Proposals to improve product quality at Jurgens Ci.

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EXECUTIVE SUMMARY

This report includes a detailed description of the problem that Jurgens Ci is facing, the lack of throughput of quality products. Jurgens Ci's daily production rate has been on a steady decline for the past two and a half years. The company does not have a quality inspection system in place that controls quality problems throughout the production process.

This report includes an extensive literature review to find the ways in which problems with quality have been addressed in the past by the experts in the field. This includes the views of J. Juran, K. Ishikawa and RJ. Schonberger among other. Further studies were done on the fields in which the company needed improvement.

This report also contains the findings of a detailed investigation into the processes of the company. The detailed investigation revealed a large imbalance in the cycle times of the stations in the assembly process and great amounts of waste that is built into and part of the fundamentals of the process. The review of the current quality inspection area revealed that the most defects and nonconformities arise from bad workmanship and that these problems originate from the furniture subassembly department.

The recommended solutions that form part of this report tries to address the problems Jurgens Ci face through the possible solution deducted from the literature review. The recommendations include the redesign of the products and the process, reducing the need for subassemblies within the factory by attaining the parts from reliable suppliers and the installation of an electronic quality inspection system.

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1 INTRODUCTION

1.1 COMPANY BACKGROUND

Jurgens Ci Pty. Ltd. (Jurgens Ci) is the oldest and largest manufacturer of caravans in South Africa. Over a history that spans 60 years, the company has assisted in driving the South African domestic tourism market and has responded to changing market needs by expanding the product range the company has to offer.

Jurgens Ci expanded the caravan business internationally by exporting caravans from the factory in Ga-Rankuwa to the Australian market, and by establishing a factory in Australia to assemble and distribute the exported parts and products. The company is looking to expand to Europe, due to an increase in interest from the European market. This provides a big opportunity for the company.

1.2 PRODUCT BACKGROUND

Jurgens Ci offers a wide range of caravans of different sizes and levels of luxury, as well as an off-road range of caravans and trailers. This includes the Jurgens and the Jurgens Safari caravans, the Sprite and the Sprite tourer caravans as well as the Gypsey caravans. The mentioned ranges are all produced in the factory in Ga-Rankuwa.

Figure 1 shows a diagram of a typical caravan that is produced in the factory to explain layout.

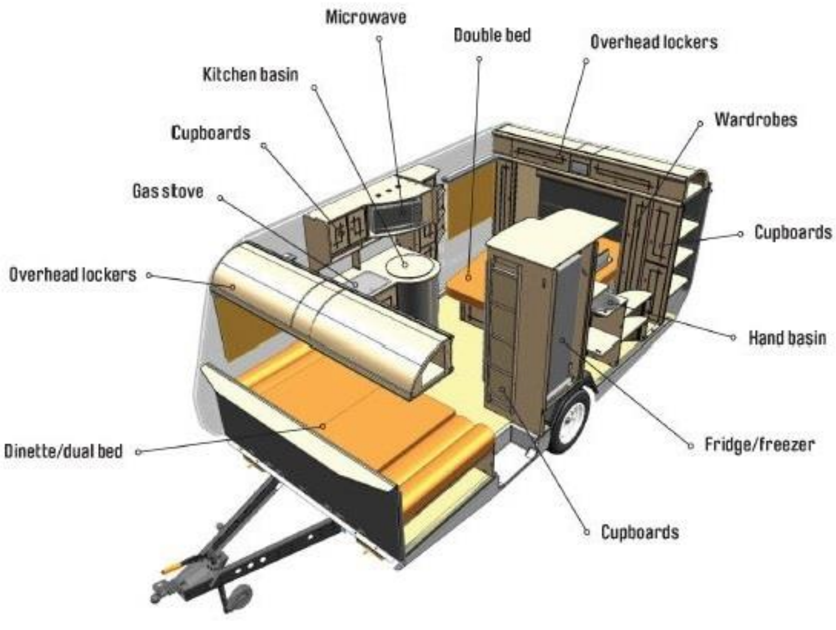

Figure 1: Diagram of a Jurgens caravan

Figure 2 shows examples of caravans to demonstrate the range of product types the company can produce. (From left to right: Jurgens Exclusive, Jurgens Safari Xplorer, and Gypsey Lite) Each product type has different variations, and there are other models and products manufactured by the company that are not shown in Figure 2, for example the range of trailers and off-road trailers.

Figure 2: Examples of products produced in the factory

1.3 Process Background

The Jurgens Ci's caravan factory is in Ga-Rankuwa in North-West province. Figure 3 shows a basic layout of the main assembly plant of the factory.

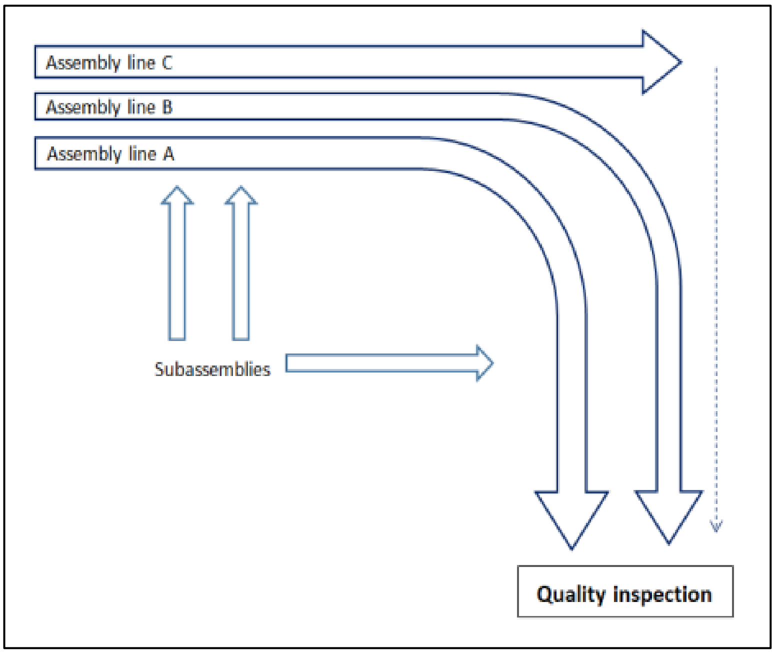

Figure 3: Simplified factory layout

Assembly Line A builds the high work content caravans, which includes the big luxury caravans in the Jurgens range, namely the Exclusive, the Classique and the Penta, as well as off-road caravans in the Jurgens Safari range, including the XCape and the Xplorer. Assembly Line B manufactures the lower work content models, including Sprite and the Gypsey varieties. Assembly Line C adds the trimmings and accessories to the off-road camping trailers, such as the XT Trooper, obtained from the Jurgens Steelworks factory.

The assembly lines manufacture the caravans on a line that moves the chassis from station to station, adding components, parts and subassemblies to the chassis. The company manufactures the various subassemblies in the factory and then move the subassemblies to the assembly line and fit it onto the chassis. There are fifteen subassembly lines in the factory that feeds its work in progress stock to the main assembly line. The factory has large amounts of interdependency between subassemblies and the assembly lines, because if one subassembly area falls behind or has a shortage of any kind, the whole process slows down causing stoppages on the main assembly line.

Examples of these subassemblies are, the station where the workers cut the wood panels to make the furniture and assemble it and move it to the line as needed. The factory also produces the subassembly for the pop-up roof, the side panels, the entry doors and the canvas flaps for the interior and move it to the assembly line. This is only naming a few of the subassemblies taking place in the factory. The subassembly and assembly processes consist mostly of manual labour. The manual labour is tedious and monotonous.

After the products have moved through the factory, the quality inspector does a quality inspection at the end of the process to detect nonconformities and to check whether rework is necessary. The product moves back onto the line if a large amount of rework is necessary, this causes a large bottleneck and adds to the stoppages on the line.

2 Problem Description

2.1 Overview

In June 2017, Jurgens Ci underwent a change in management after a six-week labour strike. According to the factory manager, the biggest problem facing the company since then is to reach the production target of the factory, as elucidated in the following sections.

