during three days experiments. This test is used a good condition sample, which means the toy head already pass 100% inspection, hair yarn is in the good condition, needle has been replace with the new one, and operate by trained-operator. The result of the experiments is form in the table below:

**Table 4.10 The Result of Experiments for Each Toy and Each Toy Head**

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| A | HA | 6 | B | HA | 6 | C | HA | 7 |
| A | HA | 5 | B | HA | 3 | C | HA | 8 |
| A | HA | 4 | B | HA | 5 | C | HA | 6 |
| A | HA | 6 | B | HA | 4 | C | HA | 9 |
| A | HA | 7 | B | HA | 6 | C | HA | 8 |

**Table 4.10 The Result of Experiments for Each Toy and Each Toy Head (Continued)**

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| A | KB | 8 | B | KB | 3 | C | KB | 7 |
| A | KB | 9 | B | KB | 5 | C | KB | 7 |
| A | KB | 7 | B | KB | 3 | C | KB | 6 |
| A | KB | 9 | B | KB | 4 | C | KB | 5 |
| A | KB | 8 | B | KB | 2 | C | KB | 5 |
| A | NS | 6 | B | NS | 8 | C | NS | 5 |
| A | NS | 8 | B | NS | 5 | C | NS | 6 |
| A | NS | 7 | B | NS | 8 | C | NS | 4 |
| A | NS | 8 | B | NS | 6 | C | NS | 4 |
| A | NS | 6 | B | NS | 7 | C | NS | 5 |
| A | PP | 4 | B | PP | 4 | C | PP | 3 |
| A | PP | 6 | B | PP | 5 | C | PP | 4 |
| A | PP | 5 | B | PP | 6 | C | PP | 4 |
| A | PP | 4 | B | PP | 2 | C | PP | 5 |
| A | PP | 5 | B | PP | 4 | C | PP | 4 |
| A | KF | 6 | B | KF | 6 | C | KF | 3 |
| A | KF | 8 | B | KF | 5 | C | KF | 2 |
| A | KF | 7 | B | KF | 4 | C | KF | 4 |
| A | KF | 6 | B | KF | 2 | C | KF | 2 |
| A | KF | 7 | B | KF | 3 | C | KF | 1 |

Table 4.10 above shows the result of test experiment that conducted between hair yarn and toy head. The test was started from trial and error towards toy head and hair yarn type. All previous 40 toy head along with all type of hair yarn in various color are used in order to get the significant result for the comparison later. Then, each toy head is process in auto rooting machine and paired with every single hair yarn type through ten samples for each hair yarn type. The number of good products out of ten is recorded as can be seen on Table 4.10 above. The complete result of 40 toys is available on Appendix 5.

After gathered all the data and by refer to the test result, a statistical approach is made as a prove for standardization and to find out what type of hair yarn that match to each toy head. One-Way ANOVA is chosen for this test as the response is number of good product and the factor is hair yarn type.

By using One-Way ANOVA, it displays whether one of the hair yarn has the same mean or one of the hair yarn type has different mean. Then to prove which hair yarn is different among the others, the test continues by using Fisher-Test. The test is analyzed by using statistical software. This test comes up with hypothesis testing which is:

$H_0$: All hair yarn means are equal

$H_1$: At least one hair yarn mean is different

Below is the result of One-Way ANOVA calculation of toy head A by using Minitab along with interval plot and the result of Fisher Pairwise Comparison test.

## One-way ANOVA: Good Products versus Hair Yarn Type

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.



Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP



Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   34,64  8,6600     9,84    0,000
Error           20   17,60  0,8800
Total           24   52,24



Model Summary

       S    R-sq  R-sq(adj)  R-sq(pred)
0,938083  66,31%     59,57%      47,36%



Means

Hair
Yarn
Type  N   Mean  StDev      95% CI
```

```
HA     5  5,600  1,140  (4,725; 6,475)
KB     5  8,200  0,837  (7,325; 9,075)
KF     5  6,800  0,837  (5,925; 7,675)
NS     5  7,000  1,000  (6,125; 7,875)
PP     5  4,800  0,837  (3,925; 5,675)

