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TranLogic Dynamic Testing Facility Delivery Problems: A Case Study

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Abstract

The Dynamic Testing Facility is a division of the TranLogic Freight Rail Division within TranLogic Pty (Ltd), and provides component testing to other divisions tasked with implementing new components in the railway system. Records over 2003 – 2007 show a steady increase in the number of tests delivered to customers after the promised date. In this report, the background to the facility is provided, extensively detailing the processes and relationships between the resources involved in the process. An analysis of the root causes for the late deliveries shows that the lack of training, and ineffective management were amongst the greatest reasons for the late deliveries. Recommendations for improvement included more active accountability of all resources, enforcement of standard operating procedures, and technical training for each resource specific to their tasks. Quick wins identified to drive these improvements included the implementation of KPI's for each resource, improvement of storage methodologies, and agreement of standard service levels with partners.

Keywords
Delivery problems, operations research, operations management

1. Introduction

Background

The Dynamic Testing Facility (DTF) is a division within the TranLogic Freight Rail Division (TFRD) of TranLogic Pty (Ltd); TranLogic a rail logistics company in South Africa. The DTF was established in 1997 with the sole purpose of providing the component testing and quality assurance for all new components used in the rail system. Most of DTF customers are also divisions within the TFRD – including the following: Bogies Technology, the Couplers and Draw Gear, the Wheel / Rail Interaction, Brakes Systems, Wagon Design, Overhead Power Supply, and Electrical Infrastructure. The Bogies Design section is responsible for ensuring that all bogies have good stability on curve performance i.e. all bogies should adhere to the group specification. Components tested at the DTF include primary suspension springs, secondary suspension rubbers and koni hydraulic dampers. The Couplers and Draw Gear section is responsible for designing and writing technical specifications for couplers and draw gears used for coupling locomotives and wagons. The DTF strain tests the draw gears and coupler components for the section.

The Wheel / Rail Interaction section is charged with the responsibility of developing the grinding strategy for consistently acceptable rail conditions. The section ensures that there is no train derailment in all TranLogic Freight Rail Divisions. The DTF helps the section by performing various tests on welded rails, including bending tests, tensile tests and compressive tests. The Brakes Systems section is responsible for designing and maintaining all brake types used in the railway environment. See appendix C, figure 13. the figure shows the set-up test for vesconite bush fitted in brakes mechanism. The types of braking systems that are used are vacuum, hydraulic, and electrical, and for each of these components, the DTF performs tests such as brake shoe tests, brake pipes bending tests and vesconite bushes plastic tests. The Overheard Power Supply section designs and constructs the overhead direct current lines for supplying electrical power to the locomotives. The DTF tests the mechanical loading capabilities of the conductors and structures that support these lines. Furthermore, the DTF also test the springs that pushes the overhead line conductors against the pantograph. The Electrical section designs and installs the antennas and ventilators used in the locomotives. The DTF performs the impact and vibration tests on the equipment to ensure that they don't fail when in service. Although each of the divisions is able to approach external vendors for such services, the DTF provides more favourable pricing, and is an accredited testing centre. On occasion the DTF also receives orders to perform tests on specimens from other large industrial companies. See appendix C, from figure 9 to figure 14. All figures show the types of tests and set-up for selected components.

Facilities

The facility's load frames are limited in components size and cannot accommodate complete wagons. The lifting capability of the overhead crane is limited to five tons. It is for this reasons that the facility cannot perform tests on complete wagons. Wagons are tested in the other competing facility within the group. The facility also has a mobile crane with a capacity 2 tons. The facility has a total of eight actuators. These actuators can be used individually or in a test group. The number of and manner in which actuators can be grouped is limited by the electronic controllers as well as by physical constraints. See figure 9 in appendix C, which shows the two actuators used at DTF in groups to test the cross anchors. Cross anchors are used in MK IV bogie type to assist in curving performance. The servo-hydraulic equipment has limitations such as the amount of force that can be applied by each actuator, the frequency of load application and the displacement of each actuator. All the divisions are situated in close proximity to the DTF facilities