2.2 Daily Production Rate

Figure 4 shows the daily production rate of the factory since 2016. The chart shows the high variation in the daily production rate, which causes the failure to reach the factory's target production rate of 7,1 caravans per day.

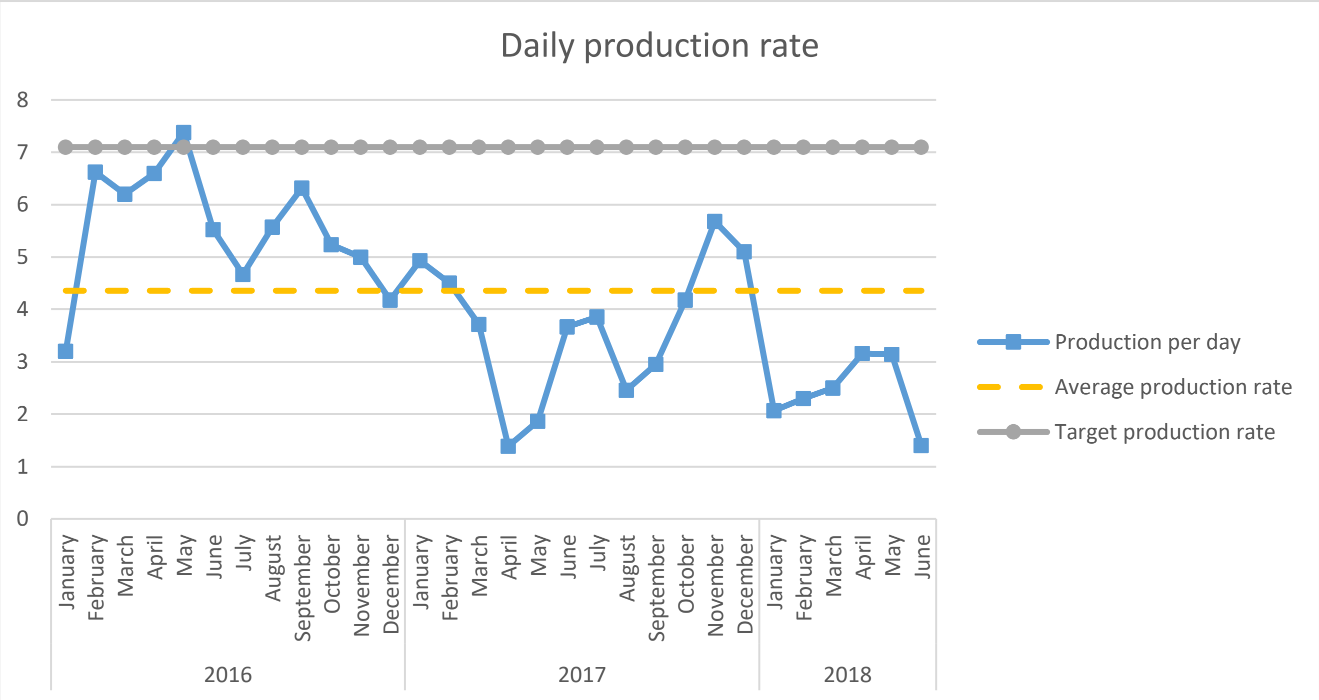

Figure 4: Daily production rate of the Jurgens factory

The chart shows a downward trend from April 2016 that reaches the lowest point in April 2017. The low production rates in April and May 2017 was due to the labour strikes and during takeover by the new management. After the change in management there was a slight recovery in the daily production rate but the rate still failed to reach the target value of 7,1 caravans per day. The rate dropped again from December 2017 to January 2018 and has not made a prominent recovery in the first half of 2018. This lack in production has caused major financial complications and the company have been unable to pay suppliers on time, which caused major shortages throughout all department of the factory.

As explain in forthcoming sections, the factory went on short time production during the second part of the execution of the project, which impacted the objectives and direction of the the project.

2.3 CUMMULATIVE EFFECT

Figure 5 represents a graph of the cumulative difference in the targeted minus the actual production rate. The snowball effect created by the lack of performance of the assembly factory throughout the past two and a half years, emphasizes the enormity of the situation Jurgens Ci finds themselves in. Even if they succeed in achieving the daily production rate, it will take the company more than 17 production days just to catch up.

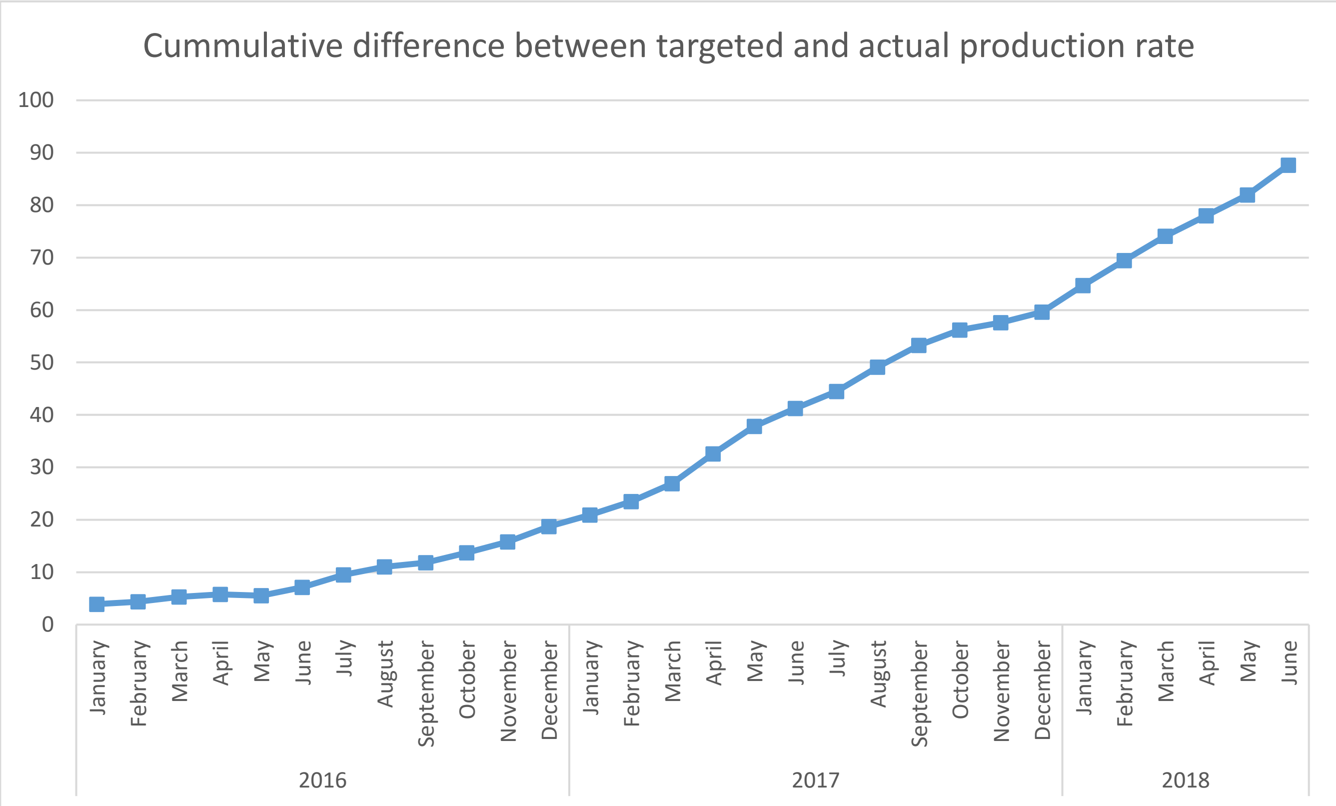

Figure 5: The cumulative difference in targeted and actual production rates

The situation demanded the implementation of drastic measures to attempt to save the business from financial ruin. During the execution of the project, management has opted to go on short time, the condition of working fewer than the regular hours per day or days per week, to have time to order the necessary supplies and products to systematically finish some of the products so that it can be sold and the money received can be used to pay suppliers to buy more raw material to finish more caravans. Short time is the last resort to get the company off its knees.