Pooled StDev = 0,938083
```

**Figure 4.11 One Way ANOVA Result for Toy Head A**

As it can be seen on calculation in Figure 4.11 above by using significance level at α= 0.05. From the result of calculation, it is known that the F-Value of this test 9.84, while F-Table (0.05, 4,24) is 2.84 or p-value (0.00) less than level of significance (α=0.05). Thus, it can be concluded that $H_0$ is reject, which means at least one mean is different. Figure 4.12 shows the interval plot of number of good products VS hair yarn type.

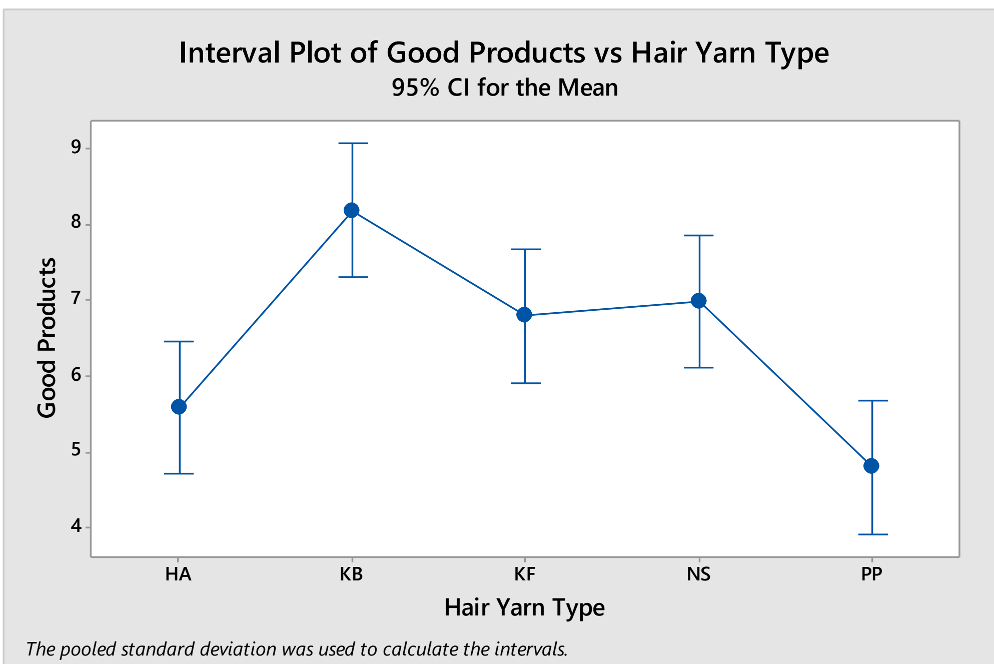



**Figure 4.12 Interval Plot of Good Products vs Hair Yarn Type**

Figure 4.12 above shows the interval plot of good products using pooled standard deviation which is 0.938083. Equal with mean value of the test where KB has the highest mean, followed with NS in the second order, then KF, HA and the last is PP.

Based on this result and to prove that which mean is not equal than the others, further analysis which is fisher pairwise comparison is used. The result of fisher test is provided in Figure below.

## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 8,200 | A |
| NS | 5 | 7,000 | A B |
| KF | 5 | 6,800 | B C |
| HA | 5 | 5,600 | C D |
| PP | 5 | 4,800 | D |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,600 | 0,593 | ( 1,362; 3,838) | 4,38 | 0,000 |
| KF - HA | 1,200 | 0,593 | (-0,038; 2,438) | 2,02 | 0,057 |
| NS - HA | 1,400 | 0,593 | ( 0,162; 2,638) | 2,36 | 0,029 |
| PP - HA | -0,800 | 0,593 | (-2,038; 0,438) | -1,35 | 0,193 |
| KF - KB | -1,400 | 0,593 | (-2,638; -0,162) | -2,36 | 0,029 |
| NS - KB | -1,200 | 0,593 | (-2,438; 0,038) | -2,02 | 0,057 |
| PP - KB | -3,400 | 0,593 | (-4,638; -2,162) | -5,73 | 0,000 |
| NS - KF | 0,200 | 0,593 | (-1,038; 1,438) | 0,34 | 0,740 |
| PP - KF | -2,000 | 0,593 | (-3,238; -0,762) | -3,37 | 0,003 |
| PP - NS | -2,200 | 0,593 | (-3,438; -0,962) | -3,71 | 0,001 |

Simultaneous confidence level = 73,57%

**Figure 4.13 Fisher Pairwise Comparison Result for Toy Head A**

Figure 4.13 above shows the calculation of Fisher Pairwise Comparison. By using fisher test it is known the mean difference between two hair yarn types. The visual result of mean difference is present in the Figure 4.15 below.

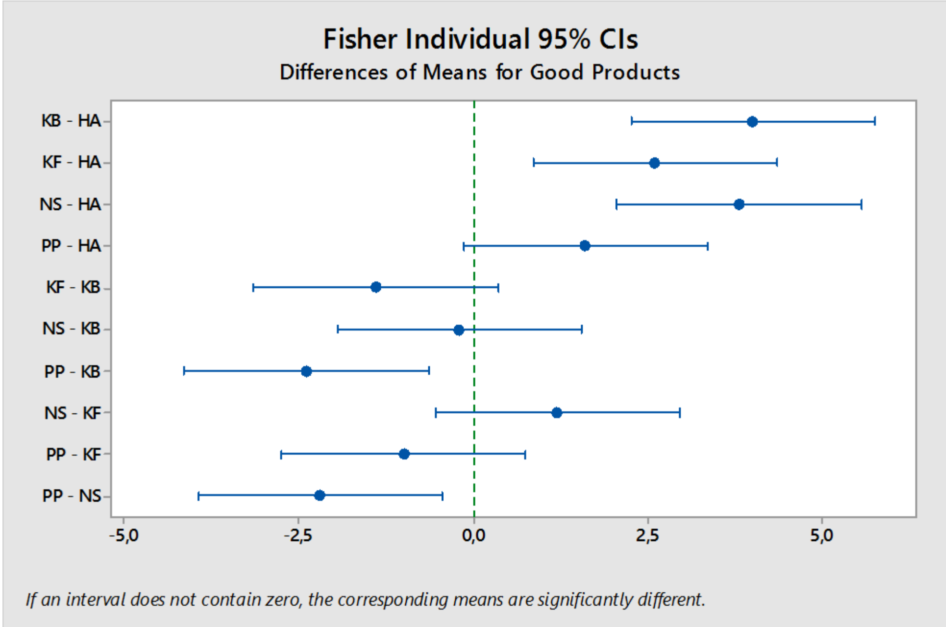



**Figure 4.14 Mean Differences for Good Products**

Figure 4.14 above shows the graph of mean difference for each toy head. If an interval does not contain zero, the corresponding means are significantly different. This graph is a continuously analysis from the result of ANOVA. In previous ANOVA result and interval plot it is known that the highest mean is KB followed with NS. Continue with the mean result in Figure 4.14 above, interval KB and NS contain zero. The third position is KF. The interval between KB and KF does contain zero. So it can be concluded that the most suitable hair yarn type for toy head A is KB, NS and KF. The result of complete calculation and graph for all of 40 toys are available on Appendix 6. Thus, the summarize result of ANOVA for each toy is form in Table 4.11 below.

**Table 4.11 Summary of F-Value Calculation for Each Toy Head**

| Toy Head | Hair Yarn Type | F-Value | Decision | Mean | Toy Head | Hair Yarn Type | F-Value | Decision | Mean |
|---|---|---|---|---|---|---|---|---|---|
| A | HA | 9.84 | Reject $H_0$ | 5.6 | B | HA | 4.54 | Reject $H_0$ | 4.8 |
| A | KB | | | 8.2 | B | KB | | | 3.4 |
| A | KF | | | 6.8 | B | KF | | | 4.0 |
| A | NS | | | 7.0 | B | NS | | | 6.8 |
| A | PP | | | 4.8 | B | PP | | | 4.2 |

**Table 4.11 Summary of F-Value Calculation for Each Toy Head (Continued)**

| Toy Head | Hair Yarn Type | F-Value | Decision | Mean | Toy Head | Hair Yarn Type | F-Value | Decision | Mean |
|---|---|---|---|---|---|---|---|---|---|
| C | HA | 20.25 | Reject $H_0$ | 7.6 | L | HA | 8.14 | Reject $H_0$ | 4.6 |
| C | KB | | | 6.0 | L | KB | | | 2.4 |
| C | KF | | | 2.4 | L | KF | | | 3.2 |
| C | NS | | | 4.8 | L | NS | | | 6.2 |
| C | PP | | | 4.0 | L | PP | | | 5.6 |
| D | HA | 8.21 | Reject $H_0$ | 6.4 | M | HA | 19.05 | Reject $H_0$ | 4.2 |
| D | KB | | | 5.4 | M | KB | | | 2.4 |
| D | KF | | | 6.8 | M | KF | | | 6.6 |
| D | NS | | | 4.2 | M | NS | | | 5.0 |
| D | PP | | | 3.4 | M | PP | | | 8.2 |
| E | HA | 0.48 | Do not Reject $H_0$ | 4.0 | N | HA | 4.58 | Reject $H_0$ | 4.2 |
| E | KB | | | 4.0 | N | KB | | | 6.4 |
| E | KF | | | 4.8 | N | KF | | | 5.6 |
| E | NS | | | 4.0 | N | NS | | | 5.0 |
| E | PP | | | 3.4 | N | PP | | | 3.8 |
| F | HA | 4.11 | Reject $H_0$ | 4.8 | O | HA | 6.11 | Reject $H_0$ | 1.6 |
| F | KB | | | 3.0 | O | KB | | | 4.6 |
| F | KF | | | 6.8 | O | KF | | | 4.0 |
| F | NS | | | 4.2 | O | NS | | | 4.4 |
| F | PP | | | 5.2 | O | PP | | | 2.4 |
| G | HA | 0.38 | Do not Reject $H_0$ | 5.0 | P | HA | 2.51 | Reject $H_0$ | 2.6 |
| G | KB | | | 4.6 | P | KB | | | 2.8 |
| G | KF | | | 4.6 | P | KF | | | 4.4 |
| G | NS | | | 5.2 | P | NS | | | 2.2 |
| G | PP | | | 5.0 | P | PP | | | 3.4 |
| H | HA | 4.97 | Reject $H_0$ | 2.8 | Q | HA | 21.00 | Reject $H_0$ | 2.0 |
| H | KB | | | 6.6 | Q | KB | | | 6.0 |
| H | KF | | | 5.2 | Q | KF | | | 2.6 |
| H | NS | | | 5.4 | Q | NS | | | 4.8 |
| H | PP | | | 4.2 | Q | PP | | | 6.8 |
| I | HA | 5.95 | Reject $H_0$ | 3.8 | R | HA | 0.29 | Do not Reject $H_0$ | 6.4 |
| I | KB | | | 6.2 | R | KB | | | 6.8 |
| I | KF | | | 2.8 | R | KF | | | 6.0 |
| I | NS | | | 3.6 | R | NS | | | 6.4 |
| I | PP | | | 2.4 | R | PP | | | 7.0 |
| J | HA | 8.53 | Reject $H_0$ | 3.4 | S | HA | 13.57 | Reject $H_0$ | 5.8 |
| J | KB | | | 4.4 | S | KB | | | 5.8 |
| J | KF | | | 2.4 | S | KF | | | 4.8 |
| J | NS | | | 4.4 | S | NS | | | 2.2 |
| J | PP | | | 7.2 | S | PP | | | 4.8 |

**Table 4.11 Summary of F-Value Calculation for Each Toy Head (Continued)**

| Toy Head | Hair Yarn Type | F-Value | Decision | Mean | Toy Head | Hair Yarn Type | F-Value | Decision | Mean |
|---|---|---|---|---|---|---|---|---|---|
| K | HA | 1.19 | Do not Reject $H_0$ | 2.4 | T | HA | 1.39 | Do not Reject $H_0$ | 4.2 |
| K | KB | | | 2.6 | T | KB | | | 4.2 |
| K | KF | | | 2.0 | T | KF | | | 3.2 |
| K | NS | | | 3.6 | T | NS | | | 3.8 |
| K | PP | | | 3.2 | T | PP | | | 2.8 |
| U | HA | 5.13 | Reject $H_0$ | 3.8 | CC | HA | 5.06 | Reject $H_0$ | 2.6 |
| U | KB | | | 1.6 | CC | KB | | | 4.0 |
| U | KF | | | 4.2 | CC | KF | | | 6.2 |
| U | NS | | | 2.6 | CC | NS | | | 4.2 |
| U | PP | | | 2.6 | CC | PP | | | 4.0 |
| V | HA | 39.82 | Reject $H_0$ | 3.4 | DD | HA | 4.0 | Reject $H_0$ | 4.2 |
| V | KB | | | 1.8 | DD | KB | | | 5.0 |
| V | KF | | | 3.2 | DD | KF | | | 4.4 |
| V | NS | | | 7.6 | DD | NS | | | 3.0 |
| V | PP | | | 6.6 | DD | PP | | | 1.8 |
| W | HA | 5.14 | Reject $H_0$ | 5.0 | EE | HA | 22.79 | Reject $H_0$ | 7.6 |
| W | KB | | | 7.6 | EE | KB | | | 4.8 |
| W | KF | | | 5.0 | EE | KF | | | 3.4 |
| W | NS | | | 6.4 | EE | NS | | | 1.6 |
| W | PP | | | 5.6 | EE | PP | | | 2.8 |
| X | HA | 10.48 | Reject $H_0$ | 7.6 | FF | HA | 2.87 | Do not Reject $H_0$ | 6.4 |
| X | KB | | | 4.6 | FF | KB | | | 7.6 |
| X | KF | | | 5.2 | FF | KF | | | 6.2 |
| X | NS | | | 4.4 | FF | NS | | | 5.6 |
| X | PP | | | 3.2 | FF | PP | | | 7.6 |
| Y | HA | 3.02 | Reject $H_0$ | 1.8 | GG | HA | 0.74 | Do not Reject $H_0$ | 5.6 |
| Y | KB | | | 2.4 | GG | KB | | | 6.6 |
| Y | KF | | | 4.0 | GG | KF | | | 5.6 |
| Y | NS | | | 3.4 | GG | NS | | | 6.4 |
| Y | PP | | | 4.8 | GG | PP | | | 6.6 |
| Z | HA | 6.69 | Reject $H_0$ | 2.6 | HH | HA | 3.77 | Reject $H_0$ | 5.6 |
| Z | KB | | | 5.8 | HH | KB | | | 5.2 |
| Z | KF | | | 4.6 | HH | KF | | | 4.8 |
| Z | NS | | | 5.6 | HH | NS | | | 6.8 |
| Z | PP | | | 6.2 | HH | PP | | | 7.2 |
| AA | HA | 7.78 | Reject $H_0$ | 3.0 | II | HA | 4.54 | Reject $H_0$ | 1.8 |
| AA | KB | | | 7.0 | II | KB | | | 5.4 |
| AA | KF | | | 5.6 | II | KF | | | 3.2 |
| AA | NS | | | 6.8 | II | NS | | | 2.8 |
| AA | PP | | | 4.6 | II | PP | | | 2.0 |

**Table 4.11 Summary of F-Value Calculation for Each Toy Head (Continued)**

| Toy Head | Hair Yarn Type | F-Value | Decision | Mean | Toy Head | Hair Yarn Type | F-Value | Decision | Mean |
|---|---|---|---|---|---|---|---|---|---|
| BB | HA | 17.69 | Reject $H_0$ | 1.6 | JJ | HA | 3.99 | Reject $H_0$ | 4.4 |
| BB | KB | | | 6.4 | JJ | KB | | | 6.8 |
| BB | KF | | | 6.0 | JJ | KF | | | 2.6 |
| BB | NS | | | 6.2 | JJ | NS | | | 4.0 |
| BB | PP | | | 6.8 | JJ | PP | | | 4.8 |
| KK | HA | 3.99 | Reject $H_0$ | 4.4 | MM | HA | 15.69 | Reject $H_0$ | 8.0 |
| KK | KB | | | 6.8 | MM | KB | | | 6.8 |
| KK | KF | | | 2.6 | MM | KF | | | 4.8 |
| KK | NS | | | 4.0 | MM | NS | | | 4.8 |
| KK | PP | | | 4.8 | MM | PP | | | 4.4 |
| LL | HA | 5.91 | Reject $H_0$ | 7.4 | NN | HA | 1.03 | Do not Reject $H_0$ | 2.2 |
| LL | KB | | | 6.6 | NN | KB | | | 3.0 |
| LL | KF | | | 4.8 | NN | KF | | | 2.2 |
| LL | NS | | | 5.2 | NN | NS | | | 2.4 |
| LL | PP | | | 5.0 | NN | PP | | | 3.6 |

Table 4.11 above present the summarize of ANOVA calculation result. It can be seen that there are only some toy heads that do not reject $H_0$ which means that means of all hair yarn type are equal. This case means that the whether all of hair yarn type are compatible with the toy head or otherwise none of hair yarn type are compatible with the toy head. To know the exact result of this calculation, a further analysis is made along with the result of Fisher test and will be compared with the result of mean difference in fisher test. From Table 4.11, the best combination between hair yarn and toy head can be concluded which is formed in Table 4.12 below.

**Table 4.12 Best Combination Between Hair Yarn Type and Toy Head**

| Toy Head | Best Combination based on Test Experiments | Current Combination | % Defect from Current Combination |
|---|---|---|---|
| A | KB, NS, KF | PP | 44% |
| B | NS | KB | 0.5% |
| C | HA | KF | 86% |
| D | KB, HA, KF | NS+KB | 32% |
| E | None of hair yarn type | NS | 88% |
| F | KF | KB | 0.54% |
| G | None of hair yarn type | KF | 32% |
| H | KB | HA | 63% |
| I | KB | HA | 0.28% |

**Table 4.12 Best Combination Between Hair Yarn Type and Toy Head (Continued)**

| Toy Head | Best Combination based on Test Experiments | Current Combination | % Defect from Current Combination |
|---|---|---|---|
| J | PP | HA | 0.54% |
| K | None of hair yarn type | HA | 34% |
| L | NS, PP | KB | 41% |
| M | PP | NS | 355 |
| N | KB, KF | HA | 26% |
| O | None of hair yarn type | HA | 94% |
| P | None  of hair yarn type | HA | 55% |
| Q | PP, KB | HA | 50% |
| R | All hair yarn type | KB | 0.41% |
| S | KB, HA, KF | NS | 75% |
| T | None of hair yarn type | KF | 61% |
| U | None of hair yarn type | KB | 44% |
| V | NS, PP | KB | 24% |
| W | KB, NS | HA | 37% |
| X | HA | PP | 41% |
| Y | None of hair yarn type | NS | 0.54% |
| Z | PP, KB, NS | HA | 45% |
| AA | KB | HA | 71% |
| BB | PP, KB, NS, KF | HA | 72% |
| CC | KF | HA | 83% |
| DD | KB | PP | 93% |
| EE | HA | NS+KF | 61% |
| FF | All hair yarn type | HA | 0.54% |
| GG | All hair yarn type | NS | 17% |
| HH | PP, NS | KB | 0.40% |
| II | None of hair yarn type | HA | 38% |
| JJ | KF, HA, KB, NS | HA | 0.38% |
| KK | KB | KF | 67% |
| LL | HA | KF | 36% |
| MM | HA | NS | 22% |
| NN | None of hair yarn type | KB | 26% |

Table 4.12 present the best combination between hair yarn type and toy head. The ressult is coming from the experiments which has been explained before, whereas each toy head paired with each hair yarn within five times replication and each replication has ten samples. Analyzing ANOVA result and Fisher pairwise comparison is the main activity in order to know which hair is compatible the most with every different type of toy head.

Analyzing the ANOVA was conducted by seeing the most significant different mean number on hair yarn, especially when the null hyphothesis is rejected, then Fisher Pairwise comparison is made in order to know which hair yarn is mostly significant among the others. In case that all of hair yarn's mean are the same, then there are two choices to be made, whether all of hair yarn are actually compatible or none of the hair yarn are appropriate to the head toy type. The decision of this case is made if the average mean of the hair yarn is below five then none of the hair yarn compatible to the toy head, otherwise all of hair yarn basically compatible to the toy head. The result of One Way ANOVA can be seen on previous table which is on Table 4.11.

As can be seen in Table 4.12 that mostly current combination between hair yarn and toy head do not compatible if compared with statistical result. This result is supported by there is high number of defect that occcur in current combination. In special case, there are some toy head have less than one percent defect, but by refering to the result it still has different combination. Then, it depends on the company whether to choose the old combination or choose the combination based on statistical result.

For most case, it can be seen that toy head and hair yarn with high number of defect compatible with other type of hair yarn. But, there are some toy heads tact compatible with all of hair yarn type while others do not compatible with none of hair yarn type. For all compatible hair yarn, it depends on the company what to choose towards the combination between hair yarn type and toy head. Meanwhile for the case that none of the hair yarn compatible with certain toy head, then company should choose another hair yarn type. In this case, nylon is being choosen since PT. X is actually used this hair yarn but not in as many as the others.

### 4.4.2 Proposed Improvement in Machine

As refer to Table 4.8 and Table 4.9, proposed improvement for machine is that creating a regular inspection towards the needle of the machine and provide SOP for technician. The proposed improvement is only focus on needle inspection since actually there is a current preventive maintenance towards the machine.

During the observation, it is found that actually lifetime of the needle is only two weeks. After more than two weeks, the needle will turn into unsharpened. This condition will lead to missing stitches defect. Hence, a regular inspection for this case head for changing machine needle for once in every Saturday for two weeks. This inspection require additional needle since the needle will be more often being replace and there is no much additional time needed for changing the needle. Technician himself basically already has a knowledge and experience for changing the needle from the current maintenance system.

In order to execute this action correctly and to ensure that the technician does not forget to change the needle for every two weeks, then a check sheet is used. The purpose is as a reminder for the technician to change the needle. This check sheet is available at the machine itself and this is an effective way to monitor the regular inspection for the needle. The form of check sheet is shown in this Figure 4.15 below.

**REGULAR INSPECTION CHANGING NEEDLE AUTO ROOTING MACHINE**

| Date | Technician | Changing needle |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

Instruction:

Please fill at column date and technician based on the date of changing needle and the person in charge. At column changing needle, please put sign of **X** as the remarks that the activity has been done.

**Figure 4.15 Form Regular Changing Needle Auto Rooting Machine**

From Figure 4.15 above, the form is made in simple way where the technician only needs to put a mark in the column needle changing as the sign that the needle has been changing for duration of two weeks (more clear form is available on Appendix 7). The same as doing 100% inspection, SOP changing needle is made in order to facilitate the technician for changing needle in correct way and to prevent any mistake during changing process. The SOP for changing needle is available on Appendix 8.

### 4.4.3 Proposed Improvement in Man

On Table 4.8 and Table 4.9, it is listed that proposed improvement for man is train the operator before they will assign to work at auto rooting area. During September until November, 43 workers work in auto rooting area for one shift. Auto rooting machine is running for two shifts in a day and five days a week.

As the main problem of the man is because the operator does not work in proper way of auto rooting machine especially for loading and unloading painted head to the machine so the painted head does not receive the right treatment from the machine. Just like the proposed improvement for the machine, proposed improvement for man does not need much effort since basically, auto rooting machines need addition number of operator when it comes to peak season. Therefore, the training does not have to be done for every month, and it does not need additional cost to be paid.

To execute this action, choosing a best trainer to train the operator is important to help the operator knows the flow of the machine and how the machine does works. Thus, a technician is assigned as a trainer because she has been working at auto rooting machine since it was existing at PT. X. The module is prepared for the trainer and operator. The module contains of introduction to the needle itself such as the position of the needle, then the main contents which is the process flow of changing the needle by considering safety equipment during the process and the last step which is ensuring the needle is in good condition. The module is available on Appendix 9.

## 4.5 Improvement Analysis

After execute the proposed improvement that listed on Table 4.8 and Table 4.9 and have been explain in detail in previous chapter then the analysis through the improvement of the process is made. The improvement for each root cause has been tried during December 2016. The result analysis is elaborated below.

### 4.5.1 Improvement Analysis in Material

As there are two different improvements that being implemented in material, then every treatment has different and analysis result. The analysis is including cost, time, and the material itself. The improvement analysis is elaborated below.

#### 4.5.1.1 Improvement Analysis in Painted Head

As mentioned and explained before that the treatment toward the output of rotocast process is doing 100% inspection. During the implementation of 100% inspection, the previous 40 toys head are used to get the same specific result. During the trial time which was on December Dec 05$^{th}$ – 10$^{th}$, 2016 and by following the work instruction for the 100% inspection, overall cost and time calculation are found.

As mentioned in previous chapter that estimated time to weight one toy head is one minute. But, during the trial of proposed improvement, it is found that time needed to weight the toy head is only around 30 seconds. Which means for 100 output needs 50 minutes to be checked. It is because the operator uses electronic machine which has sound indicator for standard weight. Operator only need to set the standard weight on the electronic scale and the electronic scale will sound with long sound if the weight does not fulfill the require weight, otherwise the electronic scale will only sound once if the toy head fulfill the standard requirement of the toy head. Then it is enough for PT. X to assigned 19 operators for doing 100% inspection. Thus, PT. X has to pay IDR 95,000,000/month for as the salary of the operator. The result of the roto cast that pass the inspection is summarized in the table below.

**Table 4.13 The Result of Reject Toy Head During 100% Inspection**

| No | Toy Head | Amount of Reject Rotocast | No | Toy Head | Amount of Reject Rotocast |
|---|---|---|---|---|---|
| 1 | A | 20 | 21 | U | 22 |
| 2 | B | 16 | 22 | V | 18 |
| 3 | C | 15 | 23 | W | 20 |
| 4 | D | 18 | 24 | X | 21 |
| 5 | E | 29 | 25 | Y | 20 |
| 6 | F | 20 | 26 | Z | 24 |
| 7 | G | 26 | 27 | AA | 14 |
| 8 | H | 25 | 28 | BB | 15 |
| 9 | I | 24 | 29 | CC | 32 |
| 10 | J | 36 | 30 | DD | 31 |
| 11 | K | 41 | 31 | EE | 29 |
| 12 | L | 35 | 32 | FF | 26 |
| 13 | M | 15 | 33 | GG | 32 |
| 14 | N | 18 | 34 | HH | 20 |
| 15 | O | 17 | 35 | II | 21 |
| 16 | P | 19 | 36 | JJ | 20 |
| 17 | Q | 16 | 37 | KK | 16 |
| 18 | R | 21 | 38 | LL | 17 |
| 19 | S | 26 | 39 | MM | 18 |
| 20 | T | 23 | 40 | NN | 20 |

Table 4.13 above is a recorded data of defect roto cast that do not fulfill required weigh for each toy in two cycle time of rotocast machine within 100 output. Compared with sample inspection which is only held for three samples per toy per machine per hour, doing 100% inspection shows more significant number of defect. Thus, only the toy head with good product will be processed to painting process before finally it delivers to auto rooting process area.

#### 4.5.1.2 Improvement Analysis in Hair Yarn

By refer to Table 4.11 and Table 4.12 which shows the result of ANOVA calculation and best combination between hair yarn and toy head, an analysis towards the result is made. This analysis has a purpose to know which hair yarn is most compatible with toy head since it is found that some of toy head only has defect lower than 1% percent, while the statistical result shows the different pair. Thus, the suggestion of best combination based on current system and ANOVA result is made that formed in Table 4.14 below.

**Table 4.14 Best Combination between Toy Head and Hair Yarn Type**

| Toy Head | Best Combination Hair Yarn | Toy Head | Best Combination Hair Yarn |
|---|---|---|---|
| A | KB | U | NYLON |
| B | KB | V | NS |
| C | HA | W | KB |
| D | KB | X | HA |
| E | NYLON | Y | NS |
| F | KB | Z | PP |
| G | NYLON | AA | KB |
| H | KB | BB | PP |
| I | KB | CC | KF |
| J | PP | DD | KB |
| K | NYLON | EE | HA |
| L | NS | FF | HA |
| M | PP | GG | NS |
| N | KB | HH | KB |
| O | NYLON | II | NYLON |
| P | NYLON | JJ | HA |
| Q | PP | KK | KB |
| R | KB | LL | HA |
| S | KB | MM | HA |
| T | NYLON | NN | NYLON |

Table 4.14 above shows the suggestion of combination between toy head and hair yarn. It can be seen that there is new type oh hair yarn which is nylon. Actually, it has no tried yet whether nylon is compatible or not to toy head. But since PT. X sometimes use nylon as their raw material, then a suggestion towards nylon is made because those toy head do not compatible for all five current hair yarn types.

In some cases, toy head still uses current hair yarn type. By way of example is toy B, toy F, Toy J, etc. These toys have different result between statistical result and current hair yarn type which only has less than 1% defect. So, the suggestion of best combination is applied to the current system.

### 4.5.2 Improvement Analysis in Machine

As doing a regular inspection towards needle is an additional action in FAR Machine, there is no major problem found during the implementation unless the schedule of technician who reponsible to replace machine needle with the new one. Since the inspection is regularly, thus PT. X needs to re-stock machine needle as to cover all machine needle needed for all machines.

### 4.5.3 Improvement Analysis in Man

Untrained operator is another caused for missing stiches which the solution to overcome this issue is by held a training toward future operator that will work in auto rooting area. This training was held in the third weeks of December and it involved one trainer and ten participants. The training was divided into two sessions because there is a limitation space since the training is conducted at auto rooting laboratory. During the training, there is no obstacle for both of parties because the participant owns their handbook and them directly watching the process on how to operate the machine.

However, the thing that being concern after training is about the space and the scope of the participant that will assigned to operate the machine when the peak season. After analyzing all aspects that related to the issue, then it conclude that the operator will be asked from auto pack area. Due to the limitation of the space at auto rooting laboratory, management agree to conduct the training in a meeting room by using a complete video of auto rooting machine as a visual way to future operator that will assigned in auto rooting process area. Figure 4.17 below shows the situation during training.


