Investigations for Improvement of the Raw Material Transportation System in Holcim Lanka Limited

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ABSTRACT

The research study was to investigate the improper raw material transporting system. Holcim (Lanka) Limited is a reputed cement manufacturing company. The basic raw material of cement is limestone and the company has their own quarry for supplying the company's raw material requirement. Holcim uses trains as their mode of limestone transportation and they have two freight trains for this purpose on their own. In this research, I have used the past records on the cycle times of two trains and the production related data in the crusher area which is the next step after transporting limestone. By analyzing the data I found that the daily expected train loads of raw material does not arrive at the plant because of the variation of the train cycle time. This affects the timely production of crushed raw materials. After identifying the causes, the simulation of the raw material transporting system by considering a set of constraints by developing a proper time schedule for both limestone trains produced the best feasible solution to overcome the issue.

KEYWORDS: Raw material transporting system, Cycle times, Freight trains, Simulation, Constraints

INTRODUCTION

Although there are several cement plants in Sri Lanka, Holcim Lanka Limited is the only plant which has all the stages of a cement manufacturing process such as quarrying and transporting, crushing, raw mill grinding and blending, clinker production, clinker storage, cement grinding, bulk loading, bag packing, dispatching. The total production process can be sub divided as clinker production and cement production.

The department of clinker production is responsible for all the operations from limestone transportation to clinker production.

The basic raw material of cement is limestone and the company has their own quarry for supplying the company's raw material requirement. The quarry is situated about 40km away from the plant. Holcim uses trains as their mode of limestone transportation and they have two freight trains for this purpose on their own.

When studying this raw material transporting system, the company could not meet their daily desired raw material target because of the errors of the transporting system.

The actual cycle time of a train deviates from the desired level and hence the company could not able to achieve the planned number of loads per day.

Proper logistic management is a very critical point when running a company regardless of the type of product. This can be defined as having the right item in the right quantity at the right time at the right place for the right price in the right condition to the right customer.

When considering the raw material supply which is a major part of logistics, even though the company has right raw material in right conditions to the right place, they are received not in right time and therefore

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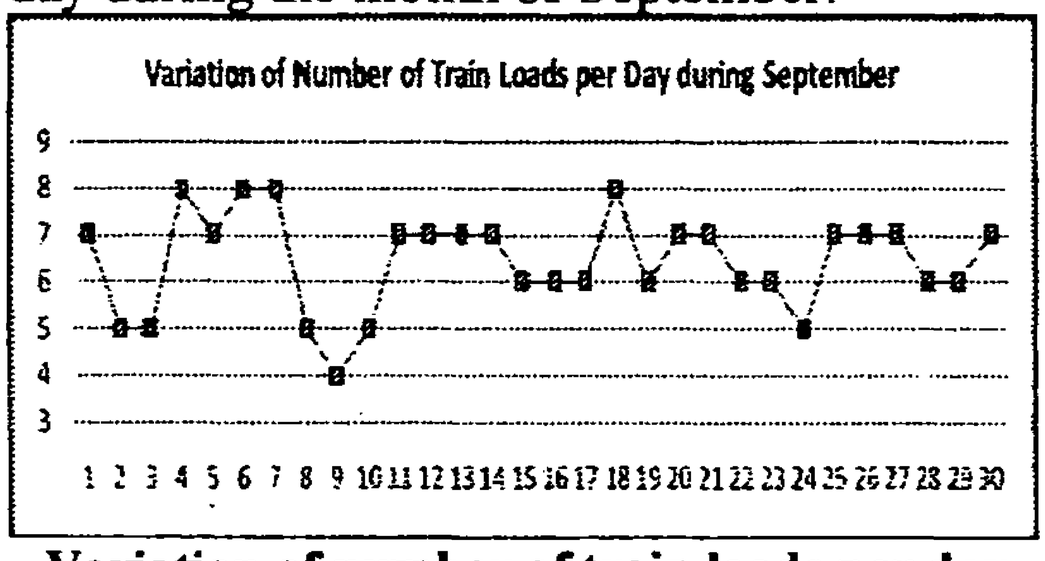
not in right quantity. This is because of the variation of cycle time of the trains. This study was focused on finding the reasons for the variation of cycle time from the desired level and give suggestions to improve the raw material transporting system.