The Organizational structure of the DTF

The DTF Operations Manager has been with the division for two years, and has been with TFRD for seven years. Four employees are permanently assigned to the facility, namely the Engineer, Technical Supervisor, Engineering Technician and the Workshop Assistant. Cleaning services are provided by a contracted company. The organogram for the DTF is as provided in Figure 2. The DTF has a very high staff turnover which began in 2004 with the resignation of the previous Operations Manager, followed by the resignation of the Engineering Technician in 2005. Reasons cited for leaving were mostly financial in nature, as well as better work opportunities. The Engineer, although relatively junior, is the next highest rank below the Operations Manager, and is responsible to coordinating the day to day activities of the facility given that the Operations Manager also manages the Mechanical Projects, Vehicle Dynamics and RSTDC divisions. The longest serving employees in the department are the Technical Supervisor, and the Workshop Assistant who reports to him. Both have been with the DTF for longer than ten years. The Technical Supervisor currently reports to the Engineer who has been at the department for a year. The Engineering technician is at the same level as the Technical Supervisor and has been working at the DTF for one year.

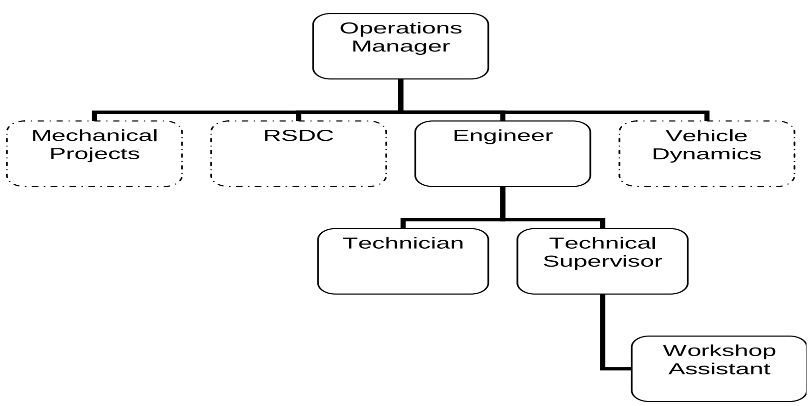

Figure 1: DTF Organogram

Process Test request procedure

Although the formal test request procedure requires that test requests are routed to the Engineer, but test requests are often received by any of the DTF representatives i.e. the Operations Manager, the Engineer, or the Technical Supervisor, verbally or via email, from an engineer in charge of testing within the client organizations. On receipt of the request, a Test Request Form (Appendix A) is forwarded to the customer for completion. The customer returns the completed form to the DTF representative, who is able to make an assessment of the test requirements. Within the form, the customer is required to provide a number of key information items. The client must specify whether the jig to be utilized for the test will be provided, retrieved from DTF storage from previous tests, or designed specifically for the test. In addition, the client must specify whether instrumentation of the specimen is expected to be performed by them, or by the DTF. The client indicates if the DTF data acquisition equipment will be used for recording; the DTF has data acquisition capabilities for 32 differential channels and data can be recorded at frequencies up to 333 kHz. Otherwise the client provides his/her own data acquisition.

Any queries by the DTF are clarified telephonically or over email, but if this is inadequate, a meeting is arranged between the DTF representative and the client; these meetings are often attended by the Operations Manager. After all the information is obtained from the client in writing, the DTF representative then provides the soonest available fixed test date booking and test duration in writing to the client. This estimation is based on past DTF experience on similar tests. In addition, the following dates are documented and agreed with the client:
The date that the test specimens must be delivered and available at the facility;

- The date that the instrumentation of the test specimen must be commenced with at the DTF;
- Date that the specimen test set-up will be performed;
- Date the first preliminary test (shakedown) will be performed;
- Date of commencement of each test series; and,
- Duration of each test series.

The client is then required to accept these test dates in writing – in the event of a dispute with the proposed test dates, the Operations Manager negotiates the dates with the line management on the client side. Clients are charged per hour, based on the time taken to perform the test as agreed on the form. No later adjustments are made to the dates after agreement; no extra charges are levied on the client for any delays regardless of the delay reason. For each test, the client is also required to provide a test specification, which details the following:

- Description of physical test set-up;
- Description of manner in which load should be applied to the specimen. This includes the actuator application positioning as well as the load and/or displacement profiles required;
- Instrumentation required per test – e.g. strain gauging locations, displacement and/or force measurements required.
- Number of test cycles per test;
- Specifications on when measurements or data recordings must be taken. For example, every 10 000 cycles or continuously;
- Necessary calculations for the test to be conducted;
- Intervals at which visual inspections of the specimen should be performed;
- Any safety considerations that DTF staff should be aware of; and,
- What emergency action should be taken in the event of a crack / deformation by the DTF staff should the client not be available.

