AN IMPROVEMENT TO THE PERFORMANCE MEASUREMENT SYSTEM OF THE LOGISTICS OPERATION

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ABSTRACT

Performance measurement is critical to the success of any organisation because it creates awareness to the competition between members in the organisation. Logistics and supply chain management has become common practices across all industries. However, the topic of Logistics Performance Measurement does not receive adequate attention therein. A good performance measurement system is a necessity for a company to grow and sustain industry leadership. The paper presents the research report studied at one of the largest gas manufacturer in Malaysia. The study is to understand the existing logistics operation performance measurement system practiced in the company in terms of delivery service, delivery reliability, delivery service measurement, safety aspects, productivity management and, distribution cost management. Beside that, the study will also identify the drawbacks and suggests improvements in line with the world class practices. The scope of the study is focusing on analysing the current practice performance measurement system which related with safety, productivity, costs and delivery reliability. Management analysis tools such as Competitive Profile Matrix, Gap analysis, SWOT analysis, Pareto analysis and Key Performance Indicators have been used in the study. These tools are used as a foundation for developing the overall performance measurement system that measures every department's performance.

Keywords: *Key Performance Indicators, Logistics Operation, Operations Management, Performance Management*

1. INTRODUCTION

~~A microstrip reflectarray antenna is an attractive~~ In order for companies to ensure achievement of their goals and objectives, performance measurement is important for evaluating, control and improves its business processes. The performance measures are also used by the customer for comparing the performance of the company before they were selected as a new vendor.

The subject of performance measurement is encountering increasing interest in both academic and managerial ambits. This, for the most part, is due to the broadening spectrum of performance required by the present-day competitive environment and the new production paradigm known as lean production or world class manufacturing. In addition, there is a need to support and verify the performance improvement programmes such as just-in-time, total quality management, concurrent engineering and etc [1]. The purpose of having a performance measurement system is to transform strategic and business plans into individual performance contract and objectives. The performance contract should include goals, measures development plans and performance rating.

Traditionally, the focus of the performance measures has been on process operation within the organisational boundaries of a company [2]. In the context of effective performance measurement involves not only the internal processes, but also requires an understanding of the performance expectation of other members such as vendors and customers [3]. Thus, the performance measurement of the lean production based company must focuses on process management beyond organisational boundaries; there is need to measure performance for effective management of the operation [4].

This paper addresses the performance measurement issues brought from the case study at one of the largest gas manufacturer in Malaysia. The study found that the performance management in the company involves the following steps as follows; setting individual performance outputs, providing performance resources, monitoring individual performance, coaching for performance, planning for the effective performance development, and assessing individual performance. Basically, the current performance measurement method used by this company is more towards the traditional performance measures which more focusing on costing and accounting systems [5, 6]. This has resulted in most measures focusing on financial data such as quantity delivered, accident rate, down time, productivity and cost.

The basic role of performance measurement system should include yielding insight into the nature of value-added processes, guiding the organisation's progress toward achievement of goals and providing critical feedback concerning the success of organisational strategies. Perhaps the performance measurement mould behaviour of not only the managers charged with the responsibility of developing competitive and operating strategies but also the workers who must implement the strategies. For these reasons, sound performance measurement almost always precedes the achievement of strategies goals [7]. The traditional approaches lead the criticism for failing to adequately address the needs of managers in an environment far different from that in which they were created.

Thus, the paper proposed the performance measurement system that incorporates the time-based issues and continuous improvement of the company that covers every aspect in the organisation. The remainder of the paper is divided into three sections. In the first, the company's current practice on the performance measurement is reviewed. This includes how the company view their performance indicators, how they measure the success of the delivery, how they measure safety of the operations and lastly their productivity. In the second, the methodology for developing the new performance measurement system is presented. In the third, the new performance measurement system that encounters every aspect in the company is discussed.

2. COMPANY'S CURRENT PRACTICE

In this section, the authors present the company's current practice on measuring its operation performance. This includes the current operation performance indicators, delivery measurement to the customers, delivery safety measurement and operation productivity measurement.

2.1 Performance Indicators

There are performance indicators in this company which can be used to analyse the performance and therefore help drive the continuous improvement to the company. The performance

indicators used by the company are on time orders [8], on time cylinders, product shortages and missed deliveries or brought-backs. On-time orders and on-time cylinders are the key performance indicator for the operations. It indicates the percentage of orders and cylinders delivered on time in line with customers expectations. Product shortage is the key performance indicator for the plant and warehouse operations. This would include all products which would normally be defined as "stock" items which were not available to be shipped at the time the trip was dispatched. Finally, missed delivery or brought-back is typically a key performance indicator for distribution operations. This would include all orders scheduled and dispatched on a trip, but not delivered as promised to the customer.