RESEARCH PROBLEM

When considering the raw material transportation, the arrival of train loads does not occur in a systematic manner. Due to improper arrival of train sometimes train has to wait for the empty wagons (due to early arrival) and sometimes crushers are idling because of the lateness of the train arrival. This may cause to vary the number of train loads which are transported to the plant per day.

This variation of the number of train load arrivals may be due to the fluctuation of the cycle time of train. Therefore it was found that it is very important to identify the reasons for the fluctuations of the cycle time and give feasible suggestions to improve the limestone transportation system.

The diagram below shows the variation of the number of train loads transported per day during the month of September.



Variation of number of train loads per day

LITERATURE REVIEW

Supply chain management

The supply chain encompasses all activities associated with the flow and transformation of goods from the raw material stage to the end user as well as associated information flow. The Supply Chain Management (SCM) is the integration of these activities through improved supply chain relationships to achieve a competitive advantage. The Supply chain management is a somewhat larger concept than logistics, because it deals with managing both the flow materials and the relationships among channel intermediaries from the point of origin of raw materials through to the final consumer. As such, supply chain management must link logistics more directly with the user's total communications network and with the firm's engineering staff. Terms such as purchasing, procurement, supply, supply chain, material, material management, sourcing and logistics are used almost interchangeably.Typically a SCM professional is required to take a variety of decisions. A typical configuration of SCM system is dependent on the decisions taken in relation to supply chain management at different levels. These levels are as follows.

Strategic level: These are the decisions having a long lasting impact on the organization. E.g.: deciding upon the number, location and capacity of warehouses and manufacturing plants and the flow in the logistics network. Supply chain design and optimization applications are used at this level.

Tactical level: These decisions like purchasing and production decisions, inventory policies, transportation strategies, customer visits and scheduling are typically updated once every quarter or annually. Advances planning and scheduling applications support decisions at this level.

Operational level: Day – to – day decisions regarding lead time, quotations, routing and truck loading and operational decisions which are typically made utilizing MRP/ERP applications.

Transportation: Transportation is a very key element of the logistics process and the supply of chain which runs from venders through operations to the customers. It involves the movement of product, service/speed and cost which are the critical issues in effective logistics.

Train Scheduling: Train scheduling consists of,

- determining how many trains to run,
- the origin, destination, and route of each train,
- the train arrival and departure times for each station at which it stops,
- the weekly operating schedule for each train, and
- the assignment of blocks of cars to trains.

The train schedule must satisfy numerous practical constraints and business rules to achieve the minimum cost. This is a very large-scale and complex mathematical optimization problem containing billions of decision variables.

RESEARCH APPROACH AND METHODOLOGY

The issue of this research is the variation of the number of raw material train loads transported per day to the plant. If this issue does not create an impact on the ensuring of the production process, it would be meaningless to study such a problem. Therefore the study began in the step of whether this issue affect on the inability of achieving the targets.

If the cycle time of a train varies, it affects to change the number of loads transported per day. Therefore it is important to study how the moving time between each station varies. So the moving times between stations from beginning at the plant to ending at the plant were studied. Then the time was allocated to identify the root causes for the variation for the moving time between each station than expected level. Then suggestions were given by deeply studying each cause.

This research executed two main data collection methods primary data and secondary data. Primary data were collected through observations and informal discussions. Due to the duties each person engaged in the areas of study it was difficult to apply other sophisticated primary data collection methods. Therefore informal discussions with the workers (drivers, operators), managers and supervisors were used to collect data. The research used secondary data too. Journals of train trips and data sheets regarding the production of each stage were used as the secondary data sources.

Basically MINITAB and Excel statistical tools were used to analyze the data. Scatter plots, correlation coefficients, regression analysis statistical tools were used in the case of identifying the existence of the relationship two variables such as, the relationship between the cycle time of train & number of train arrivals per day and number of train arrivals per day and the total crushed raw material production per day.