If a test specification is not available then the test request is delayed – all test specifications must be written and approved by the Very Important Technology (VIT) department, within the client business unit. In order for a test to commence, the Test Request Form must be signed by the client, and must be approved by the Operations Manager.

Specimen set-up jigs
Jigs utilised previously, are stored within the DTF facility, and where the form indicates the use of an existing jig, the jig is expected to be available in storage. The search for jigs is the responsibility of the Technical Supervisor. If the form specifies that a new jig is required for the test, the client is required to design a jig. The jig is normally manufactured within the in-house Machine Shop and only outsourced to external vendors where the urgency requires it, at a considerably higher cost to the client. The client is responsible for sourcing the jig manufacture materials, and delivering these to the Machine Shop. Where in-house manufacturing is utilised, construction is supervised by the client. The speed of completion of jig manufacture is dependent on the time taken to find the correct jig set-up materials within the workshop as well as the amount of work already scheduled in the machine shop. All jigs ultimately belong to the client, but can be stored at the DTF when requested by the client.

Instrumentation
Each specimen is required to be instrumented for each test; this is usually conducted in parallel with jig design and manufacture. Instrumentation often involves a specialised welding method, where the DTF is often assisted by the

Rolling Stock Test and Development Centre (RSTDC). In the event that this is not possible, the client is requested to make further makes arrangements with an external vendor. Correct instrumentation is critical to the success of the test, such that if the incorrect instruments are used, or the instruments are attached incorrectly, incorrect results will be reported, and the test must be reinitiated. Only when instrumentation is complete and the test jig available can testing begin.

Testing

Test set-up is conducted by the Technical Supervisor and the Workshop Assistant, and involves the physical setting up the test specimens, and the instruments. Testing is conducted using a Material Testing System (MTS), which automatically runs all preprogrammed tests. The Engineering technician is provided with all the test documentation, and conducts pre-testing procedures which involve configuring the application for the test, ensures the test is completed, and forwards the results of each test to the engineer. On receipt of the results, the engineer processes the results, and issues the test certificate, as well as the test report for the client where required. Both test certificate and report are forwarded to the Operations Manager, who forwards them onto the customer. This process is illustrated in Figure 3 below, and the information flow within the process is detailed in Figure 4.