**Figure 4.16 Training Session for Operator at FAR Laboratory**

As it can be seen on Figure 4.16 above that the trainer shows shows the participants the way how to operate the machine in the right way. This thing facilitate the operatot to operate the machine and to prevent any mistake during operation time in production line.

### 4.6 Analyis of Improvement Result

After all of those different treatments have implemented, then the result is being deliver to rooting process to find out the result. Analyis of improvement result in auto rooting process area is made towards the number of defect, cost, and time as elaborated below.

#### 4.6.1 Number of Defect

As the main purpose of this research is to reduce number of missing stitches defect in auto rooting area, thus it become the main concern of all improvement in every related aspects. To prove the improvement was a correct action and to get the result for both of the improvement, 20 samples is tested for before after improvement analysis for material machine and man. The result is formed in the table below.

**Table 4.15 Number of Defect of Before and After Improvement**

| Root Cause | | Before Improvement | After Improvement |
|---|---|---|---|
| Machine | Painted Head (100% inspection) | 13 | 2 |
| | Hair Yarn (Standarization) | 10 | 1 |
| Machine | Broken Needle (Regular Inspection) | 9 | 0 |
| Man | Operator (Training) | 6 | 0 |
| Total Defect | | 38 | 3 |

From Table 4.15 above, it can be seen that there is significant difference number of defect on before after improvement which is 35. Samples that being used is in good condition within the same type of toy head. Painted head is tested by using type of Head AA, which on before improvement only pass sample inspection, and on after improvement it pass 100% inspection and deliver to painted head and then to rooting process.

Standardization of hair yarn is also using the same type of toy head. On before impovement, it paired with random hair yarn type and come up with ten defects among 20 samples. On after improvement, it paired with hair yarn type of KB, and come up with only one defect among all of samples.

Treatment of broken needle is applied with the old needle and new needle. 20 samples is used for rooting process and it is foound rooting process by using a machine that has old needle come up with 9 defects. Meanwhile, the samples which use a machine with the new one has no defect. The last treatment is training operator. Two operator were assigned to run different machine and both of them is given 20 samples to be rooted. The result is untrained operator comes up with 6 defects while trained operator has no defect. The comparison between before and after improvement is stated provide in Figure 4.17 below.

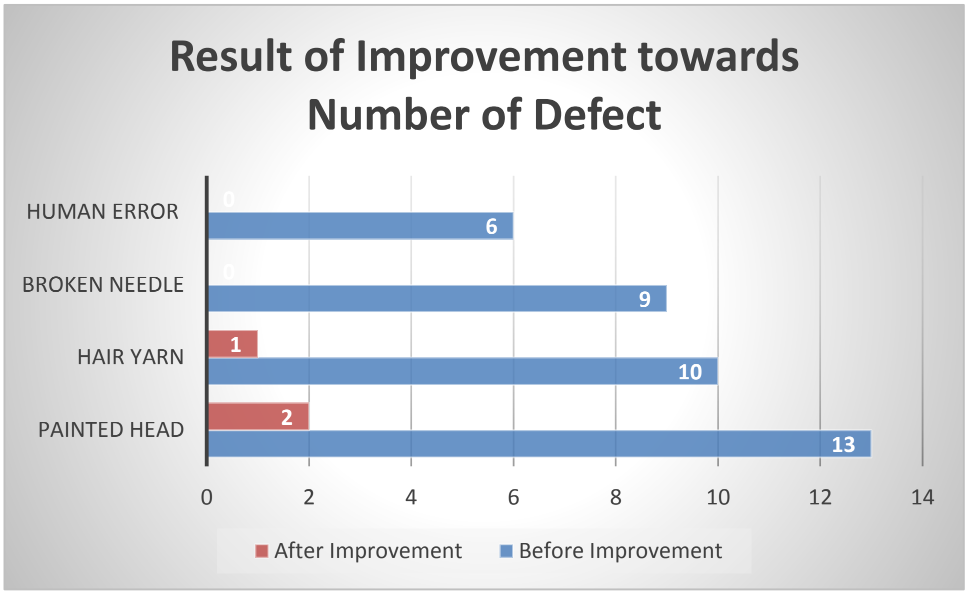



**Figure 4.17 Graph of Result of Improvement Towards Number of Defect**

Figure 4.17 above shows the result of improvement towards number of defect on before and after improvement. At the end, all of the improvement is combined into one which means selected sample is already pass 100% inspection, paired with the standard hair yarn, using new needle on machine and operate by trained operator, and using 40 samples it comes up with 2 defects of missing stitches without major area of defect which means the operator can do rework by themselves.

### 4.6.2 Cost Allocation

As the main concern of this improvement is 100% inspection that is known need much effort to be executed, it becomes major concern for the management to decide whether it is accepted or not. Thus, cost calculation on before after improvement is made in the table below.

**Table 4.16 Cost Calculation for Before and After Analysis per Month**

| | | | |
|---|---|---|---|
| Before Improvement | Salary for Sample Inspection | IDR 25,000,000 | IDR 106,304,533 |
| | Rework | IDR 40,000,000 | |
| | Scrap | IDR 40,782,933 | |
| | Needle | IDR 521,600 | |
| After Improvement | Salary for 100% Inspection | IDR 95,000,000 | IDR 97, 381,600 |
| | Needle | IDR 2,381,600 | |
| Cost Saving/Month | | | IDR 8,922,933 |

Table 4.16 above shows the cost saving on before after improvement. By implementing 100% inspection, PT. X.  could save IDR 8,922,933 per month on average. Thus it is proved that even 100 inspection required much more effort rather than the others, but it could sava a huge of money for the company in a year and produce a good quality of product without any defect. The comparison between before and after improvement cost is provided in Figure 4.18.

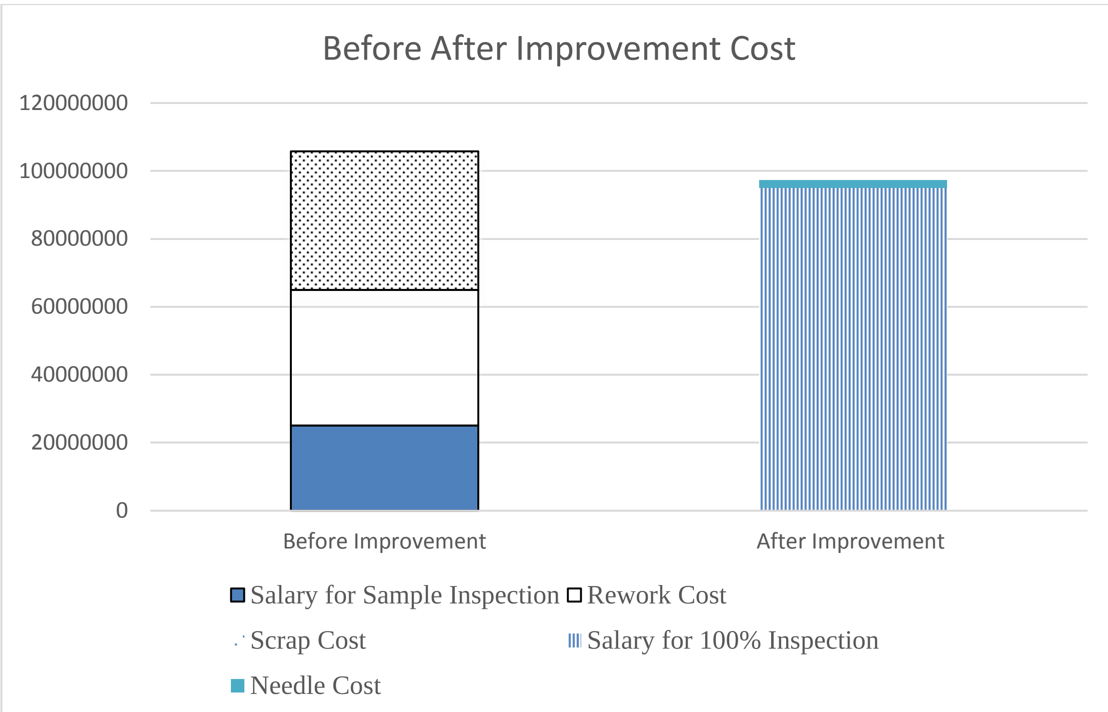



**Figure 4.18 Before and After Improvement Chart Cost**

As can be seen in Figure 4.18, PT. X has to pay more for operator salary to do 100% inspection if compared with current sample inspection. However, in before improvement PT. X loss huge amount of money for rework and scrap, meanwhile in after improvement there is no rework and scrap anymore. PT. X only need additional paid for machine needle every month.

### 4.6.2 Time Allocation

In current situation, it is known that there are rework for missing stitches from auto rooting area that takes around 11 days for the operator to finish the rework from 40 toys during September untill November 2016. As has been explained in previous section that there are no additional time needed for the operator to complete 100% inspection, so does regular inspection and training the operator. This condition means by applying proposed improvement, PT. X is able to save 11 days of production time to complete the required quantity of product.

As this research is aimed to reduce number of missing stitches defect in auto rooting area, this research is also having a key performance indicator which are time and cost that has been elaborated previously. From the calculation in Table 4.13 and Figure 4.18, it can be seen the reducing defect and cost during the implementation of 100% inspection, standardization between hair yarn and toy head, regular inspection towards needle machine and training operator. Figure 4.19 below shows the percentage of reduction of defect, cost and time during the implementation of proposed improvement.

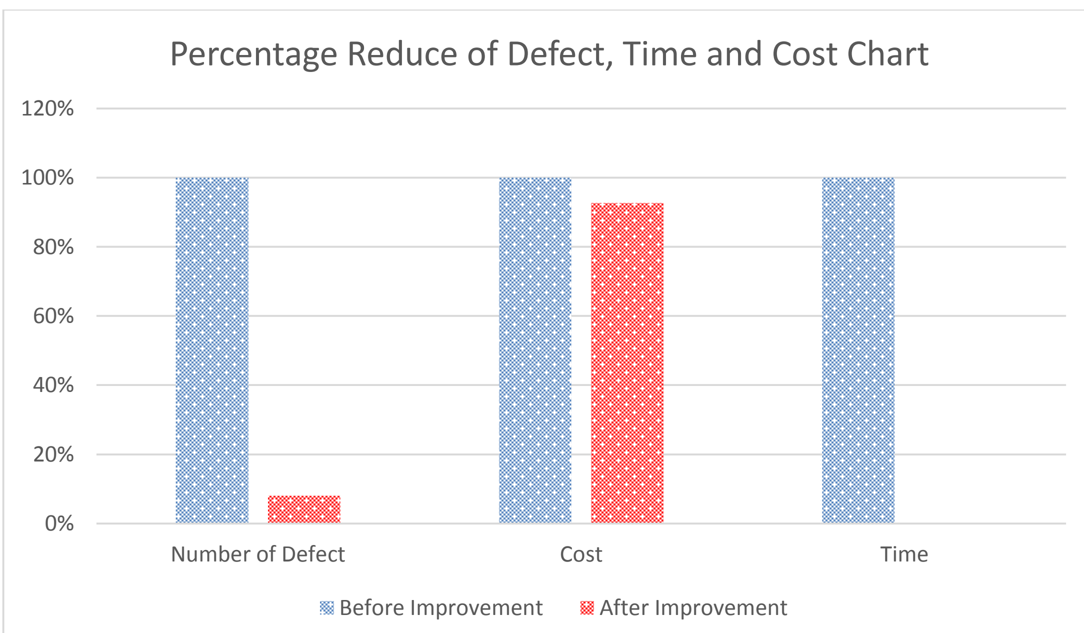



**Figure 4.19 Percentage Reduce of Defect, Time and Cost Chart**

Figure 4.19 above shows the percentage of reducing number of defect, cost and time. The highest percentage of reducing number is found on time, which gain on 100% point. This thing occurs because there is no additional time for rework whereas previously was 11 days. Then, followed by number of defect which has 92% as the number of defect is reduced from 38 to three defects only. The last percentage of reduce is cost, which has 7.9% of reducing which on before improvement is IDR 106,304,533 while after improvement is IDR 97,381,600. This percentage of reduce is calculated by per month.

# CHAPTER V
# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

Based on analysis done during the research, there is a conclusion that can be pulled out in which the objective that has been set from the beginning of research is met. The conclusion is elaborated the following sentence below:

To reduce number of missing stitches defect that occur since 2006, several appropriate solution is implemented which are applying 100% inspection, creating a standardization, regular inspection, and training operator. PT. X reduce number of defect from 38 to only 3 which is around 92%. As the performance indicator of this research is cost and time, thus PT. X is able to save money in amount of IDR 8,401,393 per month or 7.9% in a month, and there is no more rework or scrap in auto rooting process area. PT. X is also able to reduce 11 days production process or 100% reducing time through implementing those treatments.

## 5.2 Recommendation

The recommendation for future research is considering to recheck and fix any existing problem that might be occur in rotocast process area since the highest percentage of defect caused come from rotohead. Furthermore, below is more recommendations for PT. X regarding to statistical test and trial experiments:

- Consider to pair hair yarn type and toy head based on statistical match result for R&D department. If there is a new type of toy head, try to conduct a test before it is produced at PT. X.
- Providing larger space and video visualization of FAR machine in training process for the operator to save more time. Consider to choose the best candidate of operator as the new workers at FAR machine.

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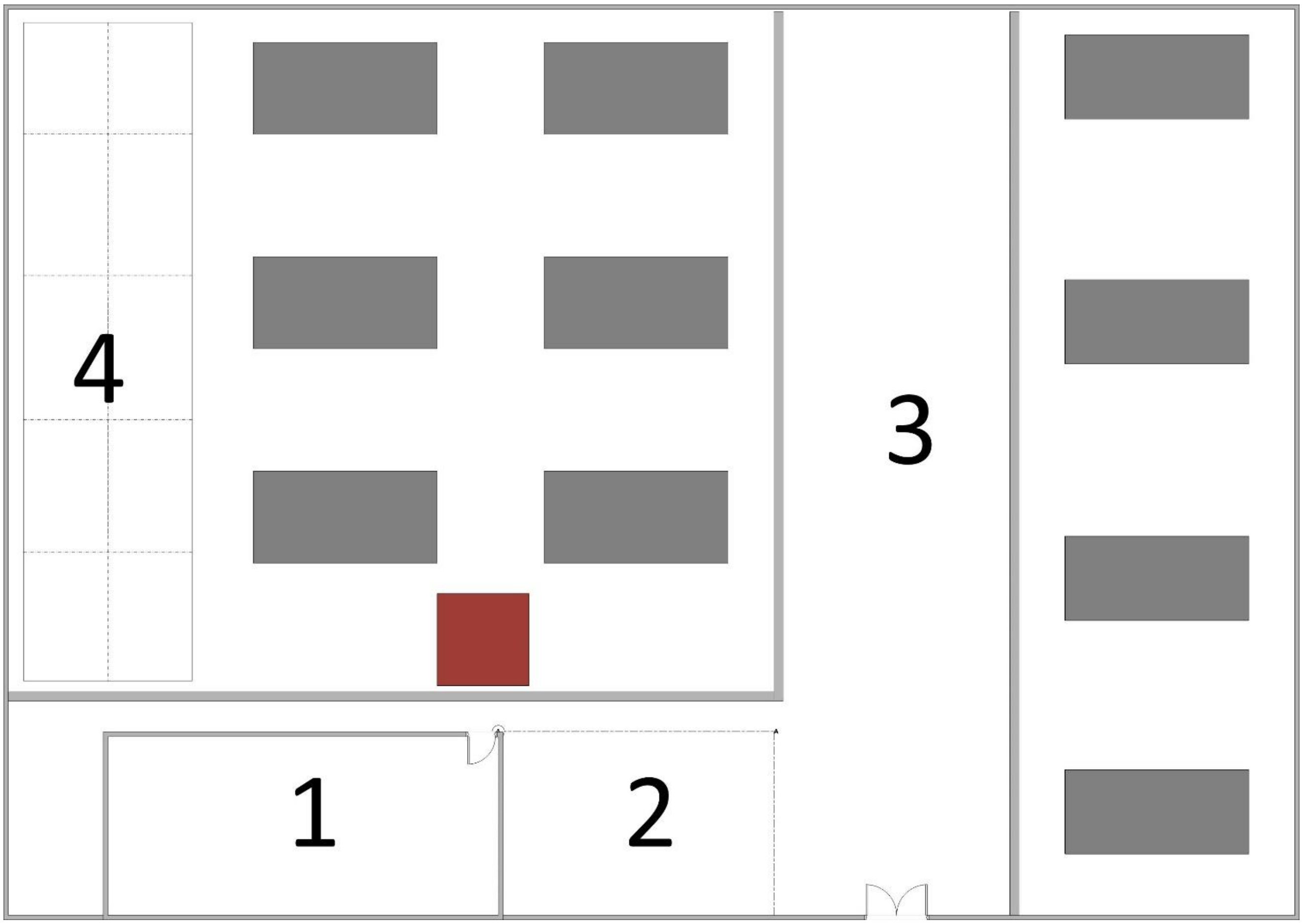
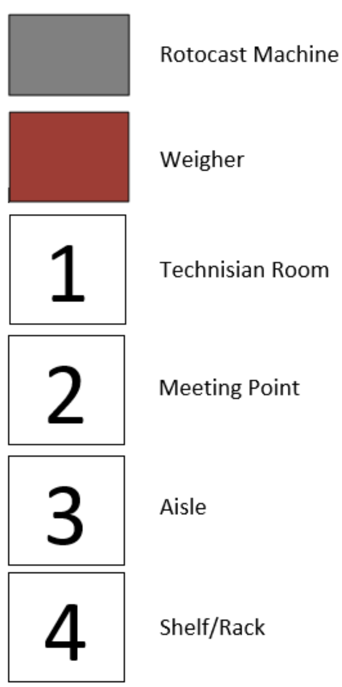
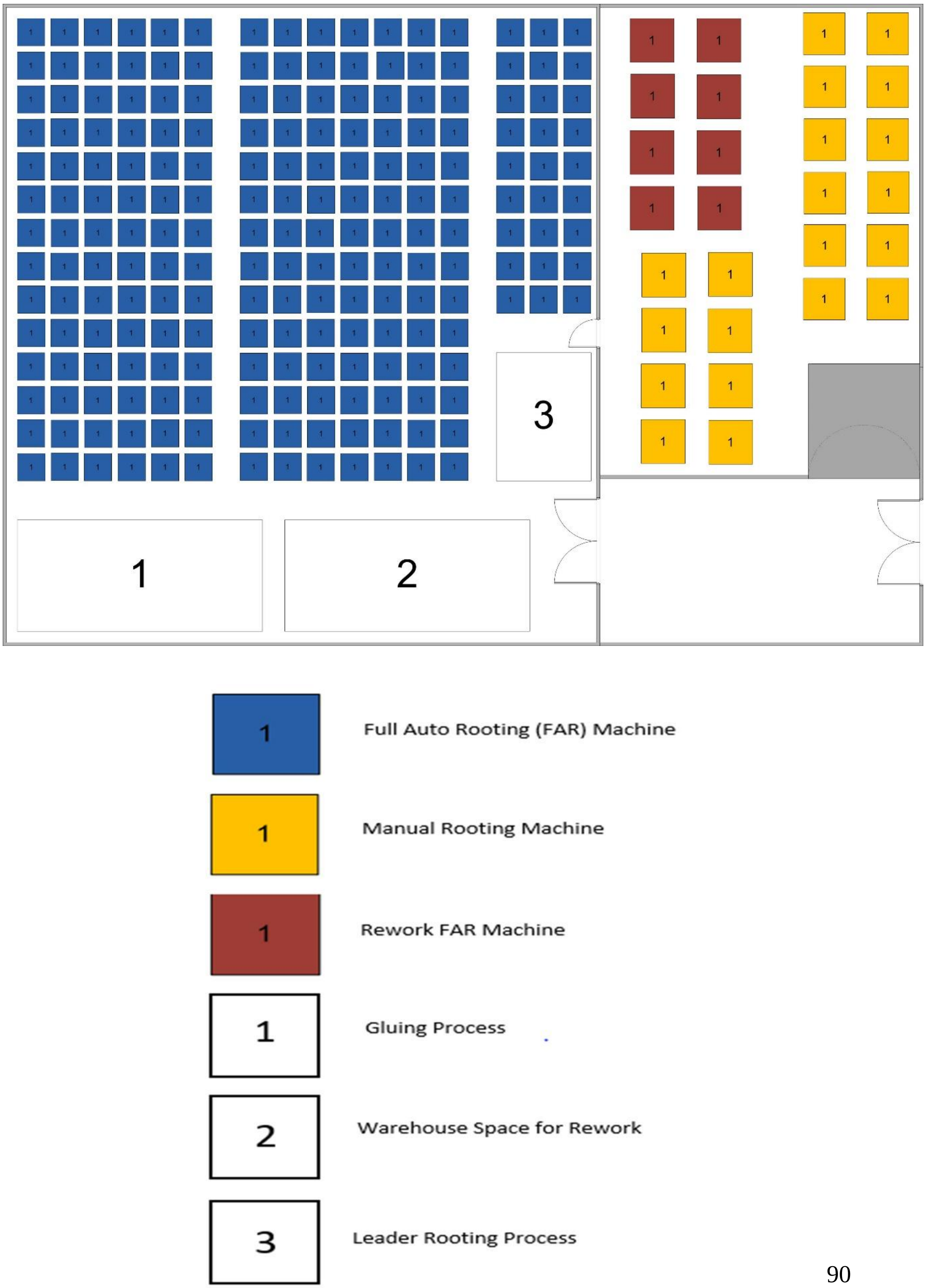
# APPENDICES

**Appendix 1- Layout Rotocast Area**



**Appendix 2-Layout Rooting Process**



**Appendix 3- SOP 100% Inspection**

# HEADER SOP

| | | | |
|---|---|---|---|
| **STANDARD OPERATIONAL PROCEDURE** | | | |
| Department : IE Primary | | Doc No : PDE/WI/0097/PO | |
| Process Area : Rotocast Area | | EFF Date : 23/12/2016 | |
| Operation : 100% Inspection | | Rev : 00 | |
| No | Description + Drawing | | |
| 1 | Posisi basket, timbangan, dan area 100% inspection | Sebelum melakukan proses 100% inspection, pastikan hal hal berikut:<br>1. Anda menggunakan standard PPE pada area rotocast<br>2. Pastikan timbangan dalam keadaan ON | |
| 2 | Setting timbangan sesuai dengan requirement berat kepala toy yang akan ditimbang | Ambil satu kepala toy yang akan ditimbang yang tersedia di basket kuning sebelah kanan operator | |
| 3 | | | |

| | | |
|---|---|---|
| | Timbang kepala toy dengan cara meletakkan diatas timbangan. Jika kepala toy yang memenuhi berat standard, maka timbangan akan berbunyi *"biiiip"* sekali saja. Namun jika kepala toy tidak memenuhi standard berat yang telah disetting, maka timbangan akan berbunyi *"biiipp"* dalam waktu yang lumayan panjang menandakan product tersebut reject. | Bunyi *"biip"* pada timbangan untuk kepala yang tidak memenuhi standard requirement berat akan berhenti ketika anda mengangkat kepala toy dari timbangan |
| 4 | | |
| | Letakkan output yang memenuhi standard requirement pada box kuning yang lainnya, sedangkan reject output diletakkan pada box merah | Hitung dan catat hasil 100% inspection pada form yang telah tersedia |
| Issued By:<br><br>Ng<br>Sr IE Engineer | | Approved By:<br><br>B.S<br>Asc IE Manager |

## Appendix 4- PM Check List FAR

# PM CHECK LIST - FAR

M/C No :
Date :
Shift :

Mekanik :
Kpk :
Mulai :
Selesai :

| No. | PERSIAPAN | |
|---|---|---|
| 1 | Persiapan Awal | Periksa kondisi mesin sebelum dilakukan PM |
| | | Periksa peralatan yang akan dipakai |
| 2 | Siapkan Prosedure TAG OUT / LOCK OUT | Gunakan Tag Out dan Lock Out pada mesin yang akan dikerjakan dengan cara menutup dan mengunci saluran **ANGIN** dan **LISTRIK** **JIKA TIDAK DIPERLUKAN** |
| | | Beri tanda " UNDER PM " pada mesin yang akan dikerjakan |

| No | Part | Titik Pemeriksaan | Kondisi | | Keterangan |
|---|---|---|---|---|---|
| | | | Baik | Tidak | |
| 1 | **Rooting mechanism** | | | | |
| | Feed dog dan mask | Periksa kondisi, jika kondisi tidak bagus (tajam,retak,patah) ganti dengan part baru dan setting ulang | | | |
| | Bearing mask holder | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| | Lower dan upper cutter | Periksa kondisi, jika tumpul ganti dengan part baru dan setting ulang | | | |
| | Shaft cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Holder Guide Cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Clamper (mesin FAR) | Periksa kondisi, jika spring kotor, bersihkan, dan jika rubber sudah aus,ganti dengan part baru dan setting ulang | | | |
| | Looper (mesin FAR) | Periksa kondisi, jika sudut-sudut yang dilewati benang tajam, haluskan atau ganti baru, dan bersihkan dari sisa benang | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Shaft looper | Periksa kondisi, jika sudah aus ganti dengan part baru, dan bersihkan dari sisa benang. | | | |
| | Bearing shaft looper | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| | Timing belt looper | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Pulley Looper | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Shaft needle | Periksa kondisi, jika sudah bengkok, ganti dengan part baru. Beri pelumas. | | | |
| | Needle post | Periksa kondisi, jika sudah kocak, ganti dengan part baru. Beri pelumas. | | | |
| | Coupling servo R1 | Periksa kondisi, jika rusak ganti dengan part baru, jika kendor kencangkan kembali. | | | |
| | Timing belt servo R2 | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Pulley servo R2 | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Ball screw slider | Periksa kondisi, jika rusak ganti dengan part baru, bersihkan dari sisa benang,beri pelumas. | | | |
| | Coupling Servo Slider | Periksa kondisi, jika rusak ganti dengan part baru, jika kendor kencangkan kembali. | | | |
| | Spiral Blower + filter | Periksa kondisi, jika sobek atau berlubang ganti dengan part baru. Bersihkan dari sisa benang | | | |
| | shaft needle clamp | Periksa kondisi, jika sudah kocak, ganti dengan part baru. Beri pelumas. | | | |
| | Cam Shaft Needle | Periksa Pin, jika kendor kencangkan, jika aus ganti dengan part baru. Beri pelumas. | | | |
| | Needle track | Periksa kondisi linear guide, jika sudah kocak, ganti dengan part baru.Olesi Grease. | | | |
| | Cam Cutter | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Shaft horizontal | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | shaft vertical | Periksa kondisi, jika sudah aus ganti dengan part baru. Beri pelumas. | | | |
| | Gear Vertical | Periksa kondisi, jika sudah aus ganti dengan part baru. Olesi grease. | | | |
| | Gear Horizontal | Periksa kondisi, jika sudah aus ganti dengan part baru. Olesi grease. | | | |
| | Timing belt Driver | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | Pulley Driver | Periksa kondisi, jika sudah aus ganti dengan part baru | | | |
| | | | | | |
| 2 | **Motor** | | | | |
| | Motor servo R1 | Periksa konektor, pastikan tersambung dengan baik. | | | |
| | Motor servo R2 | Periksa konektor, pastikan tersambung dengan baik. | | | |
| | Motor servo Slider | Periksa konektor, pastikan tersambung dengan baik. | | | |
| | Motor servo Looper | Periksa konektor, pastikan tersambung dengan baik. | | | |
| | Motor Blower | Periksa putaran kipas, pastikan tidak macet. bersihkan dari sisa benang. Cek terminal kabel, kencangkan baut konektor yang kendor. | | | |
| | | | | | |
| 3 | **Multi color FAR** | | | | |
| | Motor servo revolver | Periksa konektor, pastikan tersambung dengan baik. | | | |
| | Solenoid 1,2 dan 3 | Periksa konektor, pastikan tersambung dengan baik. Periksa fungsi, pastikan dapat membuka dan menutup dengan baik. Ganti dengan part baru jika rusak. | | | |
| | Sensor homing revolver | Periksa kondisi kabel sensor, pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Solenoid valve | Periksa kondisi, pastikan berfungsi dengan baik. Ganti dengan part baru jika rusak. | | | |
| | Selang pneumatic | Periska kondisi selang dan fitting, pastikan tidak bocor. | | | |
| | Revolver | Periksa kondisi, pastikan lubang benang halus dan tidak menghambat laju benang. Periksa baut pengunci revolver,kencangkan jika kendor. | | | |
| | Extention Shaft | Periksa baut pengunci extention shaft, kencangkan jika kendor. | | | |
| | Looper : | | | | |
| | Clamper | Periksa rubber clamper,pastikan dapat menjepit benang dengan baik, ganti baru jika sudah aus. Bersihkan dari sisa benang | | | |
| | Pin + roller | Periksa kondisi pin, pastikan tidak bengkok. Pastikan roller dapat berputar dengan lancar. Bersihkan dari sisa benang | | | |
| | Spring | Pastikan spring dapat berfungsi dengan baik ganti baru jika sudah rusak. | | | |
| | Body looper | Periksa kondisi lubang pin, ganti baru jika lubang sudah aus / oval. Bersihkan dari sisa benang | | | |
| | Cam Looper | Periksa kondisi permukaan Cam, ganti baru jika sudah aus. | | | |
| | | | | | |
| 4 | **Panel** | | | | |
| | Pengunci panel | Periksa kondisi, jika sudah rusak ganti dengan part baru. | | | |
| | ON/OFF SWITCH | Periksa kondisi, jika sudah rusak ganti dengan part baru, periksa sambungan pada terminal, jika kendor kencangkan kembali. | | | |
| | Driver Servo R1 | Periksa kondisi konektor, jika rusak ganti dengan part baru. Periksa baut pengunci konektor, jika kendor, kencangkan kembali. | | | |
| | Driver Servo R2 | Periksa kondisi konektor, jika rusak ganti dengan part baru. Periksa baut pengunci konektor, jika kendor, kencangkan kembali. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Driver Servo Slider | Periksa kondisi konektor, jika rusak ganti dengan part baru. Periksa baut pengunci konektor, jika kendor, kencangkan kembali. | | | |
| | Driver Servo Looper | Periksa kondisi konektor, jika rusak ganti dengan part baru. Periksa baut pengunci konektor, jika kendor, kencangkan kembali. | | | |
| | PLC | Periksa PLC I/O interface dan extention terminal. Periksa sambungan dan kencangkan baut terminal yang kendor. | | | |
| | MCB | Periksa Fungsi, periksa terminal, kencangkan kembali jika baut terminal kendor. | | | |
| | Cooling Fan | Periksa Fungsi, jika rusak ganti dengan unit baru. Bersihkan dari sisa benang. | | | |
| | DC power supply | Periksa terminal, kencangkan kembali jika baut terminal kendor. | | | |
| | Relay / SSR | Periksa fungsi, jika rusak, ganti dengan part baru. Kencangkan kembali baut terminal yang kendor. Bersihkan dari sisa benang. | | | |
| | Lampu LED | Periksa kondisi, jika nyala sudah redup / mati, ganti dengan part baru. Pastikan LED menempel dengan baik pada rak mesin. | | | |
| | Cable Duct | Periksa kondisi, jika body atau cover rusak, ganti dengan part baru | | | |
| | | | | | |
| 5 | **Sensor** | | | | |
| | Sensor Homing R1 | Periksa kondisi soket dan kabel sensor, pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | Sensor Homing R2 | Periksa kondisi soket dan kabel sensor, pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | Sensor Homing Slider | Periksa kondisi soket dan kabel sensor, pastikan signal masuk ke | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | PLC. Jika rusak ganti dengan part baru. | | | |
| | Sensor Homing Looper | Periksa kondisi soket dan kabel sensor, pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | | Ukur jarak antara sensor homing looper dengan bulatan trigger, pastikan jarak keduanya antara 1-2 mm | | | |
| | Sensor Benang tangle | Periksa sensor, terminal dan kabel sensor, pastikan signal masuk ke PLC. Kencangkan baut terminal jika kendor dan Jika rusak ganti dengan part baru. | | | |
| | | Pastikan sensor benang tangle berada pada jalur benang dan kencangkan baut penyangga jika kendor. | | | |
| | Sensor Benang Habis | Periksa Kondisi sensor dan kabel sensor, pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | | Pastikan sensor benang habis berada pada jalur benang dan kencangkan baut penyangga jika kendor. | | | |
| | | | | | |
| 6 | **Panel Tombol** | | | | |
| | Tombol Emergency | Periksa fungsi, kondisi tombol, terminal dan kabel, kencangkan baut terminal yang kendor. Pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | Tombol Start | Periksa fungsi, kondisi tombol, terminal dan kabel, kencangkan baut terminal yang kendor. Pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | Tombol Stop | Periksa fungsi, kondisi tombol, terminal dan kabel, kencangkan baut terminal yang kendor. Pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Tombol Reset | Periksa fungsi, kondisi tombol, terminal dan kabel, kencangkan baut terminal yang kendor. Pastikan signal masuk ke PLC. Jika rusak ganti dengan part baru. | | | |
| | Switch Looper | Periksa fungsi, kondisi switch, terminal dan kabel, kencangkan baut terminal yang kendor. Jika rusak ganti dengan part baru. | | | |
| | | | | | |
| 7 | **Safety Device** | | | | |
| | Sticker Tanda Peringatan Bahaya | Pastikan kondisi baik dan terbaca, ganti sticker baru jika diperlukan | | | |
| | Guard | Pastikan kondisi baik dan terpasang dengan benar. Ganti dengan part baru jika diperlukan | | | |

**Finishing**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Kelengkapan | Pastikan semua komponen terpasang dengan baik dan benar | | | |
| 2 | Kalibrasi mesin | Set ulang posisi Zero Topeng | | | |
| | | Set ulang posisi Zero revolver | | | |
| 3 | Test and Running | Test and running mesin dan pastikan mesin bekerja dengan sempurna | | | |
| | | House Keeping Mesin beserta lingkungannya | | | |
| | | Bila sudah selesai serahkan ke Produksi | | | |
| 4 | Machine History | Catat semua tindakan perbaikan dan penggantian spare parts | | | |
| | | Isilah PM Confirmasi setelah selesai PM | | | |
| 5 | 5 S | Jaga kebersihan area kerja | | | |
| | | Bersihkan mesin yang telah di PM, pastikan tidak ada percikan oli pada panel dan lantai disekitar mesin | | | |
| | | Rapikan kembali semua kabel, pastikan berada didalam kabel duct | | | |

| | |
|---|---|
| Replacement Part | |
| | |
| | |

Approval by Production Supervisior/Senior Leader

Signature :
Name :
Date :

Verified by

Lead Maintenance

Signature :
Name :
Date :

**Appendix 5- The Result of Experiments for Each Toy and Each Toy Head**

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| A | HA | 6 | B | HA | 6 | C | HA | 7 |
| A | HA | 5 | B | HA | 3 | C | HA | 8 |
| A | HA | 4 | B | HA | 5 | C | HA | 6 |
| A | HA | 6 | B | HA | 4 | C | HA | 9 |
| A | HA | 7 | B | HA | 6 | C | HA | 8 |
| A | KB | 8 | B | KB | 3 | C | KB | 7 |
| A | KB | 9 | B | KB | 5 | C | KB | 7 |
| A | KB | 7 | B | KB | 3 | C | KB | 6 |
| A | KB | 9 | B | KB | 4 | C | KB | 5 |
| A | KB | 8 | B | KB | 2 | C | KB | 5 |
| A | NS | 6 | B | NS | 8 | C | NS | 5 |
| A | NS | 8 | B | NS | 5 | C | NS | 6 |
| A | NS | 7 | B | NS | 8 | C | NS | 4 |
| A | NS | 8 | B | NS | 6 | C | NS | 4 |
| A | NS | 6 | B | NS | 7 | C | NS | 5 |
| A | PP | 4 | B | PP | 4 | C | PP | 3 |
| A | PP | 6 | B | PP | 5 | C | PP | 4 |
| A | PP | 5 | B | PP | 6 | C | PP | 4 |
| A | PP | 4 | B | PP | 2 | C | PP | 5 |
| A | PP | 5 | B | PP | 4 | C | PP | 4 |
| A | KF | 6 | B | KF | 6 | C | KF | 3 |
| A | KF | 8 | B | KF | 5 | C | KF | 2 |
| A | KF | 7 | B | KF | 4 | C | KF | 4 |
| A | KF | 6 | B | KF | 2 | C | KF | 2 |
| A | KF | 7 | B | KF | 3 | C | KF | 1 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| D | HA | 5 | E | HA | 2 | F | HA | 3 |
| D | HA | 6 | E | HA | 3 | F | HA | 5 |
| D | HA | 8 | E | HA | 4 | F | HA | 3 |
| D | HA | 7 | E | HA | 5 | F | HA | 7 |
| D | HA | 6 | E | HA | 6 | F | HA | 6 |
| D | KB | 4 | E | KB | 2 | F | KB | 1 |
| D | KB | 5 | E | KB | 3 | F | KB | 3 |
| D | KB | 6 | E | KB | 4 | F | KB | 5 |
| D | KB | 7 | E | KB | 6 | F | KB | 4 |
| D | KB | 5 | E | KB | 5 | F | KB | 2 |
| D | NS | 4 | E | NS | 3 | F | NS | 6 |
| D | NS | 5 | E | NS | 2 | F | NS | 5 |
| D | NS | 5 | E | NS | 5 | F | NS | 3 |
| D | NS | 4 | E | NS | 4 | F | NS | 2 |
| D | NS | 3 | E | NS | 6 | F | NS | 5 |
| D | PP | 1 | E | PP | 5 | F | PP | 4 |
| D | PP | 3 | E | PP | 3 | F | PP | 6 |
| D | PP | 4 | E | PP | 2 | F | PP | 5 |
| D | PP | 5 | E | PP | 2 | F | PP | 4 |
| D | PP | 4 | E | PP | 5 | F | PP | 7 |
| D | KF | 6 | E | KF | 6 | F | KF | 8 |
| D | KF | 7 | E | KF | 4 | F | KF | 6 |
| D | KF | 7 | E | KF | 6 | F | KF | 5 |
| D | KF | 6 | E | KF | 6 | F | KF | 7 |
| D | KF | 8 | E | KF | 2 | F | KF | 8 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| G | HA | 6 | H | HA | 1 | I | HA | 4 |
| G | HA | 4 | H | HA | 2 | I | HA | 6 |
| G | HA | 6 | H | HA | 4 | I | HA | 3 |
| G | HA | 5 | H | HA | 3 | I | HA | 2 |
| G | HA | 4 | H | HA | 4 | I | HA | 4 |
| G | KB | 4 | H | KB | 7 | I | KB | 7 |
| G | KB | 5 | H | KB | 9 | I | KB | 6 |
| G | KB | 6 | H | KB | 6 | I | KB | 7 |
| G | KB | 4 | H | KB | 5 | I | KB | 7 |
| G | KB | 4 | H | KB | 6 | I | KB | 4 |
| G | NS | 5 | H | NS | 4 | I | NS | 6 |
| G | NS | 4 | H | NS | 6 | I | NS | 3 |
| G | NS | 6 | H | NS | 8 | I | NS | 2 |