In the case of analyzing the moving time between each station 'mode' was used. Mode is the value of the variable which has high frequency of occurring. This was used to find whether the existing targets regarding moving time are attainable or not.

Apart from those, line plots and graphical summaries were used to study the variation of certain variables such as, variation of the number of train arrivals per day, variation of the cycle time of two trains, variation of the total production per day and variation of the crushing rates of two crushers.

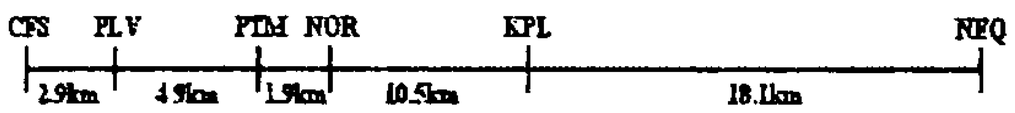
DATA COLLECTION & ANALYZING

Details of Responses

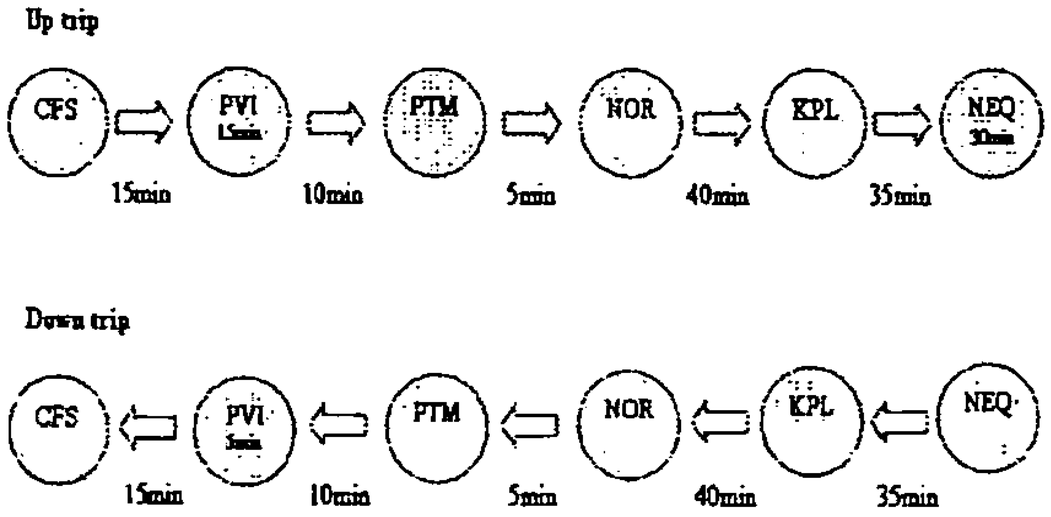
By using the above mentioned data collection strategies the following information were collected.

- The company expected the arrival of eight raw material loads per day.
- Two freight trains are used for this purpose, one owned by the company and the other owned by CGR (Ceylon government railway).
- 24 to 28 wagons are transported in one train trip.

- On average 24 tons of limestone are contained in one wagon.
- Employees work on shift basis and there are three shifts as 6.00 a.m. – 2.00 p.m., 2.00 p.m. – 10.00 p.m. and 10.00 p.m. – 6.00 a.m.
- There are six train stations between plant and quarry. They are plant station (CFS), Palavi (PVI), Puttalam (PTM), Noornagar (NOR), Karadipuval (KPL), quarry station (NEQ).
- The distance between each station is given below.



- The tracks from plant to Palavi and from Noornagar to quarry are owned by the company. And the rest is owned by the CGR.
- The public trains also run on the track owned by the CGR according to a time table.
- There are speed limits for some points of the track.
- By considering those speed limits, the company has set the target regarding the cycle time of a train. It is given below.