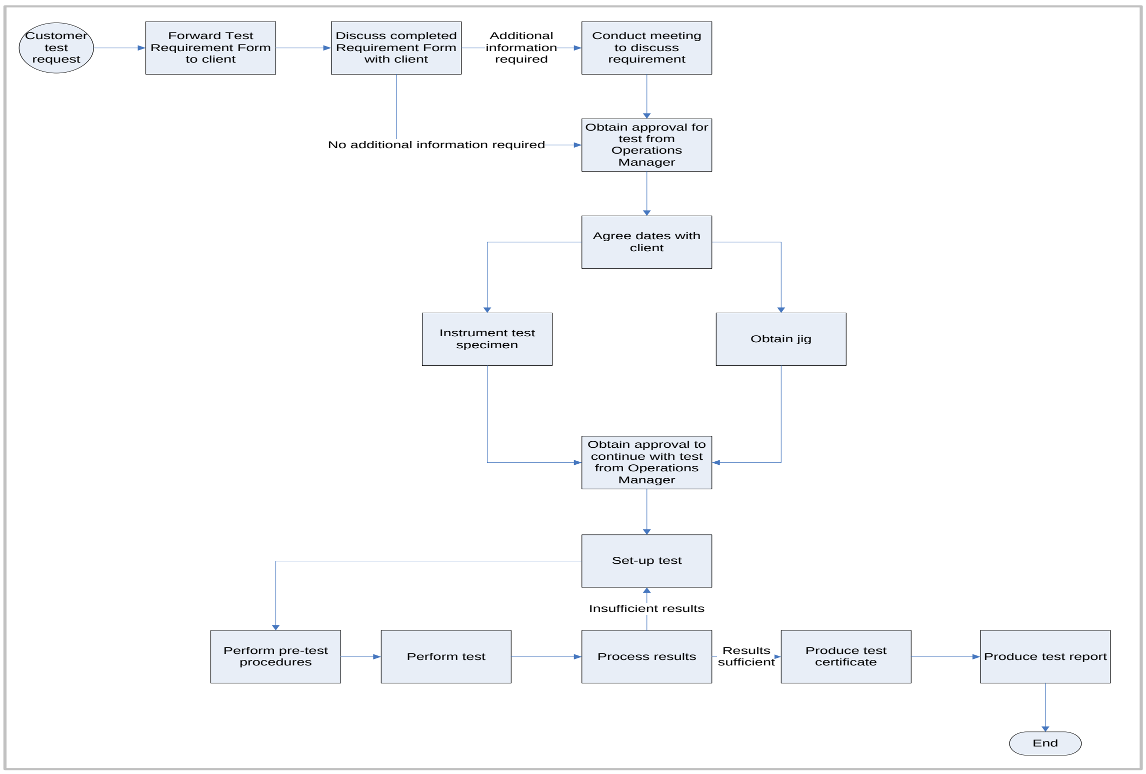

Figure 2: Process Flow Diagram

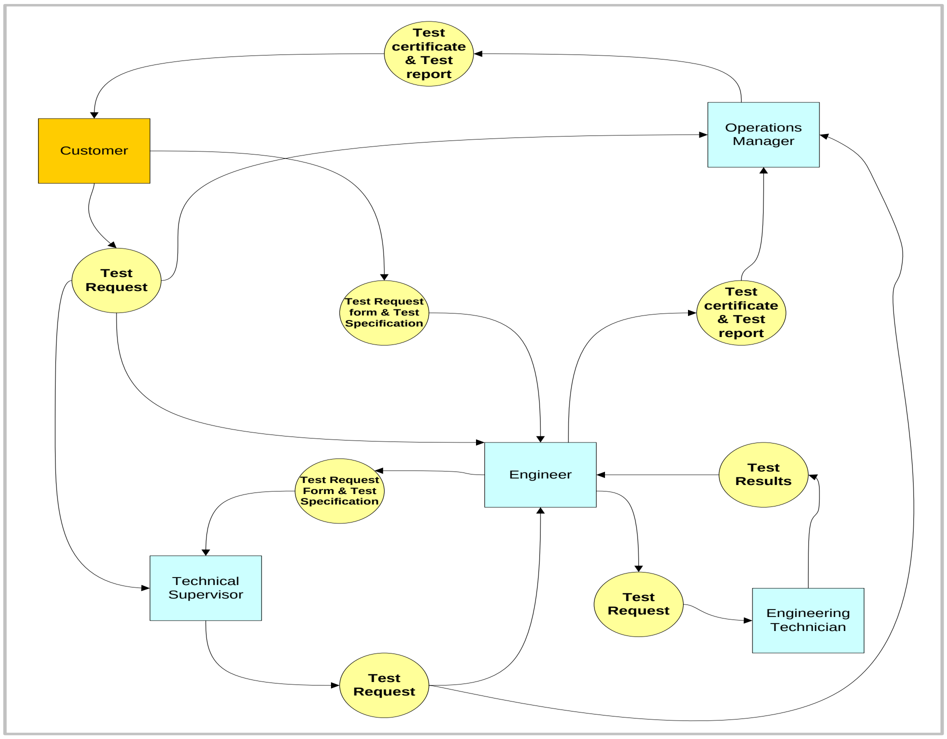

Figure 3: Information flow diagram

Current Situation

While DTF has in the past enjoyed a good reputation of service within TFR, this reputation has been tarnished more recently due to late testing delivery. Although the planned test duration provided to the client initially takes into account various risk factors such as late delivery of test specimen, faulty test instrumentation, equipment maintenance, test set-up and test breakdown times etc, there have been several instances where the actual delays experienced have resulted in deliveries even later than the estimated date. The reasons for delays in test delivery results are classified into the following five categories:

1. *Due to lack of responsibility*
2. *Shortage of strain gauges accessories*
3. *Staff limitations*
4. *Poor understanding (technical difficulties)*
5. *Jig availability*

The DTF has conducted a total of 664 tests in the period January 2003 to September 2007 with average annual growth of 4.22% between 2003 and 2006. In each year, the reasons for late delivery are illustrated in Figure 5. It is evident from Figure 6 that the shortage of strain gauge accessories such as glue and alcohol is on average the largest contributor to late deliveries. Due to the short shelf life of these items, no stock is maintained in the workshop and reordering occurs on demand, and follows the normal ordering process must be followed i.e. three quotations must be obtained from external vendors, a purchase order prepared and approved by the Operations Manager, and then the materials can be collected. This ordering process can take up to three days. The next largest contributor to late deliveries is poor understanding of the test requirements. Although the Technical Supervisor is highly experienced within the DTF, at times he does not fully understand the requirements for the test initiated through him. As a result, the test is conducted incorrectly, and delivery is further delayed when the client does not accept the results, and the test must be redone. This category is a direct result of the non-adherence to the defined test request procedure.

