

Cristallo Motorcycles



1. Introduction

Cristallo Motorcycles is a successful small manufacturer of specialist motorcycles with two factories: one in Seattle serving the USA market and one in Dunmurry, Northern Ireland for the UK and European market.

In 2019 the company was producing about 1100 electric-motorcycles per year, the company has always had a good reputation amongst enthusiasts. However, there are a number of concerns about quality. The number of customer complaints has been consistently high: 30% of customers complain, with 5% making a “serious” complaint. In addition, there are quality control problems within the factory: during the quality control tests, many faults are identified, and additional work is needed before the motorcycles can be dispatched to customers.

In response to a significant rise in current and forecasted demand, the company went to a “twenty-four seven” production cycle in 2020 – introducing three 5-day-a-week day shifts and three 2-day-a-week weekend shifts. However, the expected production capacity of 4500 electric-motorcycles per year was not achieved. The quality issues have been compounded by absenteeism rates in some core functions of production. The Human Resource Director has been collecting data on absenteeism on the three shifts in 2020. This increases costs and also the delivery time.

Cristallo Motorcycles need to solve their quality problems. The first step is to diagnose them and identify the possible sources of the complaints and faults. The Production Director and the Human Resources Director have been monitoring the situation and collecting data. The second issue is to get a handle on absenteeism and to improve overall conditions in the manufacturing plant.

It is essential that the company successfully identifies issues and develops a workable strategy for dealing with core problems. The Marketing Director has noted that there is increasing demand for electric-motorcycles that shows no signs of levelling off over the next few years. The company seeks advice about possible approaches to sustainably increasing capacity.

2. The production processes

Cristallo Motorcycles currently has 4 production models:

- **Comici**
- **Delgard**
- **Rossi**
- **Torre**

These models have many similarities, sharing the same basic frame. All production follows five build stages:

1. **Build Frame**, creating the basic structure for the e-motorcycle
2. **Power Systems 1 and 2**, installing the electrical battery and transmission system; there are two distinct power systems requiring specialist equipment and skills to install
3. **Steering & Suspension**, adjustments to the steering and suspension system to accommodate frame and power system
4. **Fittings**, adding wheels, brakes, lights, controls, mirrors, straps, storage compartments, marketing materials and any of a number of add-ons from the options list
5. **Quality Check & Fix**; the motorcycle is checked, including time on a moving road; minor faults are fixed at this stage but major problems usually involve the motorcycle having to be "reworked"

Each stage of production takes place at a work stations with dedicated equipment and skilled staff. The number of workstations for each stage reflects the time required to complete the different tasks. However, the time for each stage varies considerably. Some of this variation might be attributable to the fact that different components are used, dependent on the model of motorcycle. But most of the variation in time seems to depend on the characteristics of the staff: some being rather slow. The quality of their work might be high but their work rate is often poor.

Table 1 includes the mean time for each stage, based on a study of a sample of 50 **Comici** motorcycles in January-February 2019.

Stage	Number of workstations	Time	Utilisation
Build frame	5	7.9	87%
Power system 1	5	12.5	99%
Power system 2	3	----	80%
Steering & suspension	3	5.0	89%
Fittings	2	3.0	82%
Quality check & fix	1	1.6	82%

Table 1 Workstations and team utilisations (from a study in December 2019)

It is thought the timings for other models should be similar; the more recent data included in the quality data set (excel file supplied) should confirm the timings.