2.2 Delivery Measurement

This company measures the delivery to their customer by comparing the promised delivery dates and quantities for different items in the order, with the actual delivery dates and quantities of the order. They called it as Delivered in Full on Time (DIFOT)

$$DIFOT = 1 - \left[\frac{OTNIF + NOTIF + NOTNIF}{Total\ Number\ of\ Order}\right] \quad (1)$$

Where;
OTNIF = Delivered On Time Not In Full.
NOTIF = Delivered Not On Time In Full.
NOTNIF = Delivered Not On Time Not In Full.

OTNIF refers to products delivered to customers are more or less than quantity ordered on a promised delivery date. In contrast, NOTIF is about products delivered to customers are at correct amount but on date earlier or later than agreed delivery date. While NOTNIF is concerning to the products delivered to customers are more or less than quantity ordered on a date earlier or later than agreed delivery date.

DIFOT failure is measured from the point of view of a customer. The order is only considered successful when it achieved promised service level. It has to be taken into consideration that delivery early than promised date is considered not on time and more than required quantity is also considered not in full, and both of these criteria are categorised as failure. If there is an order with more than single items, failing any single item will cause the whole order to be categorised as unsuccessful.

In order to ensure DIFOT work successfully, the order need to be taken accurately, as well as correct lead times. The successful rate for all orders processed in the warehouse is then accumulated to determine the overall successful rate for the particular warehouse.

Failure to meet customer's order in full and on time could be attributed to number of reasons, including but not limited to the following:

a) Order taking error. This occurred due to orders was incorrectly taken at the customer's service centre.
b) Inventory error. This is due to the stocks was unavailable at the supplying warehouse.
c) Scheduling error. This is probably a human error where the delivery was not scheduled for the customers.
d) Order picking error. This error happened when the products were not loaded onto the truck.
e) Driver error. This is another human error where the deliveries were not made by the truck.

At the moment, DIFOT measurement is taken into consideration all orders taken in the system, as a base of measurement and the delivery failure could be both controllable and non-controllable. Five main classifications above are incomplete to reflect all situations during delivery. For example, customers reject order upon delivery due to changes of their plan but did not inform the company, this is a situation where the company is out of control. The most possible classification the author could think of is *Driver Error* or *Others*. To put the delivery failures as *Driver Error* is being unfair to driver but others is not a better choice as it does not reflect the real situation. The author feels that an improvement could be made here to exclude the company non-controllable delivery failure in DIFOT measurement as it is unfair to tie the uncontrollable factor on a personal/department performance. The measurement could be continue as DIFOT is suppose to be used to assist in identifying problems in the supply chain and resolving them in order to provide superior customer service.

2.3 Safety Measurement

In most country, companies are enforced by law to keep detailed information about safety problems within their plants. It is the same to this company to have their own safety procedures that exceeds the minimum requirements of the local law. There are several parameters used by the company to measure safety:

2.3.1 Truck Avoidable Accident Rate (TAAR).

The truck avoidable accident rate is determined by multiplying the number of avoidable accidents by one million and dividing that number by the total distance travelled. Each year, standard or target is established for the avoidable accidents rate. However, a standard by itself cannot prevent accident; it is a goal to achieve through constant training and supervision. Once standard is set, the employee must be trained to achieve the standard. The definition of an avoidable accident and the expected performance rate must be thoroughly explained to the employee and administered both strictly and fairly. Training in vehicles control, hazard recognitions, and safe driving techniques must be adequate.

2.3.2 Lost Workday Case Rate (LWCR).

The lost workday case rate is determined by multiplying the number of lost workday cases by 200,000hrs and dividing this number by the total number of hours worked. In some operations, the lost workday case rate is referred to lost time incident. The lost workday case is defined as any personal injury which results in the employee not being able to report for a full work shift at their next regularly schedule work day or future work days, if he absence is a consequence of the injury. Within transport operation, other work groups such as maintenance will also be covered by this.

2.3.3 Managing Safety Standards.

The definition of an avoidable accident and personal injury accident and the expected performance rate must be thoroughly explained to the employee and administered both strictly and fairly. All drivers should have performance checks through periodic observations. The results from observations, accident analysis or complaints against drivers will help the management to review the training effectiveness and its compliances to the standard. Usually only those drivers who are known to stretch the rules are checked extensively. Follow up remedial and rehabilitation efforts should be extensive at the outset until there is evidence of satisfactory performance. Spot checks for all drivers are occasionally needed to disclose "soft spots" in their performance, and to help in training and retraining. Drivers must know how to drive safely. Once they are trained in the driving technique, they can then be motivated through pride of workmanship, skill, or other factors to do a superior job. Any employee with long accident free records may be lulled into a false sense of security and may develop careless safety habits. Help to overcome this problem, the use of incentive programs such as periodic retraining and consistent demonstrations of the importance of safety is significant. Tracking the total case rate should allow further information on minor accidents to be gathered. Detection of any trends in minor accidents may help to prevent more serious accidents, by implementing corrective actions after completing the root cause analysis.