Staff limitations, the third largest issue, refer to the key man dependencies experienced in the department, specifically:

- ***Lack of welding expertise:*** As the DTF relies on the availability of RSTDC resources for specialised welding, this often results in an unforeseen delay of the tests. Attempts to remedy the situation by the DTF through performing their own welding have often resulted in incorrect instrumentation, causing further delays at the end of the initial tests.
- ***DTF unable to collect specimen:*** Although the DTF commits on occasion to fetching the test specimens, this is often not possible due to lack of transport. A vehicle must be arranged with other departments, which can cause an undue delay in delivery.
- ***No knowledge of MTS:*** Although the Engineering Technician is responsible for configuration of MTS for testing, only the Technical Supervisor has received training on the system, and can assist with any hitches

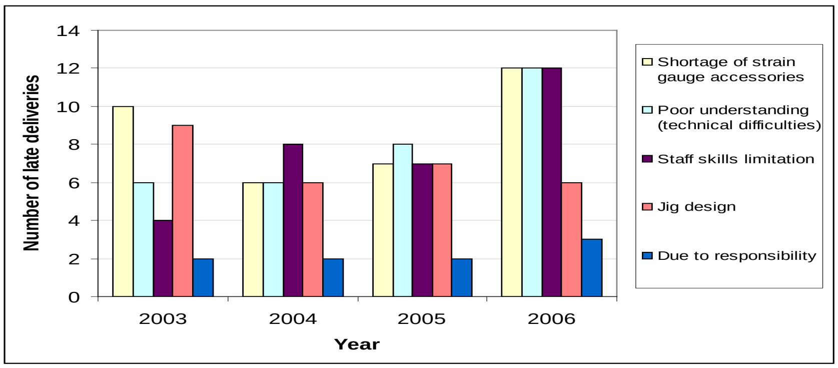

Figure 4: Reasons for late delivery 2003 - 2007

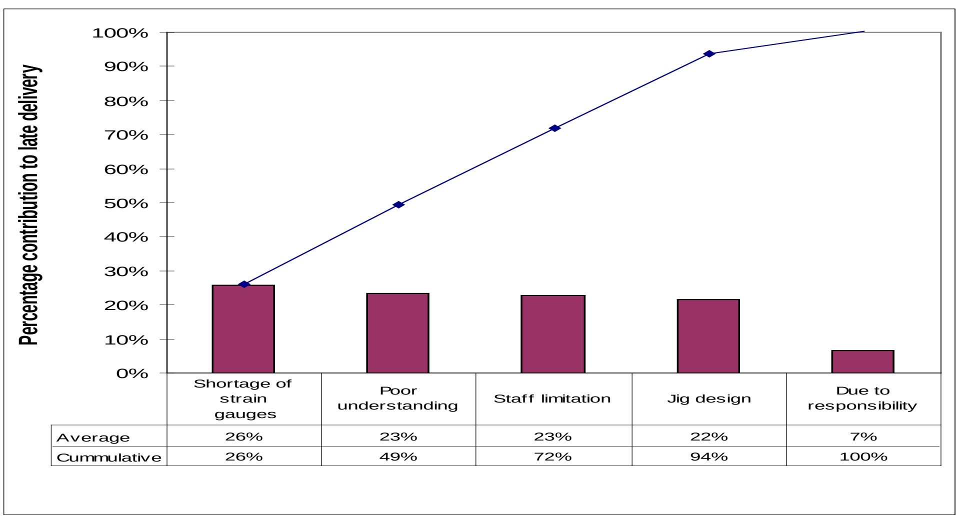

Figure 5: Average contribution of issues to late deliveries, 2003 – 2007

Delays in jig design are usually due to the following reasons:

- ***Jig search***: As no records are maintained on the jigs in storage within the DTF, it can often take up to 2 days to conduct a search to confirm the availability of jigs believed to be in storage. Often, jigs cannot be found, and the client is then requested to design or supply the jig.
- ***Jig manufacture:*** Lack of Machine Shop capacity can delay the commencement of jig manufacture for up to two weeks.
- ***Jig materials shortage:*** Jig manufacture materials such as nuts and bolts are not catalogued or stored in any methodical manner and therefore take a long time to find. When it is established that the materials are not available, the same ordering process is followed as previously described, with the associated three day delay.