The problematic situation Jurgens Ci is in emphasises the need for this project to make suggestions on how the factory can ensure that all the work is up to standard and that products conform to specified requirements in order to satisfy all the customer's needs.

2.4 Problem Statement and Objective

As shown in Figure 4, the biggest problem Jurgens Ci is facing is the failure to reach the production targets in the factory, which is aggravated by wasteful activities within the production process. The aim of the project is to investigate the process, to identify sources of waste and factors contributing to the low production rate and to make recommendations to improve. The focus initially was on, what the project refers to and is later explained as 'critical waste', referring to bad workmanship, high levels of interdependence in an unbalanced process and a lack of quality inspection throughout the process. After the company went into short time production mode, the focus of the project moved to inherent waste due to product and process design issues. The ultimate aim of the project is to recommend extensive quality improvement measures that will ensure the decrease and prevention of quality related issues on the assembly line in the future.

3 Project Approach

As explained earlier, the factory went on short time, which necessitated a change in the approach of the project. Therefore, all the phases in the planned project approach could not be executed. The adjusted approach is as follows:

Phase 1: **Define opportunities for improvement**

The initial investigation of the process shows that Jurgens Ci is struggling to produce quality products and reach production targets. This phase of the project identified the opportunity for doing in depth research on the company's current quality management system and how it can be improved.

Phase 2: **Detailed study to identify the causes of the problem**

Due the change in direction, the initial focus on root cause analysis of the unbalanced station cycle times, a lack of proper housekeeping and bad workmanship by untrained labour was expanded to include a focus on the lack of quality management throughout the process in the factory.

Phase 3: **Literature study**

The literature identified different viewpoints and means of quality management in order to derive quality management improvements to suit the needs that Jurgens Ci has to overcome.

Phase 4: **Recommended solutions**

This phase focusses on making recommendations, deducted from the literature and the investigation of the processes in the factory, that will assist Jurgens Ci in the future.

4 Literature Review

4.1 Approaches in Defining Quality

Quality is a timeless concept. Quality has existed since the creation of man and the perception of quality differs from product to product and person to person. Quality is a driving force unique to human beings. According to the dictionary quality is: 1. a distinctive attribute or characteristic possessed by something;

2. the standard of something as measured against other things of a similar kind; the degree of excellence of something.

According to Juran and Godfrey (1999) quality has different meanings in different departments and aspects of a business but there are two that are of critical importance for quality management.

1. Quality means those features of products which meet customer needs and thereby provide customer satisfaction. In this sense higher quality usually requires an investment, but the greater customer satisfaction hopes to increase income.
2. Quality means freedom from deficiencies. In this sense one looks to reduce rework and customer dissatisfaction through the reduction of deficiencies, this usually causes a reduction in the cost of quality.

For the sake of this project Juran and Godfrey's second approach to quality will be focused on.

4.2 APPROACHES TO QUALITY MANAGEMENT

This section provides an overview of the various ways in which quality can be managed.

4.2.1 Juran on quality management

The Juran (1999) quality trilogy is based on the concept that quality management consists of the following three processes oriented towards quality: quality planning, quality control and quality improvement. Figure 6 shows a graph illustrating how these processes are interrelated. The vertical axis is time and the horizontal axis is the cost of poor quality.

Figure 6 shows too forms of waste. Sporadic waste is waste that can be solved through acting that aims to restore the status quo. As with Jurgens Ci, sporadic waste relates to product deficiencies, which requires rework. However, Figure 6 shows that the largest component of total waste is the chronic waste, which refers to waste that is built into the system and that the operating forces cannot get rid of. To reduce chronic waste as Figure 6 illustrates, requires breakthrough and the implementation of a new quality improvement process.

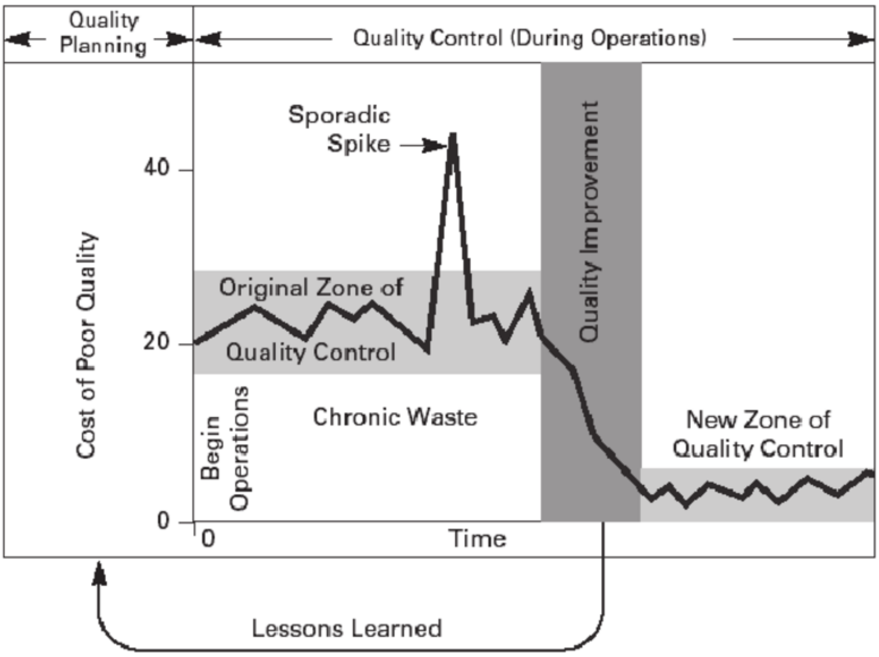

Figure 6: The Juran trilogy diagram.

The three, interrelated quality-oriented processes can be summarised in the following steps:

a. Quality planning

According to Juran, quality planning, is a structured process for developing products that ensures that customer needs are met by the final result. It is done to ensure that the gap between the customer's expectation and perception is minimized. Quality planning entails the following:

- **Establish quality goals:** Firstly, the extent of the project has to be established to set clear goals and direction to determine the infrastructure that will be needed to close the gap in the quality.

- **Identify who the customers are and determine the needs of the customer:** The next step is to identify the customers to eliminate any uncertainty about who the customers are, and the needs has to be investigated and clearly defined. This will ensure that the following steps will be taken with the customer's needs and specifications kept in mind to ensure a successful product.

- **Develop product features that respond to customers' needs:** Quality planning tools and the latest technology of the industry must be used to develop a product that will meet the identified needs of the customer. The product designers have to determine which product features must be included to ensure the optimal benefit for the customer and identify what is needed for the product to be without deficiencies. The outputs of this process are detailed designs, drawings, models and specifications. The designers must ensure that the product design meet the needs of the customers, the suppliers, the producers and beat the product offered by the competition. The designers have to keep in mind the cost of the products and strive to optimise the cost of the production of the product.

- **Develop processes able to produce the product features:** Process development is done to define a set of activities that will be performed by the operating forces to manufacture a product that meets the product quality goal. Quality planning techniques ensure that the process is capable of delivering the product as it was designed, consistently, time after time. The developed process has to be clearly defined as well as all the tasks of the process and its sequence. The inputs and outputs of all the parts of the process has to be specified.

- **Establish process controls and transferring the plans to the operating forces:** The beforementioned has to be transferred to the operating forces in such a way that the operators understand all the aspects of the product and process design to keep the standard of quality and to ensure products that delight customers. A quality control system has to be set in place from the initial transfer of the designed product and process to evaluate its performance. This has to be compared to the performance goals and action has to be taken to correct the difference. Quality control will be discussed in more detail in the coming section.

b. Quality control

Quality control is a managerial process for conducting operations to provide the stability of a process. To maintain stability, the quality control process evaluates actual performance, compares actual performance to its goals, and takes action on the difference. Quality control is dependent on continuous feedback from the manufacturing process and takes place by the use of a feedback loop. If the actual data is gathered from the process it can be processed to compare the desired targets to the actual production statistics. Through the analysis of the constant feedback, the weakness in the process can be identified and planners can then focus on this area when allocating resources or in the planning of upgrades and improvements. An appropriate tool to use as a continuous feedback tool is the control chart that uses statistical process control, and this is discussed later in this document.

c. Quality improvement

Improvement relates to the creation of beneficial change and the attainment of unprecedented levels of performance. Quality improvement is done to increase income and can be done through the revision of the overall goals and setting new ones. This requires several kinds of planning, which includes quality planning, as discussed earlier. In the case of chronic waste, the product goals are already in place as well as the processes for meeting those goals. However, the resulting products do not all meet the goals. Consequently, the reduction of chronic waste differs from quality planning. It follows the following approach:

1. Discovering the causes: Why do some products meet the goal and others do not?
2. Applying remedies to remove the causes.