2.4 Productivity Measurement

2.4.1 Optimising capacity utilisation.

Currently, the productivity of the distribution operations is improved by utilising the fleet capacity. This can be achieved by optimising equipment capacity utilisation and increasing the amount of products delivered per distance travelled. The lower cost is based on the fact that increased capacity utilisation should result in lesser trips. This would result in the need for fewer vehicles and a reduction in fixed costs.

The maximisation of equipment capacity utilisation and increasing the amount of products delivered per distance travelled contributes to lowering the cost per unit of products delivered. Capacity utilisation measures the percentage of the units of product delivered compared to the available carrying space of the vehicles, which varies according to the fleets size and total fleets in use. This is based on past historical trends.

This is done at the local site and is obtained by reviewing each trip by determining the capacity utilisation for particular trip. The site daily average could then be determined by dividing the total amount of nominal delivered by the total nominal capacity of all the vehicles utilised to complete the deliveries. Capacity utilisation should also be tracked by individual vehicles. Changes in these numbers may indicate maintenance problems that need to be corrected.

2.4.2 Vehicles Utilisation.

Vehicles utilisation measures the number of productive hours of vehicles uses per week divided by the total hours per week (in percentage). Productive hours of a vehicle is the time spent for the vehicles such as driving time, time for vehicles occupied for delivery, standard loading time and any other allowances for inspections and paper works.

The ability to effectively schedule deliveries and trips can greatly influence vehicles utilisation. The possibility of multi-tripping reduces the total vehicles requirement. Some other key elements to be aware by this company are as follows:

i) Driver hour's legislation needs to be managed so drivers are available to meet the needs of the scheduling function. Too many or too few drivers will lead to inefficiency and thus degrade vehicles utilisation.

ii) Fleet composition affects capacity utilisation and subsequently vehicles utilisation. Trailers which are lighter and have greater carrying capacity will result in fewer trips and vehicles required. Sites should identify their 'normal' or 'optimum' delivery pattern, customer type, access and so on and derive both the total fleet required and composition.

iii) Use of carriers at peak periods whether these be weekly or seasonal can also reduce the demand on the fleet. However, a trade-of needs to occur as to whether it is cheaper to continue utilising a company asset or placing it in reverse and using a carrier. In certain cases it will be appropriate to evaluate whether it is financially viable to purchase new equipment or utilise a carrier. This depends upon the likely requirement for the asset and also the risks of not guaranteeing its availability.

iv) Accurate scheduling tool will benefit the scheduling process. The ability to effectively route and determine vehicles return times will enhance vehicles utilisation.

v) Communication of available fleet resources from sites to the scheduling centre will also enhance performance of the assets. It is essential that sites also have the manpower available for the utilisation of these assets before declaring them for scheduling purposes. In addition to this, there should be a constant flow of information regarding fleet level fluctuations such as vehicle maintenance (preventive and non-preventive).

2.4.3 Factors Contributing and Contradicting to Productivity.

Close analysis of vehicles utilisation will identify those operations where there are issues within vehicles maintenance, specific vehicles type and performance related activity. Improvements in vehicles utilisation leading to reducing the number of vehicles will reflect both on vehicles depreciation costs and running costs. Vehicles purchase costs and subsequent financing costs will reduce depreciation cost. Running cost will reduced in taxation, licensing, maintenance labour, tyres, parts and so on. However, by reducing the number of vehicles, the average distance travelled of the remaining vehicles will increase. This can result in an increase in maintenance cost depends upon vehicles maintenance servicing intervals.

Areas that are hard to control and must be discussed with local sales management is customer demand changes. Generally, customer demand pattern fluctuates over time as customers are added and leave for other suppliers. In order to maximise capacity utilisation, the correct amounts must be carried on the vehicles and delivered to the customers as scheduled. If the amount loaded and delivered consistently does not match, decision must be made to revise the amounts forecasted.

Demand smoothing is a process which optimises the relationship among delivery day frequency, location delivery boundaries, customer area demand and maximum vehicle load factors. The goal of demand smoothing is to improve productivity by reducing drive, non-value added time and increasing the number of units delivered on a trip. The local transport manager must work with the sales, marketing and logistics planning functions to effectively implement demand smoothing as required.

3. METHODOLOGY

3.1 Developing Performance Measurement System

Generally, this study is focusing on analysing the performance measurement systems that are already in used, categorising performance measures and then studying the measures within a category, and building frameworks by which performance measurement system that can be applied to the logistics operations in the company.