The last issue of lesser consequence is the lack of responsibility within the facility, where employees do not fulfil the tasks assigned to them, with no acceptable reason. A comparison of the number tests conducted between January and September 2006 and the same period in 2007 show that very little growth has occurred in the DTF recently. In addition, the division is experiencing the lowest rate of delivery for the first nine months of 2007, suggesting that the problems are increasing substantially. From figure 4 below, it is clear that the division has moved from achieving an average of 70.0% on time deliveries to 23.4% in less than a year.

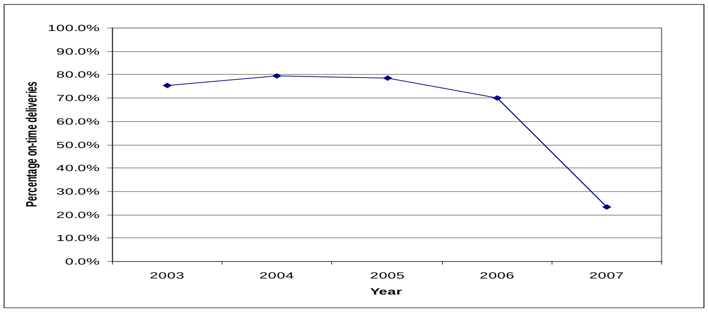

Figure 6: Yearly comparison of on time deliveries

2. Page Layout

SWOT Analysis

STRENGTHS	**WEAKNESSES**
• Reputation and recognition within TFR and other external companies • Great variety and number of tests performed • Highly experienced Technical Supervisor and Workshop Assistant • Good facility equipment • Location and easy accessibility • Sophisticated testing system in place (MTS is a fully accredited system) • Lower prices compared with competitors	• Business Development is based on relationships, which are disrupted when senior people leave TranLogic • Standard work procedures not followed • Majority of staff are new employees • No business received from other TranLogic divisions due to poor marketing • Only one member of the staff trained to operate the MTS system • Reporting lines not adhered to • Late delivery of tests • No milestone plans for each test • Poor communication within DTF • Shortage of skills available • Funding shortages from TFRD • Lengthy ordering process • Theft of workshop components
OPPORTUNITIES	**THREATS**
• Large pipeline of new business available in TranLogic • TranLogic purchasing new locomotives and wagons – increasing testing demand	• Unfair blame for failed components, which were never submitted to DTF for testing • Another TFRD testing facility in George Coch • More attractive offers to skilled engineers and technicians

The above table highlights the strengths, weaknesses, opportunities and threats surrounding the DTF workshop. The analysis can be summarised as follows:

- **DTF is well recognised and a favoured service provider within TranLogic Freight Rail (TFR) and has a large potential for growth:** The DTF workshop has a good reputation within TFRD as well as with external customers. The workshop is well recognized for the excellent work performed, and charges very low rates saving TFRD a lot of capital. On the contrary, the marketing strategies employed by DTF within the TFR group are poor. The company should be getting a larger number of internal customers who may currently not be aware of DTF, although this is potentially threatened by the late deliveries
- **There is a significant skills shortage within the DTF:** The Operations Manager and engineering technician are the only two employees who have been at DTF for many years and hence are the only two with the

expertise. Although the DTF also has a fully accredited Material Testing System (MTS) in place, the Technical Supervisor is the only employee who has been trained to use the system, and the Engineering Technician who operates it has not been trained. The fact that the current team comprises of new staff members indicates that DTF has a dilemma with skills retention. This could become a major threat if action to retain and develop skills is not embarked upon.

- **Convoluted information flow within the department and overlapping of responsibilities:** Communication is major problem and this is also evident in the information flow diagram (figure 4). The departmental structure in terms of communication links is poorly defined. Staff members are performing duties outside their scope and as a result misinterpret the job requested by the customer. Employees are not communicating via the correct channels due to a lack of standardised procedures. This non-adherence to procedure is not discouraged by the Operations Manager, who continues to approve the test requests submitted through the Technical Supervisor.

Root Cause Analysis

A review of the process flow (figure 3), the information flow (figure 4) and the observations made in the SWOT analysis has resulted in the identification of a number of root causes for the issue of late delivery within the DTF. The Ishikawa diagram used to conduct the root cause analysis is illustrated in figure 5 below, and the issues detailed below.