| G | NS | 5 | H | NS | 5 | I | NS | 5 |
| G | NS | 6 | H | NS | 4 | I | NS | 2 |
| G | PP | 4 | H | PP | 3 | I | PP | 3 |
| G | PP | 6 | H | PP | 5 | I | PP | 1 |
| G | PP | 4 | H | PP | 6 | I | PP | 2 |
| G | PP | 6 | H | PP | 3 | I | PP | 2 |
| G | PP | 5 | H | PP | 4 | I | PP | 4 |
| G | KF | 5 | H | KF | 4 | I | KF | 2 |
| G | KF | 3 | H | KF | 6 | I | KF | 3 |
| G | KF | 4 | H | KF | 7 | I | KF | 4 |
| G | KF | 5 | H | KF | 4 | I | KF | 3 |
| G | KF | 6 | H | KF | 5 | I | KF | 2 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| J | HA | 3 | K | HA | 1 | L | HA | 6 |
| J | HA | 1 | K | HA | 3 | L | HA | 5 |
| J | HA | 4 | K | HA | 3 | L | HA | 4 |
| J | HA | 5 | K | HA | 3 | L | HA | 3 |
| J | HA | 4 | K | HA | 2 | L | HA | 5 |
| J | KB | 6 | K | KB | 4 | L | KB | 2 |
| J | KB | 4 | K | KB | 2 | L | KB | 4 |
| J | KB | 5 | K | KB | 4 | L | KB | 3 |
| J | KB | 3 | K | KB | 1 | L | KB | 2 |
| J | KB | 4 | K | KB | 2 | L | KB | 1 |
| J | NS | 5 | K | NS | 2 | L | NS | 6 |
| J | NS | 3 | K | NS | 3 | L | NS | 7 |
| J | NS | 6 | K | NS | 5 | L | NS | 8 |
| J | NS | 5 | K | NS | 6 | L | NS | 6 |
| J | NS | 3 | K | NS | 2 | L | NS | 4 |
| J | PP | 8 | K | PP | 3 | L | PP | 5 |
| J | PP | 5 | K | PP | 5 | L | PP | 6 |
| J | PP | 8 | K | PP | 3 | L | PP | 4 |
| J | PP | 6 | K | PP | 2 | L | PP | 7 |
| J | PP | 9 | K | PP | 3 | L | PP | 6 |
| J | KF | 2 | K | KF | 2 | L | KF | 2 |
| J | KF | 1 | K | KF | 4 | L | KF | 2 |
| J | KF | 2 | K | KF | 1 | L | KF | 3 |
| J | KF | 3 | K | KF | 2 | L | KF | 5 |
| J | KF | 4 | K | KF | 1 | L | KF | 4 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| M | HA | 4 | N | HA | 5 | O | HA | 3 |
| M | HA | 6 | N | HA | 4 | O | HA | 1 |
| M | HA | 5 | N | HA | 3 | O | HA | 2 |
| M | HA | 4 | N | HA | 5 | O | HA | 1 |
| M | HA | 2 | N | HA | 4 | O | HA | 1 |
| M | KB | 3 | N | KB | 6 | O | KB | 5 |
| M | KB | 1 | N | KB | 7 | O | KB | 4 |
| M | KB | 1 | N | KB | 8 | O | KB | 3 |
| M | KB | 3 | N | KB | 6 | O | KB | 5 |
| M | KB | 4 | N | KB | 5 | O | KB | 6 |
| M | NS | 4 | N | NS | 4 | O | NS | 4 |
| M | NS | 5 | N | NS | 6 | O | NS | 6 |
| M | NS | 5 | N | NS | 4 | O | NS | 5 |
| M | NS | 6 | N | NS | 5 | O | NS | 4 |
| M | NS | 5 | N | NS | 6 | O | NS | 3 |
| M | PP | 8 | N | PP | 4 | O | PP | 2 |
| M | PP | 7 | N | PP | 3 | O | PP | 2 |
| M | PP | 9 | N | PP | 5 | O | PP | 1 |
| M | PP | 8 | N | PP | 3 | O | PP | 3 |
| M | PP | 9 | N | PP | 4 | O | PP | 4 |
| M | KF | 7 | N | KF | 4 | O | KF | 6 |
| M | KF | 6 | N | KF | 6 | O | KF | 5 |
| M | KF | 5 | N | KF | 4 | O | KF | 4 |
| M | KF | 8 | N | KF | 7 | O | KF | 3 |
| M | KF | 7 | N | KF | 7 | O | KF | 2 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| P | HA | 1 | Q | HA | 1 | R | HA | 5 |
| P | HA | 3 | Q | HA | 2 | R | HA | 6 |
| P | HA | 2 | Q | HA | 3 | R | HA | 7 |
| P | HA | 3 | Q | HA | 2 | R | HA | 8 |
| P | HA | 4 | Q | HA | 2 | R | HA | 6 |
| P | KB | 2 | Q | KB | 4 | R | KB | 4 |
| P | KB | 1 | Q | KB | 6 | R | KB | 6 |
| P | KB | 4 | Q | KB | 7 | R | KB | 7 |
| P | KB | 3 | Q | KB | 8 | R | KB | 8 |
| P | KB | 4 | Q | KB | 5 | R | KB | 9 |
| P | NS | 4 | Q | NS | 5 | R | NS | 4 |
| P | NS | 3 | Q | NS | 5 | R | NS | 6 |
| P | NS | 2 | Q | NS | 4 | R | NS | 5 |
| P | NS | 1 | Q | NS | 4 | R | NS | 8 |
| P | NS | 1 | Q | NS | 6 | R | NS | 9 |
| P | PP | 3 | Q | PP | 6 | R | PP | 5 |
| P | PP | 4 | Q | PP | 7 | R | PP | 8 |
| P | PP | 5 | Q | PP | 8 | R | PP | 7 |
| P | PP | 3 | Q | PP | 7 | R | PP | 9 |
| P | PP | 2 | Q | PP | 6 | R | PP | 6 |
| P | KF | 4 | Q | KF | 3 | R | KF | 6 |
| P | KF | 6 | Q | KF | 2 | R | KF | 4 |
| P | KF | 5 | Q | KF | 2 | R | KF | 6 |
| P | KF | 4 | Q | KF | 2 | R | KF | 7 |
| P | KF | 3 | Q | KF | 4 | R | KF | 7 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| S | HA | 7 | T | HA | 3 | U | HA | 4 |
| S | HA | 5 | T | HA | 4 | U | HA | 3 |
| S | HA | 6 | T | HA | 6 | U | HA | 5 |
| S | HA | 5 | T | HA | 4 | U | HA | 4 |
| S | HA | 6 | T | HA | 4 | U | HA | 3 |
| S | KB | 6 | T | KB | 6 | U | KB | 1 |
| S | KB | 7 | T | KB | 4 | U | KB | 2 |
| S | KB | 5 | T | KB | 3 | U | KB | 1 |
| S | KB | 6 | T | KB | 4 | U | KB | 2 |
| S | KB | 5 | T | KB | 4 | U | KB | 2 |
| S | NS | 1 | T | NS | 3 | U | NS | 4 |
| S | NS | 2 | T | NS | 4 | U | NS | 3 |
| S | NS | 2 | T | NS | 5 | U | NS | 2 |
| S | NS | 3 | T | NS | 3 | U | NS | 1 |
| S | NS | 3 | T | NS | 4 | U | NS | 3 |
| S | PP | 4 | T | PP | 1 | U | PP | 1 |
| S | PP | 6 | T | PP | 2 | U | PP | 2 |
| S | PP | 4 | T | PP | 4 | U | PP | 2 |
| S | PP | 6 | T | PP | 3 | U | PP | 3 |
| S | PP | 4 | T | PP | 4 | U | PP | 5 |
| S | KF | 5 | T | KF | 1 | U | KF | 4 |
| S | KF | 4 | T | KF | 5 | U | KF | 3 |
| S | KF | 6 | T | KF | 4 | U | KF | 4 |
| S | KF | 5 | T | KF | 3 | U | KF | 5 |
| S | KF | 4 | T | KF | 3 | U | KF | 5 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| V | HA | 3 | W | HA | 4 | X | HA | 8 |
| V | HA | 4 | W | HA | 5 | X | HA | 6 |
| V | HA | 3 | W | HA | 6 | X | HA | 9 |
| V | HA | 4 | W | HA | 4 | X | HA | 8 |
| V | HA | 3 | W | HA | 6 | X | HA | 7 |
| V | KB | 3 | W | KB | 7 | X | KB | 6 |
| V | KB | 2 | W | KB | 8 | X | KB | 5 |
| V | KB | 1 | W | KB | 9 | X | KB | 4 |
| V | KB | 1 | W | KB | 6 | X | KB | 3 |
| V | KB | 2 | W | KB | 8 | X | KB | 5 |
| V | NS | 7 | W | NS | 7 | X | NS | 4 |
| V | NS | 7 | W | NS | 5 | X | NS | 3 |
| V | NS | 8 | W | NS | 6 | X | NS | 4 |
| V | NS | 7 | W | NS | 6 | X | NS | 6 |
| V | NS | 9 | W | NS | 8 | X | NS | 5 |
| V | PP | 8 | W | PP | 7 | X | PP | 4 |
| V | PP | 5 | W | PP | 6 | X | PP | 3 |
| V | PP | 6 | W | PP | 5 | X | PP | 2 |
| V | PP | 7 | W | PP | 4 | X | PP | 4 |
| V | PP | 7 | W | PP | 6 | X | PP | 3 |
| V | KF | 4 | W | KF | 6 | X | KF | 7 |
| V | KF | 3 | W | KF | 4 | X | KF | 6 |
| V | KF | 2 | W | KF | 5 | X | KF | 5 |
| V | KF | 4 | W | KF | 4 | X | KF | 4 |
| V | KF | 3 | W | KF | 6 | X | KF | 4 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| Y | HA | 2 | Z | HA | 2 | AA | HA | 4 |
| Y | HA | 2 | Z | HA | 2 | AA | HA | 2 |
| Y | HA | 1 | Z | HA | 4 | AA | HA | 3 |
| Y | HA | 2 | Z | HA | 2 | AA | HA | 4 |
| Y | HA | 2 | Z | HA | 3 | AA | HA | 2 |
| Y | KB | 2 | Z | KB | 6 | AA | KB | 5 |
| Y | KB | 2 | Z | KB | 7 | AA | KB | 6 |
| Y | KB | 2 | Z | KB | 6 | AA | KB | 7 |
| Y | KB | 3 | Z | KB | 5 | AA | KB | 8 |
| Y | KB | 3 | Z | KB | 5 | AA | KB | 9 |
| Y | NS | 4 | Z | NS | 8 | AA | NS | 9 |
| Y | NS | 1 | Z | NS | 4 | AA | NS | 8 |
| Y | NS | 6 | Z | NS | 6 | AA | NS | 6 |
| Y | NS | 1 | Z | NS | 4 | AA | NS | 5 |
| Y | NS | 5 | Z | NS | 6 | AA | NS | 6 |
| Y | PP | 4 | Z | PP | 5 | AA | PP | 5 |
| Y | PP | 6 | Z | PP | 6 | AA | PP | 4 |
| Y | PP | 6 | Z | PP | 7 | AA | PP | 3 |
| Y | PP | 5 | Z | PP | 8 | AA | PP | 6 |
| Y | PP | 3 | Z | PP | 5 | AA | PP | 5 |
| Y | KF | 1 | Z | KF | 6 | AA | KF | 4 |
| Y | KF | 6 | Z | KF | 4 | AA | KF | 6 |
| Y | KF | 6 | Z | KF | 6 | AA | KF | 5 |
| Y | KF | 4 | Z | KF | 4 | AA | KF | 7 |
| Y | KF | 3 | Z | KF | 3 | AA | KF | 6 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| BB | HA | 1 | CC | HA | 3 | DD | HA | 6 |
| BB | HA | 2 | CC | HA | 4 | DD | HA | 3 |
| BB | HA | 1 | CC | HA | 3 | DD | HA | 5 |
| BB | HA | 1 | CC | HA | 2 | DD | HA | 1 |
| BB | HA | 3 | CC | HA | 1 | DD | HA | 6 |
| BB | KB | 6 | CC | KB | 2 | DD | KB | 4 |
| BB | KB | 7 | CC | KB | 6 | DD | KB | 6 |
| BB | KB | 8 | CC | KB | 5 | DD | KB | 4 |
| BB | KB | 6 | CC | KB | 4 | DD | KB | 5 |
| BB | KB | 5 | CC | KB | 3 | DD | KB | 6 |
| BB | NS | 6 | CC | NS | 2 | DD | NS | 4 |
| BB | NS | 6 | CC | NS | 4 | DD | NS | 5 |
| BB | NS | 4 | CC | NS | 6 | DD | NS | 3 |
| BB | NS | 7 | CC | NS | 5 | DD | NS | 2 |
| BB | NS | 8 | CC | NS | 4 | DD | NS | 1 |
| BB | PP | 5 | CC | PP | 4 | DD | PP | 1 |
| BB | PP | 6 | CC | PP | 3 | DD | PP | 2 |
| BB | PP | 7 | CC | PP | 3 | DD | PP | 2 |
| BB | PP | 8 | CC | PP | 4 | DD | PP | 1 |
| BB | PP | 8 | CC | PP | 6 | DD | PP | 3 |
| BB | KF | 7 | CC | KF | 6 | DD | KF | 4 |
| BB | KF | 6 | CC | KF | 5 | DD | KF | 6 |
| BB | KF | 6 | CC | KF | 7 | DD | KF | 5 |
| BB | KF | 6 | CC | KF | 7 | DD | KF | 4 |
| BB | KF | 5 | CC | KF | 6 | DD | KF | 3 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| EE | HA | 8 | FF | HA | 6 | GG | HA | 7 |
| EE | HA | 9 | FF | HA | 8 | GG | HA | 6 |
| EE | HA | 8 | FF | HA | 7 | GG | HA | 5 |
| EE | HA | 7 | FF | HA | 6 | GG | HA | 4 |
| EE | HA | 6 | FF | HA | 5 | GG | HA | 6 |
| EE | KB | 5 | FF | KB | 6 | GG | KB | 4 |
| EE | KB | 4 | FF | KB | 8 | GG | KB | 6 |
| EE | KB | 6 | FF | KB | 9 | GG | KB | 7 |
| EE | KB | 4 | FF | KB | 8 | GG | KB | 8 |
| EE | KB | 5 | FF | KB | 7 | GG | KB | 8 |
| EE | NS | 3 | FF | NS | 6 | GG | NS | 7 |
| EE | NS | 1 | FF | NS | 5 | GG | NS | 6 |
| EE | NS | 2 | FF | NS | 4 | GG | NS | 5 |
| EE | NS | 1 | FF | NS | 6 | GG | NS | 7 |
| EE | NS | 1 | FF | NS | 7 | GG | NS | 7 |
| EE | PP | 4 | FF | PP | 8 | GG | PP | 9 |
| EE | PP | 3 | FF | PP | 6 | GG | PP | 8 |
| EE | PP | 2 | FF | PP | 7 | GG | PP | 6 |
| EE | PP | 1 | FF | PP | 8 | GG | PP | 6 |
| EE | PP | 4 | FF | PP | 9 | GG | PP | 4 |
| EE | KF | 2 | FF | KF | 8 | GG | KF | 6 |
| EE | KF | 4 | FF | KF | 7 | GG | KF | 6 |
| EE | KF | 3 | FF | KF | 6 | GG | KF | 5 |
| EE | KF | 5 | FF | KF | 5 | GG | KF | 5 |
| EE | KF | 3 | FF | KF | 5 | GG | KF | 6 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| HH | HA | 6 | II | HA | 1 | JJ | HA | 7 |
| HH | HA | 5 | II | HA | 3 | JJ | HA | 8 |
| HH | HA | 4 | II | HA | 2 | JJ | HA | 9 |
| HH | HA | 8 | II | HA | 2 | JJ | HA | 4 |
| HH | HA | 5 | II | HA | 1 | JJ | HA | 5 |
| HH | KB | 6 | II | KB | 5 | JJ | KB | 6 |
| HH | KB | 5 | II | KB | 4 | JJ | KB | 5 |
| HH | KB | 5 | II | KB | 6 | JJ | KB | 8 |
| HH | KB | 6 | II | KB | 5 | JJ | KB | 6 |
| HH | KB | 4 | II | KB | 7 | JJ | KB | 7 |
| HH | NS | 8 | II | NS | 4 | JJ | NS | 6 |
| HH | NS | 7 | II | NS | 1 | JJ | NS | 8 |
| HH | NS | 6 | II | NS | 1 | JJ | NS | 5 |
| HH | NS | 5 | II | NS | 4 | JJ | NS | 6 |
| HH | NS | 8 | II | NS | 4 | JJ | NS | 4 |
| HH | PP | 6 | II | PP | 1 | JJ | PP | 6 |
| HH | PP | 9 | II | PP | 1 | JJ | PP | 5 |
| HH | PP | 8 | II | PP | 2 | JJ | PP | 4 |
| HH | PP | 7 | II | PP | 2 | JJ | PP | 6 |
| HH | PP | 6 | II | PP | 4 | JJ | PP | 5 |
| HH | KF | 4 | II | KF | 1 | JJ | KF | 8 |
| HH | KF | 5 | II | KF | 3 | JJ | KF | 7 |
| HH | KF | 5 | II | KF | 3 | JJ | KF | 7 |
| HH | KF | 6 | II | KF | 2 | JJ | KF | 6 |
| HH | KF | 4 | II | KF | 7 | JJ | KF | 8 |

| Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products | Toy Head | Hair Yarn Type | Good Products |
|---|---|---|---|---|---|---|---|---|
| KK | HA | 5 | LL | HA | 8 | MM | HA | 8 |
| KK | HA | 2 | LL | HA | 7 | MM | HA | 7 |
| KK | HA | 6 | LL | HA | 9 | MM | HA | 9 |
| KK | HA | 3 | LL | HA | 6 | MM | HA | 8 |
| KK | HA | 6 | LL | HA | 7 | MM | HA | 8 |
| KK | KB | 7 | LL | KB | 6 | MM | KB | 7 |
| KK | KB | 4 | LL | KB | 8 | MM | KB | 6 |
| KK | KB | 6 | LL | KB | 5 | MM | KB | 8 |
| KK | KB | 9 | LL | KB | 8 | MM | KB | 7 |
| KK | KB | 8 | LL | KB | 6 | MM | KB | 6 |
| KK | NS | 5 | LL | NS | 4 | MM | NS | 5 |
| KK | NS | 2 | LL | NS | 6 | MM | NS | 5 |
| KK | NS | 4 | LL | NS | 4 | MM | NS | 4 |
| KK | NS | 6 | LL | NS | 6 | MM | NS | 6 |
| KK | NS | 3 | LL | NS | 6 | MM | NS | 4 |
| KK | PP | 4 | LL | PP | 4 | MM | PP | 4 |
| KK | PP | 2 | LL | PP | 5 | MM | PP | 3 |
| KK | PP | 6 | LL | PP | 6 | MM | PP | 6 |
| KK | PP | 5 | LL | PP | 5 | MM | PP | 5 |
| KK | PP | 7 | LL | PP | 5 | MM | PP | 4 |
| KK | KF | 1 | LL | KF | 4 | MM | KF | 4 |
| KK | KF | 3 | LL | KF | 6 | MM | KF | 6 |
| KK | KF | 2 | LL | KF | 5 | MM | KF | 5 |
| KK | KF | 4 | LL | KF | 4 | MM | KF | 4 |
| KK | KF | 3 | LL | KF | 5 | MM | KF | 5 |

| Toy Head | Hair Yarn Type | Good Products |
|---|---|---|
| NN | HA | 1 |
| NN | HA | 4 |
| NN | HA | 3 |
| NN | HA | 1 |
| NN | HA | 2 |
| NN | KB | 4 |
| NN | KB | 3 |
| NN | KB | 4 |
| NN | KB | 3 |
| NN | KB | 1 |
| NN | NS | 2 |
| NN | NS | 1 |
| NN | NS | 3 |
| NN | NS | 5 |
| NN | NS | 1 |
| NN | PP | 3 |
| NN | PP | 2 |
| NN | PP | 4 |
| NN | PP | 5 |
| NN | PP | 4 |
| NN | KF | 3 |
| NN | KF | 1 |
| NN | KF | 2 |
| NN | KF | 4 |
| NN | KF | 1 |

## Appendix 6-Minitab Result for ANOVA and Fisher Test Calculation

## One-way ANOVA: Good Products versus Hair Yarn Type (Toy A)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | $\alpha$ = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 34,64 | 8,6600 | 9,84 | 0,000 |
| Error | 20 | 17,60 | 0,8800 | | |
| Total | 24 | 52,24 | | | |

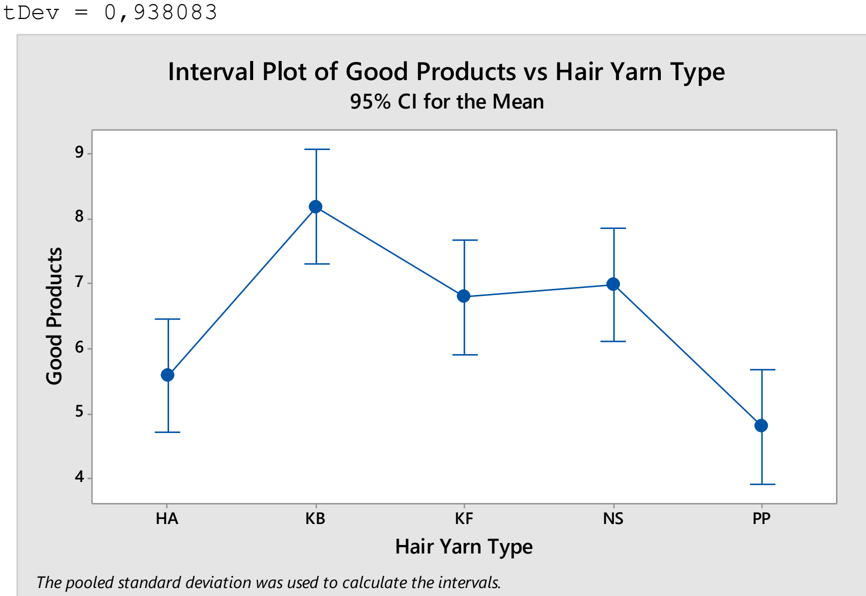
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 0,938083 | 66,31% | 59,57% | 47,36% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 5,600 | 1,140 | (4,725; 6,475) |
| KB | 5 | 8,200 | 0,837 | (7,325; 9,075) |
| KF | 5 | 6,800 | 0,837 | (5,925; 7,675) |
| NS | 5 | 7,000 | 1,000 | (6,125; 7,875) |
| PP | 5 | 4,800 | 0,837 | (3,925; 5,675) |

Pooled StDev = 0,938083



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

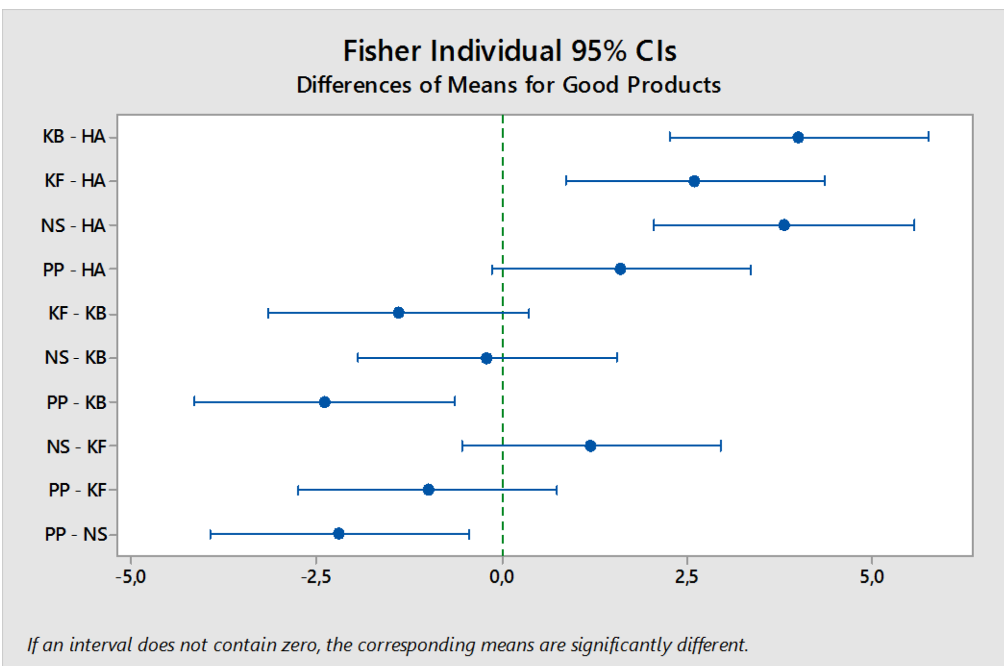
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 8,200 | A |
| NS | 5 | 7,000 | A B |
| KF | 5 | 6,800 | B C |
| HA | 5 | 5,600 | C D |
| PP | 5 | 4,800 | D |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,600 | 0,593 | ( 1,362; 3,838) | 4,38 | 0,000 |
| KF - HA | 1,200 | 0,593 | (-0,038; 2,438) | 2,02 | 0,057 |
| NS - HA | 1,400 | 0,593 | ( 0,162; 2,638) | 2,36 | 0,029 |
| PP - HA | -0,800 | 0,593 | (-2,038; 0,438) | -1,35 | 0,193 |
| KF - KB | -1,400 | 0,593 | (-2,638; -0,162) | -2,36 | 0,029 |
| NS - KB | -1,200 | 0,593 | (-2,438; 0,038) | -2,02 | 0,057 |
| PP - KB | -3,400 | 0,593 | (-4,638; -2,162) | -5,73 | 0,000 |
| NS - KF | 0,200 | 0,593 | (-1,038; 1,438) | 0,34 | 0,740 |
| PP - KF | -2,000 | 0,593 | (-3,238; -0,762) | -3,37 | 0,003 |
| PP - NS | -2,200 | 0,593 | (-3,438; -0,962) | -3,71 | 0,001 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy B)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 34,16 | 8,540 | 4,54 | 0,009 |
| Error | 20 | 37,60 | 1,880 | | |
| Total | 24 | 71,76 | | | |

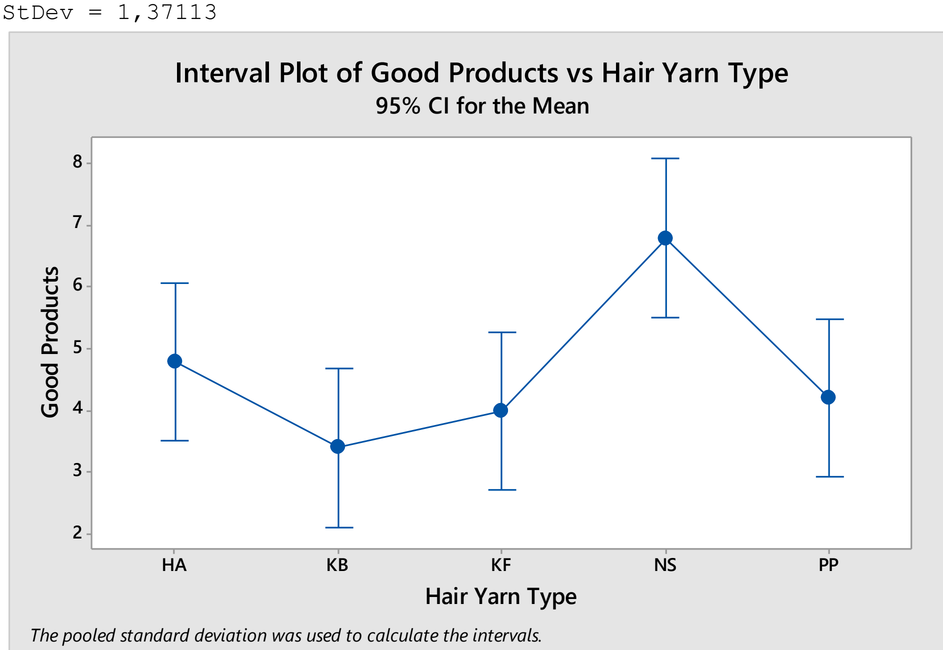
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,37113 | 47,60% | 37,12% | 18,13% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 4,800 | 1,304 | (3,521; 6,079) |
| KB | 5 | 3,400 | 1,140 | (2,121; 4,679) |
| KF | 5 | 4,000 | 1,581 | (2,721; 5,279) |
| NS | 5 | 6,800 | 1,304 | (5,521; 8,079) |
| PP | 5 | 4,200 | 1,483 | (2,921; 5,479) |

Pooled StDev = 1,37113



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

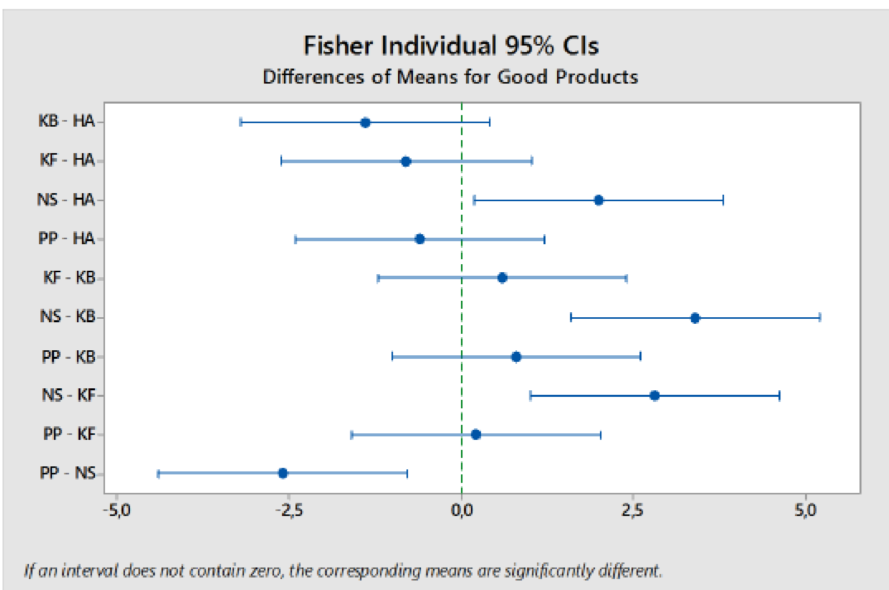
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| NS | 5 | 6,800 | A |
| HA | 5 | 4,800 | B |
| PP | 5 | 4,200 | B |
| KF | 5 | 4,000 | B |
| KB | 5 | 3,400 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

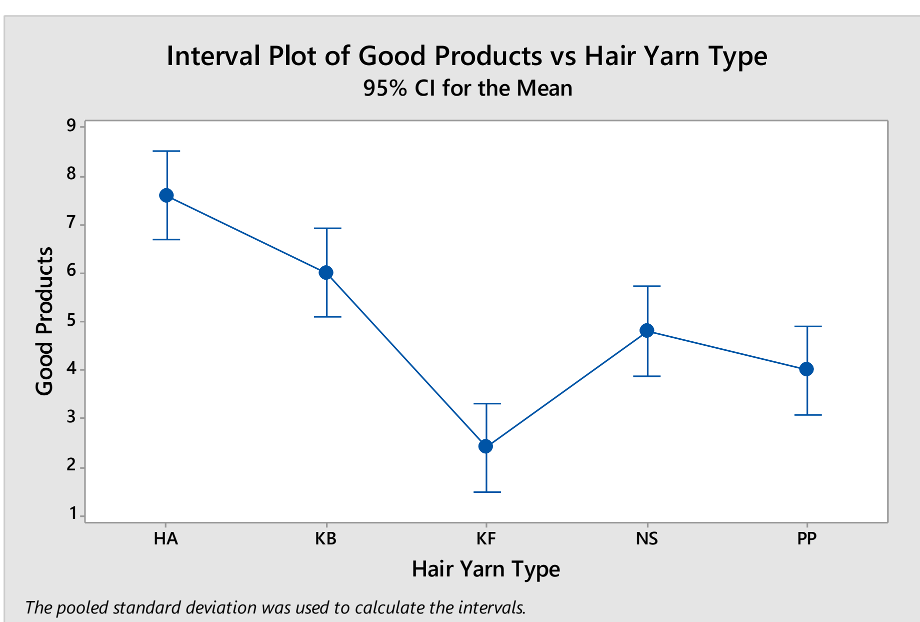
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,400 | 0,867 | (-3,209; 0,409) | -1,61 | 0,122 |
| KF - HA | -0,800 | 0,867 | (-2,609; 1,009) | -0,92 | 0,367 |
| NS - HA | 2,000 | 0,867 | ( 0,191; 3,809) | 2,31 | 0,032 |
| PP - HA | -0,600 | 0,867 | (-2,409; 1,209) | -0,69 | 0,497 |
| KF - KB | 0,600 | 0,867 | (-1,209; 2,409) | 0,69 | 0,497 |
| NS - KB | 3,400 | 0,867 | ( 1,591; 5,209) | 3,92 | 0,001 |
| PP - KB | 0,800 | 0,867 | (-1,009; 2,609) | 0,92 | 0,367 |
| NS - KF | 2,800 | 0,867 | ( 0,991; 4,609) | 3,23 | 0,004 |
| PP - KF | 0,200 | 0,867 | (-1,609; 2,009) | 0,23 | 0,820 |
| PP - NS | -2,600 | 0,867 | (-4,409; -0,791) | -3,00 | 0,007 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy C)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS   Adj MS  F-Value  P-Value
Hair Yarn Type   4   77,76  19,4400    20,25    0,000
Error           20   19,20   0,9600
Total           24   96,96


Model Summary

       S    R-sq  R-sq(adj)  R-sq(pred)
0,979796  80,20%     76,24%      69,06%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  7,600  1,140  (6,686; 8,514)
KB    5  6,000  1,000  (5,086; 6,914)
KF    5  2,400  1,140  (1,486; 3,314)
NS    5  4,800  0,837  (3,886; 5,714)
PP    5  4,000  0,707  (3,086; 4,914)

Pooled StDev = 0,979796
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

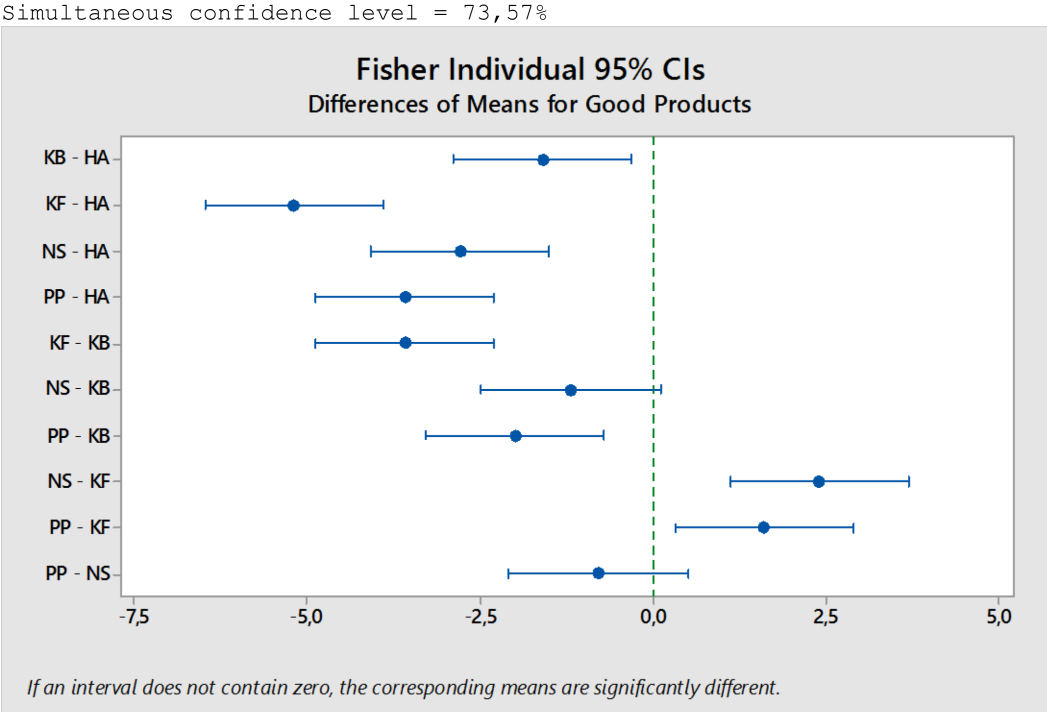
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| HA | 5 | 7,600 | A |
| KB | 5 | 6,000 | B |
| NS | 5 | 4,800 | B C |
| PP | 5 | 4,000 | C |
| KF | 5 | 2,400 | D |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,600 | 0,620 | (-2,893; -0,307) | -2,58 | 0,018 |
| KF - HA | -5,200 | 0,620 | (-6,493; -3,907) | -8,39 | 0,000 |
| NS - HA | -2,800 | 0,620 | (-4,093; -1,507) | -4,52 | 0,000 |
| PP - HA | -3,600 | 0,620 | (-4,893; -2,307) | -5,81 | 0,000 |
| KF - KB | -3,600 | 0,620 | (-4,893; -2,307) | -5,81 | 0,000 |
| NS - KB | -1,200 | 0,620 | (-2,493; 0,093) | -1,94 | 0,067 |
| PP - KB | -2,000 | 0,620 | (-3,293; -0,707) | -3,23 | 0,004 |
| NS - KF | 2,400 | 0,620 | ( 1,107; 3,693) | 3,87 | 0,001 |
| PP - KF | 1,600 | 0,620 | ( 0,307; 2,893) | 2,58 | 0,018 |
| PP - NS | -0,800 | 0,620 | (-2,093; 0,493) | -1,29 | 0,211 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy D)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 41,36 | 10,340 | 8,21 | 0,000 |
| Error | 20 | 25,20 | 1,260 | | |
| Total | 24 | 66,56 | | | |

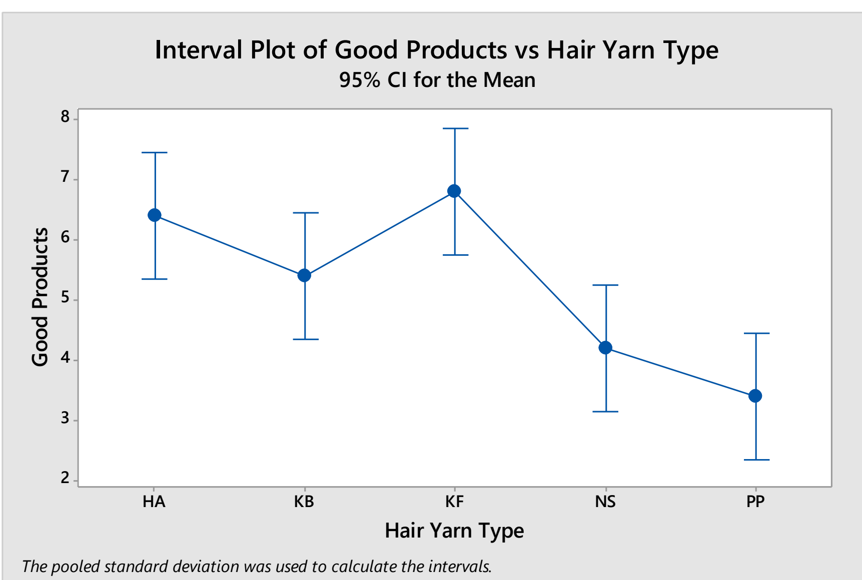
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,12250 | 62,14% | 54,57% | 40,84% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 6,400 | 1,140 | (5,353; 7,447) |
| KB | 5 | 5,400 | 1,140 | (4,353; 6,447) |
| KF | 5 | 6,800 | 0,837 | (5,753; 7,847) |
| NS | 5 | 4,200 | 0,837 | (3,153; 5,247) |
| PP | 5 | 3,400 | 1,517 | (2,353; 4,447) |

Pooled StDev = 1,12250



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

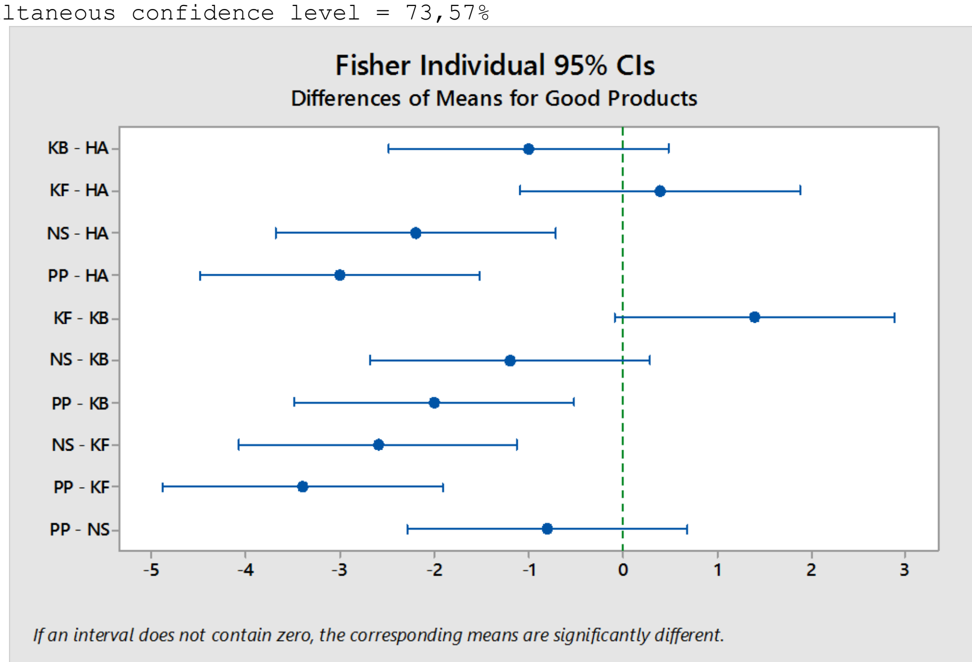
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 6,800 | A |
| HA | 5 | 6,400 | A |
| KB | 5 | 5,400 | A B |
| NS | 5 | 4,200 | B C |
| PP | 5 | 3,400 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

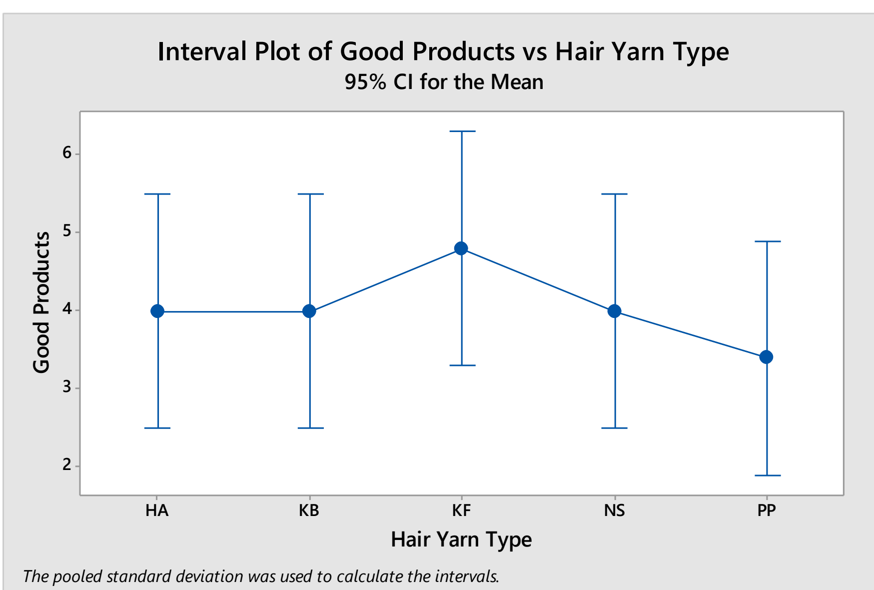
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,000 | 0,710 | (-2,481; 0,481) | -1,41 | 0,174 |
| KF - HA | 0,400 | 0,710 | (-1,081; 1,881) | 0,56 | 0,579 |
| NS - HA | -2,200 | 0,710 | (-3,681; -0,719) | -3,10 | 0,006 |
| PP - HA | -3,000 | 0,710 | (-4,481; -1,519) | -4,23 | 0,000 |
| KF - KB | 1,400 | 0,710 | (-0,081; 2,881) | 1,97 | 0,063 |
| NS - KB | -1,200 | 0,710 | (-2,681; 0,281) | -1,69 | 0,106 |
| PP - KB | -2,000 | 0,710 | (-3,481; -0,519) | -2,82 | 0,011 |
| NS - KF | -2,600 | 0,710 | (-4,081; -1,119) | -3,66 | 0,002 |
| PP - KF | -3,400 | 0,710 | (-4,881; -1,919) | -4,79 | 0,000 |
| PP - NS | -0,800 | 0,710 | (-2,281; 0,681) | -1,13 | 0,273 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy E)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   4,960   1,240     0,48    0,752
Error           20  52,000   2,600
Total           24  56,960


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,61245  8,71%      0,00%       0,00%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  4,000  1,581  (2,496; 5,504)
KB    5  4,000  1,581  (2,496; 5,504)
KF    5  4,800  1,789  (3,296; 6,304)
NS    5  4,000  1,581  (2,496; 5,504)
PP    5  3,400  1,517  (1,896; 4,904)

Pooled StDev = 1,61245
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

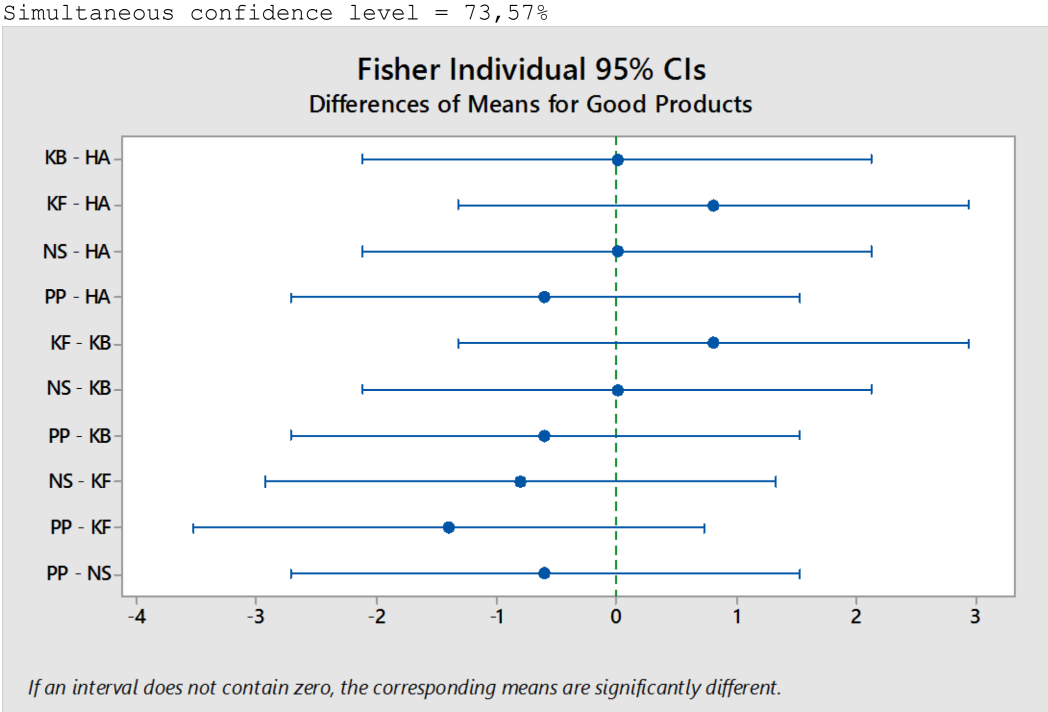
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 4,800 | A |
| NS | 5 | 4,000 | A |
| KB | 5 | 4,000 | A |
| HA | 5 | 4,000 | A |
| PP | 5 | 3,400 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

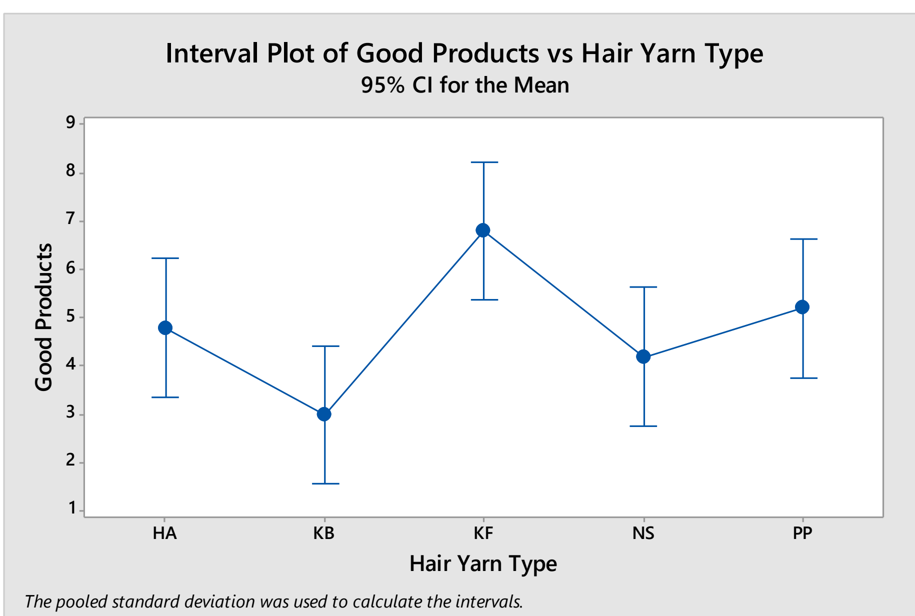
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,00 | 1,02 | (-2,13; 2,13) | 0,00 | 1,000 |
| KF - HA | 0,80 | 1,02 | (-1,33; 2,93) | 0,78 | 0,442 |
| NS - HA | 0,00 | 1,02 | (-2,13; 2,13) | 0,00 | 1,000 |
| PP - HA | -0,60 | 1,02 | (-2,73; 1,53) | -0,59 | 0,563 |
| KF - KB | 0,80 | 1,02 | (-1,33; 2,93) | 0,78 | 0,442 |
| NS - KB | 0,00 | 1,02 | (-2,13; 2,13) | 0,00 | 1,000 |
| PP - KB | -0,60 | 1,02 | (-2,73; 1,53) | -0,59 | 0,563 |
| NS - KF | -0,80 | 1,02 | (-2,93; 1,33) | -0,78 | 0,442 |
| PP - KF | -1,40 | 1,02 | (-3,53; 0,73) | -1,37 | 0,185 |
| PP - NS | -0,60 | 1,02 | (-2,73; 1,53) | -0,59 | 0,563 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy F)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   38,80   9,700     4,11    0,014
Error           20   47,20   2,360
Total           24   86,00


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,53623  45,12%     34,14%      14,24%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  4,800  1,789  (3,367; 6,233)
KB    5  3,000  1,581  (1,567; 4,433)
KF    5  6,800  1,304  (5,367; 8,233)
NS    5  4,200  1,643  (2,767; 5,633)
PP    5  5,200  1,304  (3,767; 6,633)

Pooled StDev = 1,53623
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

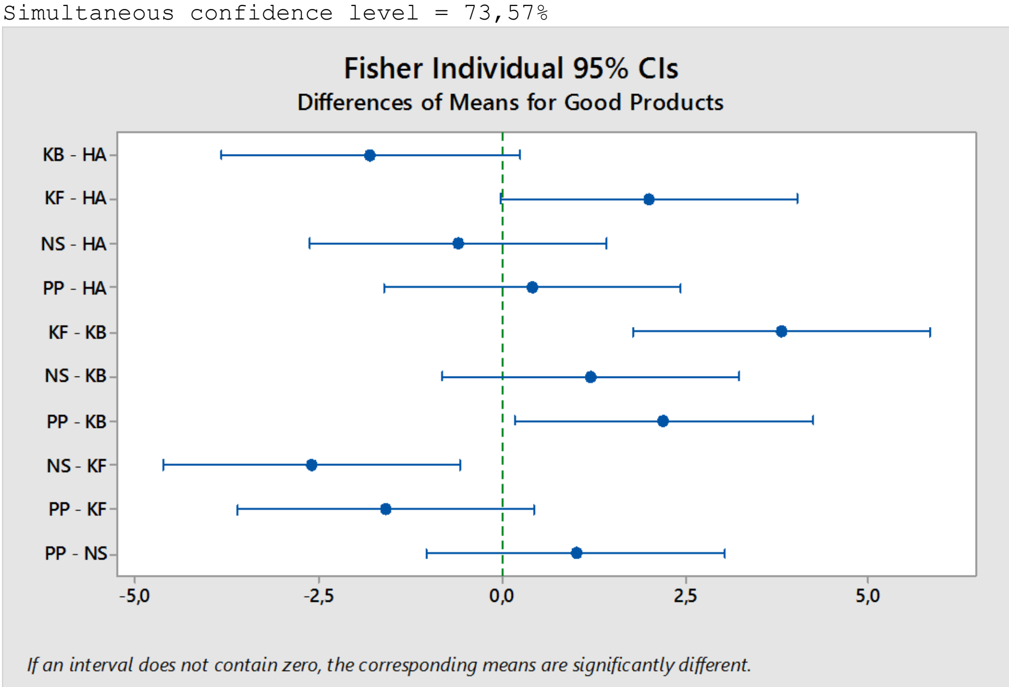
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 6,800 | A |
| PP | 5 | 5,200 | A B |
| HA | 5 | 4,800 | A B C |
| NS | 5 | 4,200 | B C |
| KB | 5 | 3,000 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,800 | 0,972 | (-3,827; 0,227) | -1,85 | 0,079 |
| KF - HA | 2,000 | 0,972 | (-0,027; 4,027) | 2,06 | 0,053 |
| NS - HA | -0,600 | 0,972 | (-2,627; 1,427) | -0,62 | 0,544 |
| PP - HA | 0,400 | 0,972 | (-1,627; 2,427) | 0,41 | 0,685 |
| KF - KB | 3,800 | 0,972 | ( 1,773; 5,827) | 3,91 | 0,001 |
| NS - KB | 1,200 | 0,972 | (-0,827; 3,227) | 1,24 | 0,231 |
| PP - KB | 2,200 | 0,972 | ( 0,173; 4,227) | 2,26 | 0,035 |
| NS - KF | -2,600 | 0,972 | (-4,627; -0,573) | -2,68 | 0,015 |
| PP - KF | -1,600 | 0,972 | (-3,627; 0,427) | -1,65 | 0,115 |
| PP - NS | 1,000 | 0,972 | (-1,027; 3,027) | 1,03 | 0,316 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy G)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 1,440 | 0,3600 | 0,38 | 0,824 |
| Error | 20 | 19,200 | 0,9600 | | |
| Total | 24 | 20,640 | | | |

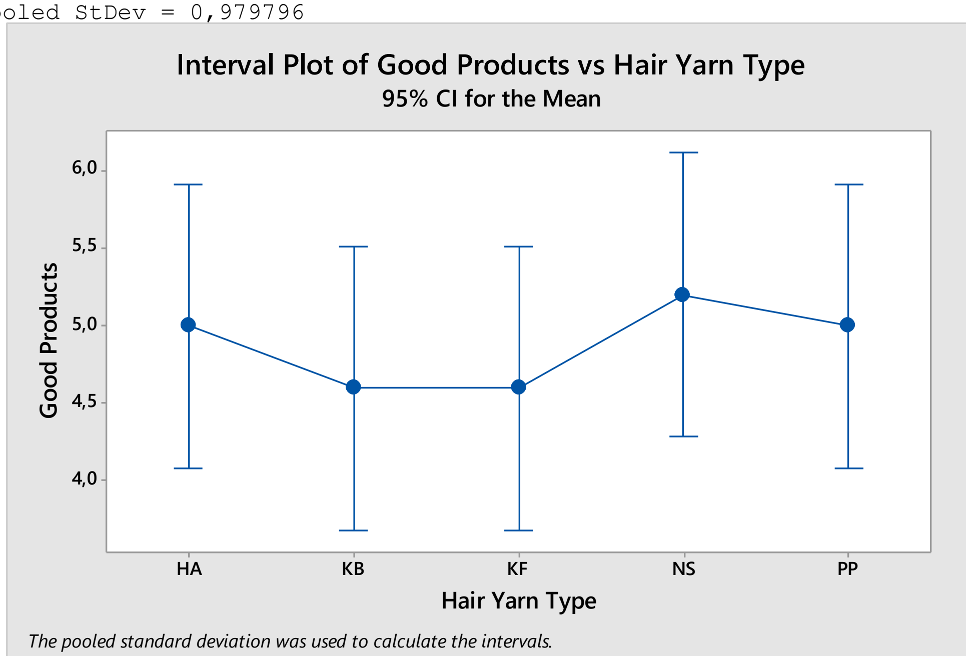
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 0,979796 | 6,98% | 0,00% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 5,000 | 1,000 | (4,086; 5,914) |
| KB | 5 | 4,600 | 0,894 | (3,686; 5,514) |
| KF | 5 | 4,600 | 1,140 | (3,686; 5,514) |
| NS | 5 | 5,200 | 0,837 | (4,286; 6,114) |
| PP | 5 | 5,000 | 1,000 | (4,086; 5,914) |

Pooled StDev = 0,979796



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

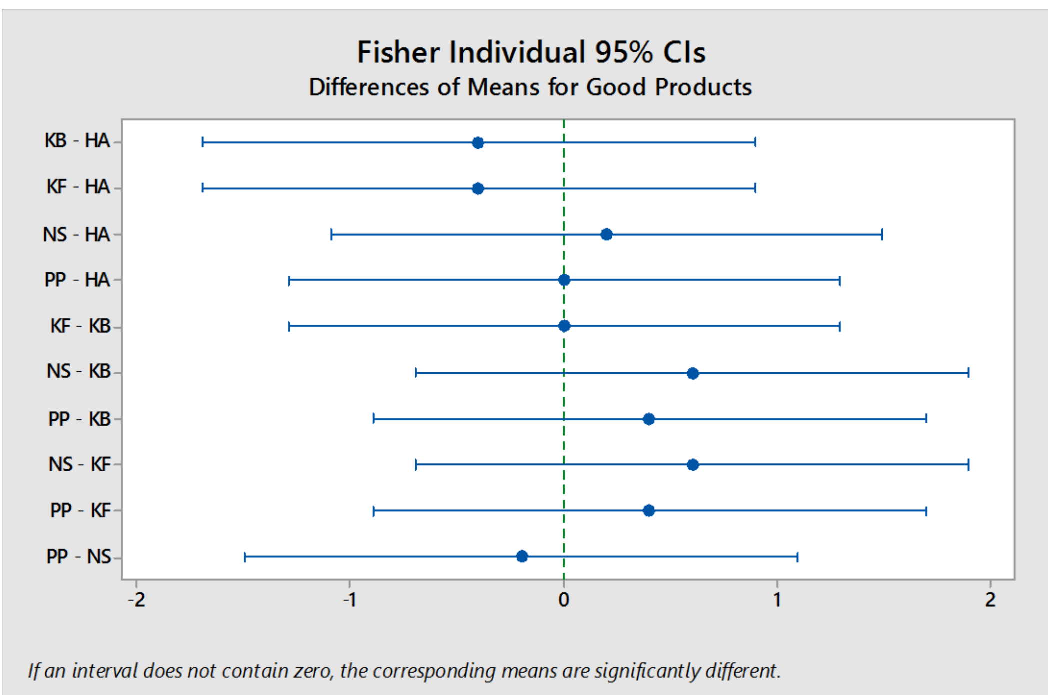
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| NS | 5 | 5,200 | A |
| PP | 5 | 5,000 | A |
| HA | 5 | 5,000 | A |
| KF | 5 | 4,600 | A |
| KB | 5 | 4,600 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -0,400 | 0,620 | (-1,693; 0,893) | -0,65 | 0,526 |
| KF - HA | -0,400 | 0,620 | (-1,693; 0,893) | -0,65 | 0,526 |
| NS - HA | 0,200 | 0,620 | (-1,093; 1,493) | 0,32 | 0,750 |
| PP - HA | 0,000 | 0,620 | (-1,293; 1,293) | 0,00 | 1,000 |
| KF - KB | 0,000 | 0,620 | (-1,293; 1,293) | 0,00 | 1,000 |
| NS - KB | 0,600 | 0,620 | (-0,693; 1,893) | 0,97 | 0,344 |
| PP - KB | 0,400 | 0,620 | (-0,893; 1,693) | 0,65 | 0,526 |
| NS - KF | 0,600 | 0,620 | (-0,693; 1,893) | 0,97 | 0,344 |
| PP - KF | 0,400 | 0,620 | (-0,893; 1,693) | 0,65 | 0,526 |
| PP - NS | -0,200 | 0,620 | (-1,493; 1,093) | -0,32 | 0,750 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy H)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 40,56 | 10,140 | 4,97 | 0,006 |
| Error | 20 | 40,80 | 2,040 | | |
| Total | 24 | 81,36 | | | |

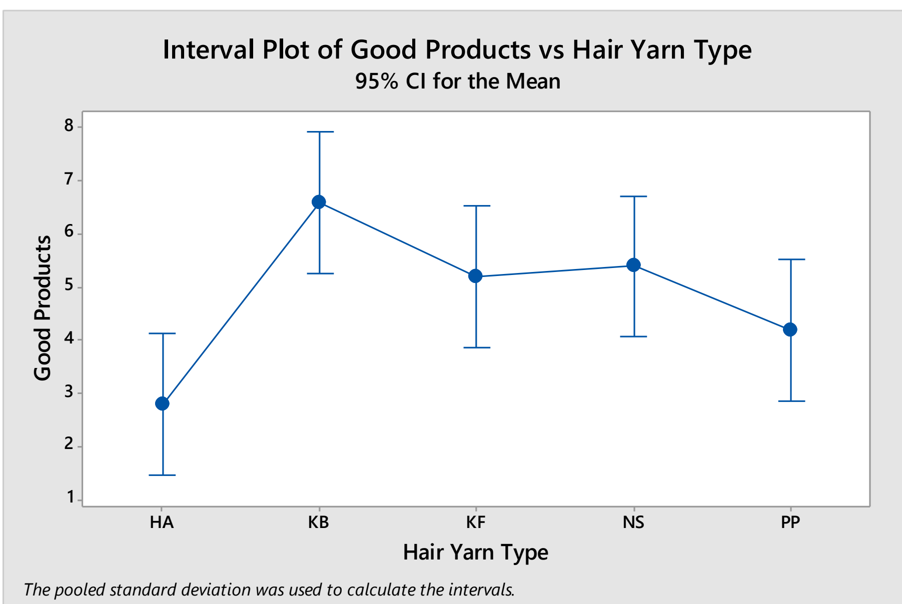
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,42829 | 49,85% | 39,82% | 21,64% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 2,800 | 1,304 | (1,468; 4,132) |
| KB | 5 | 6,600 | 1,517 | (5,268; 7,932) |
| KF | 5 | 5,200 | 1,304 | (3,868; 6,532) |
| NS | 5 | 5,400 | 1,673 | (4,068; 6,732) |
| PP | 5 | 4,200 | 1,304 | (2,868; 5,532) |

Pooled StDev = 1,42829



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

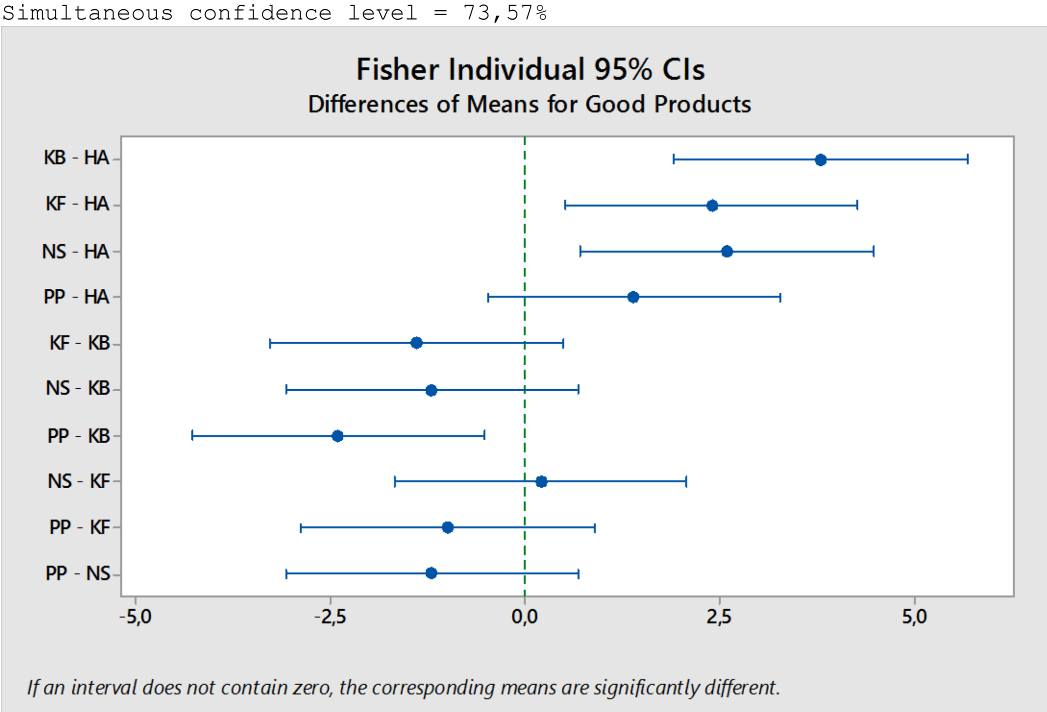
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 6,600 | A |
| NS | 5 | 5,400 | A B |
| KF | 5 | 5,200 | A B |
| PP | 5 | 4,200 | B C |
| HA | 5 | 2,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

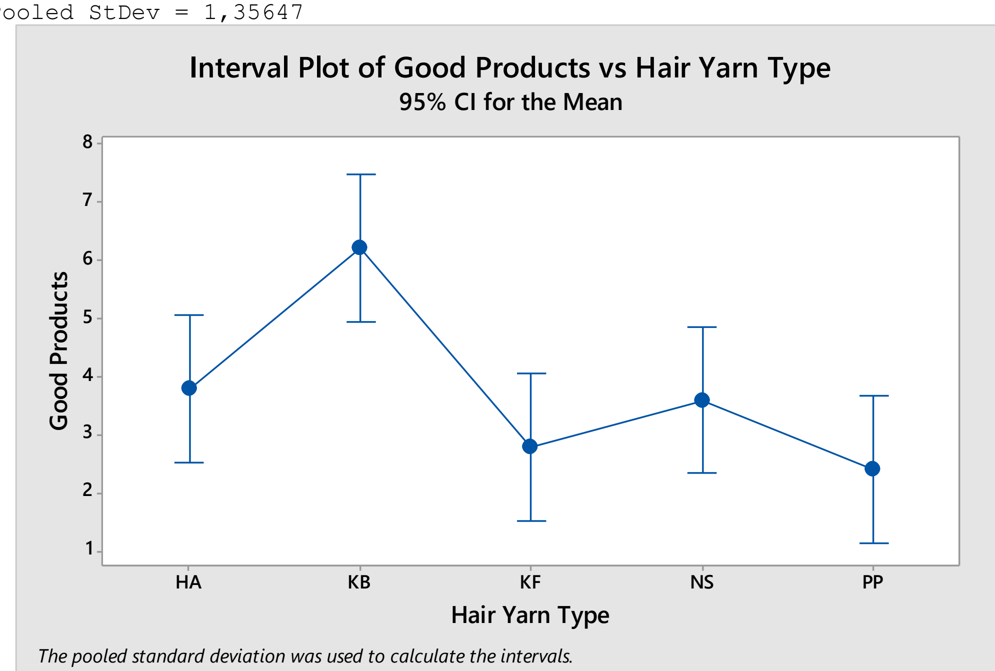