- The method called tablet receiving is used by the stations as the communication media. Under this method if a train departs from one station it is given a tablet. Then it should be returned to the next station until it receives any train does not use that track. This is used to overcome the traffic on the track.
- Once the train load arrives at the plant it is taken over after checking the wagon numbers and empty wagons are issued to the train after recording and the wagon numbers in the new journal which issued for the new train cycle.
- Placement of loaded wagons to the crushers is done by a separate engine in the plant.
- The company has two crushers to crush the raw material brought from the quarry.
- The expected rate of crusher is 150 tons per hour for both crushers.

Details of Data Analysis

According to the all analysis,

- Even though the company expected the arrival of eight train loads of raw materials per day the actual number of train loads fluctuate from four loads to eight loads. The expected number of daily train loads arrived only for few days during a month.
- Although the company's expected target of a cycle time is 3hours and 50 minutes, both trains M2 and M6, take more than five hours for a train cycle.
- The higher cycle time of trains directly affect to decrease the number of train arrivals per day.
- The variation of the number of train arrivals per day directly affects production of crushed raw materials per day. Therefore it is important to find reasons to overcome the variation of the number of train arrivals per day in order to optimize the production of crushed raw materials.
- According to the regression equation,
  If number of train arrivals = 8, Then the total crushed production per day = 333 + 518*8 = 4477.
  If the company is able to go for the target of eight train arrivals per day, they are able to achieve nearly 4500 tons of crushed raw materials per day. Therefore variation of the number of raw material train arrivals

per day can be identified as a problem which needed to be solved as it gives a significant impact for the variation of the basic production step of crushing in the clinker manufacturing process.

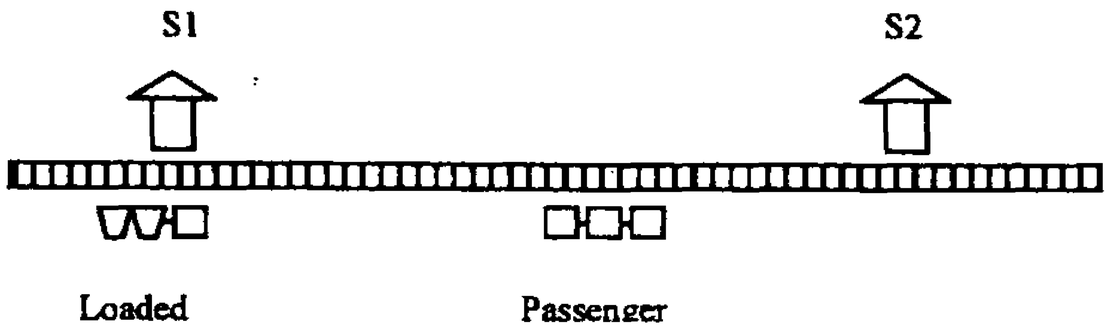
- When studying the moving time between each station,
  - Desired time to move between KPL and NOR is 40 minutes. But actually train M2 takes 30 minutes and train M6 takes 45 minutes in most of times for both up trip and down trip.
  - The desired time to move between KPL and NEQ is 35 minutes, but actually both trains take 40 minutes in most of time for both up trip and down trip.
  - Although the company does not expect any waiting in KPL in the down trip, both trains wait for five minutes in most of time.
  - The company expected to travel within ten minutes from PTM to PVI, both trains take five more minutes.
  - When considering the waiting time at the plant, it is much higher than the expected level.

  Apart from the above mentioned situations, the other moving times and waiting times cover the targets in most cases. Even though the company expects a rate of 150 tons per hour from the crushers, the actual rates are below the 140 tons per hour.

