Mitigating Backdrop in Operational Efficiency: a Case Study

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***Abstract*— The main focus of this investigation was to identify the backdrop in the operational efficiency of a rail company in South Africa - Transnet Freight Railways (TFR) and profer solutions. Qualitative approach was adopted through the administering of questionnaires to respondents in Transnet company. Even though Transnet makes effort to resolve the problems, the outcome of the results still show that the system of schedling is not consistent to a specifc standard and the turnaround time is still between poor and fair. In addition, wagon and locomotives failures is identified as one of the factors contributing to the backdrop in the operational efficiency of the TFR system. It is therefore recommended that adopting a good maintenenace system to the wagon and locomotive may help to reduce if not eliminate failures of the wagons and the locomotive. This will consequently help to improve the backdrop in the operational efficiency of the TFR system.**

Index Terms— Planning, Scheduling, and Rail Freight

I. INTRODUCTION

PLANNING and scheduling are the main aspects of every organisation especially in the operations of a logistic company. Planning and scheduling has evolved over the years simply from reacting to the available amount of resources to complete activities. In order to perform a time based planning scheduling, the ability to plan and schedule operations prior to executing activities is very important [1]. Planning and scheduling have been applied successfully to railways, airlines operations, chemical and distribution systems and production manufacturing systems. The railway system in particular demand an approach whereby the schedule time will accommodate adequate number of trains that will meet the desired targets. Scheduling gives the information about the time at which the anticipated service will be performed. The time of departure, occasional intermediate stops and times of arrival are integral components of the scheduling process.

Planning on the other hand, according to Assad [2] requires human power, and materials resources, this may often be complex. The planning operation can be categorised as operational, strategic and tactical. This became neceesary in order to meet specific demand and accordiung to global standard. Transnet Freight Railway (TFR) operates an iron ore line which is the only line of its kind in Southern Africa and the world's second longest heavy haul line [3], [4]. The iron ore exploitation and exploration operates the heavy haul line from mines of the Sishen area to the Port of Saldanha Bay, Mpumalanga mine complexes as well as in KwaZulu-Natal, South Africa. The Sishen mine has sufficient resources to sustain a 21-year production and mostly the iron ore exported, with about 6.2Mt of its production being supplied to Arcelor Mittal of South Africa (AMSA) in 2011 [5].

This essential transport line of TFR has benefited South Africa's economy by literally keeping it moving and its heavy haul operations have positioned South Africa as one of the pioneer of a cutting-edge haulage technology, offering commercial and competitive advantage to the economy with vast mineral resources. It has further moved South Africa's natural resources to factories and refineries – in order to ensure progressive growth of both large and small-scale industries [6].

Operational planning are often a short term planning, carried out on daily basis by the operational team responsible for control. Some of these operational activities may include despatching of trains and crews, managing maintenance activities and implementing new schedule. The medium term planning is rfered to as tactical planning. It is targetted at ensuring smooth allocation of the resources to ensure optimal performance. Some lf the activity may include decision on the kind of service to opeartion, posssible schedule for fleet allocation for future planning period, and the route to be followed etc. The strategic planning is often the long term planning, which is the responsibility of the top management. This type of planning often demand high capital investment that span over a long period of time. The activities may invlove long term projects, establishment of policies and operating strategies etc [1].

It is important to highlight that Africa's growth depends on the explooation and exploitation of the solid minerals hence, the good transportation networks will be very essential to actualising this. TFR being a freight-focused company even though does not have its rail nectwork linking all the

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continent's economy however, plays a vital role in strengthening Southern Africa [6], [7].

II. RESEARCH QUESTIONS

Transportation system as a means to convey people and product would be reliable if it meets the desired or expected needs. In addition, rail transpotation system that does not meet the scheduled or planned activity of moving either people or product cannot be relied upon because both people and business will suffer.

In view of this, the following questions are set to establish the panacea of mitigating the drawbacks in the freight rail system in Transnet.

- Does the train schedule align with set departure and arrival of the trains?
- Does the number of trains planned per day/week align with the sets of wagons available?
- Is there an opportunity for feedback on customers' statisfaction?
- Are the customers satisfied with the given service?