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 3,800 | 0,903 | ( 1,916; 5,684) | 4,21 | 0,000 |
| KF - HA | 2,400 | 0,903 | ( 0,516; 4,284) | 2,66 | 0,015 |
| NS - HA | 2,600 | 0,903 | ( 0,716; 4,484) | 2,88 | 0,009 |
| PP - HA | 1,400 | 0,903 | (-0,484; 3,284) | 1,55 | 0,137 |
| KF - KB | -1,400 | 0,903 | (-3,284; 0,484) | -1,55 | 0,137 |
| NS - KB | -1,200 | 0,903 | (-3,084; 0,684) | -1,33 | 0,199 |
| PP - KB | -2,400 | 0,903 | (-4,284; -0,516) | -2,66 | 0,015 |
| NS - KF | 0,200 | 0,903 | (-1,684; 2,084) | 0,22 | 0,827 |
| PP - KF | -1,000 | 0,903 | (-2,884; 0,884) | -1,11 | 0,281 |
| PP - NS | -1,200 | 0,903 | (-3,084; 0,684) | -1,33 | 0,199 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy I)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   43,76  10,940     5,95    0,003
Error           20   36,80   1,840
Total           24   80,56


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,35647  54,32%     45,18%      28,62%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  3,800  1,483  (2,535; 5,065)
KB    5  6,200  1,304  (4,935; 7,465)
KF    5  2,800  0,837  (1,535; 4,065)
NS    5  3,600  1,817  (2,335; 4,865)
PP    5  2,400  1,140  (1,135; 3,665)

Pooled StDev = 1,35647
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

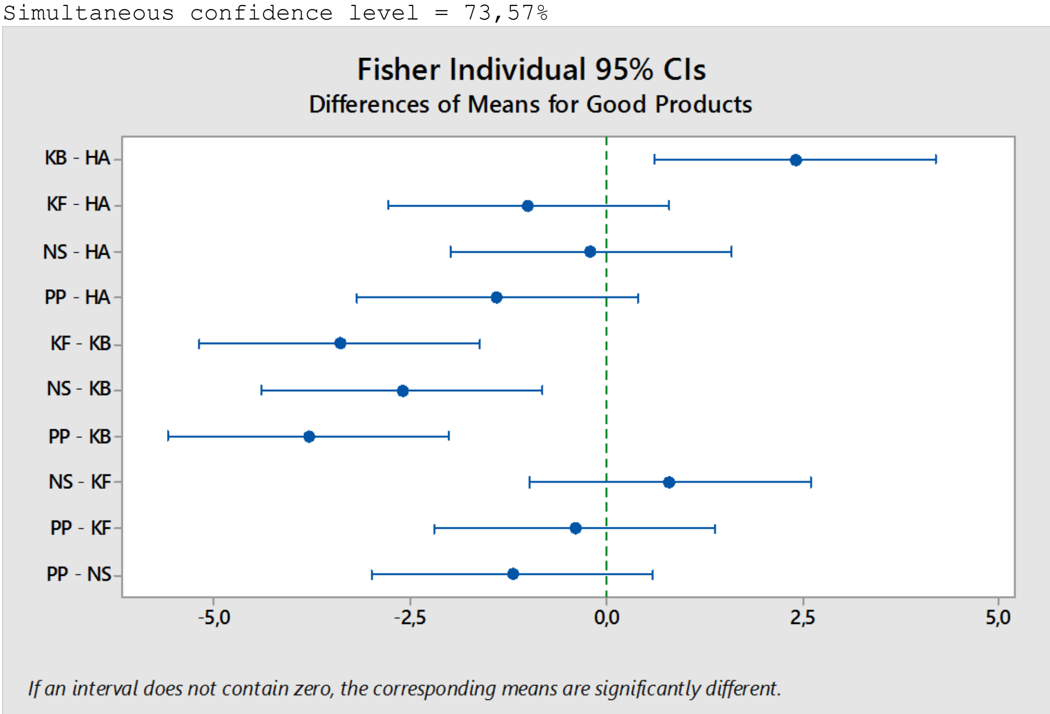
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 6,200 | A |
| HA | 5 | 3,800 | B |
| NS | 5 | 3,600 | B |
| KF | 5 | 2,800 | B |
| PP | 5 | 2,400 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,400 | 0,858 | ( 0,610; 4,190) | 2,80 | 0,011 |
| KF - HA | -1,000 | 0,858 | (-2,790; 0,790) | -1,17 | 0,257 |
| NS - HA | -0,200 | 0,858 | (-1,990; 1,590) | -0,23 | 0,818 |
| PP - HA | -1,400 | 0,858 | (-3,190; 0,390) | -1,63 | 0,118 |
| KF - KB | -3,400 | 0,858 | (-5,190; -1,610) | -3,96 | 0,001 |
| NS - KB | -2,600 | 0,858 | (-4,390; -0,810) | -3,03 | 0,007 |
| PP - KB | -3,800 | 0,858 | (-5,590; -2,010) | -4,43 | 0,000 |
| NS - KF | 0,800 | 0,858 | (-0,990; 2,590) | 0,93 | 0,362 |
| PP - KF | -0,400 | 0,858 | (-2,190; 1,390) | -0,47 | 0,646 |
| PP - NS | -1,200 | 0,858 | (-2,990; 0,590) | -1,40 | 0,177 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy J)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 64,16 | 16,040 | 8,53 | 0,000 |
| Error | 20 | 37,60 | 1,880 | | |
| Total | 24 | 101,76 | | | |

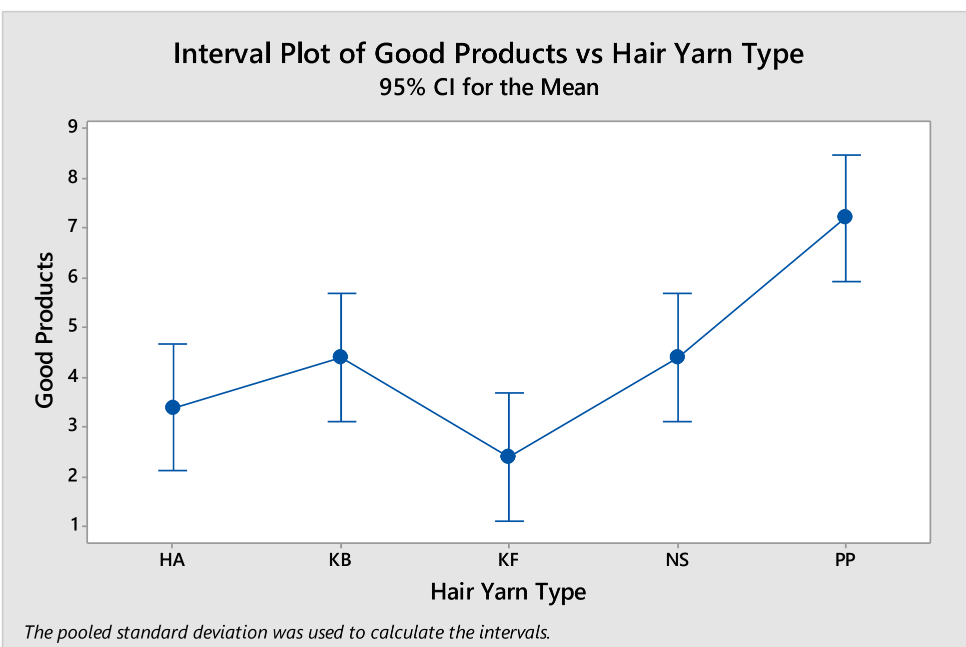
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,37113 | 63,05% | 55,66% | 42,27% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 3,400 | 1,517 | (2,121; 4,679) |
| KB | 5 | 4,400 | 1,140 | (3,121; 5,679) |
| KF | 5 | 2,400 | 1,140 | (1,121; 3,679) |
| NS | 5 | 4,400 | 1,342 | (3,121; 5,679) |
| PP | 5 | 7,200 | 1,643 | (5,921; 8,479) |

Pooled StDev = 1,37113



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

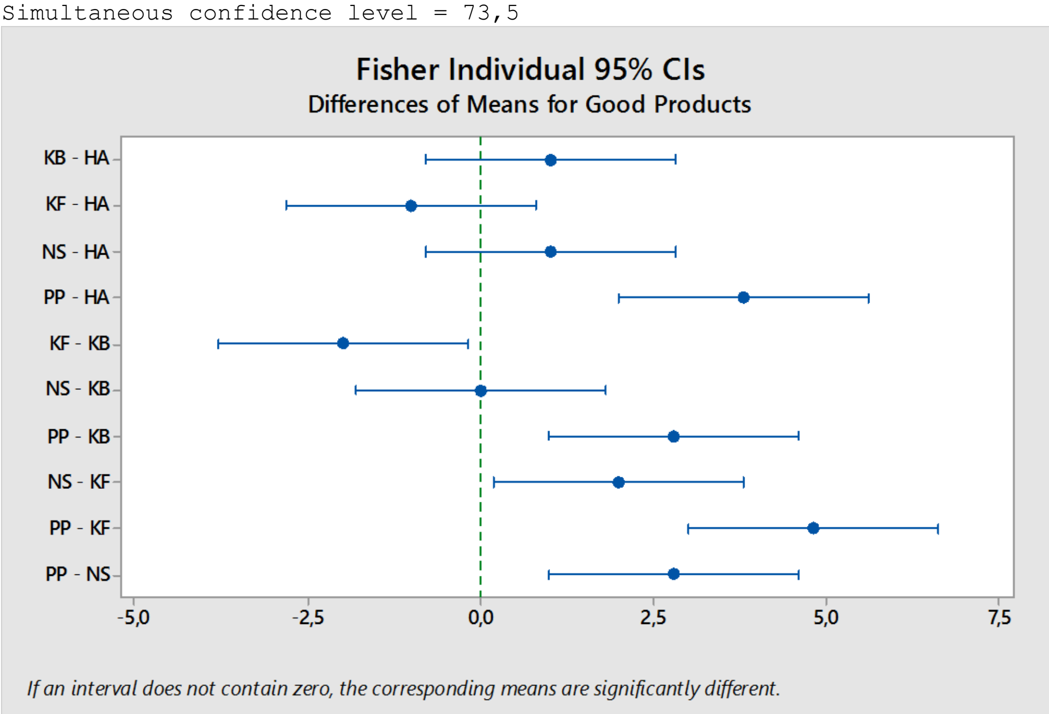
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 7,200 | A |
| NS | 5 | 4,400 | B |
| KB | 5 | 4,400 | B |
| HA | 5 | 3,400 | B C |
| KF | 5 | 2,400 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 1,000 | 0,867 | (-0,809; 2,809) | 1,15 | 0,262 |
| KF - HA | -1,000 | 0,867 | (-2,809; 0,809) | -1,15 | 0,262 |
| NS - HA | 1,000 | 0,867 | (-0,809; 2,809) | 1,15 | 0,262 |
| PP - HA | 3,800 | 0,867 | ( 1,991; 5,609) | 4,38 | 0,000 |
| KF - KB | -2,000 | 0,867 | (-3,809; -0,191) | -2,31 | 0,032 |
| NS - KB | 0,000 | 0,867 | (-1,809; 1,809) | 0,00 | 1,000 |
| PP - KB | 2,800 | 0,867 | ( 0,991; 4,609) | 3,23 | 0,004 |
| NS - KF | 2,000 | 0,867 | ( 0,191; 3,809) | 2,31 | 0,032 |
| PP - KF | 4,800 | 0,867 | ( 2,991; 6,609) | 5,54 | 0,000 |
| PP - NS | 2,800 | 0,867 | ( 0,991; 4,609) | 3,23 | 0,004 |

Simultaneous confidence level = 73,5



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy K)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 8,160 | 2,040 | 1,19 | 0,347 |
| Error | 20 | 34,400 | 1,720 | | |
| Total | 24 | 42,560 | | | |

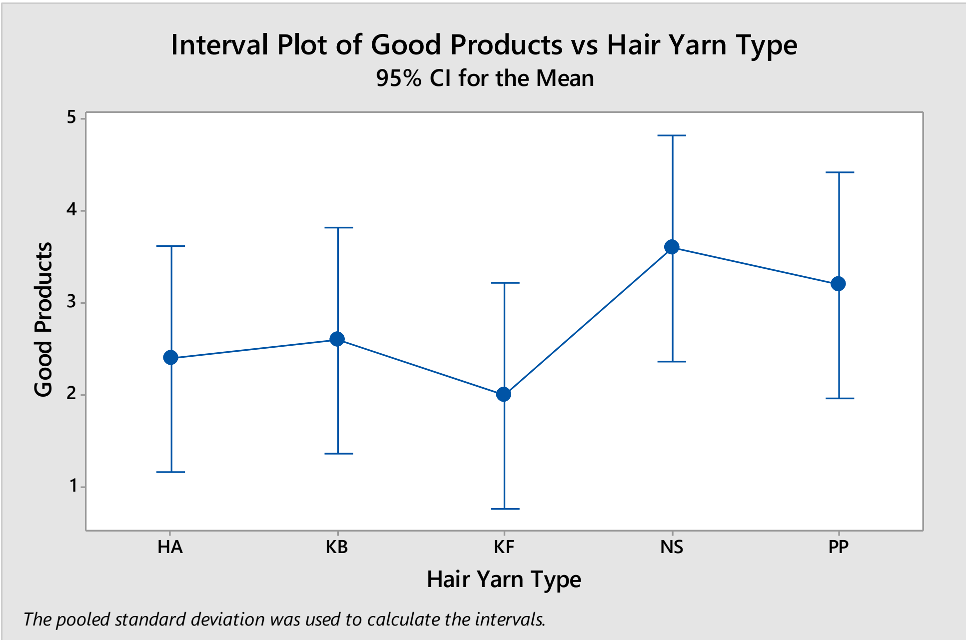
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,31149 | 19,17% | 3,01% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 2,400 | 0,894 | (1,177; 3,623) |
| KB | 5 | 2,600 | 1,342 | (1,377; 3,823) |
| KF | 5 | 2,000 | 1,225 | (0,777; 3,223) |
| NS | 5 | 3,600 | 1,817 | (2,377; 4,823) |
| PP | 5 | 3,200 | 1,095 | (1,977; 4,423) |

Pooled StDev = 1,31149



## Fisher Pairwise Comparisons

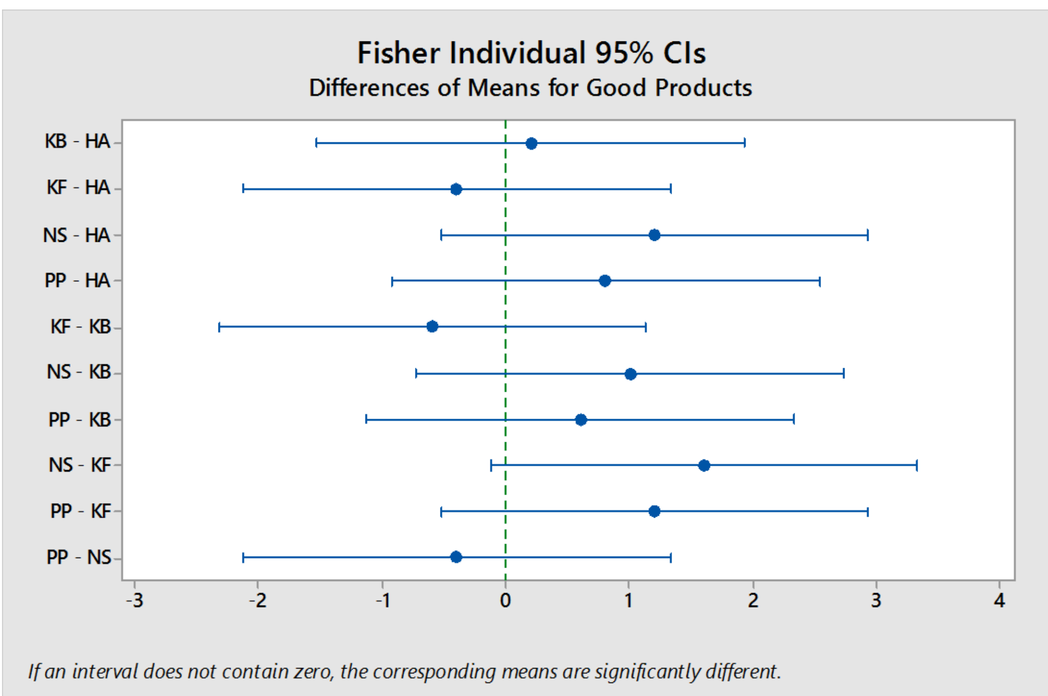
Grouping Information Using the Fisher LSD Method and 95% Confidence

| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| NS | 5 | 3,600 | A |
| PP | 5 | 3,200 | A |
| KB | 5 | 2,600 | A |
| HA | 5 | 2,400 | A |
| KF | 5 | 2,000 | A |

Means that do not share a letter are significantly different.

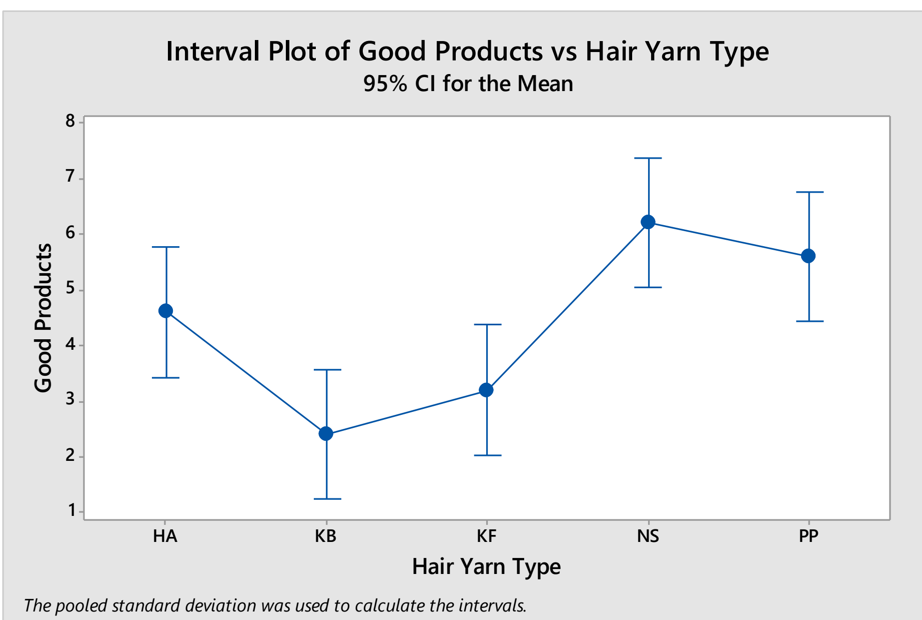
Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,200 | 0,829 | (-1,530; 1,930) | 0,24 | 0,812 |
| KF - HA | -0,400 | 0,829 | (-2,130; 1,330) | -0,48 | 0,635 |
| NS - HA | 1,200 | 0,829 | (-0,530; 2,930) | 1,45 | 0,163 |
| PP - HA | 0,800 | 0,829 | (-0,930; 2,530) | 0,96 | 0,346 |
| KF - KB | -0,600 | 0,829 | (-2,330; 1,130) | -0,72 | 0,478 |
| NS - KB | 1,000 | 0,829 | (-0,730; 2,730) | 1,21 | 0,242 |
| PP - KB | 0,600 | 0,829 | (-1,130; 2,330) | 0,72 | 0,478 |
| NS - KF | 1,600 | 0,829 | (-0,130; 3,330) | 1,93 | 0,068 |
| PP - KF | 1,200 | 0,829 | (-0,530; 2,930) | 1,45 | 0,163 |
| PP - NS | -0,400 | 0,829 | (-2,130; 1,330) | -0,48 | 0,635 |



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy L)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   50,80  12,700     8,14    0,000
Error           20   31,20   1,560
Total           24   82,00


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,24900  61,95%     54,34%      40,55%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  4,600  1,140  (3,435; 5,765)
KB    5  2,400  1,140  (1,235; 3,565)
KF    5  3,200  1,304  (2,035; 4,365)
NS    5  6,200  1,483  (5,035; 7,365)
PP    5  5,600  1,140  (4,435; 6,765)

Pooled StDev = 1,24900
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

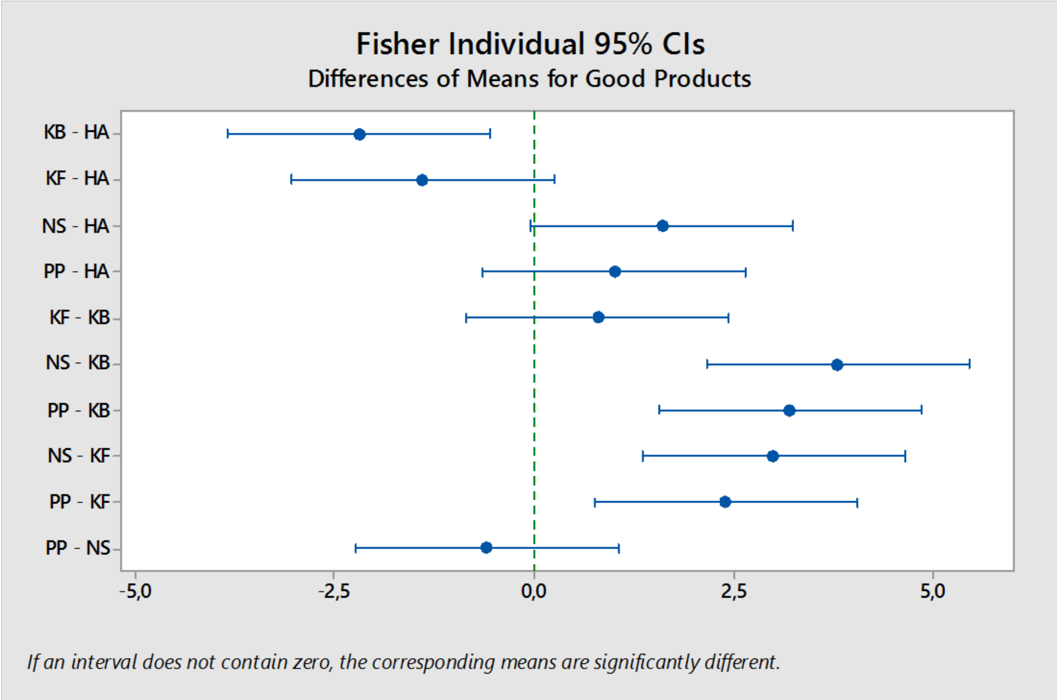
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| NS | 5 | 6,200 | A |
| PP | 5 | 5,600 | A |
| HA | 5 | 4,600 | A B |
| KF | 5 | 3,200 | B C |
| KB | 5 | 2,400 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -2,200 | 0,790 | (-3,848; -0,552) | -2,79 | 0,011 |
| KF - HA | -1,400 | 0,790 | (-3,048; 0,248) | -1,77 | 0,092 |
| NS - HA | 1,600 | 0,790 | (-0,048; 3,248) | 2,03 | 0,056 |
| PP - HA | 1,000 | 0,790 | (-0,648; 2,648) | 1,27 | 0,220 |
| KF - KB | 0,800 | 0,790 | (-0,848; 2,448) | 1,01 | 0,323 |
| NS - KB | 3,800 | 0,790 | ( 2,152; 5,448) | 4,81 | 0,000 |
| PP - KB | 3,200 | 0,790 | ( 1,552; 4,848) | 4,05 | 0,001 |
| NS - KF | 3,000 | 0,790 | ( 1,352; 4,648) | 3,80 | 0,001 |
| PP - KF | 2,400 | 0,790 | ( 0,752; 4,048) | 3,04 | 0,006 |
| PP - NS | -0,600 | 0,790 | (-2,248; 1,048) | -0,76 | 0,456 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy M)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 99,04 | 24,760 | 19,05 | 0,000 |
| Error | 20 | 26,00 | 1,300 | | |
| Total | 24 | 125,04 | | | |

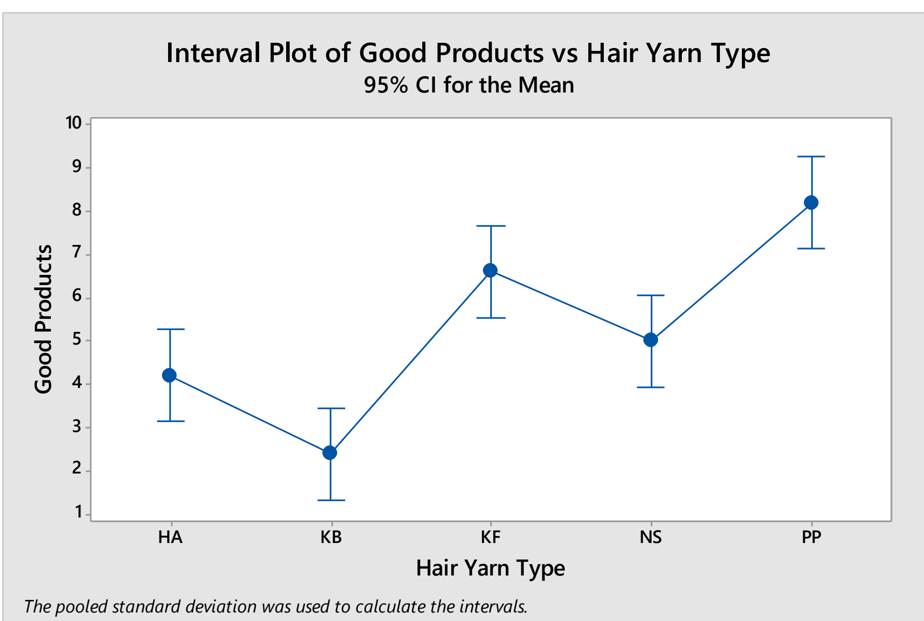
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,14018 | 79,21% | 75,05% | 67,51% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 4,200 | 1,483 | (3,136; 5,264) |
| KB | 5 | 2,400 | 1,342 | (1,336; 3,464) |
| KF | 5 | 6,600 | 1,140 | (5,536; 7,664) |
| NS | 5 | 5,000 | 0,707 | (3,936; 6,064) |
| PP | 5 | 8,200 | 0,837 | (7,136; 9,264) |

Pooled StDev = 1,14018



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

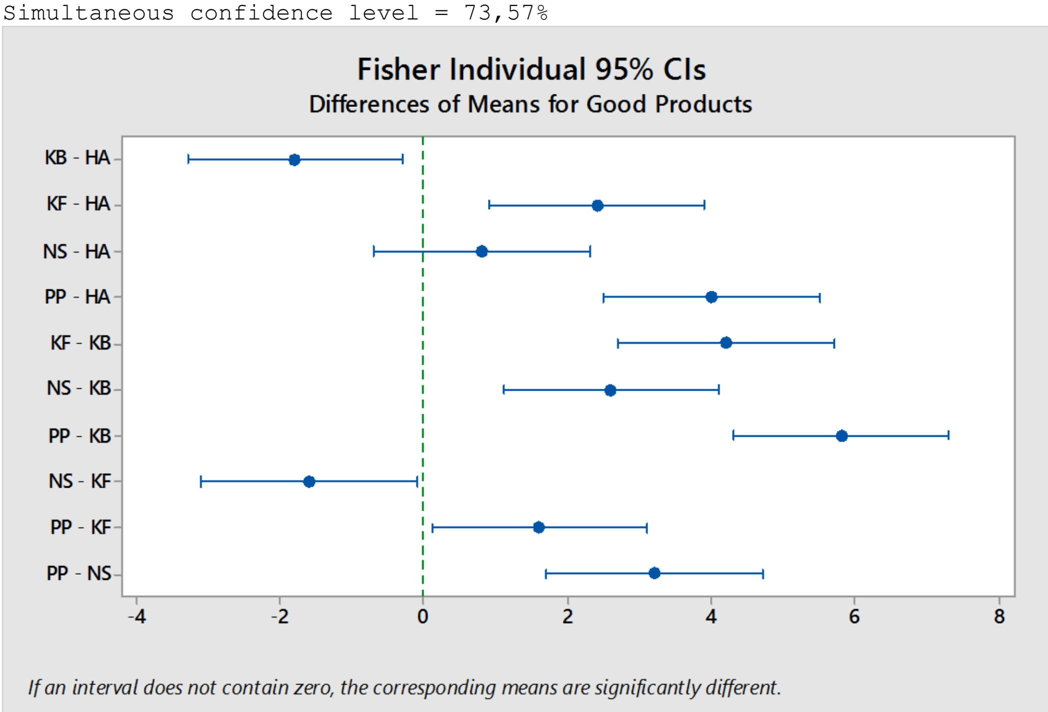
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 8,200 | A |
| KF | 5 | 6,600 | B |
| NS | 5 | 5,000 | C |
| HA | 5 | 4,200 | C |
| KB | 5 | 2,400 | D |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,800 | 0,721 | (-3,304; -0,296) | -2,50 | 0,021 |
| KF - HA | 2,400 | 0,721 | ( 0,896; 3,904) | 3,33 | 0,003 |
| NS - HA | 0,800 | 0,721 | (-0,704; 2,304) | 1,11 | 0,280 |
| PP - HA | 4,000 | 0,721 | ( 2,496; 5,504) | 5,55 | 0,000 |
| KF - KB | 4,200 | 0,721 | ( 2,696; 5,704) | 5,82 | 0,000 |
| NS - KB | 2,600 | 0,721 | ( 1,096; 4,104) | 3,61 | 0,002 |
| PP - KB | 5,800 | 0,721 | ( 4,296; 7,304) | 8,04 | 0,000 |
| NS - KF | -1,600 | 0,721 | (-3,104; -0,096) | -2,22 | 0,038 |
| PP - KF | 1,600 | 0,721 | ( 0,096; 3,104) | 2,22 | 0,038 |
| PP - NS | 3,200 | 0,721 | ( 1,696; 4,704) | 4,44 | 0,000 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy N)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 22,00 | 5,500 | 4,58 | 0,009 |
| Error | 20 | 24,00 | 1,200 | | |
| Total | 24 | 46,00 | | | |

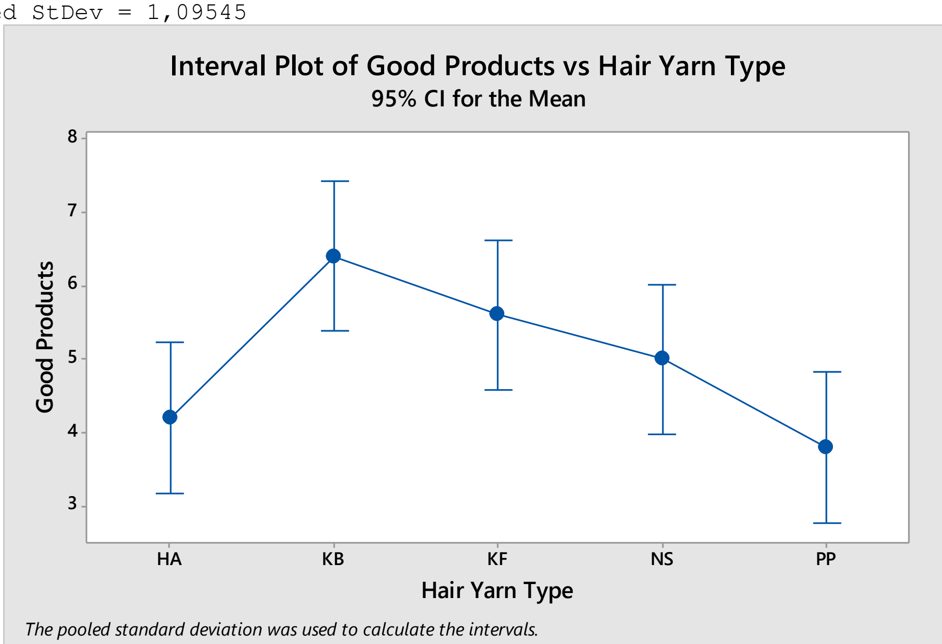
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,09545 | 47,83% | 37,39% | 18,48% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 4,200 | 0,837 | (3,178; 5,222) |
| KB | 5 | 6,400 | 1,140 | (5,378; 7,422) |
| KF | 5 | 5,600 | 1,517 | (4,578; 6,622) |
| NS | 5 | 5,000 | 1,000 | (3,978; 6,022) |
| PP | 5 | 3,800 | 0,837 | (2,778; 4,822) |

Pooled StDev = 1,09545



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

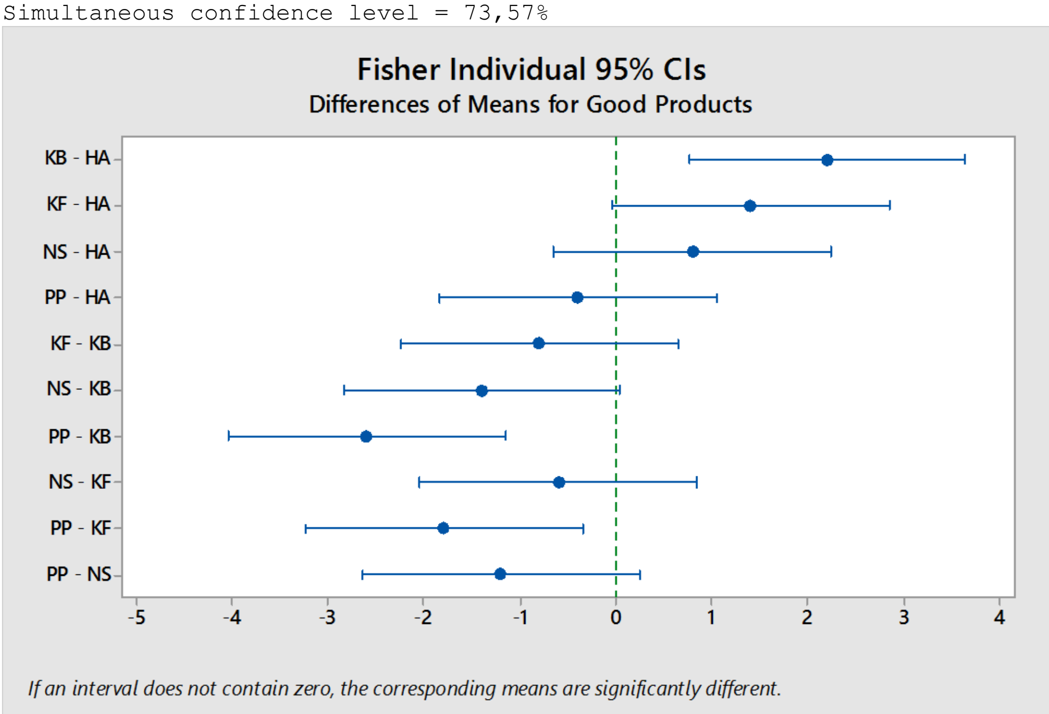
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 6,400 | A |
| KF | 5 | 5,600 | A B |
| NS | 5 | 5,000 | A B C |
| HA | 5 | 4,200 | B C |
| PP | 5 | 3,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,200 | 0,693 | ( 0,755; 3,645) | 3,18 | 0,005 |
| KF - HA | 1,400 | 0,693 | (-0,045; 2,845) | 2,02 | 0,057 |
| NS - HA | 0,800 | 0,693 | (-0,645; 2,245) | 1,15 | 0,262 |
| PP - HA | -0,400 | 0,693 | (-1,845; 1,045) | -0,58 | 0,570 |
| KF - KB | -0,800 | 0,693 | (-2,245; 0,645) | -1,15 | 0,262 |
| NS - KB | -1,400 | 0,693 | (-2,845; 0,045) | -2,02 | 0,057 |
| PP - KB | -2,600 | 0,693 | (-4,045; -1,155) | -3,75 | 0,001 |
| NS - KF | -0,600 | 0,693 | (-2,045; 0,845) | -0,87 | 0,397 |
| PP - KF | -1,800 | 0,693 | (-3,245; -0,355) | -2,60 | 0,017 |
| PP - NS | -1,200 | 0,693 | (-2,645; 0,245) | -1,73 | 0,099 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy O)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 35,20 | 8,800 | 6,11 | 0,002 |
| Error | 20 | 28,80 | 1,440 | | |
| Total | 24 | 64,00 | | | |

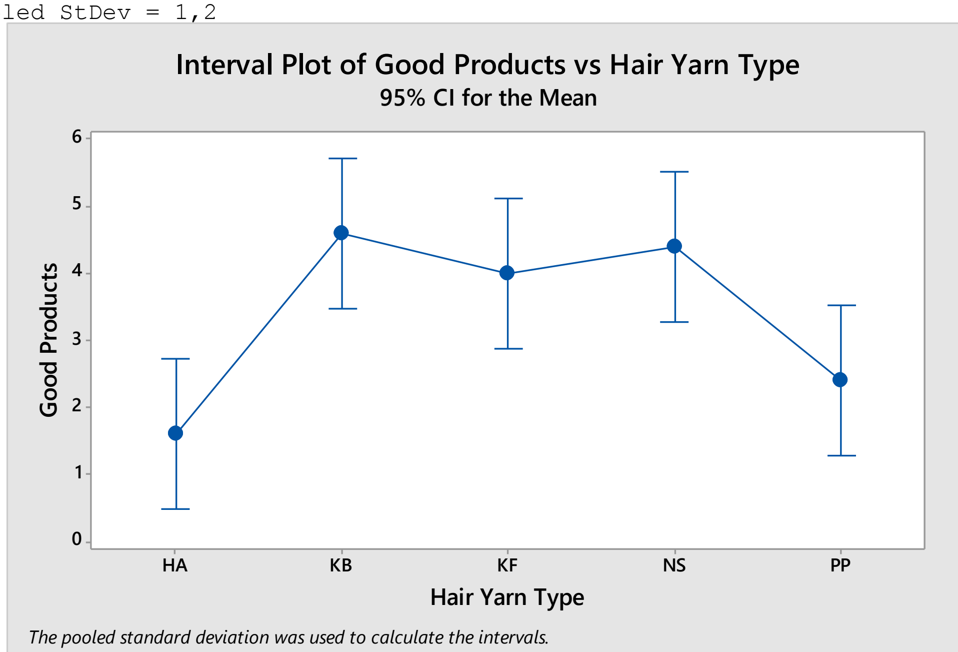
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,2 | 55,00% | 46,00% | 29,69% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 1,600 | 0,894 | (0,481; 2,719) |
| KB | 5 | 4,600 | 1,140 | (3,481; 5,719) |
| KF | 5 | 4,000 | 1,581 | (2,881; 5,119) |
| NS | 5 | 4,400 | 1,140 | (3,281; 5,519) |
| PP | 5 | 2,400 | 1,140 | (1,281; 3,519) |

Pooled StDev = 1,2



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

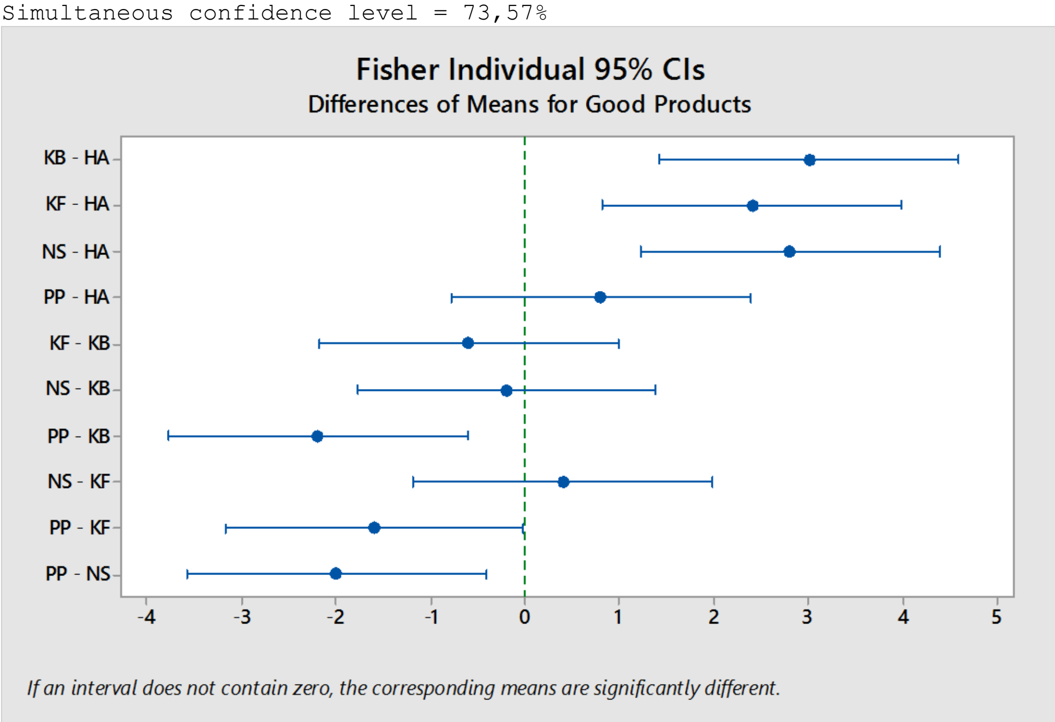
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 4,600 | A |
| NS | 5 | 4,400 | A |
| KF | 5 | 4,000 | A |
| PP | 5 | 2,400 | B |
| HA | 5 | 1,600 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 3,000 | 0,759 | ( 1,417; 4,583) | 3,95 | 0,001 |
| KF - HA | 2,400 | 0,759 | ( 0,817; 3,983) | 3,16 | 0,005 |
| NS - HA | 2,800 | 0,759 | ( 1,217; 4,383) | 3,69 | 0,001 |
| PP - HA | 0,800 | 0,759 | (-0,783; 2,383) | 1,05 | 0,304 |
| KF - KB | -0,600 | 0,759 | (-2,183; 0,983) | -0,79 | 0,438 |
| NS - KB | -0,200 | 0,759 | (-1,783; 1,383) | -0,26 | 0,795 |
| PP - KB | -2,200 | 0,759 | (-3,783; -0,617) | -2,90 | 0,009 |
| NS - KF | 0,400 | 0,759 | (-1,183; 1,983) | 0,53 | 0,604 |
| PP - KF | -1,600 | 0,759 | (-3,183; -0,017) | -2,11 | 0,048 |
| PP - NS | -2,000 | 0,759 | (-3,583; -0,417) | -2,64 | 0,016 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy P)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 14,64 | 3,660 | 2,51 | 0,075 |
| Error | 20 | 29,20 | 1,460 | | |
| Total | 24 | 43,84 | | | |

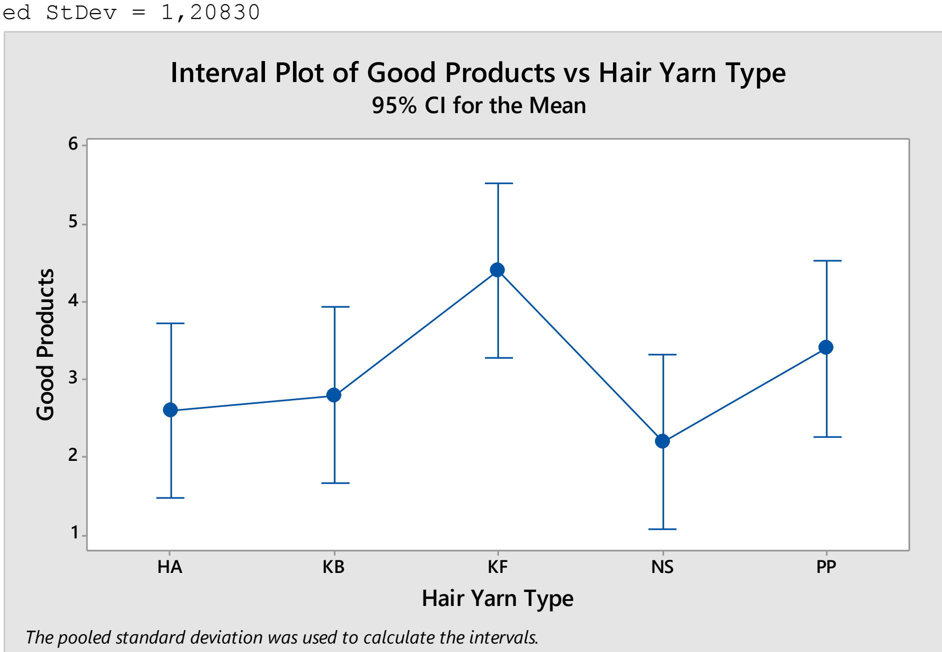
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,20830 | 33,39% | 20,07% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 2,600 | 1,140 | (1,473; 3,727) |
| KB | 5 | 2,800 | 1,304 | (1,673; 3,927) |
| KF | 5 | 4,400 | 1,140 | (3,273; 5,527) |
| NS | 5 | 2,200 | 1,304 | (1,073; 3,327) |
| PP | 5 | 3,400 | 1,140 | (2,273; 4,527) |

Pooled StDev = 1,20830



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

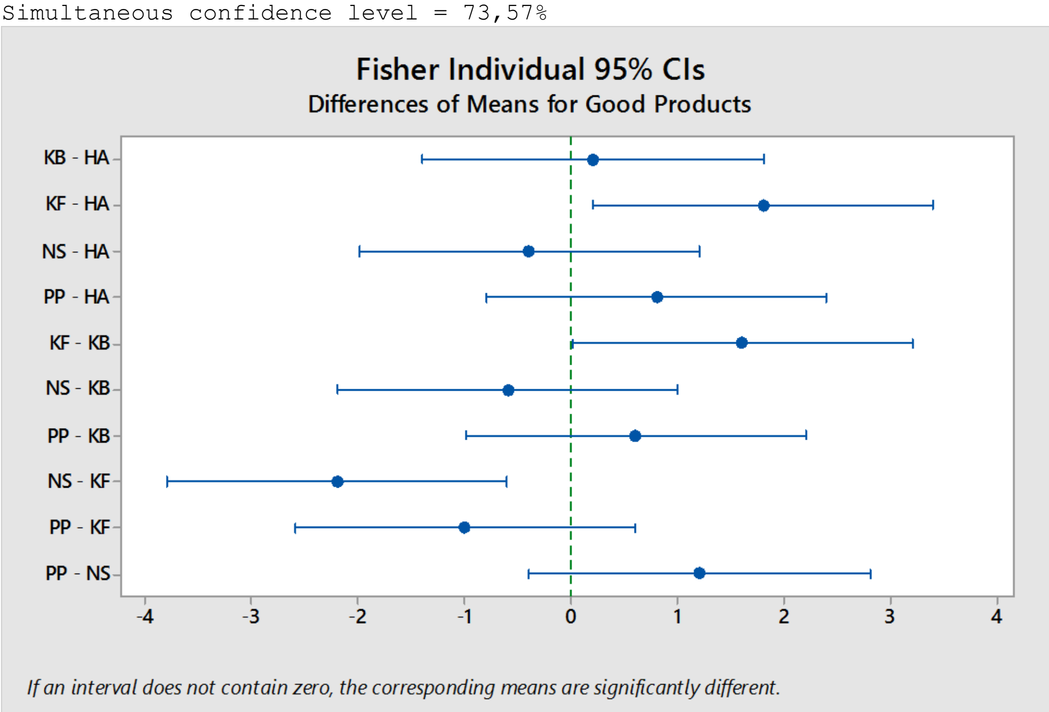
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 4,400 | A |
| PP | 5 | 3,400 | A B |
| KB | 5 | 2,800 | B |
| HA | 5 | 2,600 | B |
| NS | 5 | 2,200 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

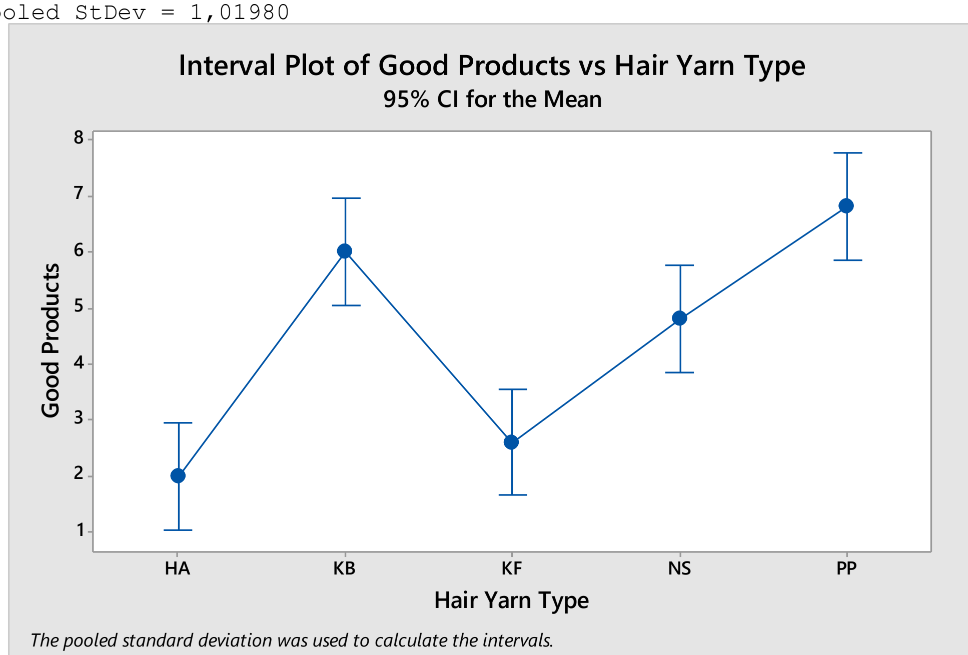
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,200 | 0,764 | (-1,394; 1,794) | 0,26 | 0,796 |
| KF - HA | 1,800 | 0,764 | ( 0,206; 3,394) | 2,36 | 0,029 |
| NS - HA | -0,400 | 0,764 | (-1,994; 1,194) | -0,52 | 0,606 |
| PP - HA | 0,800 | 0,764 | (-0,794; 2,394) | 1,05 | 0,308 |
| KF - KB | 1,600 | 0,764 | ( 0,006; 3,194) | 2,09 | 0,049 |
| NS - KB | -0,600 | 0,764 | (-2,194; 0,994) | -0,79 | 0,442 |
| PP - KB | 0,600 | 0,764 | (-0,994; 2,194) | 0,79 | 0,442 |
| NS - KF | -2,200 | 0,764 | (-3,794; -0,606) | -2,88 | 0,009 |
| PP - KF | -1,000 | 0,764 | (-2,594; 0,594) | -1,31 | 0,206 |
| PP - NS | 1,200 | 0,764 | (-0,394; 2,794) | 1,57 | 0,132 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy Q)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor           Levels  Values
Hair Yarn Type        5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   87,36  21,840    21,00    0,000
Error           20   20,80   1,040
Total           24  108,16


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,01980  80,77%     76,92%      69,95%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  2,000  0,707  (1,049; 2,951)
KB    5  6,000  1,581  (5,049; 6,951)
KF    5  2,600  0,894  (1,649; 3,551)
NS    5  4,800  0,837  (3,849; 5,751)
PP    5  6,800  0,837  (5,849; 7,751)

Pooled StDev = 1,01980
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

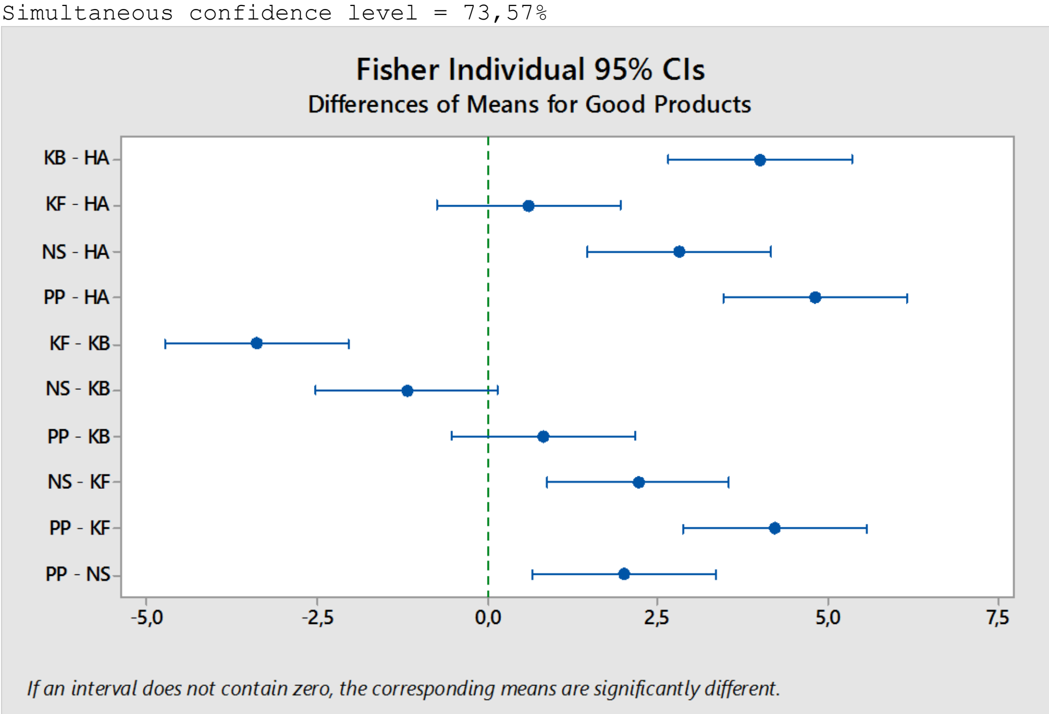
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 6,800 | A |
| KB | 5 | 6,000 | A B |
| NS | 5 | 4,800 | B |
| KF | 5 | 2,600 | C |
| HA | 5 | 2,000 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 4,000 | 0,645 | ( 2,655; 5,345) | 6,20 | 0,000 |
| KF - HA | 0,600 | 0,645 | (-0,745; 1,945) | 0,93 | 0,363 |
| NS - HA | 2,800 | 0,645 | ( 1,455; 4,145) | 4,34 | 0,000 |
| PP - HA | 4,800 | 0,645 | ( 3,455; 6,145) | 7,44 | 0,000 |
| KF - KB | -3,400 | 0,645 | (-4,745; -2,055) | -5,27 | 0,000 |
| NS - KB | -1,200 | 0,645 | (-2,545; 0,145) | -1,86 | 0,078 |
| PP - KB | 0,800 | 0,645 | (-0,545; 2,145) | 1,24 | 0,229 |
| NS - KF | 2,200 | 0,645 | ( 0,855; 3,545) | 3,41 | 0,003 |
| PP - KF | 4,200 | 0,645 | ( 2,855; 5,545) | 6,51 | 0,000 |
| PP - NS | 2,000 | 0,645 | ( 0,655; 3,345) | 3,10 | 0,006 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy R)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 3,040 | 0,7600 | 0,29 | 0,884 |
| Error | 20 | 53,200 | 2,6600 | | |
| Total | 24 | 56,240 | | | |

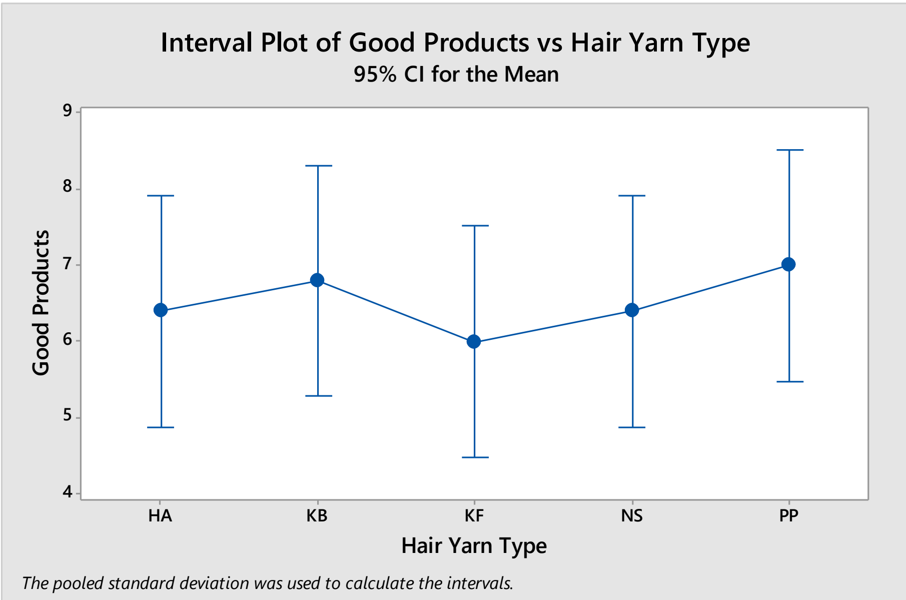
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,63095 | 5,41% | 0,00% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 6,400 | 1,140 | (4,879; 7,921) |
| KB | 5 | 6,800 | 1,924 | (5,279; 8,321) |
| KF | 5 | 6,000 | 1,225 | (4,479; 7,521) |
| NS | 5 | 6,400 | 2,074 | (4,879; 7,921) |
| PP | 5 | 7,000 | 1,581 | (5,479; 8,521) |

Pooled StDev = 1,63095



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

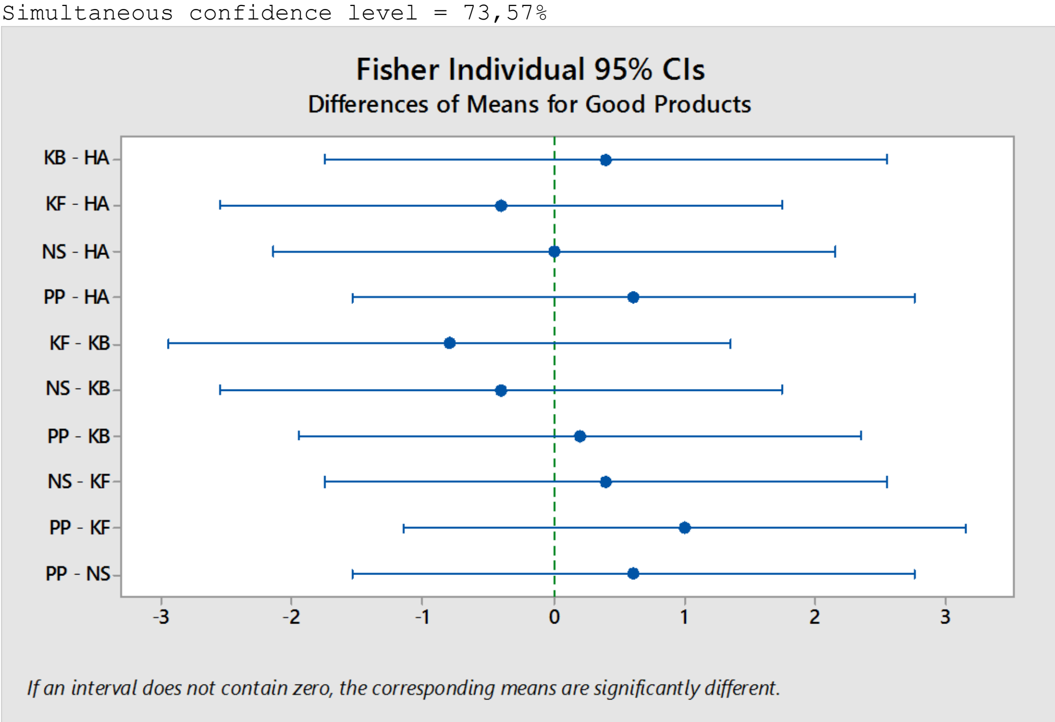
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 7,000 | A |
| KB | 5 | 6,800 | A |
| NS | 5 | 6,400 | A |
| HA | 5 | 6,400 | A |
| KF | 5 | 6,000 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,40 | 1,03 | (-1,75; 2,55) | 0,39 | 0,702 |
| KF - HA | -0,40 | 1,03 | (-2,55; 1,75) | -0,39 | 0,702 |
| NS - HA | 0,00 | 1,03 | (-2,15; 2,15) | 0,00 | 1,000 |
| PP - HA | 0,60 | 1,03 | (-1,55; 2,75) | 0,58 | 0,567 |
| KF - KB | -0,80 | 1,03 | (-2,95; 1,35) | -0,78 | 0,447 |
| NS - KB | -0,40 | 1,03 | (-2,55; 1,75) | -0,39 | 0,702 |
| PP - KB | 0,20 | 1,03 | (-1,95; 2,35) | 0,19 | 0,848 |
| NS - KF | 0,40 | 1,03 | (-1,75; 2,55) | 0,39 | 0,702 |
| PP - KF | 1,00 | 1,03 | (-1,15; 3,15) | 0,97 | 0,344 |
| PP - NS | 0,60 | 1,03 | (-1,55; 2,75) | 0,58 | 0,567 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy S)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | $\alpha$ = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 43,44 | 10,8600 | 13,57 | 0,000 |
| Error | 20 | 16,00 | 0,8000 | | |
| Total | 24 | 59,44 | | | |

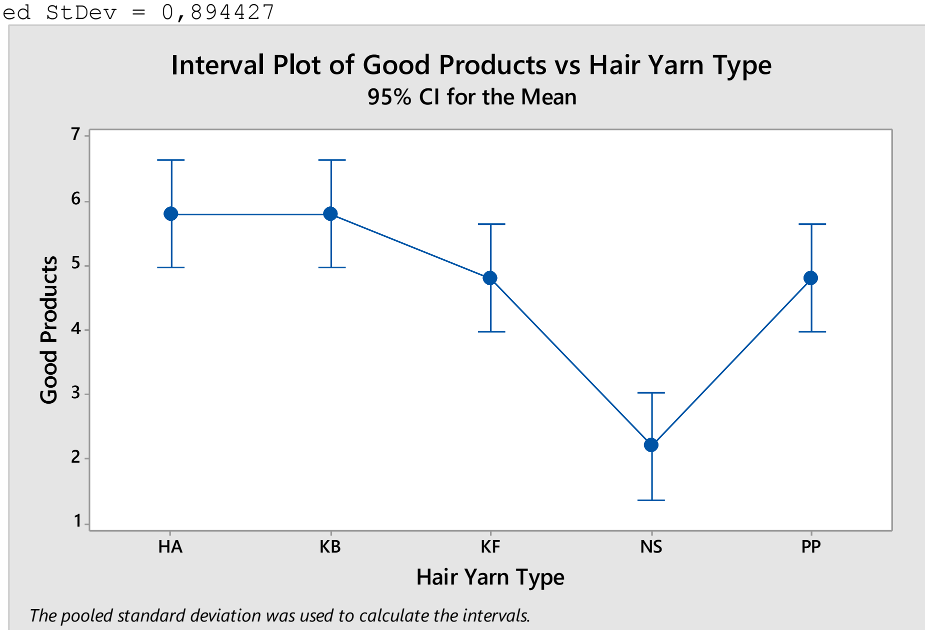
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 0,894427 | 73,08% | 67,70% | 57,94% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 5,800 | 0,837 | (4,966; 6,634) |
| KB | 5 | 5,800 | 0,837 | (4,966; 6,634) |
| KF | 5 | 4,800 | 0,837 | (3,966; 5,634) |
| NS | 5 | 2,200 | 0,837 | (1,366; 3,034) |
| PP | 5 | 4,800 | 1,095 | (3,966; 5,634) |

Pooled StDev = 0,894427



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

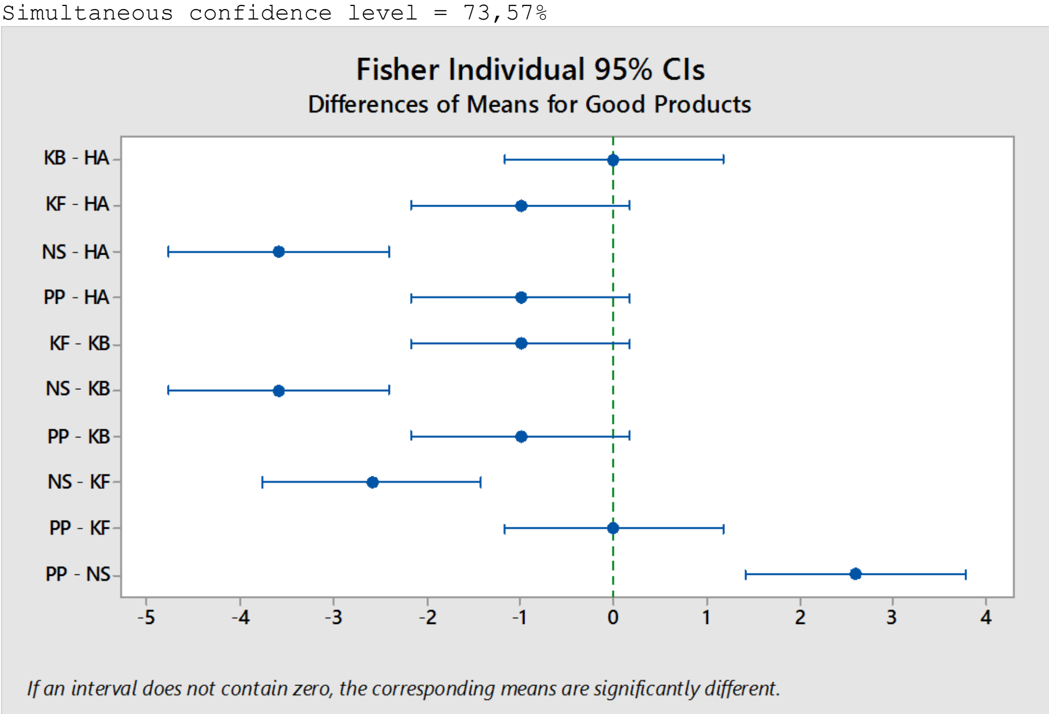
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 5,800 | A |
| HA | 5 | 5,800 | A |
| PP | 5 | 4,800 | A |
| KF | 5 | 4,800 | A |
| NS | 5 | 2,200 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

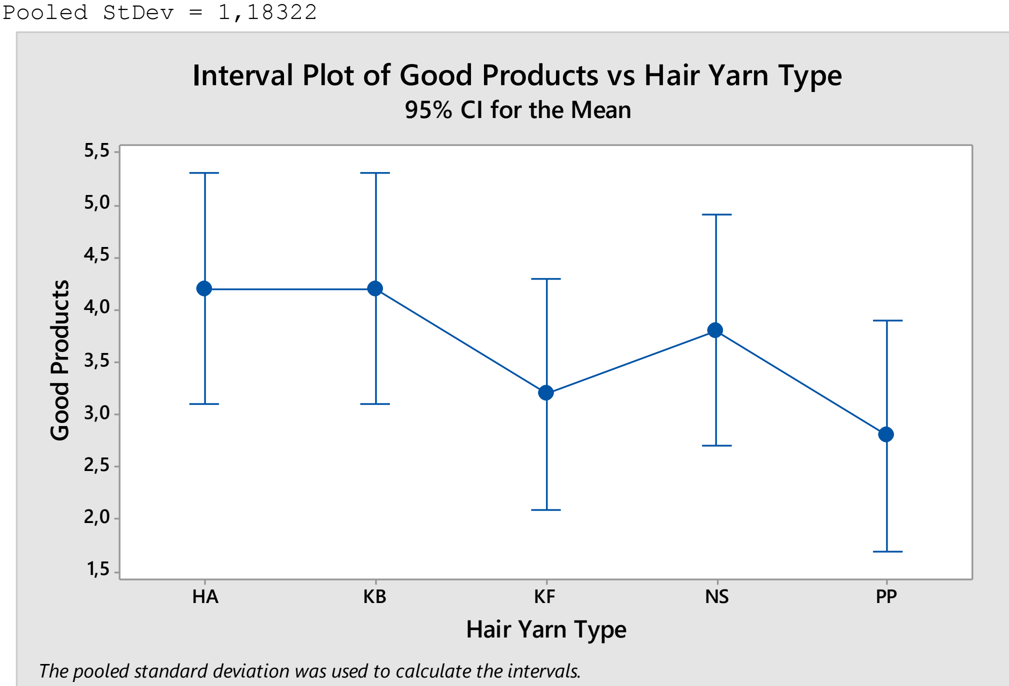
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,000 | 0,566 | (-1,180; 1,180) | 0,00 | 1,000 |
| KF - HA | -1,000 | 0,566 | (-2,180; 0,180) | -1,77 | 0,092 |
| NS - HA | -3,600 | 0,566 | (-4,780; -2,420) | -6,36 | 0,000 |
| PP - HA | -1,000 | 0,566 | (-2,180; 0,180) | -1,77 | 0,092 |
| KF - KB | -1,000 | 0,566 | (-2,180; 0,180) | -1,77 | 0,092 |
| NS - KB | -3,600 | 0,566 | (-4,780; -2,420) | -6,36 | 0,000 |
| PP - KB | -1,000 | 0,566 | (-2,180; 0,180) | -1,77 | 0,092 |
| NS - KF | -2,600 | 0,566 | (-3,780; -1,420) | -4,60 | 0,000 |
| PP - KF | 0,000 | 0,566 | (-1,180; 1,180) | 0,00 | 1,000 |
| PP - NS | 2,600 | 0,566 | ( 1,420; 3,780) | 4,60 | 0,000 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy T)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   7,760   1,940     1,39    0,275
Error           20  28,000   1,400
Total           24  35,760


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,18322  21,70%      6,04%       0,00%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  4,200  1,095  (3,096; 5,304)
KB    5  4,200  1,095  (3,096; 5,304)
KF    5  3,200  1,483  (2,096; 4,304)
NS    5  3,800  0,837  (2,696; 4,904)
PP    5  2,800  1,304  (1,696; 3,904)

Pooled StDev = 1,18322
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

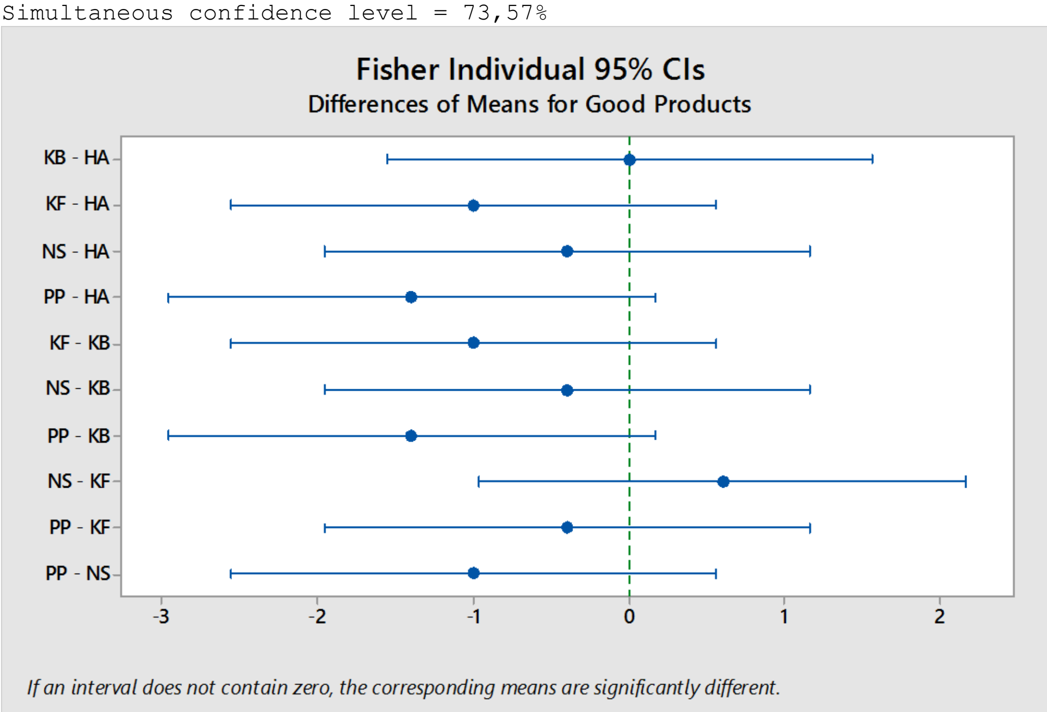
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 4,200 | A |
| HA | 5 | 4,200 | A |
| NS | 5 | 3,800 | A |
| KF | 5 | 3,200 | A |
| PP | 5 | 2,800 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

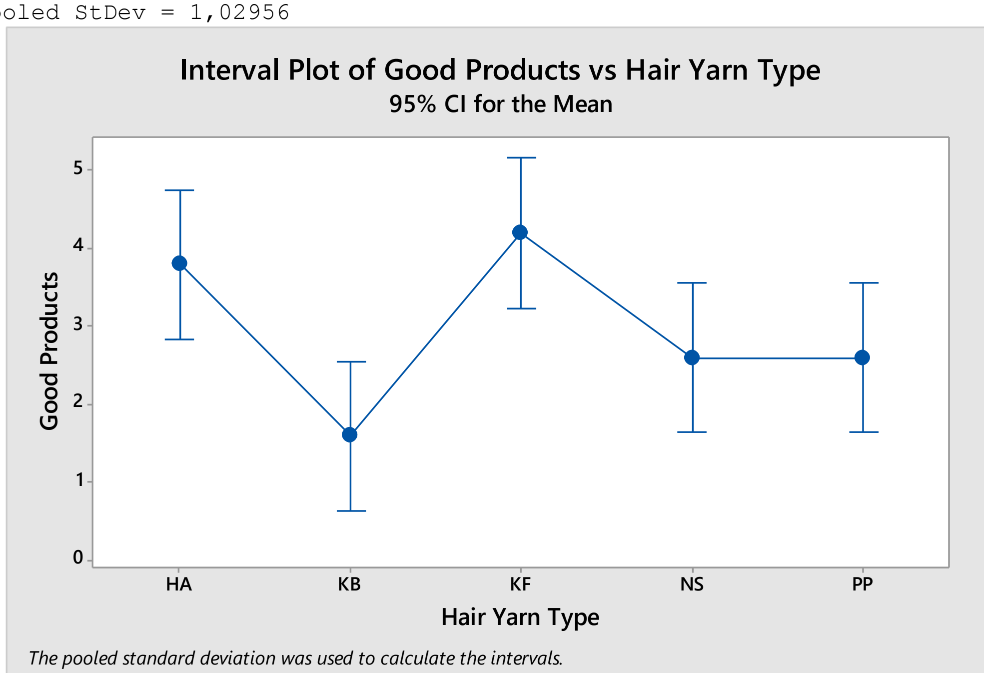
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,000 | 0,748 | (-1,561; 1,561) | 0,00 | 1,000 |
| KF - HA | -1,000 | 0,748 | (-2,561; 0,561) | -1,34 | 0,196 |
| NS - HA | -0,400 | 0,748 | (-1,961; 1,161) | -0,53 | 0,599 |
| PP - HA | -1,400 | 0,748 | (-2,961; 0,161) | -1,87 | 0,076 |
| KF - KB | -1,000 | 0,748 | (-2,561; 0,561) | -1,34 | 0,196 |
| NS - KB | -0,400 | 0,748 | (-1,961; 1,161) | -0,53 | 0,599 |
| PP - KB | -1,400 | 0,748 | (-2,961; 0,161) | -1,87 | 0,076 |
| NS - KF | 0,600 | 0,748 | (-0,961; 2,161) | 0,80 | 0,432 |
| PP - KF | -0,400 | 0,748 | (-1,961; 1,161) | -0,53 | 0,599 |
| PP - NS | -1,000 | 0,748 | (-2,561; 0,561) | -1,34 | 0,196 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy U)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   21,76   5,440     5,13    0,005
Error           20   21,20   1,060
Total           24   42,96


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,02956  50,65%     40,78%      22,89%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  3,800  0,837  (2,840; 4,760)
KB    5  1,600  0,548  (0,640; 2,560)
KF    5  4,200  0,837  (3,240; 5,160)
NS    5  2,600  1,140  (1,640; 3,560)
PP    5  2,600  1,517  (1,640; 3,560)

Pooled StDev = 1,02956
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

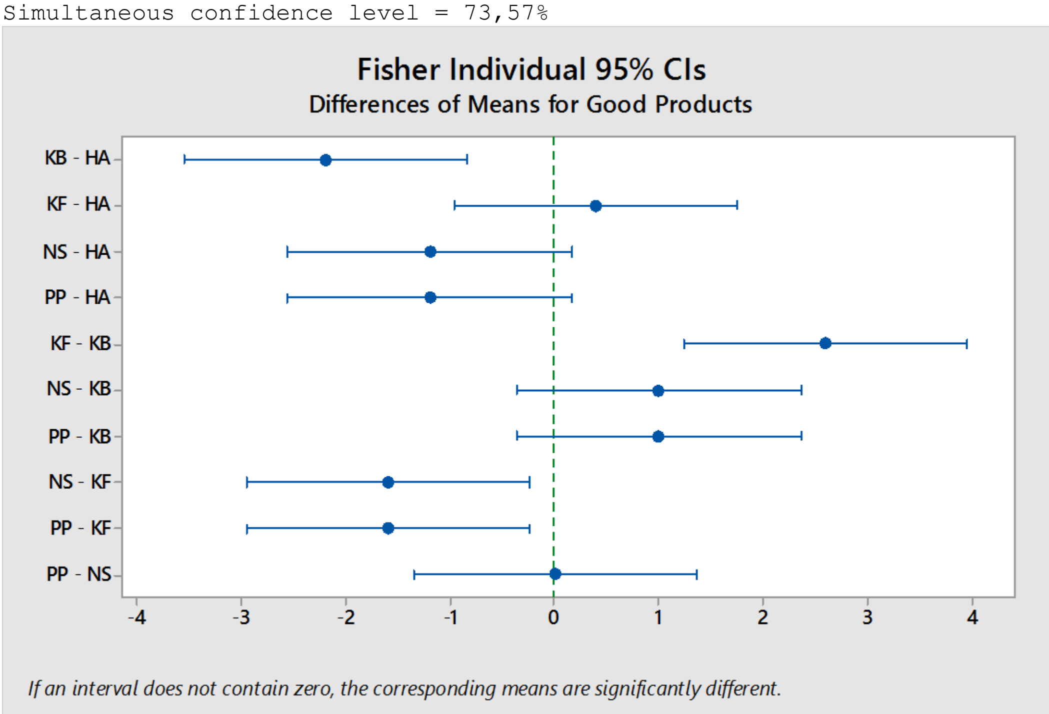
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 4,200 | A |
| HA | 5 | 3,800 | A B |
| PP | 5 | 2,600 | B C |
| NS | 5 | 2,600 | B C |
| KB | 5 | 1,600 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -2,200 | 0,651 | (-3,558; -0,842) | -3,38 | 0,003 |
| KF - HA | 0,400 | 0,651 | (-0,958; 1,758) | 0,61 | 0,546 |
| NS - HA | -1,200 | 0,651 | (-2,558; 0,158) | -1,84 | 0,080 |
| PP - HA | -1,200 | 0,651 | (-2,558; 0,158) | -1,84 | 0,080 |
| KF - KB | 2,600 | 0,651 | ( 1,242; 3,958) | 3,99 | 0,001 |
| NS - KB | 1,000 | 0,651 | (-0,358; 2,358) | 1,54 | 0,140 |
| PP - KB | 1,000 | 0,651 | (-0,358; 2,358) | 1,54 | 0,140 |
| NS - KF | -1,600 | 0,651 | (-2,958; -0,242) | -2,46 | 0,023 |
| PP - KF | -1,600 | 0,651 | (-2,958; -0,242) | -2,46 | 0,023 |
| PP - NS | 0,000 | 0,651 | (-1,358; 1,358) | 0,00 | 1,000 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy V)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 121,04 | 30,2600 | 39,82 | 0,000 |
| Error | 20 | 15,20 | 0,7600 | | |
| Total | 24 | 136,24 | | | |

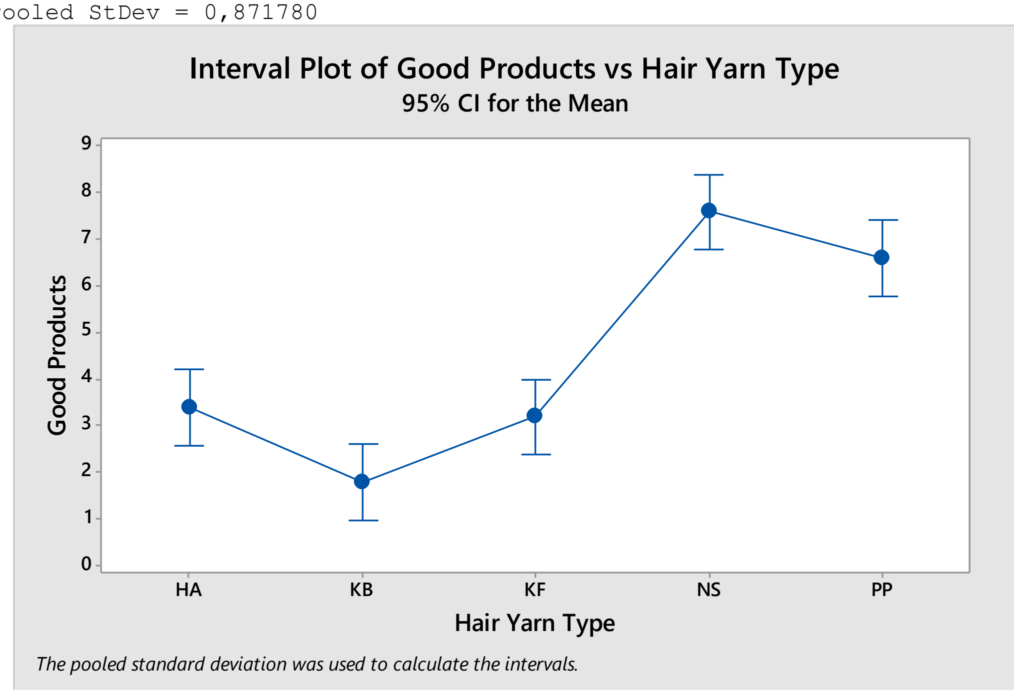
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 0,871780 | 88,84% | 86,61% | 82,57% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 3,400 | 0,548 | (2,587; 4,213) |
| KB | 5 | 1,800 | 0,837 | (0,987; 2,613) |
| KF | 5 | 3,200 | 0,837 | (2,387; 4,013) |
| NS | 5 | 7,600 | 0,894 | (6,787; 8,413) |
| PP | 5 | 6,600 | 1,140 | (5,787; 7,413) |

Pooled StDev = 0,871780



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

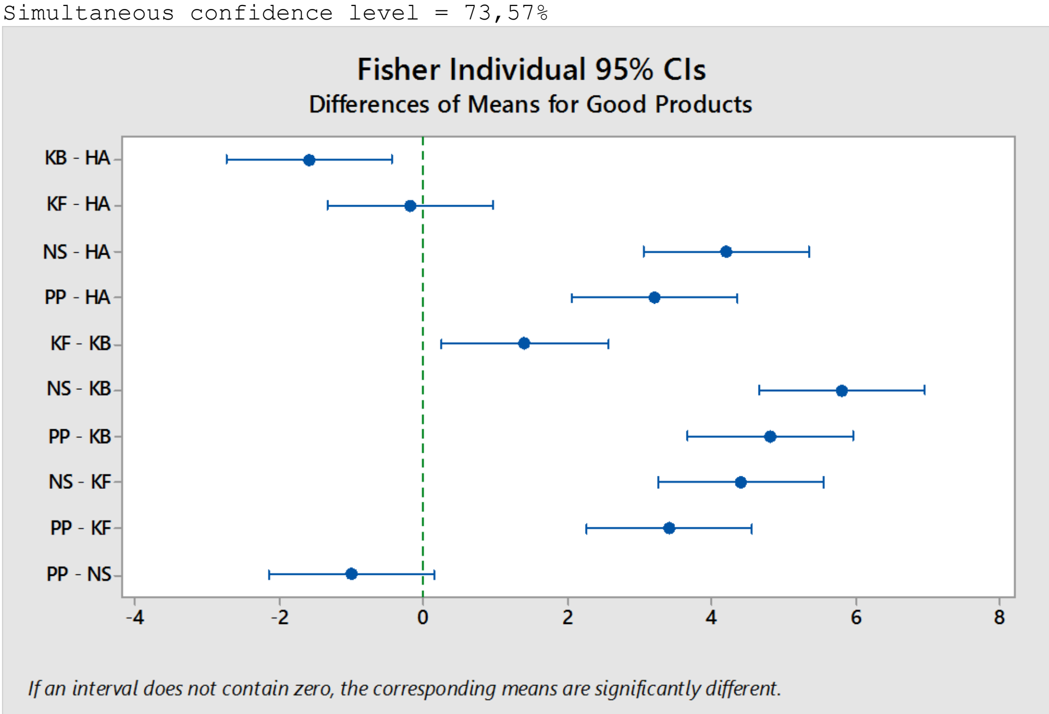
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| NS | 5 | 7,600 | A |
| PP | 5 | 6,600 | A |
| HA | 5 | 3,400 | B |
| KF | 5 | 3,200 | B |
| KB | 5 | 1,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,600 | 0,551 | (-2,750; -0,450) | -2,90 | 0,009 |
| KF - HA | -0,200 | 0,551 | (-1,350; 0,950) | -0,36 | 0,721 |
| NS - HA | 4,200 | 0,551 | ( 3,050; 5,350) | 7,62 | 0,000 |
| PP - HA | 3,200 | 0,551 | ( 2,050; 4,350) | 5,80 | 0,000 |
| KF - KB | 1,400 | 0,551 | ( 0,250; 2,550) | 2,54 | 0,020 |
| NS - KB | 5,800 | 0,551 | ( 4,650; 6,950) | 10,52 | 0,000 |
| PP - KB | 4,800 | 0,551 | ( 3,650; 5,950) | 8,71 | 0,000 |
| NS - KF | 4,400 | 0,551 | ( 3,250; 5,550) | 7,98 | 0,000 |
| PP - KF | 3,400 | 0,551 | ( 2,250; 4,550) | 6,17 | 0,000 |
| PP - NS | -1,000 | 0,551 | (-2,150; 0,150) | -1,81 | 0,085 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy W)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 24,24 | 6,060 | 5,14 | 0,005 |
| Error | 20 | 23,60 | 1,180 | | |
| Total | 24 | 47,84 | | | |

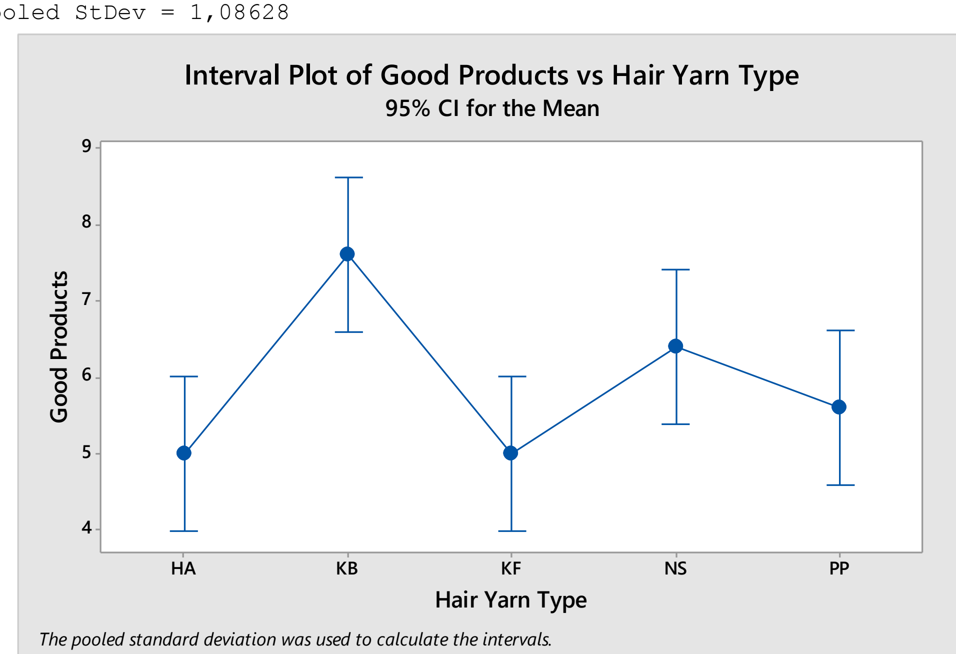
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,08628 | 50,67% | 40,80% | 22,92% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 5,000 | 1,000 | (3,987; 6,013) |
| KB | 5 | 7,600 | 1,140 | (6,587; 8,613) |
| KF | 5 | 5,000 | 1,000 | (3,987; 6,013) |
| NS | 5 | 6,400 | 1,140 | (5,387; 7,413) |
| PP | 5 | 5,600 | 1,140 | (4,587; 6,613) |

Pooled StDev = 1,08628



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

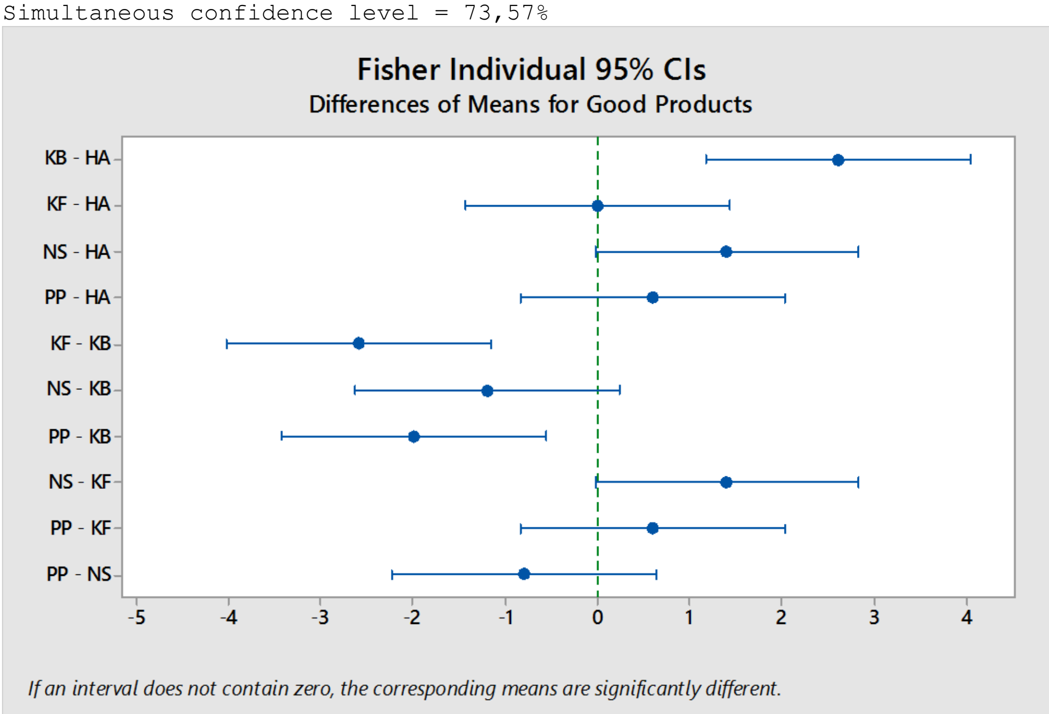
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 7,600 | A |
| NS | 5 | 6,400 | A B |
| PP | 5 | 5,600 | B |
| KF | 5 | 5,000 | B |
| HA | 5 | 5,000 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

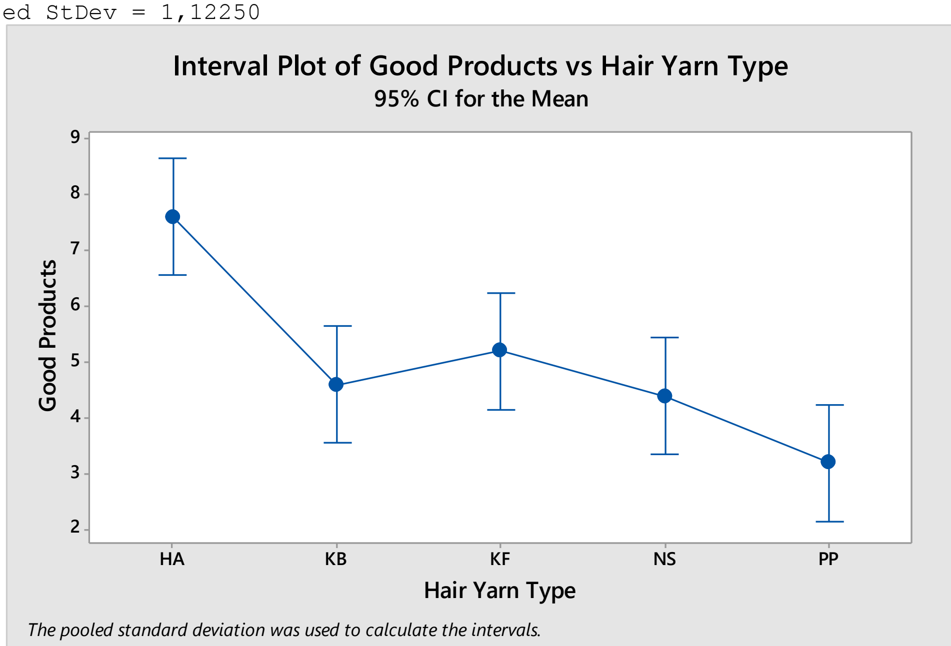
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,600 | 0,687 | ( 1,167; 4,033) | 3,78 | 0,001 |
| KF - HA | 0,000 | 0,687 | (-1,433; 1,433) | 0,00 | 1,000 |
| NS - HA | 1,400 | 0,687 | (-0,033; 2,833) | 2,04 | 0,055 |
| PP - HA | 0,600 | 0,687 | (-0,833; 2,033) | 0,87 | 0,393 |
| KF - KB | -2,600 | 0,687 | (-4,033; -1,167) | -3,78 | 0,001 |
| NS - KB | -1,200 | 0,687 | (-2,633; 0,233) | -1,75 | 0,096 |
| PP - KB | -2,000 | 0,687 | (-3,433; -0,567) | -2,91 | 0,009 |
| NS - KF | 1,400 | 0,687 | (-0,033; 2,833) | 2,04 | 0,055 |
| PP - KF | 0,600 | 0,687 | (-0,833; 2,033) | 0,87 | 0,393 |
| PP - NS | -0,800 | 0,687 | (-2,233; 0,633) | -1,16 | 0,258 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy X)