Continuing improvement is needed for both kinds of quality, since competitive pressures apply to each. Customer needs are a moving target. Competitive costs are also a moving target. However, improvement for these two kinds of quality has in the past progressed at very different rates. The main reason is that many upper managers give higher priority to increasing sales than to reducing costs. This difference in priority is usually reflected in the respective organization structures.

4.2.2 Ishikawa on supplier relationships

According to Ishikawa (1985), "the practice of quality control is to develop, design, and produce a quality product which is most economical, most useful, and always satisfactory to the customer." The term quality control in the Japanese environment is the equivalent to quality management in the Western world. To meet this goal everyone in the company has to work together and participate in the promotion of quality control.

Quality planning tools and the latest technology in the industry has to be used during the development of the product. According to Ishikawa it does not matter how well and without defects your product is produced if its design is faulty or the materials used is not correct. On average, Japanese manufacturers spend an equivalent of 70% of manufacturing cost in purchasing materials and parts from companies (suppliers). Therefore, unless the quality, quantity, price and time of delivery is right, the purchaser and manufacturer (assembler) cannot promise and deliver quality products to customers. Thus, the quality control of the suppliers' products and parts is of utmost importance to purchasers.

With this in mind, it is extremely important for purchasers to select the right suppliers that implement quality control to ensure quality parts and quality products. Regarding supplier selection, Ishikawa suggests the following ten quality control principles for purchaser - supplier relationships:

Principle 1: Both parties are fully responsible for quality control application with mutual understanding and cooperation between the quality control systems.

Principle 2: Both parties should be independent of each other and esteem the independence of the other party.

Principle 3: The purchaser should give clear and adequate information and requirements to the supplier so that the vendor can know precisely what he should manufacture.

Principle 4: Both parties, before entering into business transactions, should conclude a rational contract between them in respect to quality, quantity, price, delivery terms, and method of payment.

Principle 5: The supplier is responsible for quality assurance that will satisfy the purchaser and he is responsible for submitting necessary and actual data upon the purchaser's request.

Principle 6: Both parties should decide on the evaluation method of various items beforehand and this should be satisfactory to both parties.

Principle 7: Both parties should establish contractually the procedure they will follow to reach settlement whenever problems occur.

Principle 8: Both parties should exchange information necessary to carry out better quality control.

Principle 9: Both parties should always carry out control activities efficiently to maintain a satisfactory relationship.

Principle 10: Both parties should always take full account of customer's interests.

From the beforementioned 10 principles it can be deducted that the selection of a supplier is of utmost importance. Quality and reliability from the supplier is needed to ensure a good long-term agreement with them.

4.2.3 Schonberger on quality management

Schonberger (1986) guidance to quality management includes the following:

a. Product design

Schonberger states that engineers should design products for the customers. This means that the design of products should always have the end-user and a quality product in mind. One should always practice quality control to produce products that will satisfy the requirements of consumers. The requirements of consumers change continually, and this has to be kept in mind. Therefore, the quality control system must be kept up to date with these changing requirements.

Two ways to design for quality and simplify the process is by minimizing the part count and using modular design. Fewer parts are also very important for quality reasons, as there are less parts that has to be checked and therefore fewer mistakes that can creep in from the beginning. The overall number of parts can also be reduced through standardization across the different product ranges.

Develop loose tolerances on specifications that are tightly enforced, rather than tight tolerances lightly enforces, as Johnson puts it. This has to take the customer's requirements and the capability of the maker into account.

b. Training of the Operating Forces

Training is the foundation of implementation in quality improvement. Word Class Management means continual and rapid improvement and the implementation thereof means continual and rapid training. According to Schonberger it is important for direct labour and first-line supervisors to be a part of the training from the early stages. This is important for the operator to feel included in the improvement process from the start and that their opinions matter and have the clearest view of the waste that occurs daily because the operators work with it every day. It is also very important for the operators to buy into the improvement program and they often get the most excited about the possible improvements.

c. Process Analysis

According to Schonberger one has to ensure continuous and rapid improvement of a process through continual improvement efforts. There are different ways in which the current processes can be assessed. This includes the following process analysis tools:

1. **Process flow chart:** Tracking the flow of the product through all its steps and activities.
2. **Pareto analysis:** Plot the disturbances in every step of the process flow and determine and select the worst case for further study. This will be discussed in more detail later in this document.
3. **Fishbone chart:** Make the selected worst case the centre of the fishbone chart and the causes thereof the bones that connect to the centre. Connect tertiary cases as bones to the secondary bones. Develop solutions by starting with tertiary bones and moving inward until the centre problem is solved.
4. **Run diagrams and control charts:** Plot the measured data of the most critical characteristics on a run chart or a SPC chart. The SPC chart will be discussed at a later stage in the document.
5. **Scatter diagrams and correlation:** A scatter diagram can be used for continuous improvement of a process. A certain metric can be plotted continually and if a correlation is formed attention has to be given to the process that forms the metric.

Through the use of quality planning and process analysis techniques, a process can be developed that is capable of delivering the designed product on a constant basis. In the past it was believed that the key to the distribution of quality products laid in the inspection thereof, but it was later realised that if the process is executed in such a manner that it does not produce defective products there is no need for excessive inspection.

4.2.4 Other industrial engineering techniques

a. Statistical Process Control

According to Montgomery (2005) statistical process control (SPC) can be used to monitor a system to find ways to improve it. Montgomery describes a system that is in control as a system that continuously produce products with minimal variation that will meet or exceed customer needs and requirements. Statistical process control (SPC) is an assortment of problem-solving tools used to improve process stability and capability by reducing the variability in the system. Among these tools are the control chart developed by WA. Shewhart in the 1920's.

One of the goals of SPC is to detect when assignable causes occur in a process so that it can be acted on and corrected quickly to ensure that the smallest number of nonconforming units are produced. The control chart is a technique used in such cases to monitor the process.

A company can use the information gathered in a control chart to evaluate a process to determine the process performance and its capability. Control charts can also provide information to improve the process.

b. The 5S philosophy

Takasi Osada (1991) developed the 5S philosophy in Japan. The 5S philosophy is based on the following five Japanese acronyms: **Seiri** - organization, **Setion** - neatness, **Sesio** - cleaning, **Seiketsu** - standardization and **Shitsuke** - discipline. The steps of the 5S philosophy intends to improve efficiency, strengthens the company's performance and provide a platform for continuous improvement.

With the implementation of a 5S plan a company strives for a well-organized workplace that provides a safe, clean and efficient production environment. This will lead to an enhanced employee morale, will inspire pride and ownership in their work and the responsibilities given to them.

Table 1 gives a description of the five Japanese acronyms in the 5S plan:

Table 1: Description of 5S philosophy (Randhawa and Ahuja, 2017)

Japanese word	**English meaning**	**Description**
Seiri	Sort/structure/organize	Remove all items that is not needed for current production. Keep the essential items and discard unnecessary items from the workplace.
Seiton	Set in order/systematize	Arrange all the needed items so that they are easy to retrieve and store. A place for everything and everything in its place.
Seiso	Sanitize/shine/clean	Keep everything, the factory, station and equipment, clean every day.
Seiketsu	Standardize	Maintain the high standard of housekeeping described in the previous steps.
Shitsuke	Sustain/discipline	Make a habit of maintaining the correct procedures as described above.

The 5S approach can be applied in any organization because it is simple and easy to understand and implement. 5S is not only a housekeeping process but is a tool that contributes to the growth and development of a company in the long term. It is an essential tool that is required for a company to compete on a global level.