III. LITERATURE REVIEW

Transnet Freight Rail focuses on optimising the supply chains in the ore industry by providing integrated logistical solutions, which consist of both the TFR-owned and subcontracted activities beyond the rail. The advantages to customers include the elimination of inefficiencies, a capacity for inventory management throughout the supply chain, and reduced supply chain costs. Transnet Freight Rail's locomotive and wagon fleet renewal plan has been updated to address the growth requirements in terms of the increased demand for rail services [6].

Starting in 1997, Canadian Pacific Railway (CPR) began exploring the concept of running a scheduled railway. With this approach, trains are operated with a high degree of schedule adherence; this has the immediate benefit of improved customer service and asset utilization [8]. However, it was feared that if all the trains were run in accordance with a fixed timetable, an excessive number of trains would be required, and costs would increase dramatically. This problem was resolved by ensuring that the operating plan is tightly matched to the available traffic, and updated on a regular and consistent basis to ensure that shifts in traffic patterns were accounted for within the operating plan.

Furthermore, transportation is a demand-pull industry. In a typical month, CPR's operating plan must respond to approximately 10,000 unique origin-destination combinations between any combinations of 4,200 locations [8].

There are two competing practices for operating railways in North America: Tonnage-based dispatching, and schedule-based dispatching. Schedule-based dispatching is once again gaining favour in North America, as new management science tools that are used for crafting cost-effective and customer-effective operating plans. Canadian Pacific Railway is one of the first railways to adopt a true schedule-based approach that can quickly adjust to changing traffic demands, and is the most rigorously disciplined railway in its scheduling [8].

On the other hand, tonnage-based train dispatching is based on the premise that reducing the number of trains operated and creating longer trains would minimize costs. A tonnage-based approach has wagons held in a yard until sufficient wagons have been gathered to form a train. In recent years, some railways have set that level at a minimum of 80 wagons. Their operating plan may list a train that operates every day; but if there are insufficient wagons, they cancel or delay the train.

However, the tonnage-based approach, has serious drawbacks, some of which are as follows:

- Unreliable services are often what customers gets.
- It may actually increase crew cost and locomotive-resource demand, due to increased light locomotives, which is the non-productive movement of crew and equipment resources to position them for productive work. It reduces the ability to better plan crew and locomotive use; and it increases the unproductive time.
- It does not allow the yards to fine-tune their operations on the basis of a repetitive schedule. It also increases the "standing capacity" (the maximum number of wagons that can be held in a yard) required at the yards; and it decreases the effectiveness in processing wagons.
- The total equipment needs for wagons is increased, this is attributed to slower transit time and consequently increased turn-around time of wagons idly waiting for train assembly.

Transnet Freight Rail, on the other hand employ support software, hence, changed from tonnage-based to schedule-based dispatching for their carload and intermodal business, which accounts for a significant portion of TFR's operations and revenues (57%). The other segment is bulk commodities moving as unit trains, which are typically scheduled separately from 3 to 14 days in advance. These trains always have sufficient tonnage to justify their operation [9]. This has been a significant accomplishment.

The problem required the scheduling of 65,000 wagons over a 14,000-kilometre network. There are about 250 capacity-constrained yards consuming limited wagons, locomotive and train crew resources that further complicate the problem. Then one could reduce the enterprise-extending constraints of supply-chain management on transportation systems; and the degree of difficulty then increases again [9].

Mkhatshwa [10] investigated the improvement of coal tonnages at Transnet Freight Railway Coal Export Line, his study revealed that the vehicle routing problem is one of the popular methods used to solve transportation and distribution problems. Though it's a complex integrative optimization where a number of clients need to be served by a fleet of trains with known demands and capacities. To solve the problem, one must design an optimal route that will result in the reduction of cycle time, hence, increasing the coal tonnage shipped from the mines to Ermelo and eventually to Richards's bay for exports [10].

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Furthermore, it is important that some of the challenges at the railway are caused by unavailability of drivers, that is, when booking the drivers, there should be a standby driver for deviations in case the booked driver could not make it to work. Likewise, there is no communication between the client at the mines and Transnet causing the wagons to delay and the train not departing on time from the origin. This was the reason behind the criticism and attack against Transnet by some mining executives showing that they are responsible for South Africa losing out on much of the global commodities boom over the past few years, including the capacity constraints which also added to South Africa's inability to profit as much as it should have from Iron Ore [11].