```
Method

Null hypothesis          All means are equal
Alternative hypothesis   At least one mean is different
Significance level       α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   52,80  13,200    10,48    0,000
Error           20   25,20   1,260
Total           24   78,00


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,12250  67,69%     61,23%      49,52%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  7,600  1,140  (6,553; 8,647)
KB    5  4,600  1,140  (3,553; 5,647)
KF    5  5,200  1,304  (4,153; 6,247)
NS    5  4,400  1,140  (3,353; 5,447)
PP    5  3,200  0,837  (2,153; 4,247)

Pooled StDev = 1,12250
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

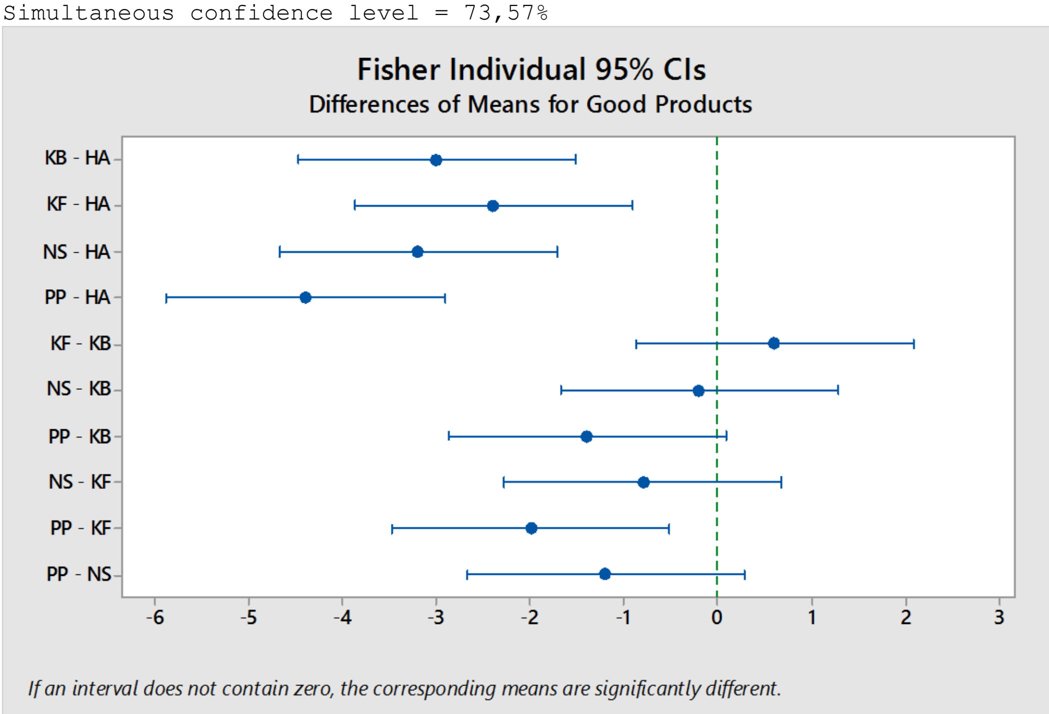
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| HA | 5 | 7,600 | A |
| KF | 5 | 5,200 | B |
| KB | 5 | 4,600 | B C |
| NS | 5 | 4,400 | B C |
| PP | 5 | 3,200 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -3,000 | 0,710 | (-4,481; -1,519) | -4,23 | 0,000 |
| KF - HA | -2,400 | 0,710 | (-3,881; -0,919) | -3,38 | 0,003 |
| NS - HA | -3,200 | 0,710 | (-4,681; -1,719) | -4,51 | 0,000 |
| PP - HA | -4,400 | 0,710 | (-5,881; -2,919) | -6,20 | 0,000 |
| KF - KB | 0,600 | 0,710 | (-0,881; 2,081) | 0,85 | 0,408 |
| NS - KB | -0,200 | 0,710 | (-1,681; 1,281) | -0,28 | 0,781 |
| PP - KB | -1,400 | 0,710 | (-2,881; 0,081) | -1,97 | 0,063 |
| NS - KF | -0,800 | 0,710 | (-2,281; 0,681) | -1,13 | 0,273 |
| PP - KF | -2,000 | 0,710 | (-3,481; -0,519) | -2,82 | 0,011 |
| PP - NS | -1,200 | 0,710 | (-2,681; 0,281) | -1,69 | 0,106 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy Y)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 29,04 | 7,260 | 3,02 | 0,042 |
| Error | 20 | 48,00 | 2,400 | | |
| Total | 24 | 77,04 | | | |

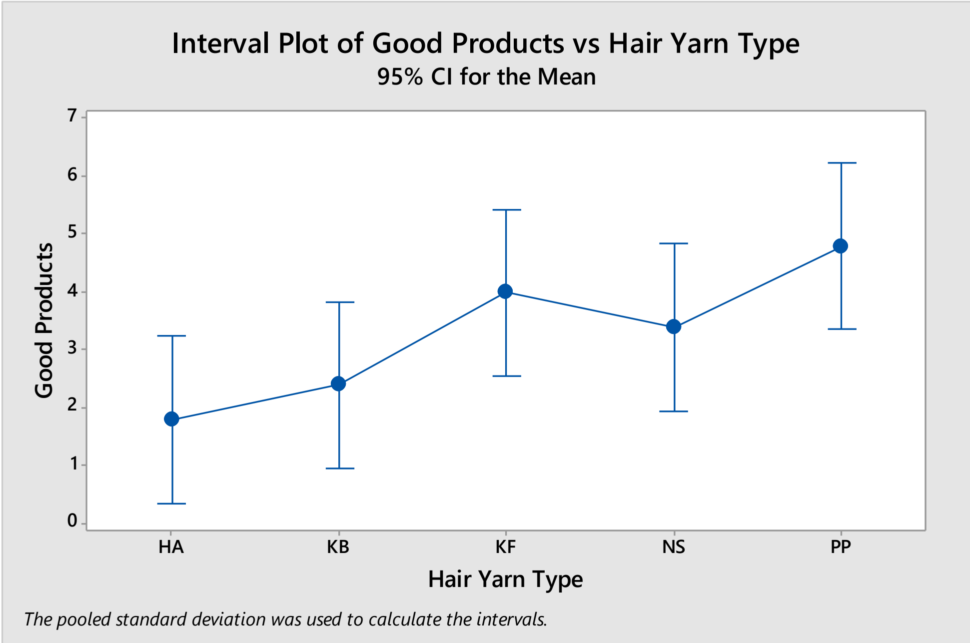
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,54919 | 37,69% | 25,23% | 2,65% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 1,800 | 0,447 | (0,355; 3,245) |
| KB | 5 | 2,400 | 0,548 | (0,955; 3,845) |
| KF | 5 | 4,000 | 2,121 | (2,555; 5,445) |
| NS | 5 | 3,40 | 2,30 | ( 1,95; 4,85) |
| PP | 5 | 4,800 | 1,304 | (3,355; 6,245) |

Pooled StDev = 1,54919



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

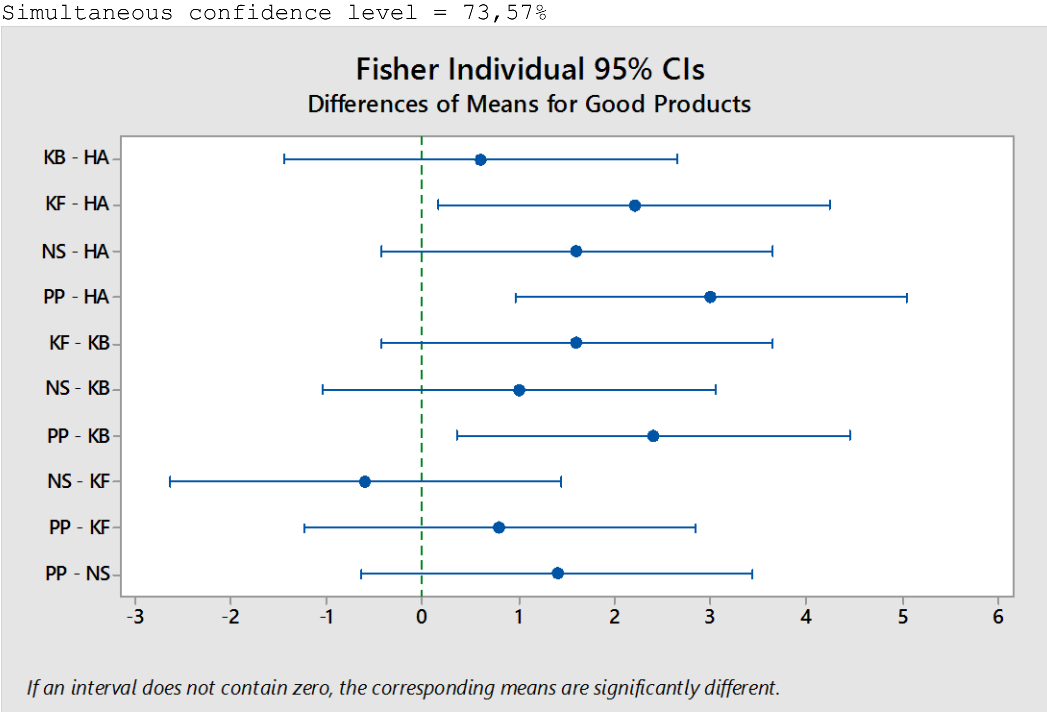
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 4,800 | A |
| KF | 5 | 4,000 | A B |
| NS | 5 | 3,40 | A B C |
| KB | 5 | 2,400 | B C |
| HA | 5 | 1,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