5S provides overall improvements in worker participation, communication within the organisation, teamwork, production, quality, work-flow, safety, maintenance, customer satisfaction, rejections and rework, absenteeism and work environment which leads to increased competitiveness of the organisation. (Randhawa and Ahuja, 2017)

c. The Pareto principle

According to Montgomery (2005), the Pareto Principle originated in the nineteenth-century, when Vilfredo Pareto observed a pattern of "predictable imbalance" where 20% of Italy's population held 80% of country's wealth. Quality engineers observed that defects tend to follow a similar distribution. The Pareto Principle is also known as the 80/20 rule. The Pareto chart was derived from this principle. The Pareto chart is a frequency distribution of attribute data arranged by category. It visually identifies the most frequently occurring types of defects. The causes of defects that has the highest frequency can be identified first. The company can develop a plan to reduce and eliminate the cause of the high frequency defect.

5 INVESTIGATION

This section provides an overview of the investigation at the factory, the information gathered, and observations and deductions made.

5.1 DETAILED PROCESS DESCRIPTION

Given that the activities of all three assembly lines are very similar, it was therefore decided to study Assembly Line A, because it has the highest work content. The table below briefly describes the activities of each station on Assembly Line A.

Table 2: Description of station activities in the factory

Station number	Activity description
Station 1A	Fasten wooden floor panel to the chassis.
Station 1B	Stick Vinyl onto wooden panel to finish the floor panel.
Station 2	Build electrical and plumbing harness and fasten the furniture on the chassis. Furniture is received from the furniture subassembly
Station 3	Lift chassis with a hydraulic lift to fasten the plumbing and electrical harnesses.
Station 4	Secure power pack and make plug fitments.
Station 5	Fix the side panels, made and cut in the panel subassembly, to the caravan.
Station 6	Fix fibre panels to the front and back of the caravan.
Station 7	Fit the lights and fasten the soft fit fibre roof.
Station 8	Fit accessories.
Buffer Zone	Buffer zone to compensate for the unbalanced line.
Station 9	Fit front flap door and accessories.
Station 10	Fit pop-up roof.
Station 11	Finish pop-up roof and side trimmings.
Station 12	Fit accessories.
Station 13	Fit Port-a-potty slide.
Station 14	Lift cassis with another hydraulic lift to finish off the underside.
Station 15	Fit outside side flap doors.
Station 16	Fit side entry doors.
Station 17	Outside cleaning and finishing.
Station 18	Final preparation.
Quality inspection	Do water test and quality checks and fix defects.

The information in Table 2 is based on information provided by the production manager. Figure 7 shows a simplified layout of the stations as described in Table 2.

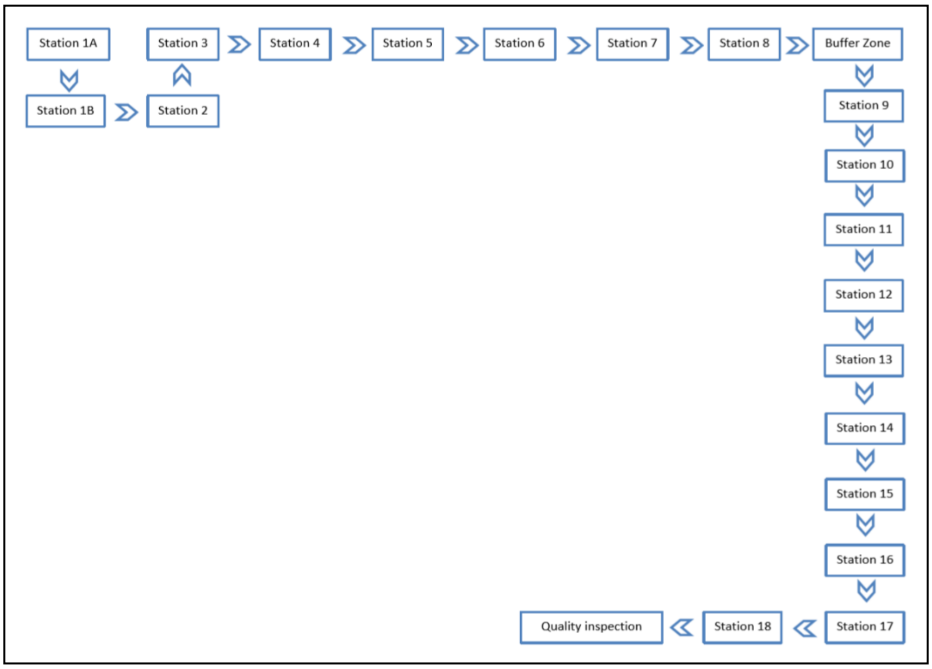

Figure 7: Detailed layout of Assembly Line A

5.2 Unbalanced Cycle Times

Figure 8 shows the results of an initial study on the cycle times of the stations of Assembly Line A. The station numbers in Figure 8 relates to the station numbers stated in Table 2.

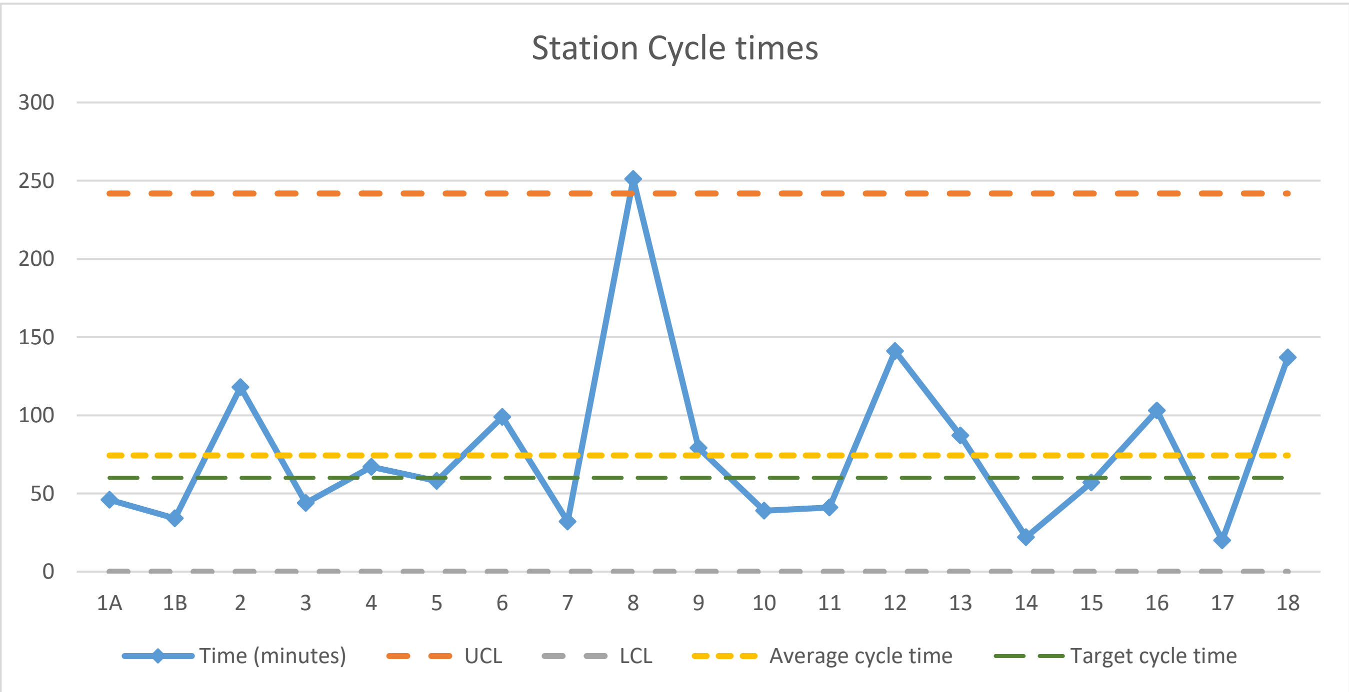

Figure 8: Current station cycle times of the Jurgens Ci factory

Figure 8 shows the lack of balance in station cycle times. According to the production manager, the target cycle time is 60 minutes. The graph shows a large amount of variation in the cycle time, one of the points falls outside of the upper control limit at station 8. This means that the activities of station 8 takes much longer than any of the other stations and this causes a bottleneck at station 8 and idle time at the subsequent stations. Station 8 fits the accessories on the caravan. The unbalanced cycle times causes bottlenecks, stoppages and idle time at other stations in the process.