A good system of loading and desembacking are necessary in order to have an improved operational efficiency of both the wagon and locomotive. It is also ncessary to have insurance cover on all transported goods in order to have the confidence of customers' patronage. However, besides late arrival and departure times, wagon availability has been a problem. TFR strives to improve he service delivery to clients, therefore the operation managers at the depots is responsible for planning and scheduling of train movements, which is considered being ineffective as it has resulted into higher cycle times, insufficient capacity and insufficient service to clients [10], [13]. The ability to forecast freight volumes, tonnages and the expected distance coverage from point of dispatch to destination is an integral component of rail operations. This must be properly harmonised to avoid damages and lossses and all data must be captured daily, the type of traffic, capacity of wagon/locomotive and other traffic interchange at TFR.

A railway operating plan describes how wagons should be transported (the routing and train plan), and often includes the use of the major assets (such as train crews, locomotives, yards and tracks) needed to move the wagons. At TFR, this is called the Integrated Train Plan (ITP), a total replacement of the existing operating plan except for IATMS, it was designed to dramatically improve service and significantly reduce the number of trains, which are often competing goals [7], [13].

Costs associated with long trains include the need for longer passing sidings and increased turnaround time for wagons in order to accumulate sufficient wagons to operate the train. A hidden cost component is whether the wagons on the train are traveling out-of-route in order to build up sufficient volume to justify the train. This is called circuity, and it is measured by the ratio of the distance the wagons travels in trains from its origin to its destination and the shortest-path distance [7].

IV. METHODOLOGY

This study is aimed at investigating the panacia to mitigate the backdrop in freight rail of Transnet. In order to establish this, the train schedule plan were analysed using both qualitative and quantitative approach.

V. DATA COLLECTION

The data were collected comprehensively and systematically on the relevant section, between the drop-off depot (Postmasburg) and the Mine (Sishen). In order to address the research questions, the method deployed was through administering questionnaire which was anonymous. This allowed all participants to explore the subject matter and give their frank opinion and ideas.

a) Sample Size

100 questionnaires were administered, 30 in the customer-care department, 30 in the Train and Network Planning department, and 40 between Sishen and the Postmasburg depot.

b) Questionnaire Design

In this study, the questionnaires were designed and followed according to a quantitative approach. The questionnaire contained eight (8) sections to which the employees and managers were asked to comment on.

The Likert Scale was a useful device to build a degree of sensitivity and differentiation of responses while generating numbers and the respondent indicated agreement or disagreement with the statement. The reports of previous years were also retrieved, which was helpful. Cross-tabulation was used for statistics and to reveal formerly hidden relationships that helped to explain the data more clearly.

VI. RESULTS AND DISCUSSIONS

According to the majority of the respondents, Transnet Frieght Rail does not run a scheduled railway. The Turnaround Time of wagons exceeded the expected time and sets a bad record for customer's satisfaction.

(a) Responses to scheduled Railway

The result in Figure 1 revealed that 76% of the respondents said that Transnet Freight Rail does not run a scheduled system for their railway. This may be part of the reasons responsible for the drawback experienced in not meeting the delivery tartget.

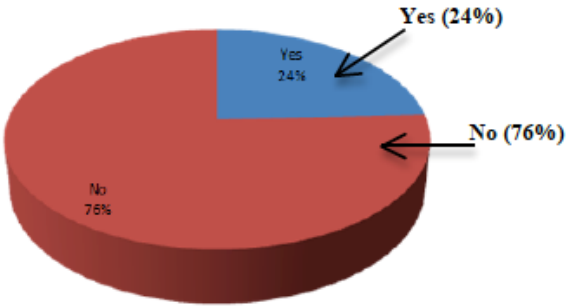

Fig 1: Employees responses to scheduled Railway

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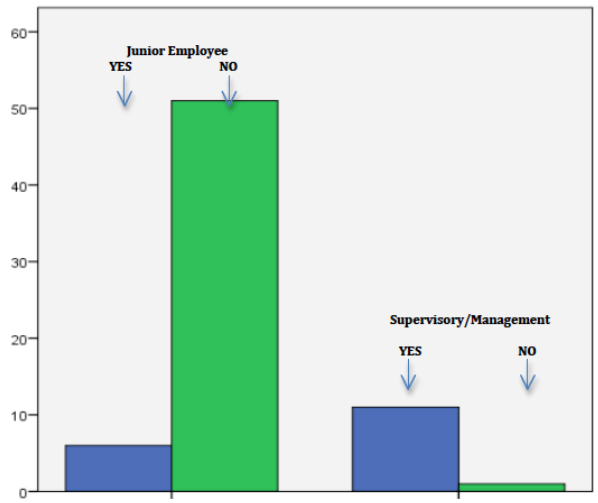