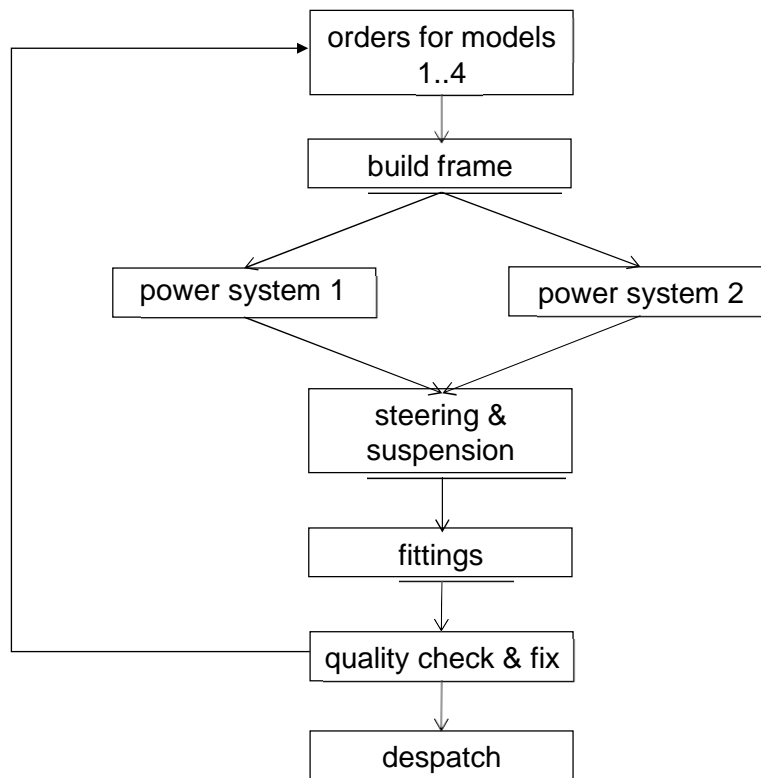


Figure 1: The Production Process

The production flow ([Figure 1](#)) involves assembling a number of large components delivered from a number of suppliers. Different components are often used for each model.

Between these workstations there is limited space to store partially completed motorcycles. Most workstations have space for 2 motorcycles to “wait” (so the three “steering & suspension” workstations have a total space for 6 partially built motorcycles). The only exception is for reworked motorcycles’ these can be stored outside before being brought back in to repeat the production process: there is no practical limit to the number that can be stored outside.

3. Staff and shifts

Each workstation has a specialist small team of workers. For maximum throughput each workstation needs 4 people, but they can operate with a minimum of 2 staff in each workstation team, with reduced production.

In 2019, the factory worked a single shift pattern of 09:00-17:00 each day, Monday to Friday. Production stopped at weekends and also for 2 weeks annual holidays over the Christmas/ New Year period. There were some arguments about workload over the last year and a recent Human Resources study confirmed that there seems to be a substantial variation in workload, as summarised in [table 1](#). Ideally the mean staff utilisations should be about 80-90%: if it's too low additional costs are being incurred; if too high the stress on the staff is too great and quality may be affected.

In 2020, the new change to 24-7 working took place. The HR Director was put under pressure to recruit new staff, develop some HR analytics that will help to identify issues that need improvement, and make the 24-7 strategy sustainable. The shifts the plant runs are shown in [table 2](#):

Weekdays	Weekends
Monday to Friday: Day – 7am – 3pm Swing : 3pm – 11pm Night: 11pm – 7am	Saturday, Sunday Day – 7am – 3pm Swing : 3pm – 11pm Night: 11pm – 7am

Table 2: Shift Patterns

4. Quality and production concerns

Data are provided (see [quality 2019.xlsx](#)) describing the production of 1069 motorcycles during 2019. The quality score is that awarded when the complete motorcycle is first checked, before any faults are fixed. The mean quality score is 86 but there is much variability. Minor problems are resolved as part of the “quality check & fix” stage. However, sometimes (approximately 3%) more major work is needed and the order has to be “reworked” from the beginning, disrupting the production process and incurring substantial extra costs. It can be assumed that the times required at each stage when an order is reworked are similar to those for a new order: sometimes the motorcycle is scrapped and a whole new motorcycle is constructed.