Absent Management

- There are not set goals on what the DTF needs to achieve. This shows lack of interest on what the DTF is doing by the Operations Manager. Without set goals there is nothing that would motivate employees to perform better. In addition, the Operations Manager encourages the Technical Supervisor to continue to disrespect the processes by continuing to take requests from customers instead of him directing them to the Engineer who is charged with that responsibility. The problem with the Technical Supervisor taking orders from the customers is that in most cases he does not capture all the information needed which result in unnecessary delays (rework as the customer would have to be contacted again to clarify information).
- It is also worrying that orders from client come to different people at the DTF, i.e. there are three different entry points for orders from clients. Lack of standardisations, is likely to continue to lead to confusion in the information exchanged between the different parties.
- There is no effective management of the DTF. The day to day running is assigned to an engineer who is not equipped in terms of management training to effectively manage the facility. The Technical Supervisor is loose canon that does not respect the authority of the engineer. There has been instances when he would leave for his house during lunch time without informing the engineer and come back the following day. The Operations Manager does not have a management system that informs him of the performance of the DTF.

Lack of Training

- The Technical Supervisor is the only person trained on the Material Testing Computer Aided Engineering System (MTS) which was purchase from the USA. All other employees are learning through trial and error. This situation is very risky because if the supervisor was to leave the company's employ it would pose challenges on the remaining staff.
- Also, the lack of welding and instrumentation training within the DTF creates dependency on specific individuals, which worsens the situation. The evident lack of training could also be a reputational risk for the DTF.

Ineffective Storage Methods

- The process of searching for the correct jig for the test specimen is too laborious and time consuming. The fact that the supervisor has to go to all storerooms to check if they have the correct size jig for the test specimen means that the facility does not have a system of recording and stacking jigs. Furthermore, if the correct jig is not available, a new jig is designed and manufactured, which is an additional cost which possibly could be avoided.
- This issue again manifests itself in the storage of nuts and bolts used in jig manufacture, and could easily be avoided.
- Security at the DTF is so lax that guards that are employed to guard the DTF property are the ones that cannibalise the welding machines for copper from time to time

Maintenance

- Within the DTF there is no maintenance policy on their machinery. Machines are repaired as and when they break. Their machines are not always busy and it would be advisable for the DTF to adopt the planned maintenance program.