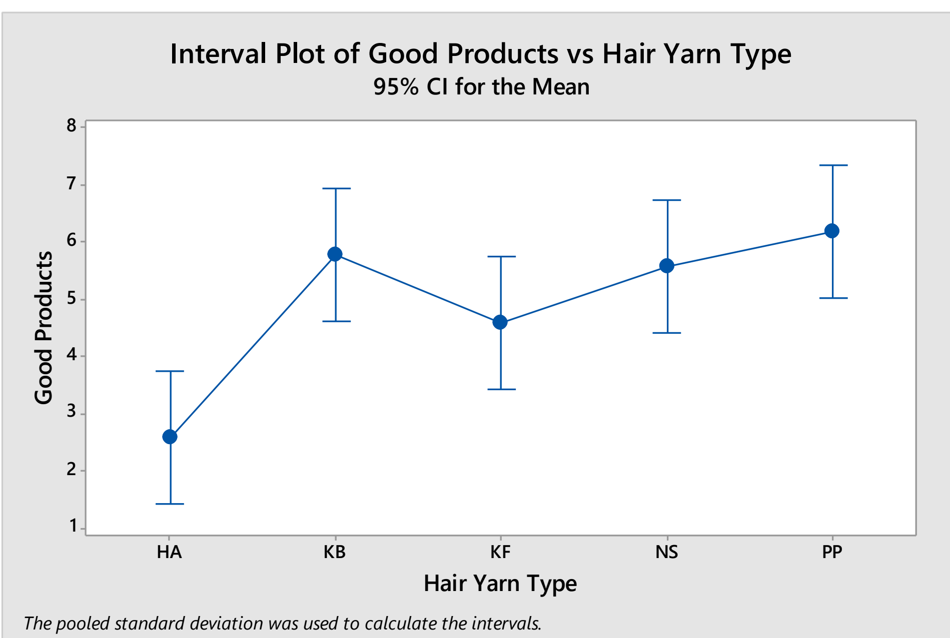
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,600 | 0,980 | (-1,444; 2,644) | 0,61 | 0,547 |
| KF - HA | 2,200 | 0,980 | ( 0,156; 4,244) | 2,25 | 0,036 |
| NS - HA | 1,600 | 0,980 | (-0,444; 3,644) | 1,63 | 0,118 |
| PP - HA | 3,000 | 0,980 | ( 0,956; 5,044) | 3,06 | 0,006 |
| KF - KB | 1,600 | 0,980 | (-0,444; 3,644) | 1,63 | 0,118 |
| NS - KB | 1,000 | 0,980 | (-1,044; 3,044) | 1,02 | 0,320 |
| PP - KB | 2,400 | 0,980 | ( 0,356; 4,444) | 2,45 | 0,024 |
| NS - KF | -0,600 | 0,980 | (-2,644; 1,444) | -0,61 | 0,547 |
| PP - KF | 0,800 | 0,980 | (-1,244; 2,844) | 0,82 | 0,424 |
| PP - NS | 1,400 | 0,980 | (-0,644; 3,444) | 1,43 | 0,168 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy Z)

```
Method

Null hypothesis          All means are equal
Alternative hypothesis   At least one mean is different
Significance level       α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   41,76  10,440     6,69    0,001
Error           20   31,20   1,560
Total           24   72,96


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,24900  57,24%     48,68%      33,18%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  2,600  0,894  (1,435; 3,765)
KB    5  5,800  0,837  (4,635; 6,965)
KF    5  4,600  1,342  (3,435; 5,765)
NS    5  5,600  1,673  (4,435; 6,765)
PP    5  6,200  1,304  (5,035; 7,365)

Pooled StDev = 1,24900
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

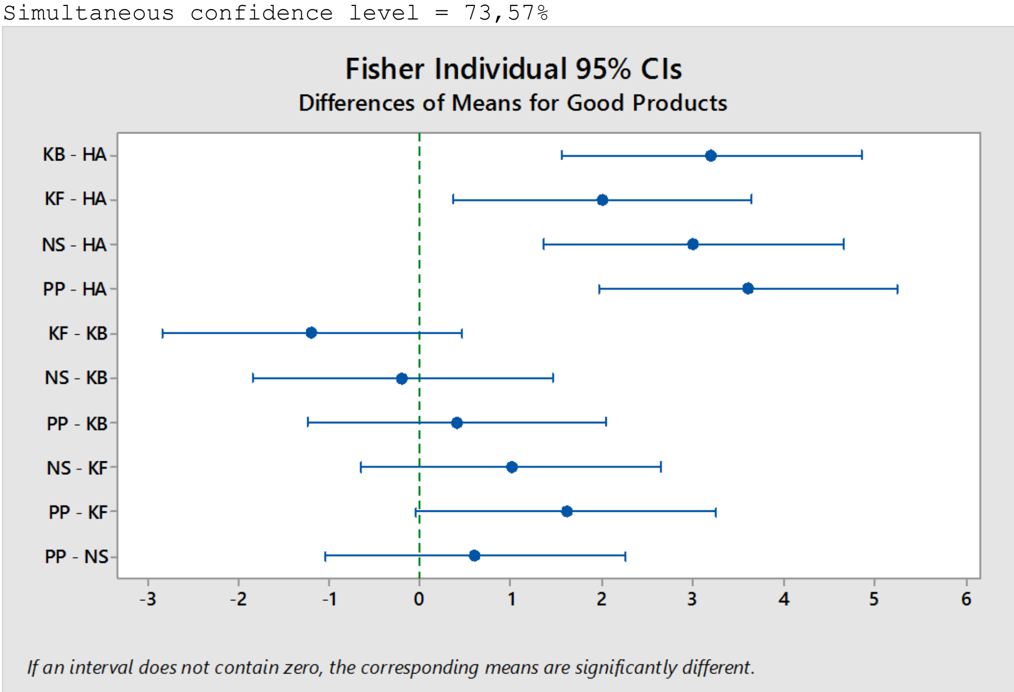
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 6,200 | A |
| KB | 5 | 5,800 | A |
| NS | 5 | 5,600 | A |
| KF | 5 | 4,600 | A |
| HA | 5 | 2,600 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 3,200 | 0,790 | ( 1,552; 4,848) | 4,05 | 0,001 |
| KF - HA | 2,000 | 0,790 | ( 0,352; 3,648) | 2,53 | 0,020 |
| NS - HA | 3,000 | 0,790 | ( 1,352; 4,648) | 3,80 | 0,001 |
| PP - HA | 3,600 | 0,790 | ( 1,952; 5,248) | 4,56 | 0,000 |
| KF - KB | -1,200 | 0,790 | (-2,848; 0,448) | -1,52 | 0,144 |
| NS - KB | -0,200 | 0,790 | (-1,848; 1,448) | -0,25 | 0,803 |
| PP - KB | 0,400 | 0,790 | (-1,248; 2,048) | 0,51 | 0,618 |
| NS - KF | 1,000 | 0,790 | (-0,648; 2,648) | 1,27 | 0,220 |
| PP - KF | 1,600 | 0,790 | (-0,048; 3,248) | 2,03 | 0,056 |
| PP - NS | 0,600 | 0,790 | (-1,048; 2,248) | 0,76 | 0,456 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy AA)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | $\alpha$ = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 54,80 | 13,700 | 7,78 | 0,001 |
| Error | 20 | 35,20 | 1,760 | | |
| Total | 24 | 90,00 | | | |

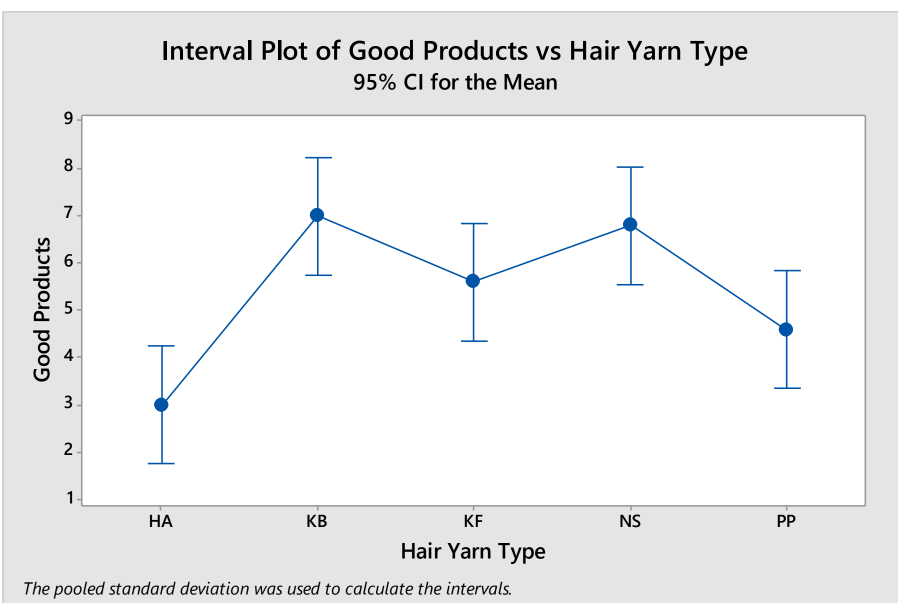
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,32665 | 60,89% | 53,07% | 38,89% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 3,000 | 1,000 | (1,762; 4,238) |
| KB | 5 | 7,000 | 1,581 | (5,762; 8,238) |
| KF | 5 | 5,600 | 1,140 | (4,362; 6,838) |
| NS | 5 | 6,800 | 1,643 | (5,562; 8,038) |
| PP | 5 | 4,600 | 1,140 | (3,362; 5,838) |

Pooled StDev = 1,32665



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

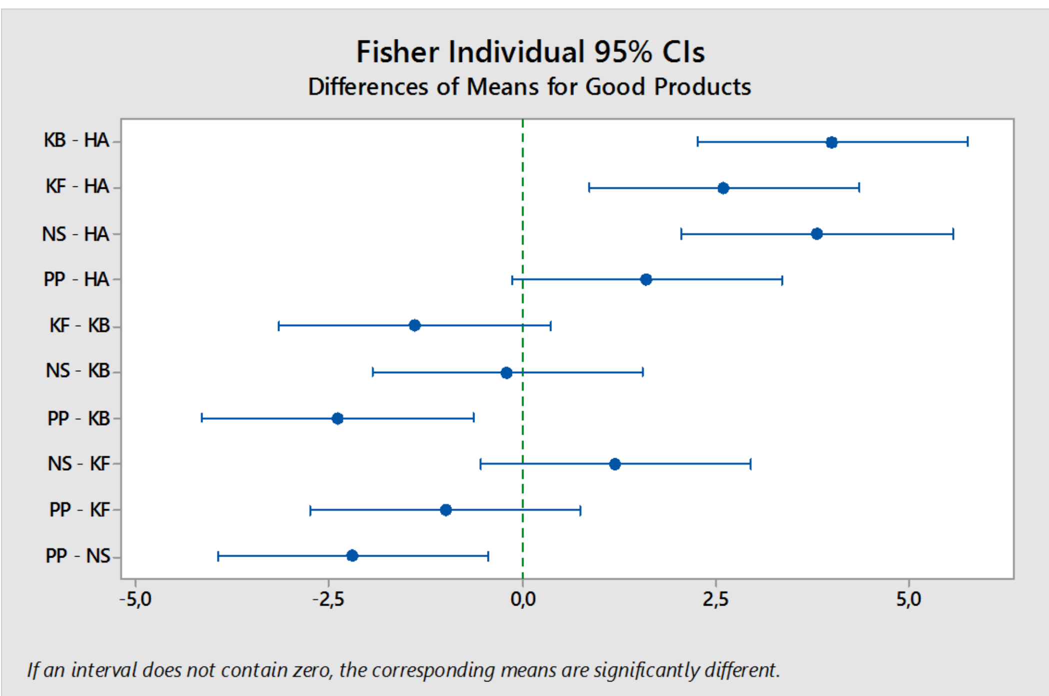
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 7,000 | A |
| NS | 5 | 6,800 | A |
| KF | 5 | 5,600 | A B |
| PP | 5 | 4,600 | B C |
| HA | 5 | 3,000 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 4,000 | 0,839 | ( 2,250; 5,750) | 4,77 | 0,000 |
| KF - HA | 2,600 | 0,839 | ( 0,850; 4,350) | 3,10 | 0,006 |
| NS - HA | 3,800 | 0,839 | ( 2,050; 5,550) | 4,53 | 0,000 |
| PP - HA | 1,600 | 0,839 | (-0,150; 3,350) | 1,91 | 0,071 |
| KF - KB | -1,400 | 0,839 | (-3,150; 0,350) | -1,67 | 0,111 |
| NS - KB | -0,200 | 0,839 | (-1,950; 1,550) | -0,24 | 0,814 |
| PP - KB | -2,400 | 0,839 | (-4,150; -0,650) | -2,86 | 0,010 |
| NS - KF | 1,200 | 0,839 | (-0,550; 2,950) | 1,43 | 0,168 |
| PP - KF | -1,000 | 0,839 | (-2,750; 0,750) | -1,19 | 0,247 |
| PP - NS | -2,200 | 0,839 | (-3,950; -0,450) | -2,62 | 0,016 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy BB)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 92,00 | 23,000 | 17,69 | 0,000 |
| Error | 20 | 26,00 | 1,300 | | |
| Total | 24 | 118,00 | | | |

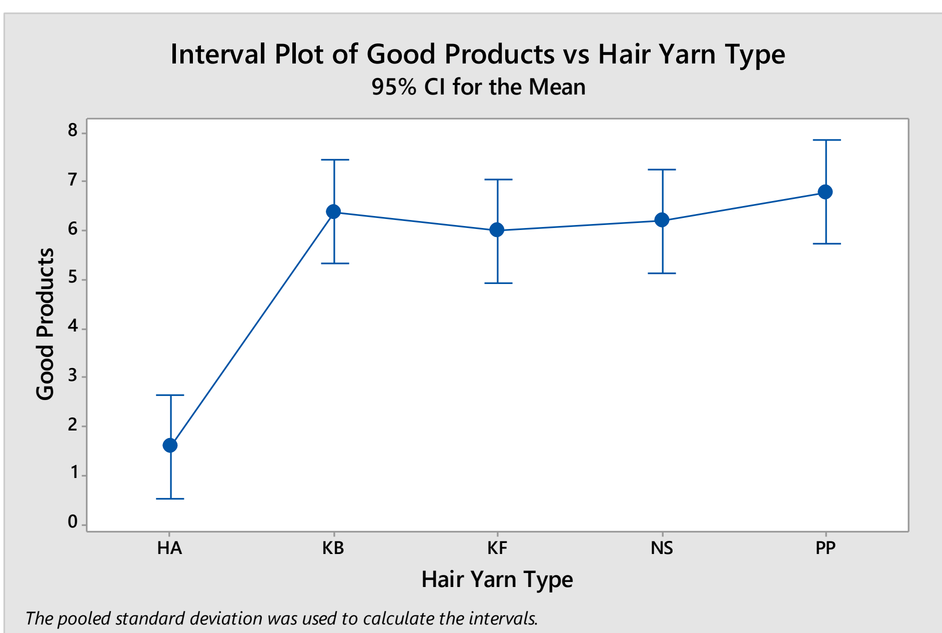
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,14018 | 77,97% | 73,56% | 65,57% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 1,600 | 0,894 | (0,536; 2,664) |
| KB | 5 | 6,400 | 1,140 | (5,336; 7,464) |
| KF | 5 | 6,000 | 0,707 | (4,936; 7,064) |
| NS | 5 | 6,200 | 1,483 | (5,136; 7,264) |
| PP | 5 | 6,800 | 1,304 | (5,736; 7,864) |

Pooled StDev = 1,14018



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

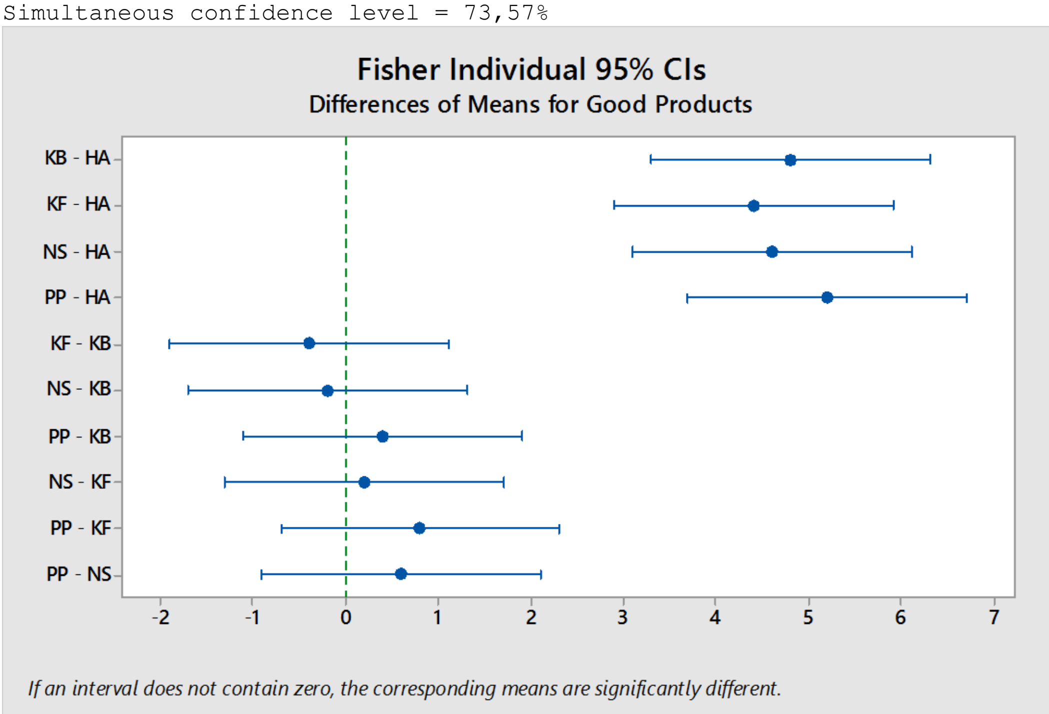
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 6,800 | A |
| KB | 5 | 6,400 | A |
| NS | 5 | 6,200 | A |
| KF | 5 | 6,000 | A |
| HA | 5 | 1,600 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 4,800 | 0,721 | ( 3,296; 6,304) | 6,66 | 0,000 |
| KF - HA | 4,400 | 0,721 | ( 2,896; 5,904) | 6,10 | 0,000 |
| NS - HA | 4,600 | 0,721 | ( 3,096; 6,104) | 6,38 | 0,000 |
| PP - HA | 5,200 | 0,721 | ( 3,696; 6,704) | 7,21 | 0,000 |
| KF - KB | -0,400 | 0,721 | (-1,904; 1,104) | -0,55 | 0,585 |
| NS - KB | -0,200 | 0,721 | (-1,704; 1,304) | -0,28 | 0,784 |
| PP - KB | 0,400 | 0,721 | (-1,104; 1,904) | 0,55 | 0,585 |
| NS - KF | 0,200 | 0,721 | (-1,304; 1,704) | 0,28 | 0,784 |
| PP - KF | 0,800 | 0,721 | (-0,704; 2,304) | 1,11 | 0,280 |
| PP - NS | 0,600 | 0,721 | (-0,904; 2,104) | 0,83 | 0,415 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy CC)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 33,20 | 8,300 | 5,06 | 0,006 |
| Error | 20 | 32,80 | 1,640 | | |
| Total | 24 | 66,00 | | | |

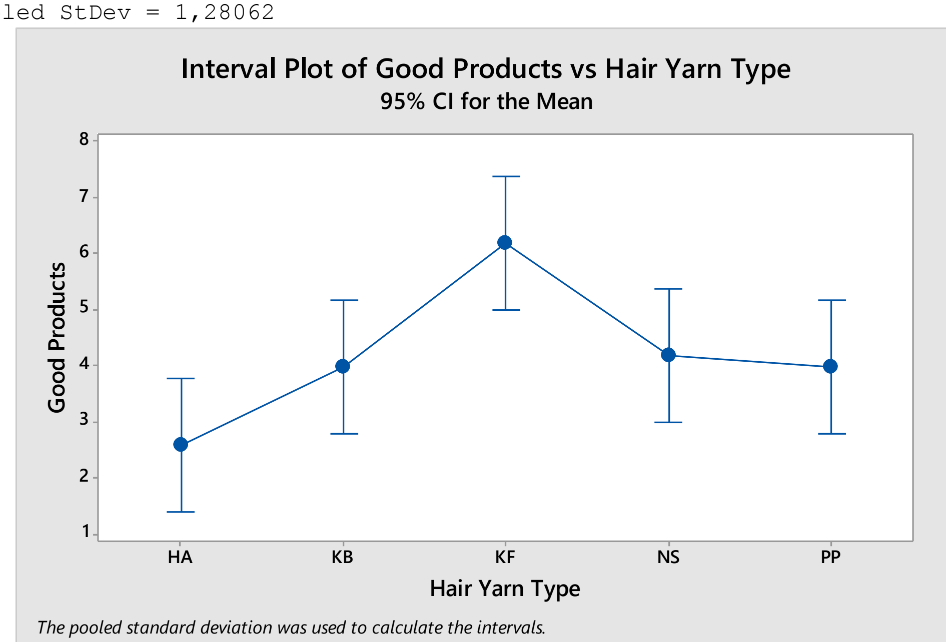
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,28062 | 50,30% | 40,36% | 22,35% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 2,600 | 1,140 | (1,405; 3,795) |
| KB | 5 | 4,000 | 1,581 | (2,805; 5,195) |
| KF | 5 | 6,200 | 0,837 | (5,005; 7,395) |
| NS | 5 | 4,200 | 1,483 | (3,005; 5,395) |
| PP | 5 | 4,000 | 1,225 | (2,805; 5,195) |

Pooled StDev = 1,28062



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

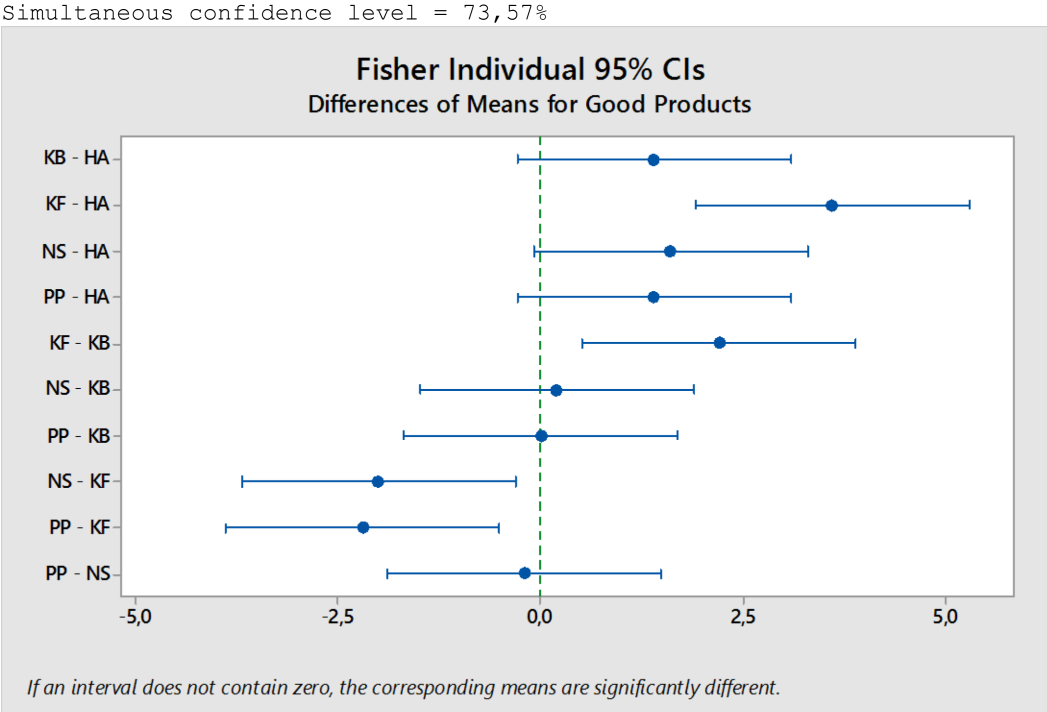
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 6,200 | A |
| NS | 5 | 4,200 | B |
| PP | 5 | 4,000 | B |
| KB | 5 | 4,000 | B |
| HA | 5 | 2,600 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

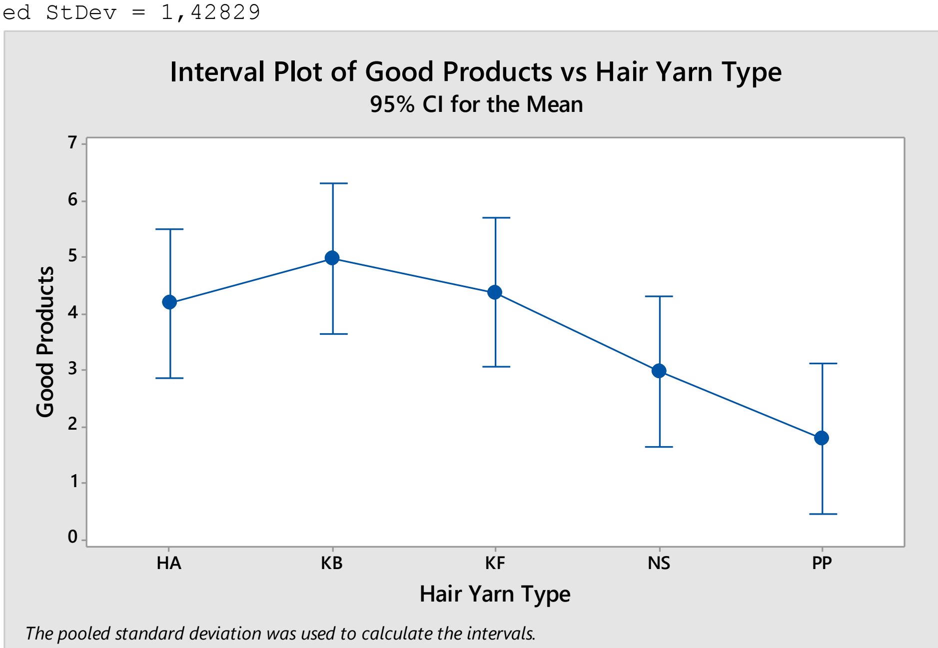
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 1,400 | 0,810 | (-0,290; 3,090) | 1,73 | 0,099 |
| KF - HA | 3,600 | 0,810 | ( 1,910; 5,290) | 4,44 | 0,000 |
| NS - HA | 1,600 | 0,810 | (-0,090; 3,290) | 1,98 | 0,062 |
| PP - HA | 1,400 | 0,810 | (-0,290; 3,090) | 1,73 | 0,099 |
| KF - KB | 2,200 | 0,810 | ( 0,510; 3,890) | 2,72 | 0,013 |
| NS - KB | 0,200 | 0,810 | (-1,490; 1,890) | 0,25 | 0,807 |
| PP - KB | 0,000 | 0,810 | (-1,690; 1,690) | 0,00 | 1,000 |
| NS - KF | -2,000 | 0,810 | (-3,690; -0,310) | -2,47 | 0,023 |
| PP - KF | -2,200 | 0,810 | (-3,890; -0,510) | -2,72 | 0,013 |
| PP - NS | -0,200 | 0,810 | (-1,890; 1,490) | -0,25 | 0,807 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy DD)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   32,64   8,160     4,00    0,015
Error           20   40,80   2,040
Total           24   73,44


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,42829  44,44%     33,33%      13,19%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  4,200  2,168  (2,868; 5,532)
KB    5  5,000  1,000  (3,668; 6,332)
KF    5  4,400  1,140  (3,068; 5,732)
NS    5  3,000  1,581  (1,668; 4,332)
PP    5  1,800  0,837  (0,468; 3,132)

Pooled StDev = 1,42829
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

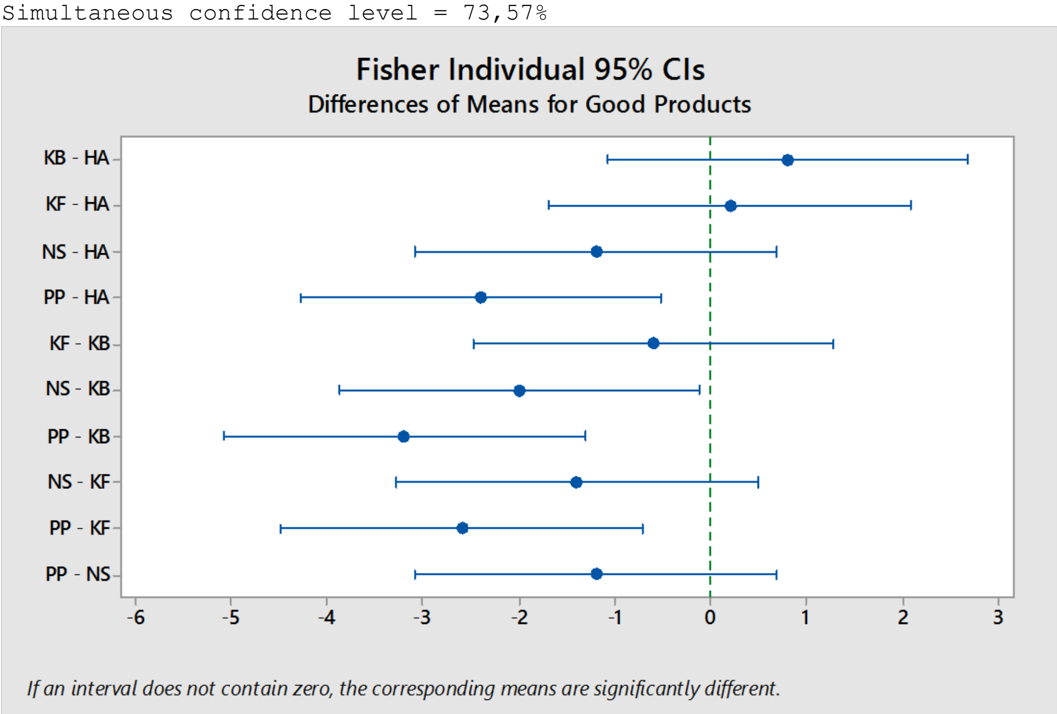
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 5,000 | A |
| KF | 5 | 4,400 | A B |
| HA | 5 | 4,200 | A B |
| NS | 5 | 3,000 | B C |
| PP | 5 | 1,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

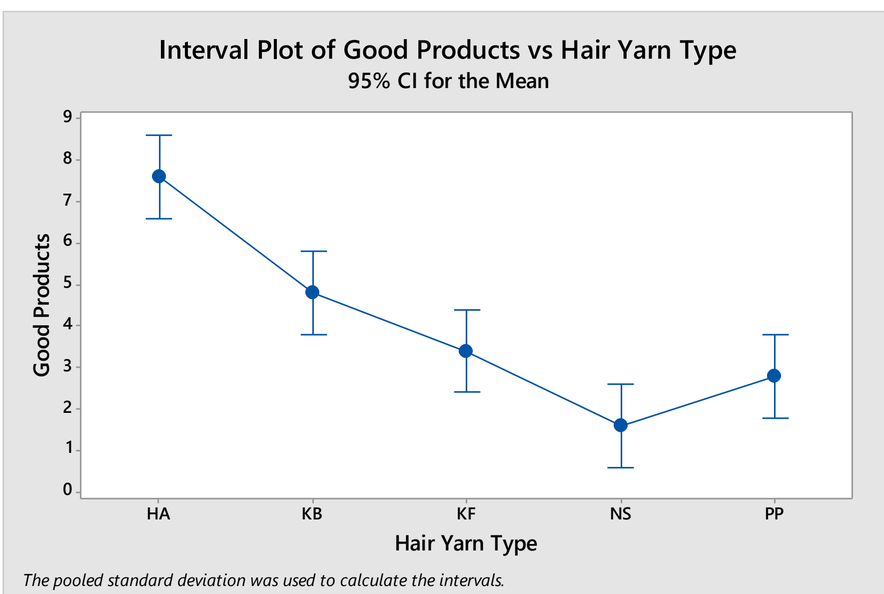
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,800 | 0,903 | (-1,084; 2,684) | 0,89 | 0,386 |
| KF - HA | 0,200 | 0,903 | (-1,684; 2,084) | 0,22 | 0,827 |
| NS - HA | -1,200 | 0,903 | (-3,084; 0,684) | -1,33 | 0,199 |
| PP - HA | -2,400 | 0,903 | (-4,284; -0,516) | -2,66 | 0,015 |
| KF - KB | -0,600 | 0,903 | (-2,484; 1,284) | -0,66 | 0,514 |
| NS - KB | -2,000 | 0,903 | (-3,884; -0,116) | -2,21 | 0,039 |
| PP - KB | -3,200 | 0,903 | (-5,084; -1,316) | -3,54 | 0,002 |
| NS - KF | -1,400 | 0,903 | (-3,284; 0,484) | -1,55 | 0,137 |
| PP - KF | -2,600 | 0,903 | (-4,484; -0,716) | -2,88 | 0,009 |
| PP - NS | -1,200 | 0,903 | (-3,084; 0,684) | -1,33 | 0,199 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy EE)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4  105,76  26,440    22,79    0,000
Error           20   23,20   1,160
Total           24  128,96


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,07703  82,01%     78,41%      71,89%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  7,600  1,140  (6,595; 8,605)
KB    5  4,800  0,837  (3,795; 5,805)
KF    5  3,400  1,140  (2,395; 4,405)
NS    5  1,600  0,894  (0,595; 2,605)
PP    5  2,800  1,304  (1,795; 3,805)

Pooled StDev = 1,07703
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

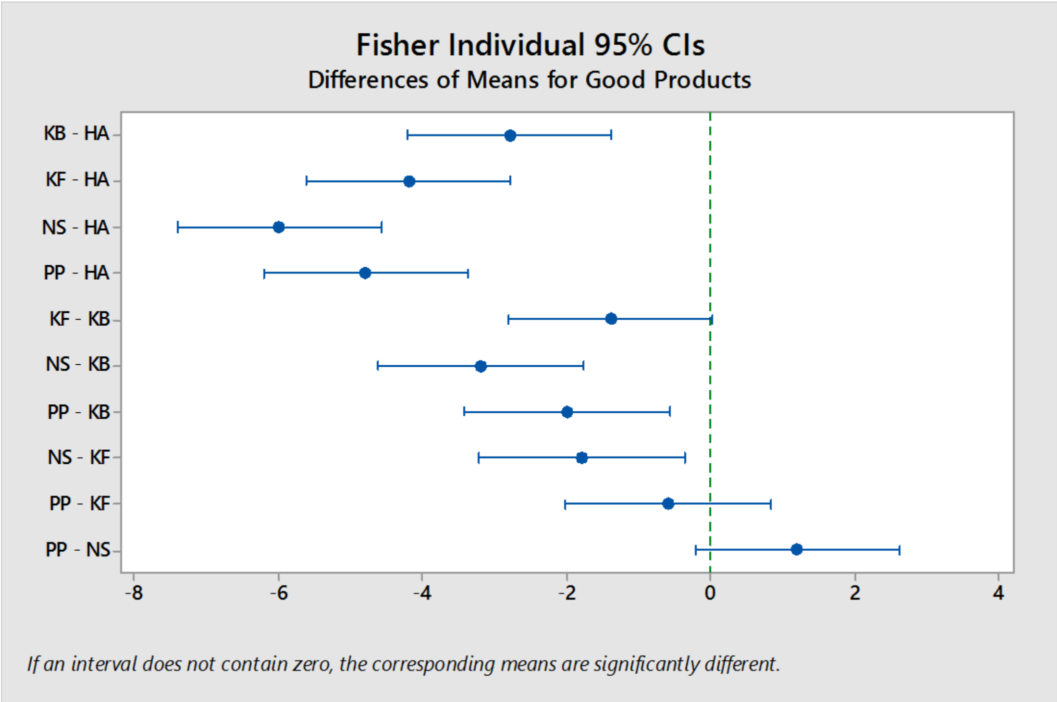
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| HA | 5 | 7,600 | A |
| KB | 5 | 4,800 | B |
| KF | 5 | 3,400 | B C |
| PP | 5 | 2,800 | C D |
| NS | 5 | 1,600 | D |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

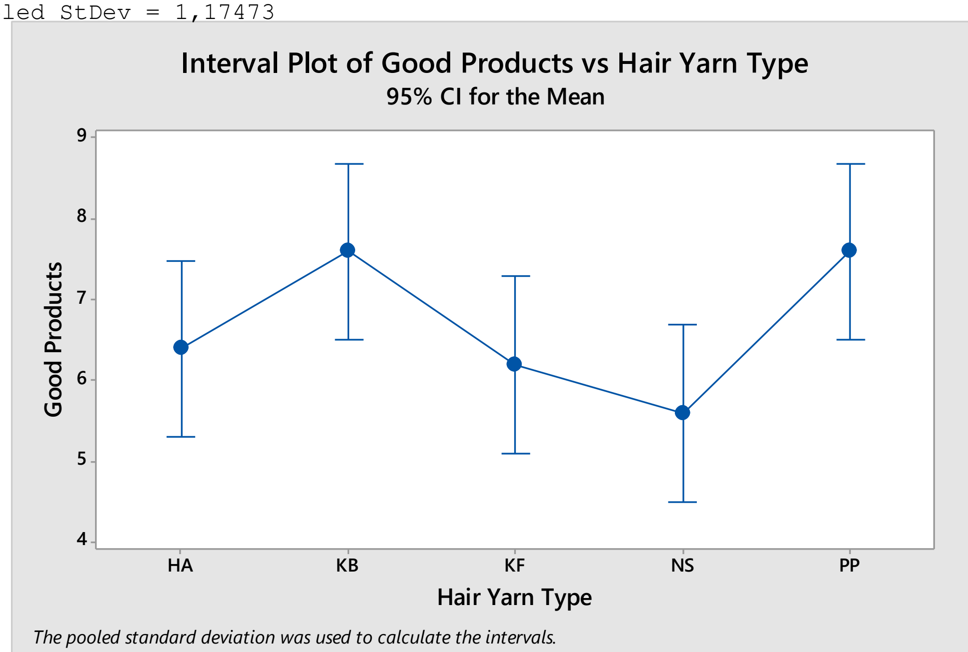
| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -2,800 | 0,681 | (-4,221; -1,379) | -4,11 | 0,001 |
| KF - HA | -4,200 | 0,681 | (-5,621; -2,779) | -6,17 | 0,000 |
| NS - HA | -6,000 | 0,681 | (-7,421; -4,579) | -8,81 | 0,000 |
| PP - HA | -4,800 | 0,681 | (-6,221; -3,379) | -7,05 | 0,000 |
| KF - KB | -1,400 | 0,681 | (-2,821; 0,021) | -2,06 | 0,053 |
| NS - KB | -3,200 | 0,681 | (-4,621; -1,779) | -4,70 | 0,000 |
| PP - KB | -2,000 | 0,681 | (-3,421; -0,579) | -2,94 | 0,008 |
| NS - KF | -1,800 | 0,681 | (-3,221; -0,379) | -2,64 | 0,016 |
| PP - KF | -0,600 | 0,681 | (-2,021; 0,821) | -0,88 | 0,389 |
| PP - NS | 1,200 | 0,681 | (-0,221; 2,621) | 1,76 | 0,093 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy FF)

```
Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor           Levels  Values
Hair Yarn Type        5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   15,84   3,960     2,87    0,050
Error           20   27,60   1,380
Total           24   43,44


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,17473  36,46%     23,76%       0,73%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  6,400  1,140  (5,304; 7,496)
KB    5  7,600  1,140  (6,504; 8,696)
KF    5  6,200  1,304  (5,104; 7,296)
NS    5  5,600  1,140  (4,504; 6,696)
PP    5  7,600  1,140  (6,504; 8,696)

Pooled StDev = 1,17473
```



## Fisher Pairwise Comparisons

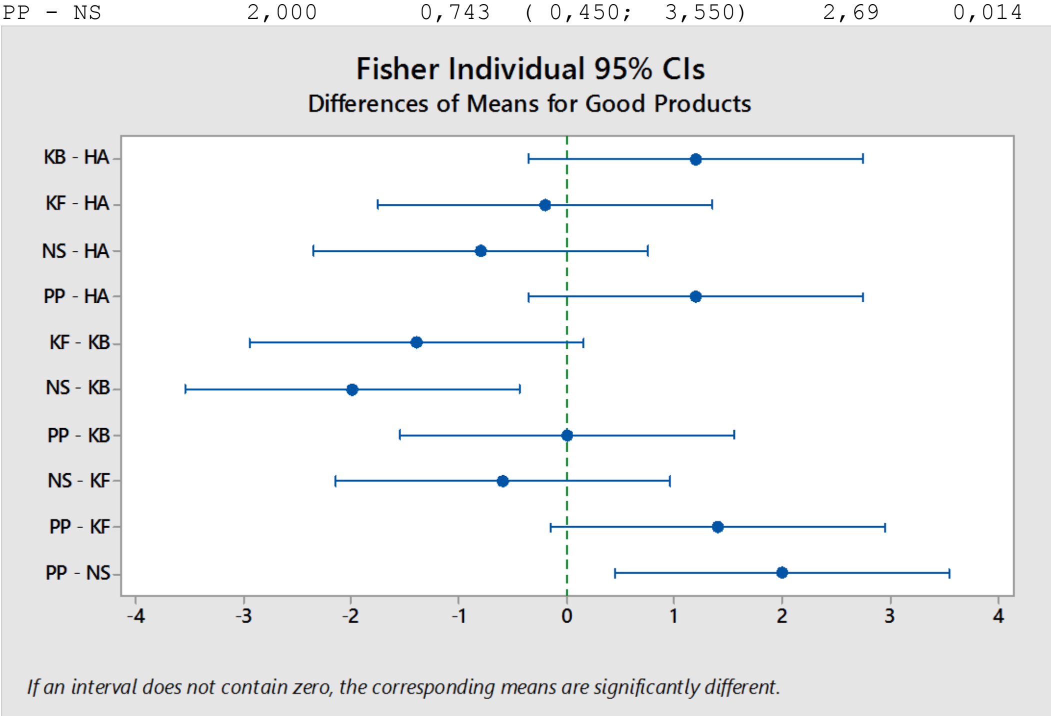
Grouping Information Using the Fisher LSD Method and 95% Confidence

| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 7,600 | A |
| KB | 5 | 7,600 | A |
| HA | 5 | 6,400 | A B |
| KF | 5 | 6,200 | A B |
| NS | 5 | 5,600 | B |

Means that do not share a letter are significantly different.

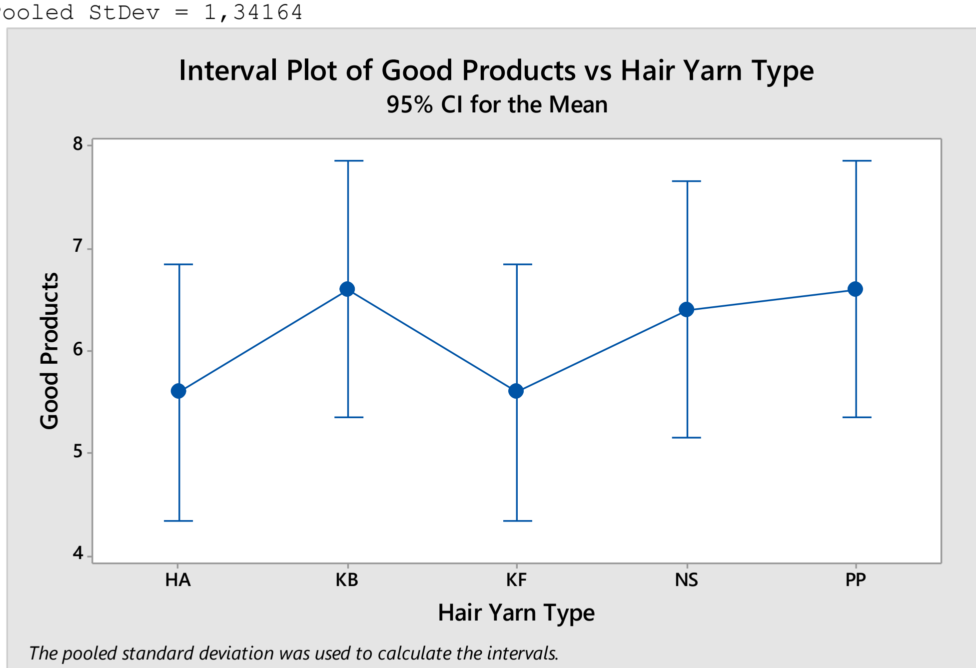
Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 1,200 | 0,743 | (-0,350; 2,750) | 1,62 | 0,122 |
| KF - HA | -0,200 | 0,743 | (-1,750; 1,350) | -0,27 | 0,791 |
| NS - HA | -0,800 | 0,743 | (-2,350; 0,750) | -1,08 | 0,294 |
| PP - HA | 1,200 | 0,743 | (-0,350; 2,750) | 1,62 | 0,122 |
| KF - KB | -1,400 | 0,743 | (-2,950; 0,150) | -1,88 | 0,074 |
| NS - KB | -2,000 | 0,743 | (-3,550; -0,450) | -2,69 | 0,014 |
| PP - KB | 0,000 | 0,743 | (-1,550; 1,550) | 0,00 | 1,000 |
| NS - KF | -0,600 | 0,743 | (-2,150; 0,950) | -0,81 | 0,429 |
| PP - KF | 1,400 | 0,743 | (-0,150; 2,950) | 1,88 | 0,074 |
| PP - NS | 2,000 | 0,743 | ( 0,450; 3,550) | 2,69 | 0,014 |



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy GG)

```
Method

Null hypothesis          All means are equal
Alternative hypothesis   At least one mean is different
Significance level       α = 0,05

Equal variances were assumed for the analysis.


Factor Information

Factor          Levels  Values
Hair Yarn Type       5  HA; KB; KF; NS; PP


Analysis of Variance

Source          DF  Adj SS  Adj MS  F-Value  P-Value
Hair Yarn Type   4   5,360   1,340     0,74    0,573
Error           20  36,000   1,800
Total           24  41,360


Model Summary

      S    R-sq  R-sq(adj)  R-sq(pred)
1,34164  12,96%      0,00%       0,00%


Means

Hair
Yarn
Type  N   Mean  StDev       95% CI
HA    5  5,600  1,140  (4,348; 6,852)
KB    5  6,600  1,673  (5,348; 7,852)
KF    5  5,600  0,548  (4,348; 6,852)
NS    5  6,400  0,894  (5,148; 7,652)
PP    5  6,600  1,949  (5,348; 7,852)