IDENTIFICATION OF CAUSES AND ALTERNATIVE SOLUTIONS

List of causes

a. Not having a systematic schedule:



At present there is no any systematic time schedule which indicates the time of should arrival and departure at each station. Once the raw material is loaded, transportations begin. In that case, sometimes loaded train meets a passenger train or the train with the empty wagons. Then the train has to wait at a station for the shunting requirements. This delay occurs in most situations, accounting for the highest contribution to the increase of train cycle time.

b. Unexpected errors:

When the raw material is transported, engine breakdowns are frequent. This is because of the improper maintenance of the engine and the train being overloaded at times, beyond the maximum capacity. This affects to increase the frequency of engine breakdowns. As this type of errors occur and the old methods of communication such as changing tablets are still practiced (explained above), it takes more time to correct such error of the system. This also affects to increase the cycle time of a train.

c. Higher waiting time at the plant:

After the raw material is unloaded at the plant, the empty wagons are brought back to the quarry. When the loaded train arrives at the plant, the empty wagons should be ready, but it most occasions this does not happen. Therefore the train has to wait for long periods until the empty wagons are available.

Delay of crushing mostly affect for the delay of supplying empty wagons. In the crusher area several machineries such as crusher, tippler, and beetle are working together in the crushing process.

Because of the slow speed of these machineries, it takes a longer time to crush a load. Also, when crushing the raw material the bay to which the raw material was unloaded needs to be cleaned. Although there are air blasters for this process they are not working properly. So they have to use an excavator for cleaning the bay. This also accounts for the delay. Further due to the boulder size and moisture level of raw materials crusher is sometimes tripped off. Frequent occurrence of tripped offs affect to delay the crushing of load. The waiting time

at the plant is increased because of these reasons.

d. Errors of the transporting system:

There are certain kinds of errors in the infrastructure. In some places there are still wooden sleepers and in some areas the train has to pass old bridges. These causes also decrease the speed of the train and hence the cycle time will increase. In some areas, because of the geographical conditions especially between KPL and NOR, the set targets could not be achieved. These things also account for the variation of the cycle time.

e. Human errors:

Although the company pays high attention for most operations in the company, the control over the limestone transportation process is somewhat less. The train crews have lack of awareness about the importance of achieving the targets. These reasons may affect to behave them in their own way. This also creates a huge impact on increasing the cycle time of a train.

List of alternative solutions

a. Review the target regarding cycle time

When analyzing the moving time between stations, although most of the moving times and waiting times cover the targets, there are some places that need to be reviewed the targets since they are not attainable due to uncontrollable reasons. In most cases, the moving time between NEQ and KPL is 40 minutes due to the speed limits in the bridge area even though the target is 35 minutes.

The waiting time in KPL in the down trip, even though the system does not expect to wait in that station, the train has to stop there for five minutes because of an uncontrollable factor of police checking. Therefore it necessary to review the targets by finding whether they are attainable or not.

b. Implement statistical process control procedure

Statistical process control is one of the best methods of monitoring a process during its operation, in order to control the quality of the products while they are being produced rather than relying on inspection to find problems after the process. It involves gathering information about the product, or the process itself, on a near real-time basis so that the operator can take action during the process. This is done in order to identify special causes of variation and other abnormal processing conditions, thus bringing the process under statistical control and reducing variation. When finding the reasons for the variation of cycle time, the lack of control over employees was also identified as a cause. For that improving the control through a statistical process control system is more advantageous. First set the upper and lower control limits regarding the moving time, waiting time and crushing time by studying the past records. Then continuous attention should be paid for all processes and observe whether they operate within the control limit, find reasons and take immediate actions if any out of control point occurs. This will help ensure a continuous flow of raw material supply chain.

c. Set another track

When using the CGR track, since the priority is given for public trains, sometimes the limestone train has to wait at a station for long periods. The company uses CGR tracks from NOR to KPL only. All the other tracks are maintained by the company. So if it is possible to set another track system instead of using CGR tracks the delays caused by the public trains can be avoided.

d. Simulate the limestone transporting system

The basic reason for this inefficient limestone transportation system is not

having a proper time schedule for the train loads per day. Therefore it affects for loosing control over the raw material transporting system. If the trains operate without considering constraints on the track, it may reasons for the variation of cycle time.