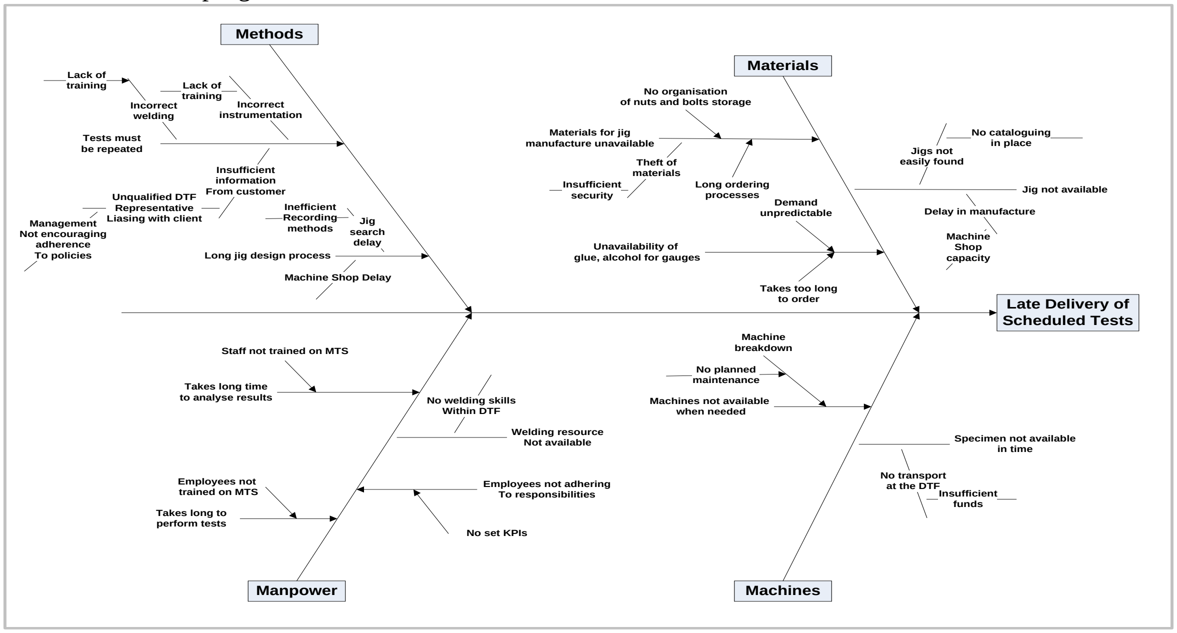

Figure 7: Root Cause Analysis of DTF Issues

3. Solutions and Recommendation

- **More Active Management**
  - The Operations Manager should, together with his employees, formulate Key Performance Indicators (KPIs) for the DTF. Once these KPIs are formulated, he should set targets that the DTF should attain on an ongoing basis. Periodically the Operations Manager should evaluate the DTF performance against set targets. This will help him correct deviations when they occur.
  - Based on the set KPIs, the DTF should produce a monthly report to the Operations Manager. These reports should reveal to the Operations Manager as to whether the DTF is operating in a manner agreed to between himself and the DTF.
  - Each position should have a job profile that clearly defines the position's responsibility and accountability. The reporting matrix should be clear for every employee, i.e. each employee should know who their superiors are and where to go if they need help in terms of their work and any human resources related issue that may arise. Employees should be held accountable for their actions and any blatant disrespect for authority should be corrected / punishable.
- **Standard Operating Procedures**
  - The DTF should clearly define standardised method for clients to request work and furthermore, clients should use only one entry point in submitting their requests.
  - The DTF should draw a service level agreement (SLA) with the Machine Shop detailing what is expected of the workshop once they receive an order to make a jig. Compliance to the SLA should guarantee more work from the DTF whereas failure to deliver as expected would result in loss of business.
- **Multipurpose jigs**
  - In order to avoid delays related to jig manufacture, the facility is encouraged to design a multipurpose jig that would be suitable for all test specimens with minor modifications. A single jig for same component type with different dimensions should be considered.

- **Work Area Organisation:**
  - The problem of mixed small materials such as bolts and nuts should be solved by installing clearly labelled shelves in the storeroom. Materials of same make and type should be stored in one shelf. This will facilitate easy identification of materials when they are needed.
  - The problem of taking long times in finding the required jig for a particular operation would be alleviated by labelling jigs and recording their storage area on a system that is easy to use and is accessible to all employees who are authorised to use jigs.
  - It is essential to imbibe an overall quality management system that would help in improving the planning of the storerooms layout, provide an impetus for a clean environment which in turn can reduce health and safety hazards. 5S is a technique that is used to establish and maintain a quality environment that help in reducing waste and maintain a high degree of cleanliness and orderliness in the work place that is expected to be sustainable. The 5S concept refers to the five structured programs using the Japanese principles of seiri, seiton, seison, seiketsu, and shitsuke-or commonly referred to as sort, set, shine, standardize and sustain, respectively.
- **Training of Employees**
  - The other two technical literate employees (the engineer and the engineering technician) should be trained on the MTS to eliminate trial and error learning.
  - In addition to employing a professional welder, the Technical Supervisor and the Technician should be trained to perform the welding function.
  - All technical literate employees should be trained on the techniques for attaching strain gauges to the test specimen.
- **Improved Security**
  - The DTF should introduce access control to their storerooms and the workshop.
  - Vehicles and people leaving the premises should be searched.
  - They should install surveillance cameras in the storerooms, workshop and in strategic positions in the yard.

4. Implementations and Measurement

Although a number of interventions have been highlighted in the section above, it is important to highlight the 'quick wins' attainable immediately with the lowest cost of resources, time and capital given the current funding shortage. The implementation of the changes by management explained above is expected to result in a remarkable change in the DTF's performance which should be easily visible. Analysis of the KPI's is not expected to take more than two weeks of the management, and should immediately eradicate most issues related to lack of responsibility, and poor technical difficulties, eliminating up to 30 % of the issues, at merely the cost of management's two weeks salary. Implementation of proper storage methodologies, such as labeling existing jigs and recording them, constructing labeled shelves for the different bolt sizes and nuts and implement 5s system (sort, set, shine, standardize and sustain) is expected to also yield the next greatest benefit, and might even substantially decrease the jig availability issue. The cost to implement this would be the salaries of the Technical Supervisor and the Workshop Assistant as well as the cost to implement shelving. By implementing just these items immediately, the DTF should see a market improvement in their processes, at a minimal cost. These items, coupled with the SLA with the machine shop should also assist with more accurate estimations of delivery dates in the future.

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