5.3 REVIEW OF QUALITY INSPECTION STUDY

During the study of Jurgens Ci's quality inspection area, it was found that the worker inspecting the finished products and repairing the defects, must also fill out the quality inspection sheet. Appendix B holds an example of this sheet. Filling out the sheet takes up a lot of time. The quality inspector collects the sheets and files it, but no system is in place to process the data that could be deducted from the continuous quality study of the manufacturing process.

After a study of the quality inspection sheets that were available, information was gathered through the analysis. Figure 9 shows the areas affecting the quality aspect of the finished products the most. The categorization of the study of the quality inspection area was done according to Ishikawa's 6M's of production - machines, methods, materials, measurements, Mother Nature (environment) and manpower. (Juran and Godfrey, 1999)

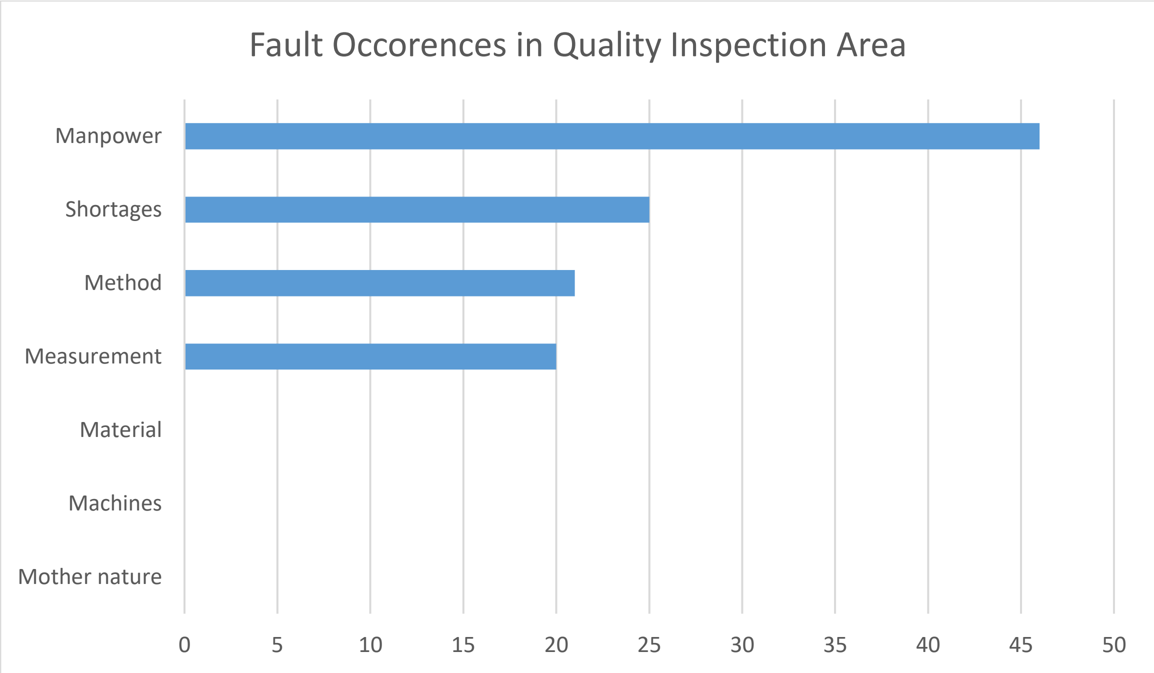

Figure 9: Frequency of fault occurrences

None of the problems could be categorized as material (which would be faulty material for example), machines (machine malfunction for example) or Mother Nature (environmental influences). These categories will therefore not be discussed in depth.

The biggest problem lies with the manpower, or in other words, the workforce. The assembly process consists mostly of manual labour and the nature of the work allows a lot of room for human error. About forty percent of the problems fell in the manpower category.

The problems caused in the method category was due to poor handling of the products and poor execution of the assembly process. Problems in this category occurred about twenty percent of the time in the sampled study. This indicates a big problem in the handling area and much room for improvement. The problems caused in the measurement category occurred eighteen percent of the time in the study. This includes parts not fitting as it should due to poor conformance to specifications.

The last problem category was shortages, which occurred twenty-two percent of the time in the study. This is not part of the 6M categories but was one of the largest problems Jurgens Ci was faced with. The shortages of parts occurred throughout the entire factory and not just the assembly lines. This means that some of the subassembly stations had shortages that affected the main assembly lines. The shortages are mostly due to the financial crisis the company is currently in. The company is not paying their suppliers on time and the suppliers don't trust them to pay them in the near future.

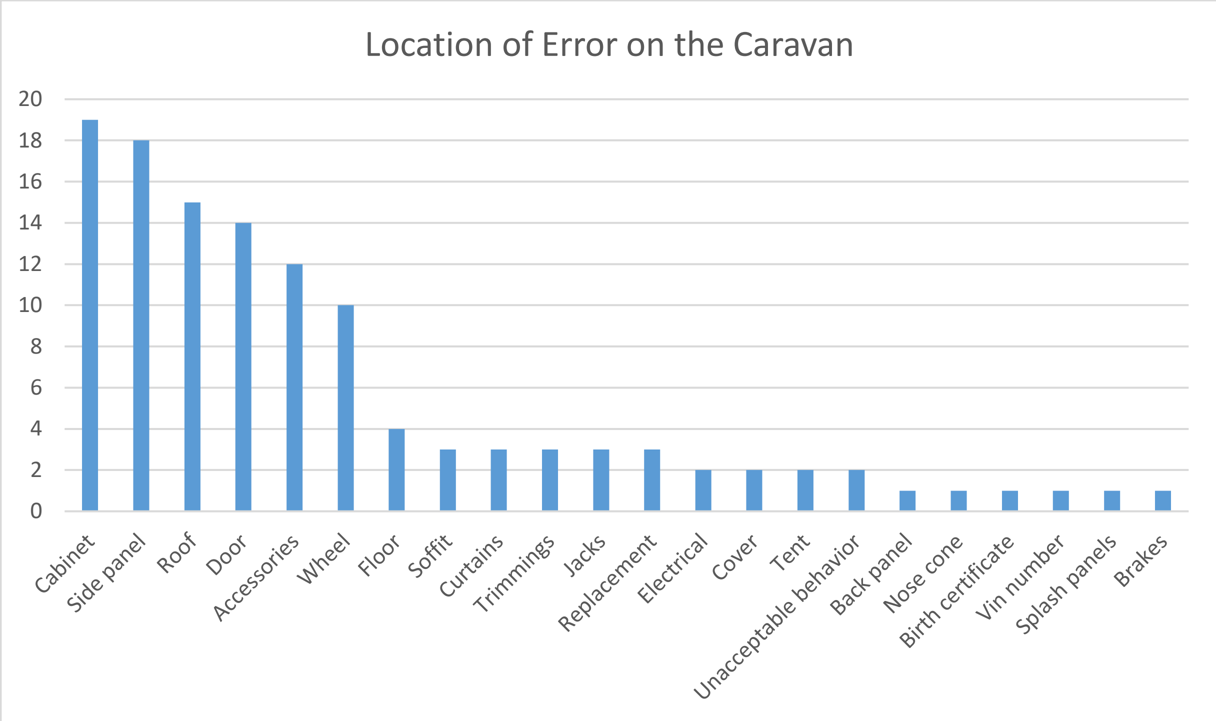

Figure 10: Error location graph deducted from quality sheet study

Figure 10 shows a frequency graph of the errors, defects and/or nonconformities picked up during the analysis of the quality sheets collected at the quality inspection area. The first two problem areas are already more than thirty percent. Consequently, if an improvement effort is made that only focus on the improvement of these areas, there will be an immense improvement in overall quality. The cabinets and side panels are both made and assembled in the factory as subassemblies. This means that a delay in these subassemblies impacts the main assembly line and that if defects and errors that occur in the subassembly area it, gets transferred to the main assembly line and finished product.