Fig 2: Feedback of Junior and supervisory employees

Figure 2 shows the relationship between the junior employees and the supervisor/management in a bar chart on whether Transnet runs a scheduled railway. Figure 2 indicates that the junior employees believed that Transnet does not run a scheduled railway; while in the contrary, the management affirmed that it runs a scheduled railway.

(b) Effectiveness of schedling

The result shown in Figure 3, revealed how effectively the respondents evaluated the scheduling approach of Transnet Freight Railway.

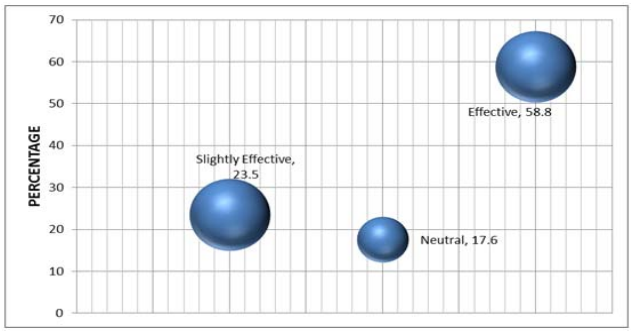

Fig 3: Effectiveness of the scheduling at TFR

(c) Turnaround time of the Wagons

The results in Figure 4 show that 77.1% rated the turn-around time of the wagons to be between poor and fair; and only 23% said the time was good.

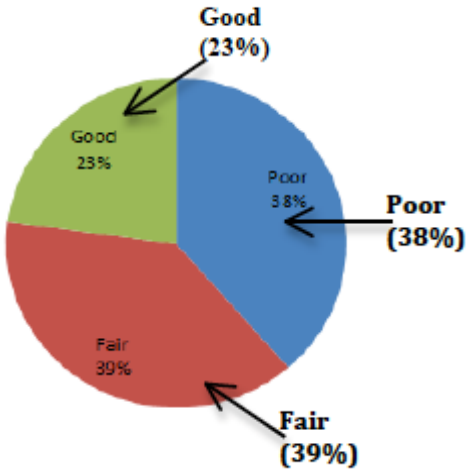

Fig 4: Turnaround time of the Wagon

Their feelings of frustration, not only concerning the Turnaround Time of wagons, but also about the real operational problems, limitations and restrictions to function effectively in this environment came through very strongly.

c) Factors contributing to poor turnaround time of the Wagon

Figure 5 presents the distribution of the factors contributing to the turnaround time of the wagons.

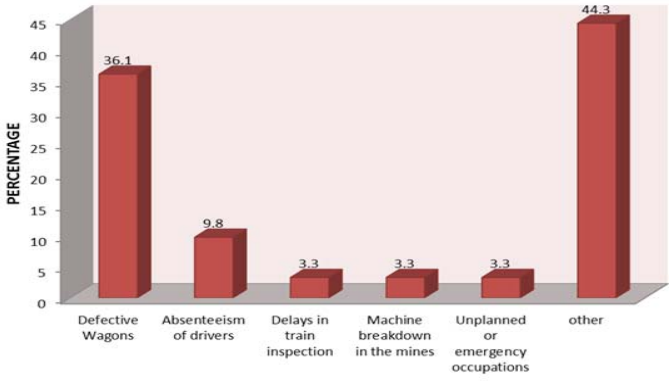

Fig 5: Factors contributing to the turnaround time of the Wagons

Figure 5 shows the results in which the majority of the respondents suggested in order to improve the turn-around time of wagons the company needs to have a proper planning with regard to the wagons and locomotives; and that the resources must be well maintained. As many as 36.1% said that the defective wagons were contributing to the poor turn-around time of the wagons; whilst 44.3% said it was the challenges presented by the locomotives.