The data also record the customer complaints, coded as:

0	no complaint
1	minor complaint
2	significant complaint requiring some work at a garage
3	serious complaint often requiring the motorcycle to be returned to the factory

The company has some ideas, with suggestions that the quality problems could arise from various sources. Different directors have their personal views and some of their comments are noted below:

- Marketing Director: “The model is important; Torre customers have higher expectations and tend to complain more”

- Purchasing Director: “We seem to have more problems with power system 1. I think we should only use power system 2. OK these power units are more expensive and it would reduce our profits, but I think it would be worth it to fix our quality problems. It has been suggested that all of our quality problems will go away if we provide all staff with better quality training. I have authorised an experiment and we have some results that we will need to explore. Personally, I think our quality issues need something more than just a new approach to training.”
- HR Director “It has been suggested that we try to manage the staff’s performance more rigorously and reduce production time. But I’m worried about this PMS idea. I think we have to understand issues with absences before we start to put more pressures on the workforce.”
- Production Director: “We are seeing absences on some key elements of the production, sometimes we are seeing more than one person absent on a key process per shift. We need to find a way of balancing workload and getting all of our tasks done if we intend to ramp up output.”

Despite the quality concerns, demand for Cristallo Motorcycles is high and it would be advantageous to increase capacity. One possible approach to increasing capacity is to set stricter targets for the assembly times. The current times are highly variable: the workforce are given a lot of freedom with no real performance management. It has been suggested that a stricter performance monitoring system (PMS) should be introduced and applied to each stage of production. It is thought that using PMS on any stage should ensure that all workers complete the activities of that stage in similar times to the best 50% at present; it is claimed that this could produce a reduction of 15% in activity timings on average.

5. Demand and waiting lists

Although the USA and Irish factories use the same designs and equipment, they operate independently as separate profit centres: each tries to satisfy its own demand. The production capacity of the Irish factory is not quite sufficient to meet the European demand. Data from year ending December 2019, indicates that 1069 motorcycles were produced (another 33 were partially completed). At the start of December each year, the orders are reviewed and those which cannot be completed by the end of the year are supplied from the USA factory which has some spare capacity, but at considerable expense. Some customers had to wait many weeks to have their motorcycle built and delivered.

Table 3 summarises the orders for 2019 but there is some evidence of increasing demand.

Model	Orders
Comici	416
Delgado	405
Rossi	186
Torre	178

Table 3: Bike Orders 2019

6. Proposals for increasing capacity

The company directors have made various proposals to increase production capacity:

1. There is money and space to invest in new capacity. The question is, would it be better to train the workforce to improve their quality output on the current workstations, or should an investment in new capacity be made? Four new workstations (with extra storage space) could be built and staff recruited. If so, where would it be best to invest in new capacity?
2. Reducing the production times with the stricter PMS.
3. Adopting an “embedding quality” initiative: this involves more quality control checks during each stage, taking an extra 30 minutes at each. But it should reduce the amount of rework to 1% which could help increase the effective capacity.

The Business Analytics Task

Examine the company data provided in the file [quality 2019.xlsx](#). This is a workbook with a number of pages, describing production for 2019, giving order data, the current quality scores, information about complaints, production details on the old workstations, training details (before and after quality scores), and Human Resources Management information of the workforce.

Produce descriptive summary statistics and graphics describing what has been happening in the production side of the company and in the Human Resources side of the company (addressing the observations given by the management team). Scrutinize your graphics for interesting patterns and analyse the possible factors that might influence the quality scores, absences from work and complaints. Some have been identified above but you may consider additional factors.

In your report you must use a range of hypothesis tests, including at least one each of:

- parametric test comparing a change of means in samples
- a t-test
- a non-parametric test

Develop insight for the company on how things are going as of now in terms of quality, complaint and Human Resource issues. Then develop advice on how to combine the results from your Production and HR analyses to recommend possible management actions. Particularly, consider whether to keep things as they are, any expansion options, or any other improvement options that will help with coping with the increased demand.

Be sure to reference the evidence you have developed in justifying the advice you give.