Figure 11 below shows a diagram of a typical Jurgens caravan. The highlighted areas are all part of the furniture of the caravan. Each model differs but the main components stay the same. The biggest problem at the time of the study originated in the cabinet subassembly. This subassembly area makes all the furniture. The wood is cut to the needed specified size, the different pieces of furniture is assembled and then it is fastened to the caravans on the assembly line.

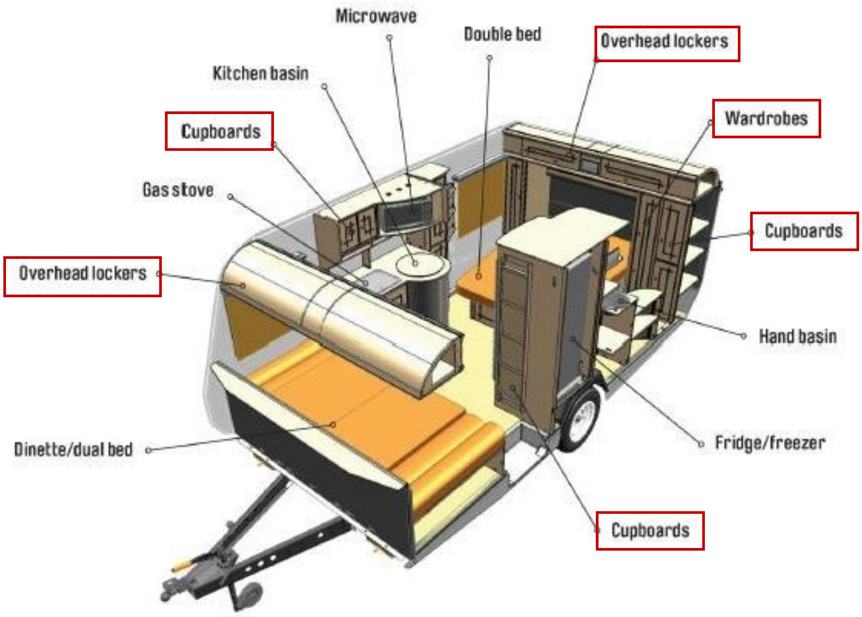

Figure 11: Diagram of a Jurgens caravan

5.4 CHRONIC WASTE

Due to the slow production, the investigation focussed on chronic waste. The aim is to identify wasteful activities that are built into, and which are part of the fundamentals of the product design and the manufacturing process. The following sections show the results of further studies at the factory and its processes.

5.4.1 Product design problems

Seemingly, the company possesses no detailed drawings of the products, as the student was unable to uncover any during the execution of this project. This is extremely troubling, because a lack of technical drawings implies a lack of prober design, which implies that production does not know to which standard the product must be produced.

5.4.2 Process design problems

a. Quality inspection of incoming stock

It also became apparent that, currently, Jurgens Ci has no proper system in place to check the stock received from suppliers for conformance to quality standards. This leads to stock being rejected at a later stage, such as processing in the subassembly. This affects the production rate and increases the financial strain on an already struggling business.

b. Interdependence leading to bottlenecks

The current assembly process is under a lot of strain due to the fact that it has to wait for parts from the various subassembly areas. The parts that are sourced from the subassembly areas do not meet the specifications every time and then the assembly team has to adjust the part or is has to be sent back to the subassembly area for adjustment and in the worst cases be scraped and new parts have to be sourced.

c. Quality inspection system

The quality inspection system Jurgens is currently implementing is paper based. The operator at the quality control station at the end of the line has to fill the sheet with the problems, defects and shortages of each caravan in by hand and this gets filed and are seldomly looked at again.

5.4.3 Overall observations

a. Method

During the initial investigation of the process it was striking how cluttered the general factory was. There were obvious signs that very little attention is payed to keeping the factory neat, clean and in order. Parts and subassemblies piled up in the walkways, the dustbins were overflowing, and tools and parts were in disorder at the stations.

There were visual management system boards and 5S boards present in the factory, but it was underutilised, outdated or completely unused.

b. Manpower

Jurgens Ci had to employ a lot of freshman recruits in the factory after the labour strike in 2017. According to management the new recruits has not undergone the proper training and most of the new recruits has not received detailed standard operation procedures for the tasks assigned to them. The inexperienced workers tend to make unnecessary, avoidable mistakes that cause nonconformities.

A lack of accountability exists along the process because they only pick up mistakes and nonconformities at the end of the process at the quality inspection area. The workers do not take responsibility and are not held accountable for the mistakes made.

c. Storage and shortages

Currently, Jurgens Ci has large amounts of redundant stock in the warehouse that is left over from discontinued models and have never been sold or sent back to the supplier to be repurposed. This must be used or cleared in order to overcome the storage problems. This will allow them to make storage space available and to purchase the stock needed to finish the caravans systematically so that those products can be sold to generate cash flow. If Jurgens Ci generates enough cash, they can start to pay off the dept of suppliers and then the suppliers will allow them to purchase the stock needed and to build healthy relationships with the suppliers. When the company has built healthy relationships with the suppliers, they can start to investigate the possibility of implementing a JIT (just in time) production process. JIT is a system in which parts and materials are delivered immediately before it is required in order to minimize storage costs.

During the initial observation period shortages of some critical parts worsened the imbalance of the station cycle times. According to the line manager, the part shortages are due to current financial issues the company is facing.

6 RECOMMENDED SOLUTIONS

From the observations made at Jurgens Ci it is evident that they suffer from chronic waste that is imbedded in the product and process design.

6.1 RE-ESTABLISH CUSTOMER NEEDS

As the popular saying goes: "The customer is always right." This has to be incorporated in the development of new products, specifications and processes. Jurgens Ci has to revise the needs of their customers in order to get the right perspective on the current products and the products that the customers would like to have enter the market. This can also help the company to restrict their product range. The wide variety the company is currently producing contributes to the challenges they are facing due to more parts, raw material and resources necessary to obtain the right parts as needed for the different products. The exact determination of the customer needs will help Jurgens Ci to execute the technical drawings of the different caravans and determine the specifications and tolerances of the parts. The clearly defined needs of the customer can also assist the caravan designers in the standardization of parts across the product ranges.

6.2 REDESIGN PRODUCT

The overall number of parts can also be reduced through standardization across the different product ranges. This will allow Jurgens Ci to buy fewer parts in larger quantities leading to lower costs and more supplier options. The redesign of the products will also permit Jurgens Ci to create the right product specifications and tolerances that both meets the customer's needs and falls within the capability of the operating forces and the manufacturing process. The redesign of the products also has to focus on the manufacturability of the product and the flow of the product through the assembly process.

6.3 REDESIGN PROCESS

The standardization of the process is of utmost importance. The workforce has to have standard operation procedures to ensure that the operators know exactly what has to be done at each station and step in the process. This will increase accuracy and quality and decrease human error, which is the leading cause of quality problem in the Jurgens factory. The standard operating procedures has to be accompanied with thorough training of all the operators to ensure that human error does not occur due to a lack of knowledge in the tasks at hand.

Balancing the cycle time is one of the ways to improve the flow of production throughout the assembly process and decreasing the idle time of certain stations. (Becker and Scholl, 2006) The balancing of the station cycle times will allow for a fixed production rate which can ultimately lead to the achievement of the targeted daily production rate of 7,1 caravans per day.

Quality checks can also be done throughout the manufacturing process to ensure that defects and nonconformities are addressed before the product gets to the end of the line. This will reduce the time that quality inspection on the finished products take. This can be done by adding quality inspection areas in the process, for example in the buffer zone or before a bottleneck. This will reduce the nonconformities and defects that reach the final quality inspection area, which means more finished products can processed more easily.

6.4 SUPPLIERS

Jurgens Ci can look to source most of the currently manufactured subassemblies from outside suppliers. This will decrease the interdependencies within the factory, relieve the pressure on the internal supply chain and with the right supplier, it can assure good quality parts. This will allow the Jurgens factory to focus on the assembly of good quality products. The 10 Principles for supplier relationships has to be kept in mind as discussed earlier in this report.