Pooled StDev = 1,34164
```



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

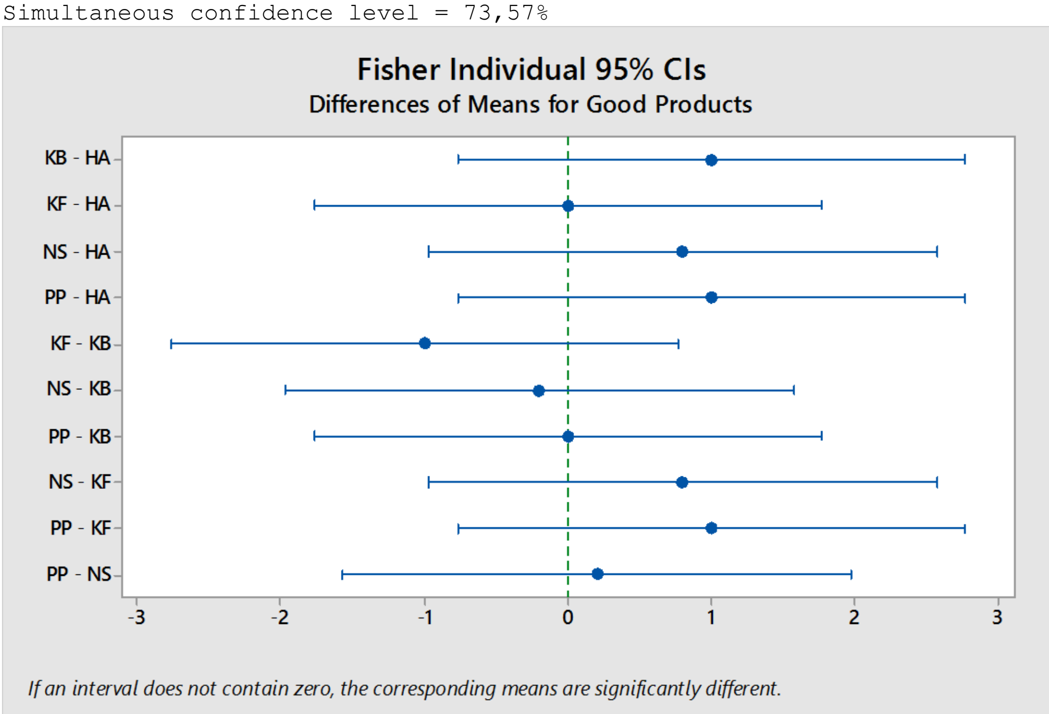
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 6,600 | A |
| KB | 5 | 6,600 | A |
| NS | 5 | 6,400 | A |
| KF | 5 | 5,600 | A |
| HA | 5 | 5,600 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 1,000 | 0,849 | (-0,770; 2,770) | 1,18 | 0,252 |
| KF - HA | 0,000 | 0,849 | (-1,770; 1,770) | 0,00 | 1,000 |
| NS - HA | 0,800 | 0,849 | (-0,970; 2,570) | 0,94 | 0,357 |
| PP - HA | 1,000 | 0,849 | (-0,770; 2,770) | 1,18 | 0,252 |
| KF - KB | -1,000 | 0,849 | (-2,770; 0,770) | -1,18 | 0,252 |
| NS - KB | -0,200 | 0,849 | (-1,970; 1,570) | -0,24 | 0,816 |
| PP - KB | 0,000 | 0,849 | (-1,770; 1,770) | 0,00 | 1,000 |
| NS - KF | 0,800 | 0,849 | (-0,970; 2,570) | 0,94 | 0,357 |
| PP - KF | 1,000 | 0,849 | (-0,770; 2,770) | 1,18 | 0,252 |
| PP - NS | 0,200 | 0,849 | (-1,570; 1,970) | 0,24 | 0,816 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy HH)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 21,44 | 5,360 | 3,77 | 0,019 |
| Error | 20 | 28,40 | 1,420 | | |
| Total | 24 | 49,84 | | | |

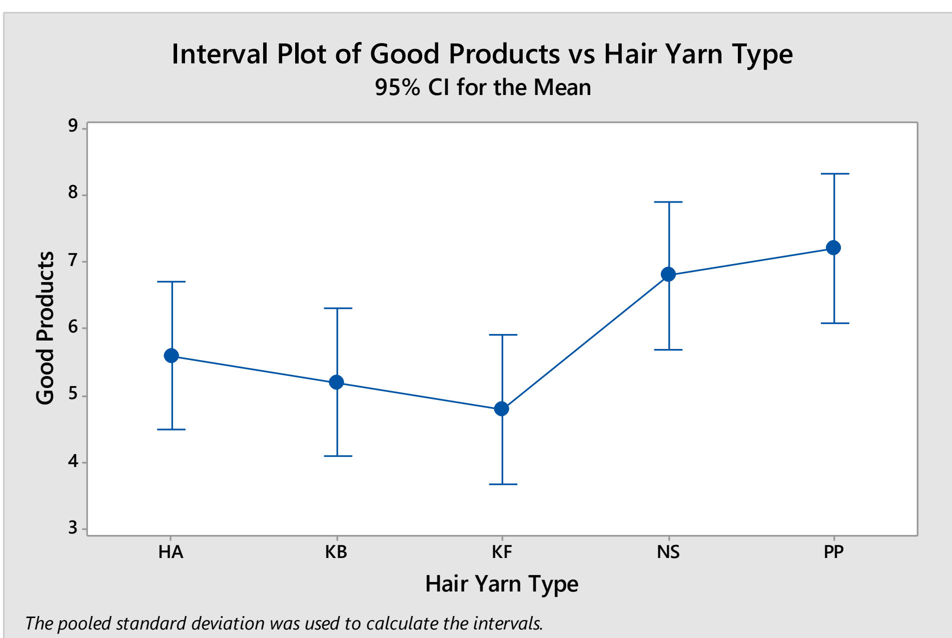
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,19164 | 43,02% | 31,62% | 10,97% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 5,600 | 1,517 | (4,488; 6,712) |
| KB | 5 | 5,200 | 0,837 | (4,088; 6,312) |
| KF | 5 | 4,800 | 0,837 | (3,688; 5,912) |
| NS | 5 | 6,800 | 1,304 | (5,688; 7,912) |
| PP | 5 | 7,200 | 1,304 | (6,088; 8,312) |

Pooled StDev = 1,19164



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

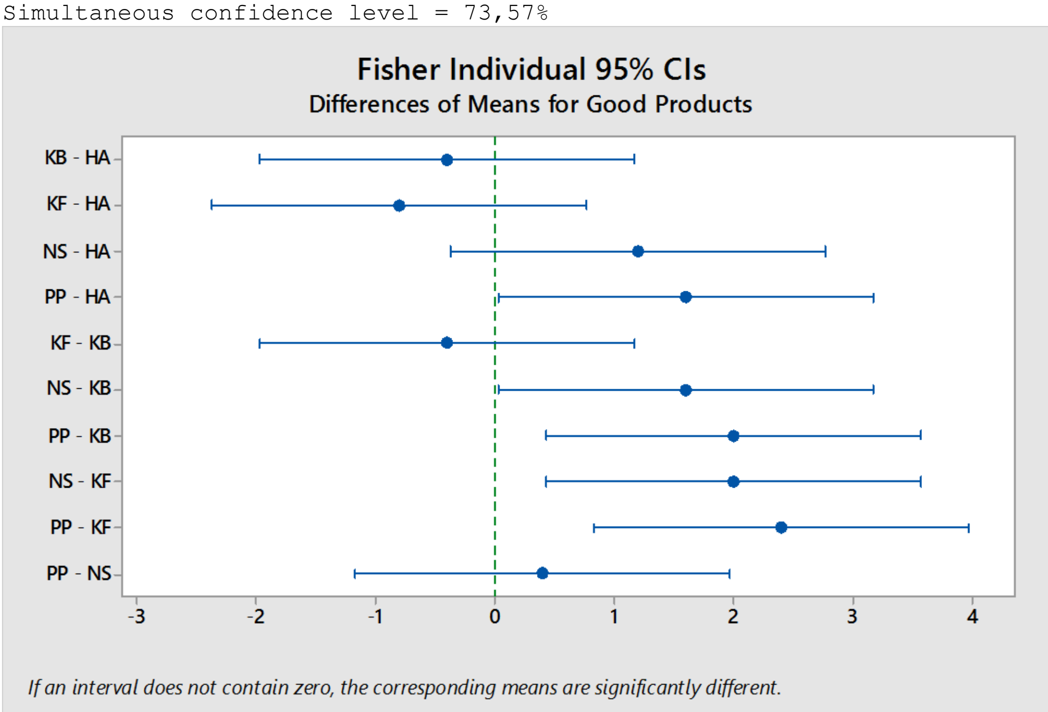
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 7,200 | A |
| NS | 5 | 6,800 | A B |
| HA | 5 | 5,600 | B C |
| KB | 5 | 5,200 | C |
| KF | 5 | 4,800 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -0,400 | 0,754 | (-1,972; 1,172) | -0,53 | 0,601 |
| KF - HA | -0,800 | 0,754 | (-2,372; 0,772) | -1,06 | 0,301 |
| NS - HA | 1,200 | 0,754 | (-0,372; 2,772) | 1,59 | 0,127 |
| PP - HA | 1,600 | 0,754 | ( 0,028; 3,172) | 2,12 | 0,046 |
| KF - KB | -0,400 | 0,754 | (-1,972; 1,172) | -0,53 | 0,601 |
| NS - KB | 1,600 | 0,754 | ( 0,028; 3,172) | 2,12 | 0,046 |
| PP - KB | 2,000 | 0,754 | ( 0,428; 3,572) | 2,65 | 0,015 |
| NS - KF | 2,000 | 0,754 | ( 0,428; 3,572) | 2,65 | 0,015 |
| PP - KF | 2,400 | 0,754 | ( 0,828; 3,972) | 3,18 | 0,005 |
| PP - NS | 0,400 | 0,754 | (-1,172; 1,972) | 0,53 | 0,601 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy II)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 41,36 | 10,340 | 4,54 | 0,009 |
| Error | 20 | 45,60 | 2,280 | | |
| Total | 24 | 86,96 | | | |

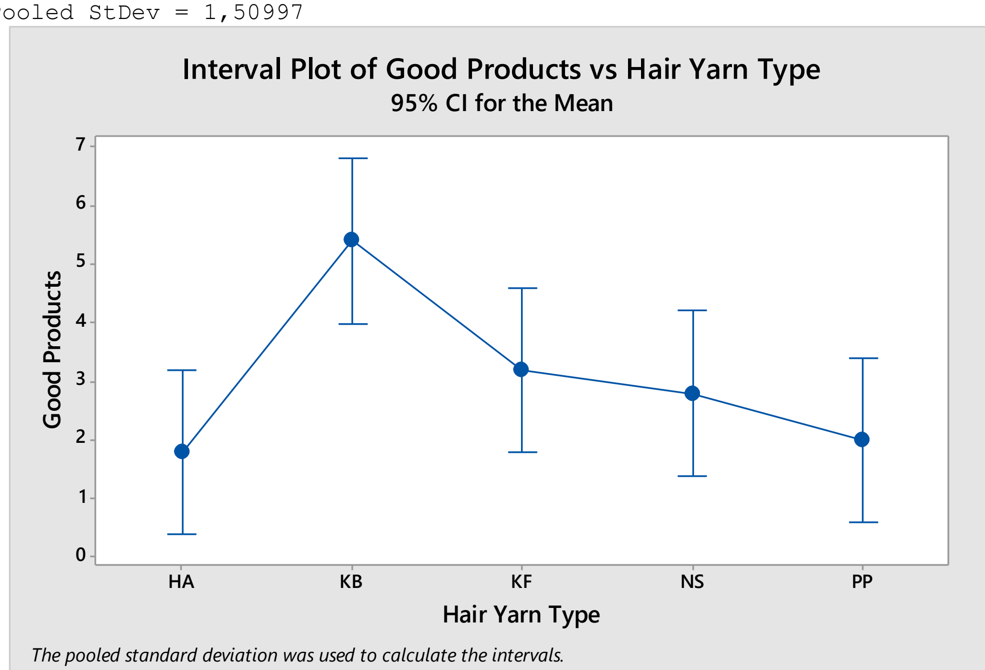
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,50997 | 47,56% | 37,07% | 18,07% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 1,800 | 0,837 | (0,391; 3,209) |
| KB | 5 | 5,400 | 1,140 | (3,991; 6,809) |
| KF | 5 | 3,20 | 2,28 | ( 1,79; 4,61) |
| NS | 5 | 2,800 | 1,643 | (1,391; 4,209) |
| PP | 5 | 2,000 | 1,225 | (0,591; 3,409) |

Pooled StDev = 1,50997



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

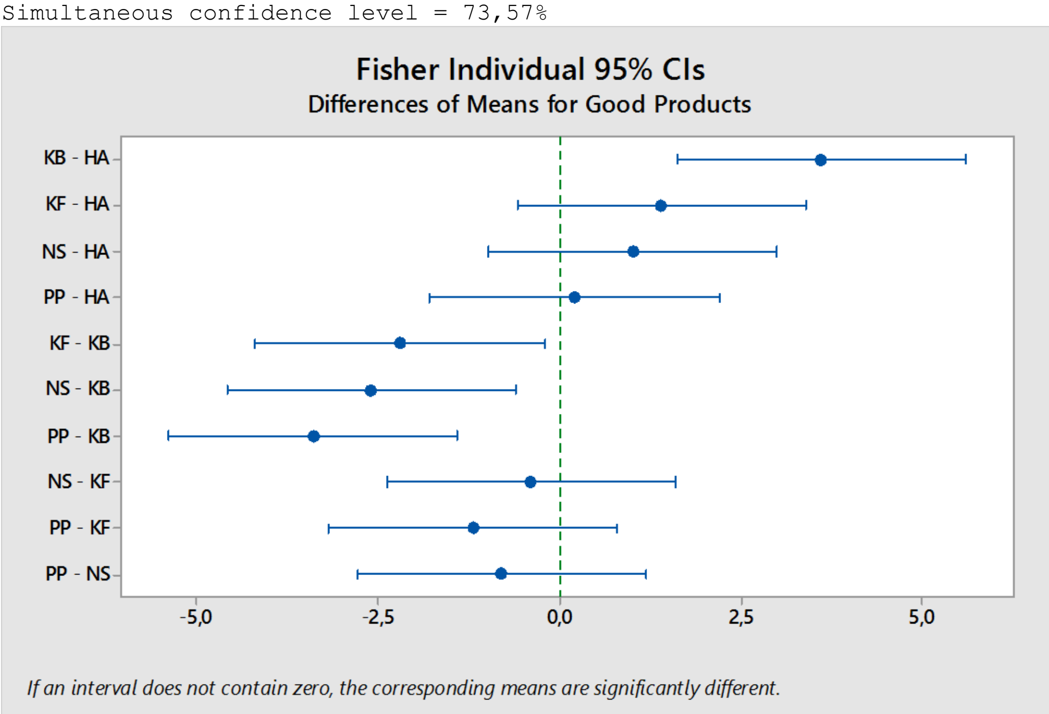
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 5,400 | A |
| KF | 5 | 3,20 | B |
| NS | 5 | 2,800 | B |
| PP | 5 | 2,000 | B |
| HA | 5 | 1,800 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 3,600 | 0,955 | ( 1,608; 5,592) | 3,77 | 0,001 |
| KF - HA | 1,400 | 0,955 | (-0,592; 3,392) | 1,47 | 0,158 |
| NS - HA | 1,000 | 0,955 | (-0,992; 2,992) | 1,05 | 0,308 |
| PP - HA | 0,200 | 0,955 | (-1,792; 2,192) | 0,21 | 0,836 |
| KF - KB | -2,200 | 0,955 | (-4,192; -0,208) | -2,30 | 0,032 |
| NS - KB | -2,600 | 0,955 | (-4,592; -0,608) | -2,72 | 0,013 |
| PP - KB | -3,400 | 0,955 | (-5,392; -1,408) | -3,56 | 0,002 |
| NS - KF | -0,400 | 0,955 | (-2,392; 1,592) | -0,42 | 0,680 |
| PP - KF | -1,200 | 0,955 | (-3,192; 0,792) | -1,26 | 0,223 |
| PP - NS | -0,800 | 0,955 | (-2,792; 1,192) | -0,84 | 0,412 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy JJ)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 11,76 | 2,940 | 1,60 | 0,214 |
| Error | 20 | 36,80 | 1,840 | | |
| Total | 24 | 48,56 | | | |

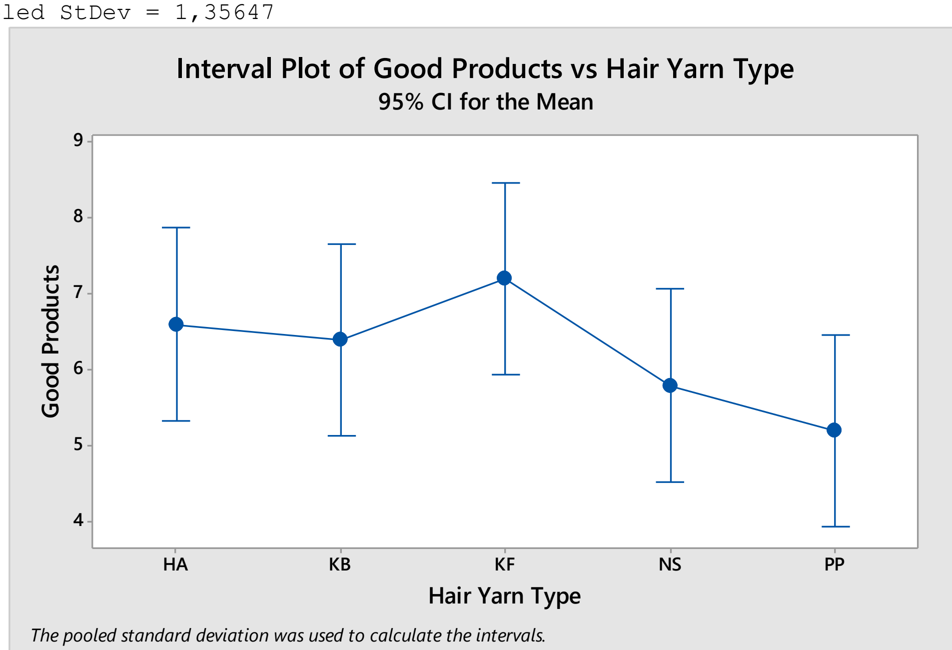
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,35647 | 24,22% | 9,06% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 6,600 | 2,074 | (5,335; 7,865) |
| KB | 5 | 6,400 | 1,140 | (5,135; 7,665) |
| KF | 5 | 7,200 | 0,837 | (5,935; 8,465) |
| NS | 5 | 5,800 | 1,483 | (4,535; 7,065) |
| PP | 5 | 5,200 | 0,837 | (3,935; 6,465) |

Pooled StDev = 1,35647



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

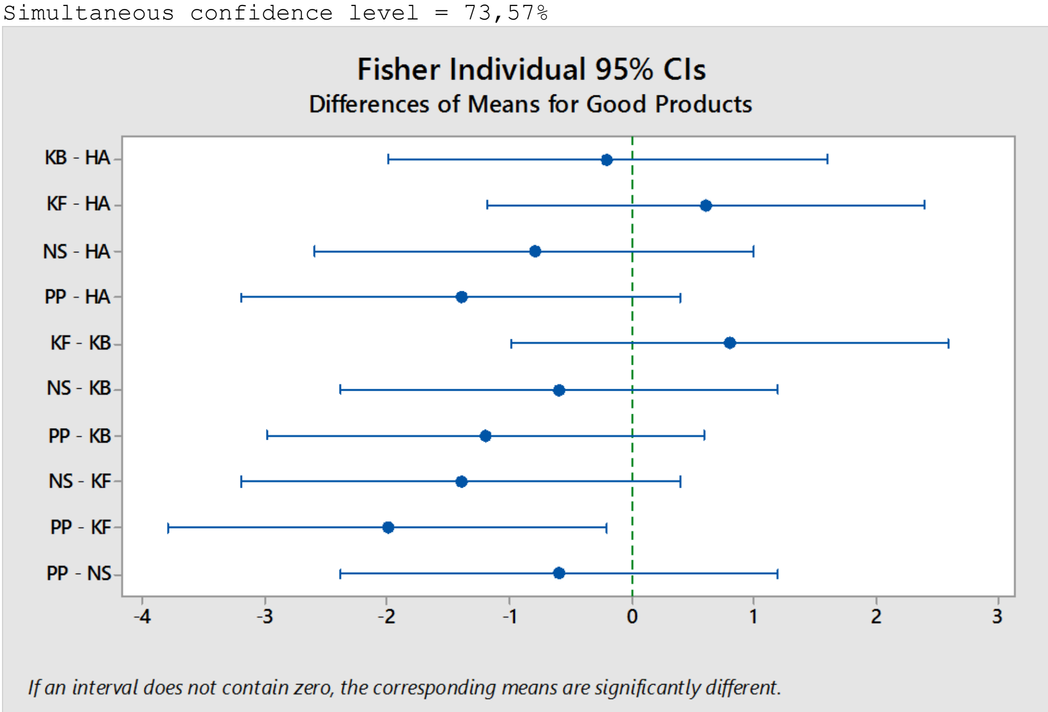
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KF | 5 | 7,200 | A |
| HA | 5 | 6,600 | A B |
| KB | 5 | 6,400 | A B |
| NS | 5 | 5,800 | A B |
| PP | 5 | 5,200 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -0,200 | 0,858 | (-1,990; 1,590) | -0,23 | 0,818 |
| KF - HA | 0,600 | 0,858 | (-1,190; 2,390) | 0,70 | 0,492 |
| NS - HA | -0,800 | 0,858 | (-2,590; 0,990) | -0,93 | 0,362 |
| PP - HA | -1,400 | 0,858 | (-3,190; 0,390) | -1,63 | 0,118 |
| KF - KB | 0,800 | 0,858 | (-0,990; 2,590) | 0,93 | 0,362 |
| NS - KB | -0,600 | 0,858 | (-2,390; 1,190) | -0,70 | 0,492 |
| PP - KB | -1,200 | 0,858 | (-2,990; 0,590) | -1,40 | 0,177 |
| NS - KF | -1,400 | 0,858 | (-3,190; 0,390) | -1,63 | 0,118 |
| PP - KF | -2,000 | 0,858 | (-3,790; -0,210) | -2,33 | 0,030 |
| PP - NS | -0,600 | 0,858 | (-2,390; 1,190) | -0,70 | 0,492 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy JJ)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 46,24 | 11,560 | 3,99 | 0,015 |
| Error | 20 | 58,00 | 2,900 | | |
| Total | 24 | 104,24 | | | |

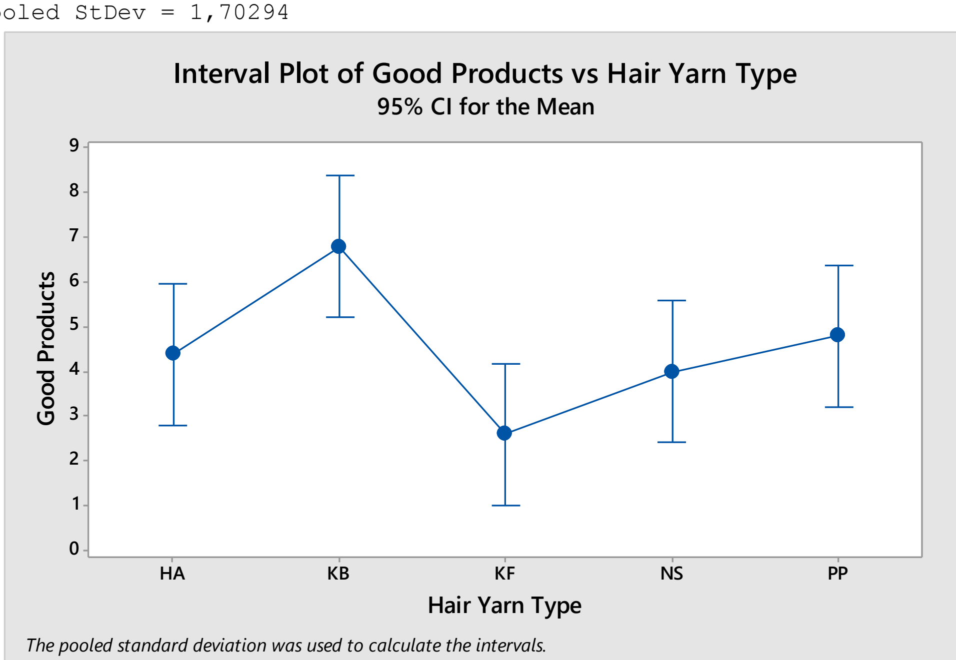
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,70294 | 44,36% | 33,23% | 13,06% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 4,400 | 1,817 | (2,811; 5,989) |
| KB | 5 | 6,800 | 1,924 | (5,211; 8,389) |
| KF | 5 | 2,600 | 1,140 | (1,011; 4,189) |
| NS | 5 | 4,000 | 1,581 | (2,411; 5,589) |
| PP | 5 | 4,800 | 1,924 | (3,211; 6,389) |

Pooled StDev = 1,70294



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

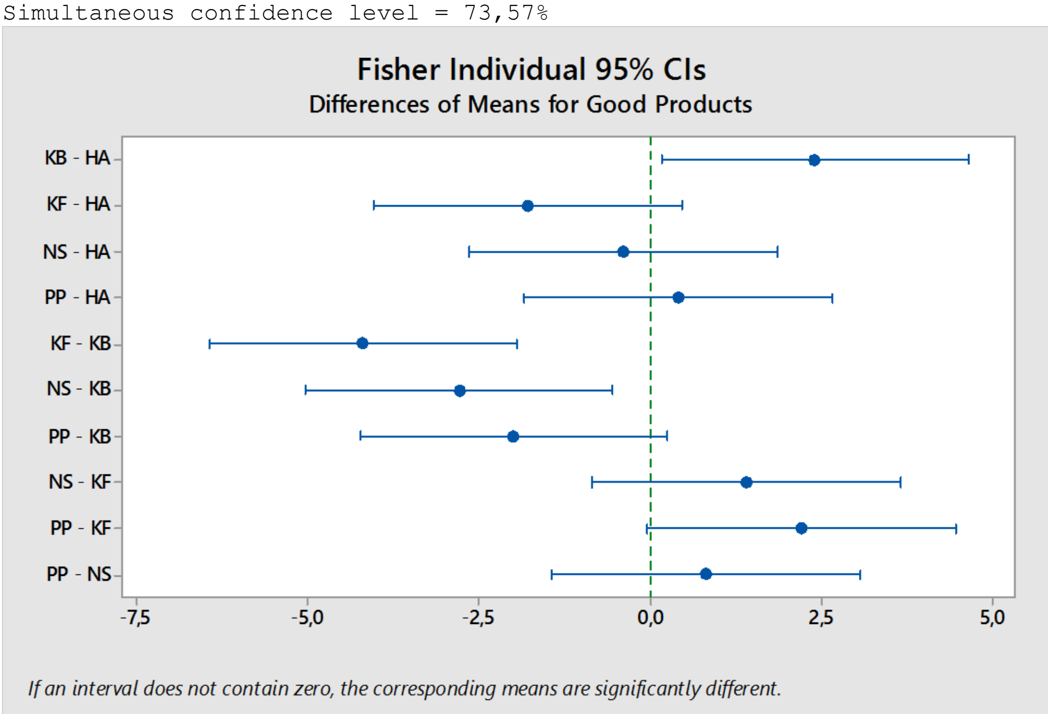
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| KB | 5 | 6,800 | A |
| PP | 5 | 4,800 | A B |
| HA | 5 | 4,400 | B |
| NS | 5 | 4,000 | B |
| KF | 5 | 2,600 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 2,40 | 1,08 | ( 0,15; 4,65) | 2,23 | 0,037 |
| KF - HA | -1,80 | 1,08 | (-4,05; 0,45) | -1,67 | 0,110 |
| NS - HA | -0,40 | 1,08 | (-2,65; 1,85) | -0,37 | 0,714 |
| PP - HA | 0,40 | 1,08 | (-1,85; 2,65) | 0,37 | 0,714 |
| KF - KB | -4,20 | 1,08 | (-6,45; -1,95) | -3,90 | 0,001 |
| NS - KB | -2,80 | 1,08 | (-5,05; -0,55) | -2,60 | 0,017 |
| PP - KB | -2,00 | 1,08 | (-4,25; 0,25) | -1,86 | 0,078 |
| NS - KF | 1,40 | 1,08 | (-0,85; 3,65) | 1,30 | 0,208 |
| PP - KF | 2,20 | 1,08 | (-0,05; 4,45) | 2,04 | 0,054 |
| PP - NS | 0,80 | 1,08 | (-1,45; 3,05) | 0,74 | 0,466 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy KK)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 26,00 | 6,500 | 5,91 | 0,003 |
| Error | 20 | 22,00 | 1,100 | | |
| Total | 24 | 48,00 | | | |

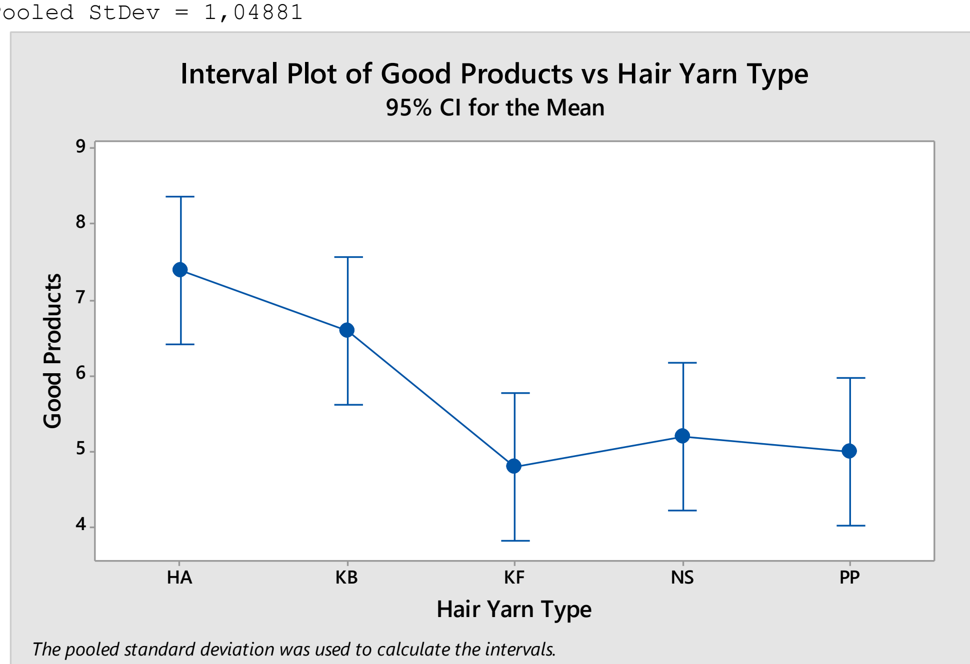
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,04881 | 54,17% | 45,00% | 28,39% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 7,400 | 1,140 | (6,422; 8,378) |
| KB | 5 | 6,600 | 1,342 | (5,622; 7,578) |
| KF | 5 | 4,800 | 0,837 | (3,822; 5,778) |
| NS | 5 | 5,200 | 1,095 | (4,222; 6,178) |
| PP | 5 | 5,000 | 0,707 | (4,022; 5,978) |

Pooled StDev = 1,04881



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

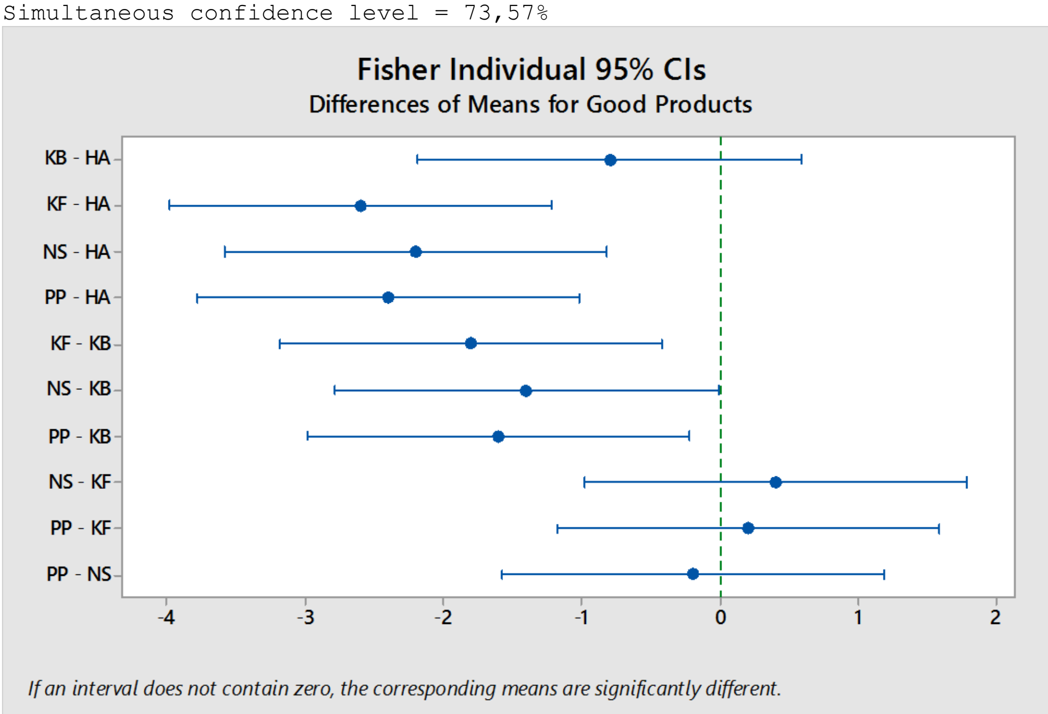
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| HA | 5 | 7,400 | A |
| KB | 5 | 6,600 | A |
| NS | 5 | 5,200 | B |
| PP | 5 | 5,000 | B |
| KF | 5 | 4,800 | B |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -0,800 | 0,663 | (-2,184; 0,584) | -1,21 | 0,242 |
| KF - HA | -2,600 | 0,663 | (-3,984; -1,216) | -3,92 | 0,001 |
| NS - HA | -2,200 | 0,663 | (-3,584; -0,816) | -3,32 | 0,003 |
| PP - HA | -2,400 | 0,663 | (-3,784; -1,016) | -3,62 | 0,002 |
| KF - KB | -1,800 | 0,663 | (-3,184; -0,416) | -2,71 | 0,013 |
| NS - KB | -1,400 | 0,663 | (-2,784; -0,016) | -2,11 | 0,048 |
| PP - KB | -1,600 | 0,663 | (-2,984; -0,216) | -2,41 | 0,026 |
| NS - KF | 0,400 | 0,663 | (-0,984; 1,784) | 0,60 | 0,553 |
| PP - KF | 0,200 | 0,663 | (-1,184; 1,584) | 0,30 | 0,766 |
| PP - NS | -0,200 | 0,663 | (-1,584; 1,184) | -0,30 | 0,766 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy MM)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 48,96 | 12,2400 | 15,69 | 0,000 |
| Error | 20 | 15,60 | 0,7800 | | |
| Total | 24 | 64,56 | | | |

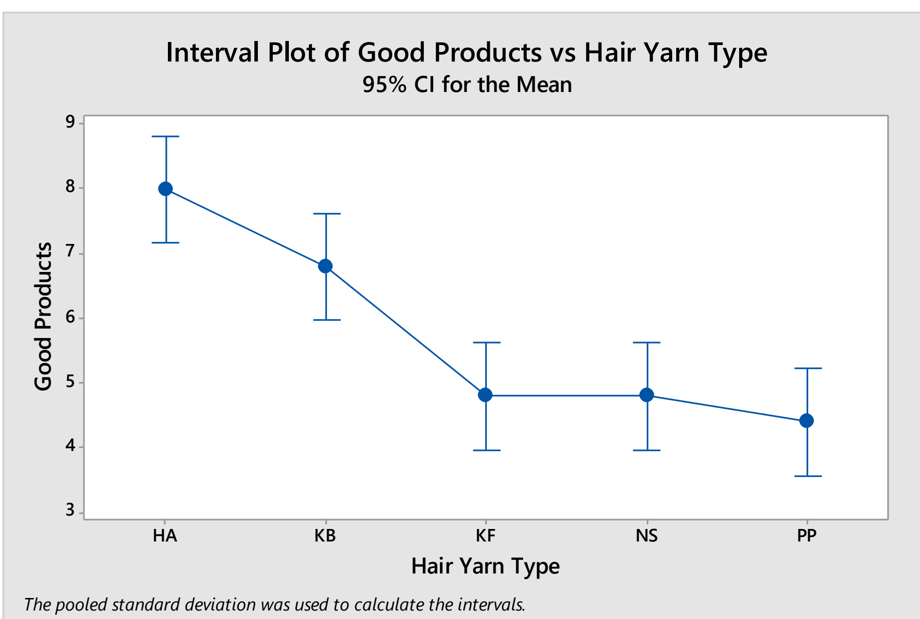
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 0,883176 | 75,84% | 71,00% | 62,24% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 8,000 | 0,707 | (7,176; 8,824) |
| KB | 5 | 6,800 | 0,837 | (5,976; 7,624) |
| KF | 5 | 4,800 | 0,837 | (3,976; 5,624) |
| NS | 5 | 4,800 | 0,837 | (3,976; 5,624) |
| PP | 5 | 4,400 | 1,140 | (3,576; 5,224) |

Pooled StDev = 0,883176



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

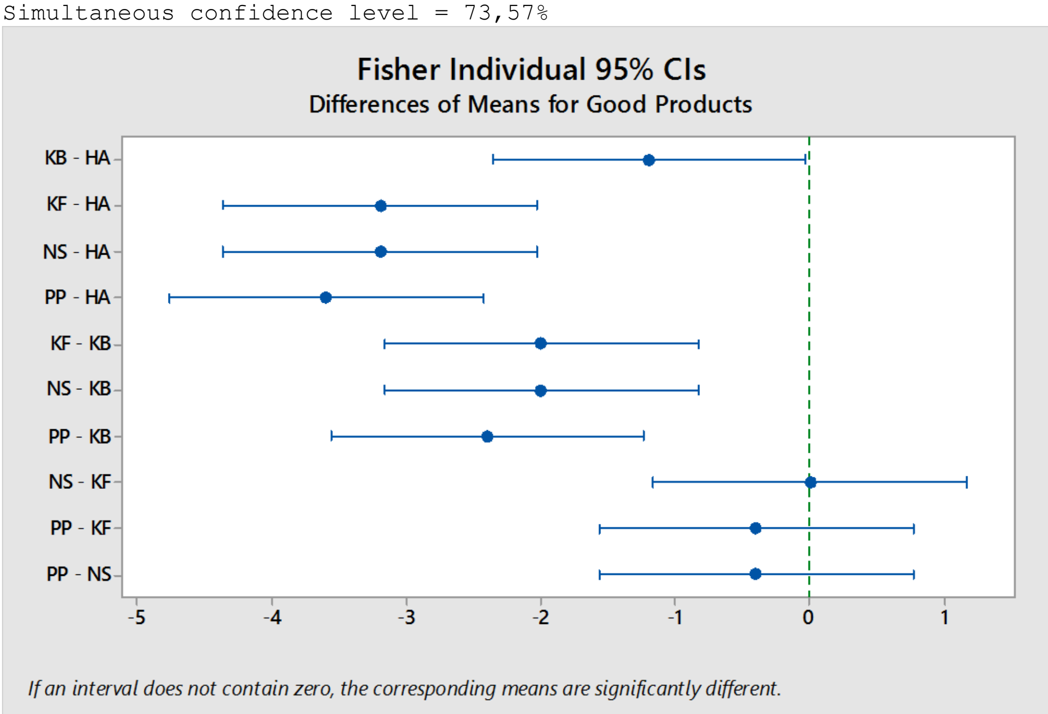
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| HA | 5 | 8,000 | A |
| KB | 5 | 6,800 | B |
| NS | 5 | 4,800 | C |
| KF | 5 | 4,800 | C |
| PP | 5 | 4,400 | C |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | -1,200 | 0,559 | (-2,365; -0,035) | -2,15 | 0,044 |
| KF - HA | -3,200 | 0,559 | (-4,365; -2,035) | -5,73 | 0,000 |
| NS - HA | -3,200 | 0,559 | (-4,365; -2,035) | -5,73 | 0,000 |
| PP - HA | -3,600 | 0,559 | (-4,765; -2,435) | -6,45 | 0,000 |
| KF - KB | -2,000 | 0,559 | (-3,165; -0,835) | -3,58 | 0,002 |
| NS - KB | -2,000 | 0,559 | (-3,165; -0,835) | -3,58 | 0,002 |
| PP - KB | -2,400 | 0,559 | (-3,565; -1,235) | -4,30 | 0,000 |
| NS - KF | 0,000 | 0,559 | (-1,165; 1,165) | 0,00 | 1,000 |
| PP - KF | -0,400 | 0,559 | (-1,565; 0,765) | -0,72 | 0,482 |
| PP - NS | -0,400 | 0,559 | (-1,565; 0,765) | -0,72 | 0,482 |

Simultaneous confidence level = 73,57%



## One-way ANOVA: Good Products versus Hair Yarn Type (Toy NN)

Method

| | |
|---|---|
| Null hypothesis | All means are equal |
| Alternative hypothesis | At least one mean is different |
| Significance level | α = 0,05 |

Equal variances were assumed for the analysis.

Factor Information

| Factor | Levels | Values |
|---|---|---|
| Hair Yarn Type | 5 | HA; KB; KF; NS; PP |

Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Hair Yarn Type | 4 | 7,440 | 1,860 | 1,03 | 0,415 |
| Error | 20 | 36,000 | 1,800 | | |
| Total | 24 | 43,440 | | | |

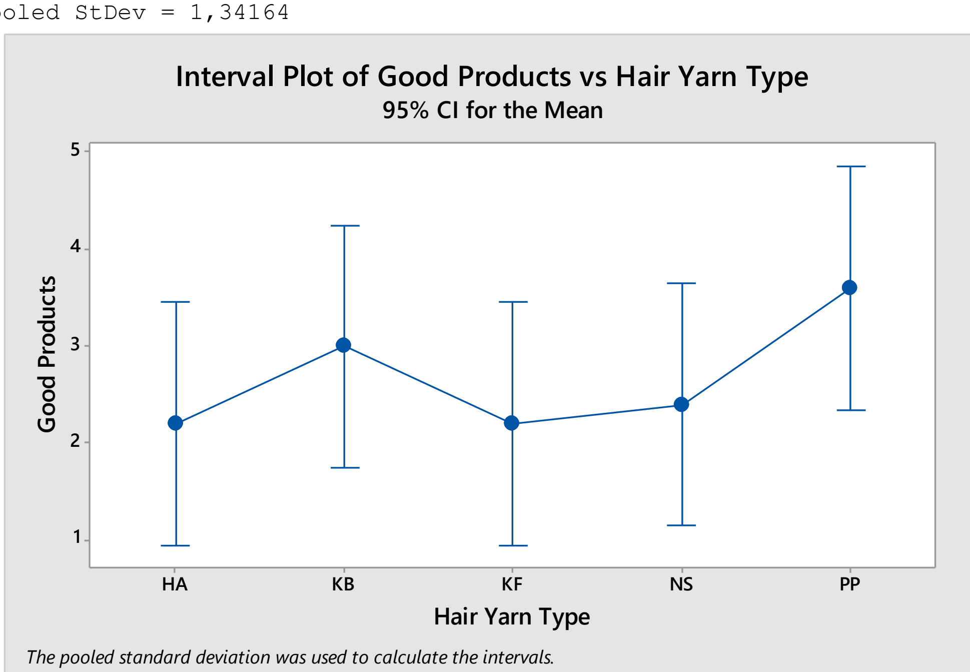
Model Summary

| S | R-sq | R-sq(adj) | R-sq(pred) |
|---|---|---|---|
| 1,34164 | 17,13% | 0,55% | 0,00% |

Means

| Hair Yarn Type | N | Mean | StDev | 95% CI |
|---|---|---|---|---|
| HA | 5 | 2,200 | 1,304 | (0,948; 3,452) |
| KB | 5 | 3,000 | 1,225 | (1,748; 4,252) |
| KF | 5 | 2,200 | 1,304 | (0,948; 3,452) |
| NS | 5 | 2,400 | 1,673 | (1,148; 3,652) |
| PP | 5 | 3,600 | 1,140 | (2,348; 4,852) |

Pooled StDev = 1,34164



## Fisher Pairwise Comparisons

Grouping Information Using the Fisher LSD Method and 95% Confidence

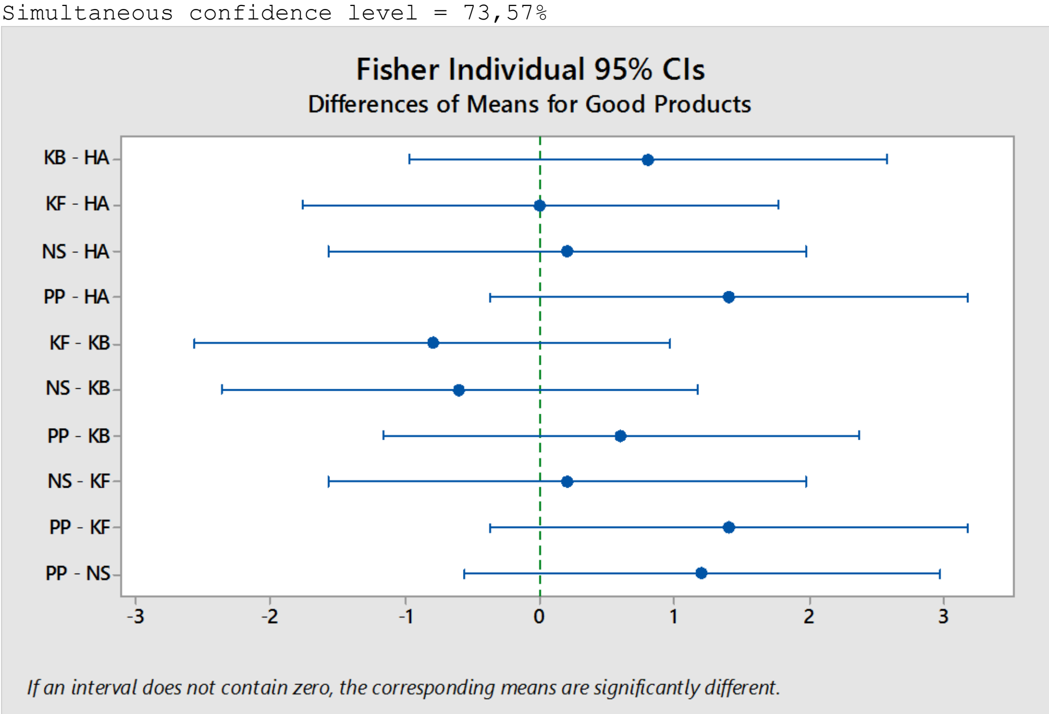
| Hair Yarn Type | N | Mean | Grouping |
|---|---|---|---|
| PP | 5 | 3,600 | A |
| KB | 5 | 3,000 | A |
| NS | 5 | 2,400 | A |
| KF | 5 | 2,200 | A |
| HA | 5 | 2,200 | A |

Means that do not share a letter are significantly different.

Fisher Individual Tests for Differences of Means

| Difference of Levels | Difference of Means | SE of Difference | 95% CI | T-Value | Adjusted P-Value |
|---|---|---|---|---|---|
| KB - HA | 0,800 | 0,849 | (-0,970; 2,570) | 0,94 | 0,357 |
| KF - HA | 0,000 | 0,849 | (-1,770; 1,770) | 0,00 | 1,000 |
| NS - HA | 0,200 | 0,849 | (-1,570; 1,970) | 0,24 | 0,816 |
| PP - HA | 1,400 | 0,849 | (-0,370; 3,170) | 1,65 | 0,115 |
| KF - KB | -0,800 | 0,849 | (-2,570; 0,970) | -0,94 | 0,357 |
| NS - KB | -0,600 | 0,849 | (-2,370; 1,170) | -0,71 | 0,488 |
| PP - KB | 0,600 | 0,849 | (-1,170; 2,370) | 0,71 | 0,488 |
| NS - KF | 0,200 | 0,849 | (-1,570; 1,970) | 0,24 | 0,816 |
| PP - KF | 1,400 | 0,849 | (-0,370; 3,170) | 1,65 | 0,115 |
| PP - NS | 1,200 | 0,849 | (-0,570; 2,970) | 1,41 | 0,173 |

Simultaneous confidence level = 73,57%



## Appendix 7- Form Regular Changing Needle Auto Rooting Machi

**REGULAR INSPECTION CHANGING NEEDLE AUTO ROOTING MACHINE**

| Date | Technician | Changing needle |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

Instruction:

Please fill at column date and technician based on the date of changing needle and the person in charge. At column changing needle, please put sign of **X** as the remarks that the activity has been done.

**Appendix 8-SOP Changing Needle**

# HEADER SOP

| **STANDARD OPERATIONAL PROCEDURE** | | |
|---|---|---|
| Department : IE Secondary | | Doc No : PDE/WI/0096/PO |
| Process Area : Full Auto Rooting Area | | EFF Date : 14/12/2016 |
| Operation : Changing Needle | | Rev : 00 |
| No | Description + Drawing | |
| 1 |   Gunakan kunci pas no 9 untuk membuka pengunci jarum | - Matikan mesin sebelum mengganti jarum<br>- Pastikan anda menggunakan sarung tangan, earplug dan safety shoes pada saat proses mengganti jarum. |
| 2 |   |   |

<table>
<tr><td></td><td>Setelah pengunci jarum terbuka, ganti jarum lama dengan menggunakan jarum baru</td><td>Pastikan posisi jarum berhadapan tepat dengan ara looper agak benang tertancap dengan sempurna</td></tr>
<tr><td rowspan="2">3</td><td>
</td><td>REGULAR INSPECTION CHANGING NEEDLE AUTO ROOTING MACHINE<br>
<table><tr><th>Date</th><th>Technician</th><th>Changing needle</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr></table>
Instruction:<br>
Please fill at column date and technician based on the date of changing needle and the person in charge. At column changing needle, please put sign of X as the remarks that the activity has been done.</td></tr>
<tr><td>Eratkan kembali pengunci jarum dengan menggunakan kunci pas no 9</td><td>Setelah selesai, pastikan untuk mengisi form penggantian jarum yang tersedia di mesin</td></tr>
<tr><td colspan="2">Issued By:<br><br>Ng<br>Sr IE Engineer</td><td>Approved By:<br><br>B.S<br>Asc IE Manager</td></tr>
</table>

**Appendix 9-FAR Module Training**

# MODULE FAR MACHINE

This document is made for training session new operator at FAR process area

PT. X

## A. ROOTING PROSES

Rooting adalah proses pada IE Secondary yang fokus kepada menjahit benang pada kepala toy. PT. X memiliki dua cara pada rooting proses, yakni Manual rooting dan Auto Rooting. Modul ini akan berfokus pada auto rooting proses.

## B. AUTO ROOTING TOOLING

Berikut ini merupakan tooling tooling yang digunakan pada saat proses auto rooting berlangsung.

1. Majun

Digunakan untuk membersihkan tangan setelah memegang Jhonson

2. Trimmer

Digunakan untuk memotong benang yang tangle (kusut)

3. Jhonson


Cairan yang digunakan untuk mencegah rambut boneka yang rontok

4. Tempat Jhonson

Wadah untuk menampung cairan

5. Botol Aquades


Diteteskan di gulungan benang supaya rambut boneka tidak rontok

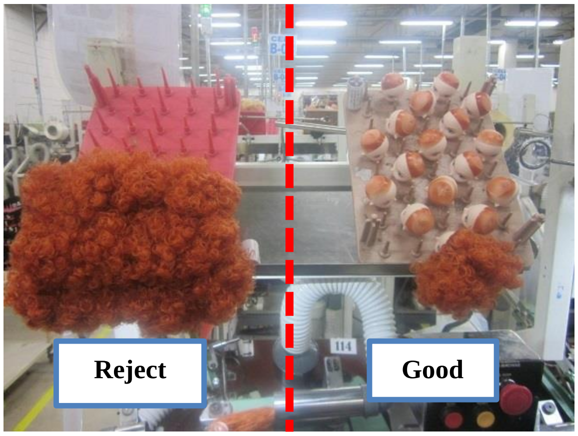
6. Regard

Digunakan untuk memasukkan benang ke looper

7. Traceability label


Label identitas kepala

8. Segregation




Media penyimpanan sementara hasil rooting proses. Segregration merah untuk product rejec, sedangkan segregation coklat untuk product yang baik

## C. MESIN AUTO ROOTING

Mesin Auto Rooting memiliki beberapa part penting selama proses produksi. Part tersebut adalah:

1. Looper;
2. Blower;
3. Mask;
4. V-Dox;
5. Needle;
6. Vacuum;

7. Sensor; Sensor yang berfungsi untuk mendeteksi benang kusut pada rambut keriting dan benang habis pada rambut lurus.

## D. ISTILAH ISTILAH AUTO ROOTING

| | |
|---|---|
| Part line | Jahitan Belahan Barbie |
| Part line Kanan / Right | Jahitan Belahan Kanan Barbie |
| Part line Kiri / Left | Jahitan Belahan Kiri Barbie |
| Part line Tengah/ Center | Jahitan Belahan Tengah Barbie |
| Part line Right to Center | Jahitan Belahan Kanan Serong Ke Tengah |
| Part line Left to Center | Jahitan Belahan Kiri Serong Ke Tengah |
| Phery-Phery | Jahitan Paling Depan dan Belakang Kepala barbie |
| Crown | Jahitan Di bagian Dalam Kepala Barbie |
| Cut Length | Panjang Rambut |
| BOH | Beginning On Hand, total inventory di awal shift |
| CT | Cycle Time, waktu yang dibutuh seorang operator untuk menyelesaikan satu piece |
| DSA | Daily Schedule Adherence, pencapaian schedule harian |
| FTY | First Time Yield,hasil pertama yang keluar dari Mesin |
| PPM | Part Per Million, total part per sejuta |
| PH | Painted Head, Kepala botak yang belum diproses di auto rooting |
| RH | Rooted Head, Kepala yang sudah diproses di auto rooting, sudah ada rambutnya |
| MH | Material Handler, orang yang akan membawa material |
| Storage | Tempat penyimpanan |
| TT | Takt Time, waktu yang diperlukan untuk memenuhi permintaan custumer. |

## E. ANDON

- Andon, digunakan untuk memberi indikasi ke teman yang lain.
- Andon merah digunakan untuk meminta bantuan mekanik

- Andon kuning digunakan untuk meminta yarn (benang)
- Andon hijau digunakan untuk meminta PH (Kepala Botak)

## F. REJECT AUTO ROOTING

| | |
|---|---|
| Broken Wall | Kepala toy pecah/sobek |
| Bald Spot | Kepala toy yang jahitan crownnya jarang lebih dari 1/4 |
| Extended Periphery | Periphery Jelek |
| Molded Line | Tidak mengikuti garis periphery |
| Missing Stitches | Bekas jahitan tidak ada benangnya |
| Stratch Head | Tergires benda tajam |
| Dirty Face | Kepala Barbie kotor |
| Wrong Head | Salah kepala |

## G. SOP PROCESS MESIN AUTO ROOTING

1. Hidupkan mesin dan pastikan mesin berada dalam mode auto
2. Letakkan benang kedalam yarn holder dan masukkan benang kedalam yarn outlet, pastikan jalur dan tata caranya benar
3. Pastikan rotating motor berada pada posisi yang tepat untuk mencegah tabrakan antara rotating motor dengan looper
4. Lepaskan tombol emergency, stop, dan tekan tombol reset
5. Letakkan kepala kedalam head mask, pastikan kepala diposisikan dengan benar di dalam head mask
6. Tekan tombol start untuk menjalankan mesin. Mesin akan berhenti otomatis apabila rooting sudah selesai
7. Bersihkan vacum absorber setiap 4 jam sekali.