Therefore it is useful to simulate the limestone transport system by considering constraints such as speed limits, public trains and the daily target. Then the company can optimize their control over the transport system and thereby ensure a smooth flow of the key steps of cement manufacturing process.

e. Suggestions to overcome the empty wagon delay at the plant

- **Control the boulder size**
  Due to different boulder sizes, feeding raw materials have to be controlled by the operator, because large boulders could overload the crusher, which could then tripped off. If it is possible to control the boulder size, the apron speed can be increased. This will allow feed more raw materials into the crusher. So the crushing speed can be increased.
- **Control the moisture level**
  High moisture level may cause to jam the crusher. Also jamming the crusher could occur when hammers are worn out. The maximum moisture level is 7% per unit mass. Therefore by maintaining the moisture level below 7%, a better performance of the crusher can be ensured.
- **Modifications to increase the speed of the beetle and tippler**
  Presently the beetle is moving at a speed of 51 feet per minute. If the beetle speed can be increased, the rate of placing the wagons to the tippler can also be increased. If the beetle speed increases, the tippler with have to be modified because otherwise it may cause to derail the wagons. By modifying both these machineries, fast unloading of wagons can be arranged.
- **Modifications of the air blasting system**
  Air blasters are not efficient at present since they are not working properly. Therefore, the excavator has to be used to clean the unloading bay. Therefore it takes an extra expense to hire the excavator. Doing some modifications to get effective output from the air blasters the company can recover the extra expenses and increase the efficiency of the crushing process.
- **Using spare wagons**
  When a train arrives at the plant with a load, the previous load may not have been crushed completely due to breakdowns or delays. It may remain two or three wagons for each crusher. Then the spare wagons can be used to leave engine without a delay.
- **Maintaining suitable time between two loaded trains**
  Sometimes the limestone train arrives at the plant before the minimum time required that needs to crush a load. At this time the crusher is unable to release the empty wagons. Therefore maintaining a suitable time gap between the two trains can be arranged to overcome this problem of empty wagon delay in an effective manner.

Comparative Analysis and Feasibility Study of Alterative Solutions

The major problem of this research is not covering the daily required raw material train loads due to improper transportation system. When analyzing the feasibility, the extent of the ability to overcome the problem, economic feasibility and technical feasibility were taken in to account. When developing a solution it should be able to overcome the most of the causes of the main issue, therefore in order to select the best suggestion, which the criterion of extent of the ability to overcome the problem was taken in to account. The criterion of technical feasibility was taken to identify whether the required technology is available or not and to identify whether the required resources are available or not. And the

criterion of economic feasibility is taken in to account to identify which suggestion involves the least monetary expense.

The best feasible solution to overcome this issue of improper raw material transporting system is the simulation of limestone transporting system to develop a standard time schedule for limestone transportation by allocating reasonable times for each step in the train cycle. In the case of developing a time schedule the best solution to overcome the empty wagon delay in the plant is maintaining a suitable time between two trains.

CONCLUSION

For any kind of organization regardless of the product or service, proper control over the supply chain is a very significant factor when competing in the market. When hearing the word "supply chain" most people assume that a supply chain take place from business to customer, business to business etc with a link to the external environment. But there are supply chains that have to be managed within the organization. Without having a proper run at the micro level supply chains, go for managing the supply chain at macro level is meaningless.

A small leakage at a small place can cause a major impact, even though most places in an organization run in a proper manner. Therefore it is necessary to introduce regular supervision and inspection in order to get the optimum output. And also employees are the key persons for the success of a company, but they need to be properly managed by using different strategies when aiming for a target. If there is no regular control, they behave in their own way and further the awareness of employees on the achievement of targets is a very critical factor. By encouraging those to work for a target and continuous inspection could produce immediate solutions for the problems encountered with motivating employees. It results to improve their efficiency and that of the total system. All these key points can be achieved by introducing a standard time schedule for the limestone transportation system. If so, employees are within control because they have targets to be achieved regarding the moving time between stations and the management can continuously inspect and take immediate actions if there is an out of order. And there needs to allocate a specific time for the maintenance of each machinery, the trains and the crushers which is vital for a long run. By practicing the employees to go on standard schedule the company can overcome most of the causes which affect for the improper raw material transportation system and ensure consistent flow of the key steps of cement manufacturing process.

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