6.5 OPERATIONS AND CONTROL

The implementation of the 5S philosophy, as discussed in the Literature Review section, can easily be implemented throughout the factory. This will ensure a positive, clean working environment and will have an encouraging effect on all operators and employees.

The current manual quality inspection process and be replaced with an electronic quality monitoring system. A spreadsheet with which the operator can just log the caravan and select out of a pre-existing list of common defects, problems or shortages or other for each caravan that passes through the quality inspection area. This then updates a graph that shows the frequency of the occurrence of a certain problem. The problem emphasised by the graph can then be addressed by management. Such a quality management system will keep accurate, up to date data of the quality status of the products produced and it will reduce the time spent by the quality inspector on the administrative part of the inspection process.

7 CONCLUSION

Evidence gathered during the project shows that Jurgens Ci is in desperate need of a total quality evaluation and improvement that focusses on chronic and sporadic waste. If the company wants to remove the chronic waste, which is the largest priority, the company needs to invest in a quality improvement plan. The implementation of the recommended solutions discussed in the previous section will have an extensive positive effect on the quality of the products produced in the factory. Starting with clearing up the needs of customers and working through the redesign of the products and the process, can significantly improve customer satisfaction and reduce the defects and nonconformities produced. Through the investigation of outsourcing and supplier options Jurgens Ci can find suppliers and build relationship to ensure the supplied material and parts are of good quality and is delivered when it is needed. Investment in an electronic quality control system will assist the company to analyse the data from the quality inspection department which will enable them to react to recurring problems. This will allow them to continuously improve their products, process and customer satisfaction.

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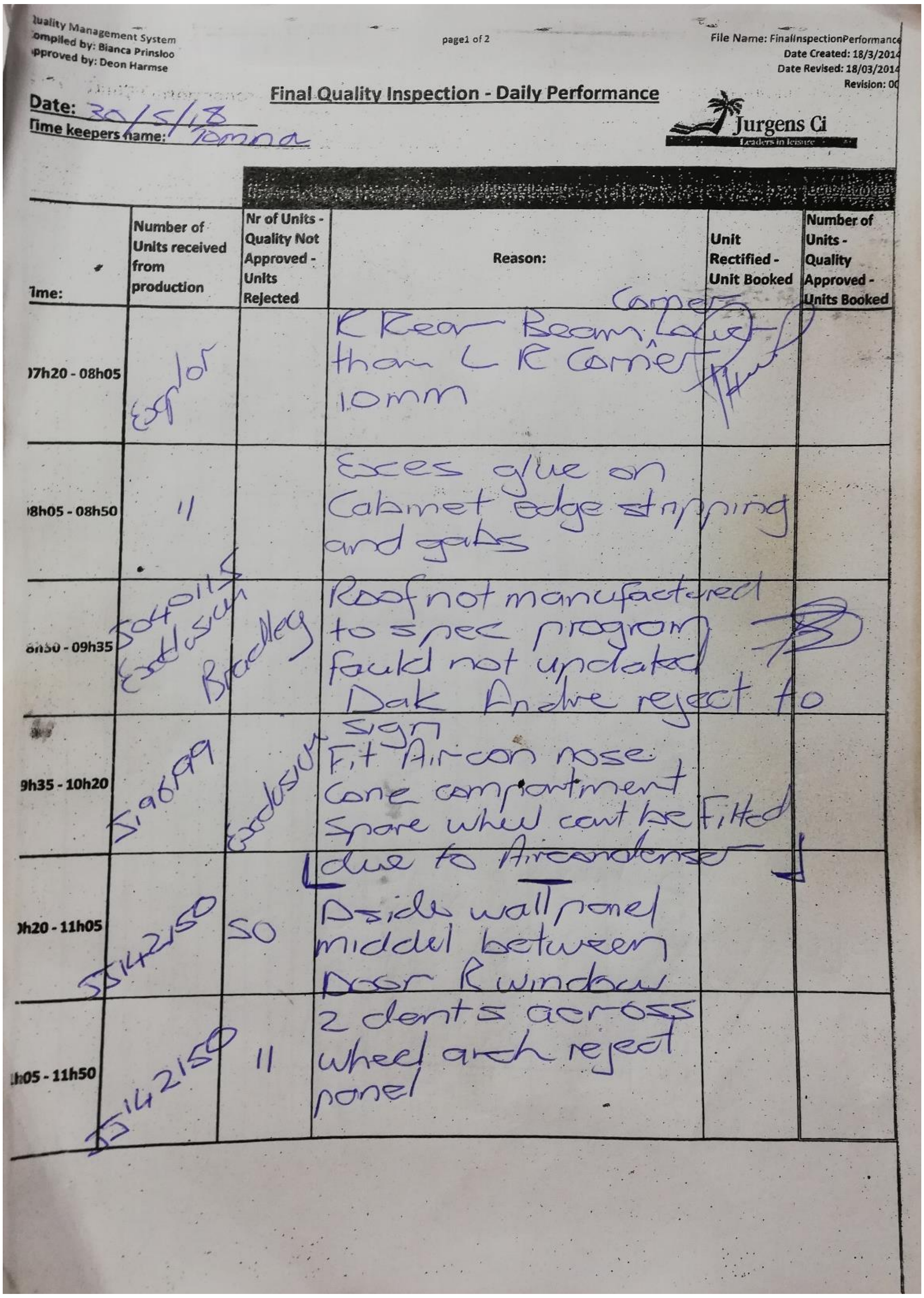
APPENDIX B



Quality Management System
Compiled by: Bianca Prinsloo
Approved by: Deon Harmse

page1 of 2

File Name: FinalInspectionPerformance
Date Created: 18/3/2014
Date Revised: 18/03/2014
Revision: 00

Final Quality Inspection - Daily Performance

Jurgens Ci
Leaders in leisure

Date: 30/5/18
Time keepers name: Tomna

Time:	Number of Units received from production	Nr of Units - Quality Not Approved - Units Rejected	Reason:	Unit Rectified - Unit Booked	Number of Units - Quality Approved - Units Booked
07h20 - 08h05	Esp 105		R Rear Beam Lower than L R Corner 10mm		
08h05 - 08h50	11		Exces glue on Cabinet edge stripping and gabs		
08h50 - 09h35	504011 Exclusion	Bradley	Roof not manufactured to spec program fauld not updated Dak Andre reject to sign		
09h35 - 10h20	516999	Exclusion	Fit Aircon nose cone compartment Spare wheel cant be Fitted due to Aircondenser		
10h20 - 11h05	5514215	50	Aside wall panel middel between Door R window		
11h05 - 11h50	5514215	11	2 dents across wheel arch reject panel		

Figure 12: Example of Quality inspection sheet

INDUSTRY MENTORSHIP FORM

Department of Industrial & Systems Engineering
University of Pretoria

Final Year Project Mentorship Form
2018

Introduction

An industry mentor is the key contact person within a company for a final year project student. The mentor should be the person that could provide the best guidance on the project to the student and is most likely to gain from the success of the project.

The project mentor has the following important responsibilities:

1. To select a suitable student/candidate to conduct the project.
2. To confirm his/her role as project mentor, duly authorised by the company by signing this **Project Mentor Form**. Multiple mentors can be appointed, but is not advised.
3. To ensure that the **Project Definition** adequately describes the project.
4. To review and approve the **Project Proposal**, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable.
5. To review and approve all subsequent project reports, particularly the **Final Project Report** at the end of the second semester, thereby ensuring that information is accurate and the solution addresses the problems and/or design requirements of the defined project.
6. Ensure that sensitive confidential information or intellectual property of the company is not disclosed in the document and/or that the necessary arrangements are made with the Department regarding the handling of the reports.

Project Mentor Details

Company:	**Jurgens Ci**
Project Description:	Define, analyse and make improvement suggestions on the quality standards and systems available at Jurgens Ci.
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Student Signature:	
Mentor Name:	**Willie Lundall**
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