They mostly gave an insight into the internal critical factors regarding organisational issues that they struggled with on a day to day basis. The following deviations were observed and listed:

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a) Locomotive issues: some of the locomotives are being out worked or being over used to pull oversized load than the required quantity. Some of the locomotives were not serviced as required because of the demand of loads from the customer.
b) Wagons that fails on rail: the company is experiencing some of the wagons being out of the service and not being maintained as supposed to.
c) Turnaround time of wagons because sometimes wagons are placed for loading but the client will leave it to load other prioritzed trains.

According to most respondents top management should be responsible for delivering as the commitment to the customer. The lack of a clear command and control chain was a contentious issue with most respondents, especially from middle management down to operational level. The reason was that so many people are appointed as managers with only train experience, most do not have the credentials resulting in priority issues being handled inefficiently.

VII. CONCLUSION

The qualitative approach was employed in the data collection in this study. This methodology helped in investigating the research procedure and to outline the research procedures with the objectives describing the impact that the drawback has on customer satisfaction. The Likert scale approach was adopted in the design of the questionnaire.

The results revealed that 76% of the respondents confirmed that Transnet Freight Railway does not run a scheduled railway system. This may the fundamental causes of the backdrop in the operations and this consequently impacts negatively on the customers' satisfaction. Further analysis of this outcome between the junior employees and the supervisors, revealed that junior employee believed that TFR does not run a scheduled railway system while the supervisors differs. The result further showed that about 59% thinks that current scheduled approach is effective even though there is room for improvement.

In addition, about 77% of the respondents shows that turnaround time of the wagons are between fair and poor. Thus, it further confirms the need for improvement. Factors that contributed to the poor turnaround time of the wagon were also studied. It was observed that about 36.1% confirmed that the defective wagons were contributing to the poor turn-around time of the wagons; whilst 44.3% confirmed that it was the challenges presented by the locomotives. All these put together significantly contributes to the backdrop in the operational efficiency of TFR.

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REFERENCES

[1] Crainic T.G. Tactical Planning model for rail freight transportation. Transportation Science (Vol. 18), 1999.
[2] Assad, A. Modeling of Rail networks: Towards a routing/makeup. Transportation Research (Vol. 14), 1980.
[3] Kumba Resources. Sishen Iron ore. Cape Town. Dyason Design & Print: 12. 2002.
[4] Delivering development and growth for a nation. Transnet. Available at: http://mg.co.za/print/2011-10-28-delivering-development-and-growth-for-a-nation
[5] Transport News. (Accessed March 2013). *Transnet plans to speed up freight*. [Online] Available at: http://www.bizcommunity.com/Article/196/582/91098.html.
[6] Transport News. *Transnet plans to speed up freight*. Available from: http://www.bizcommunity.com/Article/196/582/91098.html (Accessed March 2016).
[7] Rail Planning Blog. Available at: http://www.railplanning.com/CP-MultiModal-IOP-Project%20Rev%201.PDF (Accessed April 2016).
[8] Kraft, E. R. *The Yard: Railwaying's Hidden Half -- Part I.* Trains Magazine, June 2002, 46-67; Part II, July 2002, 36-47.
[9] Dlamini, D. *South Africa*: *How Transnet Derails Coal Export Expansion*. *Business Day*. Available from: http://www.sarwatch.org/publications/news/1353 (Accessed November 2015).
[10] Mkhatshwa, N. *Improvement of Coal Tonnages with Minimum Capital Investment at Transnet Freight Rail Coal Export Line*. Department of Industrial and Systems Engineering: University of Pretoria.(2010).
[11] Admin. *Localisation for Africa*. [Online] Available at: http://localisationforafrica.com/article/view/fast-tracking-freight (Accessed April 2016).
[12] Bang-Yan, W., Jun-Meng, W., and Y. U. Hong-ping. Y. U. Study on Track Alignment in Huangguoshu–Beipanjiang Section of Shanghai-Kunming Passenger Dedicated Line. *Journal of Railway Engineering Societey*. 157(10): 2011, pp. 19-24
[13] Transnet. (2009), Transnet Limited: Annual report 2009.