Besides analysing the measures based on their effectiveness, benchmarking is another important method that is used in the evaluation stage. Benchmarking serves as a means of identifying improvement opportunities. In order to study large number of performance measures, it is easier to categorise them as suggested in [9] including quality, productivity and cost.

One of the most difficult areas of the performance measurement selection is the performance measurement system design. Important questions must be addressed such as: What to measure? How to measure? How often to measure? How are multiple individual measures integrated into a measurement system [6, 10, and 11]?

3.2 The Design of a Performance Measurement system

The design of a performance measurement system is principally a cognitive exercise, translating views of customer and other stakeholder needs into business objectives and appropriate performance measures. There are three activities to be carried out during the system design phase [10].

i. Assemble and organise the raw case data. There are three ways to collect data from a system: ask, observe, and use system documentation.
ii. Edit data, summarise the case information and eliminate redundant data.
iii. Developing a comprehensive performance measurement system. A total performance measurement matrix will be developed.

The objective of this phase is achieved through few interviews with line management and senior management team to analyse the company's current business.

Series of tools such as SWOT analysis, Gap analysis, Competitive Profile Matrix (CPM) analysis, System Thinking and Pareto analysis were used to facilitate the interview as well as to compile and summarise the results. These tools are important as it helps the author to reassess the company's strategy systematically and identifying both customer and stakeholders' needs before blending these to develop new set of performance measurement system. These tools provide guided frame works for the author to arrange and organise pieces of raw information collected from interviews, readings as well as other means, into meaningful information.

3.3 Use of Business Analysis Tools

The SWOT analysis was employed to categorised management and employee's opinions in the business environment and it helps to identify company's internal strength and weaknesses; CPM analysis was used to identify how customer view the company's performance against other competitors, gap analysis was also employed to measure the improvement gap of the identified key performance indicators between current performance and desired target; system thinking was practised while organising the results while Pareto analysis was used to identify the most important factors to be taken care during the improvement process.

An employee opinion survey was carried out to identify the Critical Success Factors (CSF's) for the industry. Twenty five sets of questionnaires were distributed to employees from various departments. Employees were asked to choose eight of the listed CSF's which they think is most important and applicable to the company. Then, they were requested to rate the performance of the company and other competitors for the selected CSF's. Finally, the combination of weightage assigned and performance rating will be summarised and presented as CPM analysis.

The CSF's which is direct controllable by Logistics Operations Department will be selected and transformed into Key Performance Indicators (KPI's). Again, a weightage will be assigned to each KPI by the management according to the importance of the KPI. Next, the Gap Analysis will be carried out. A discussion will be conducted together with the Logistics Operations Manager and Transportation Supervisor to analyse department's current situation and desired performance on these KPI's. Lastly, current score and desired score will be awarded to the KPI and the gap in between will then be identified.

4. RESULTS AND DISCUSSION

4.1 Competitive Profile Matrix

In the Competitive Profile Matrix (CPM) Analysis conducted to evaluate the position of the company together with three other major competitors, which were said to be the top market player in the industry is shown in Table 1. The company did better (by a small margin of 0.5 points) than its major competitor and, product and operational safety is one of the Critical Success Factor (CSF) which carries higher weight and contributing to the difference.

In the CPM analysis, nine CSF's were identified through an employee opinion survey. These nine CSF's, were the top nine most favourable CSFs in the employee opinion survey. Total of twenty five employees from various departments were invited to participate in the survey. Each of them was required to select eight CSF's which they think is important to the business and to assign performance rating for relevant company for the selected CSFs, ranging from 5 to 1 for best to worst performance. Score for each CSF was acquired by multiplying average rating with the weightage assigned by the management. The weightages assigned were based on judgement on the importance of the CSF as well as the emphasis that has to be laid on. Summation of all the scores will then represents the company's overall achievement.

From the CSF's identified in CPM analysis, price competition, product and operational safety and delivery was recognised as direct controllable (to a certain extend if not all) by logistics operations department. At the mean time, high weightage carried by these CSF's shows that management had put the accent on these areas.

As a summary, the company has adopted cost, productivity, safety and quality as the main dimension of focus in its performance measurement system. These four dimensions of performance measurement will be translated into a model with related key performance indicators suitable to the company.

i) Cost
- Total distribution cost per distance travelled
- Delivery cost per nominal

ii) Productivity
- Capacity utilisation
- Vehicle utilisation

iii) Safety
- Truck avoidable accident rate (TAAR)
- Lost workday case rate (LWCR)

iv) Quality (Delivery reliability)
- Delivery in full on time (DIFOT)

4.2 Gap Analysis

A gap analysis is being carried out to identify the gap between current performance and desire performance for the four main identified KPI's. The result is shown in Figure 1.

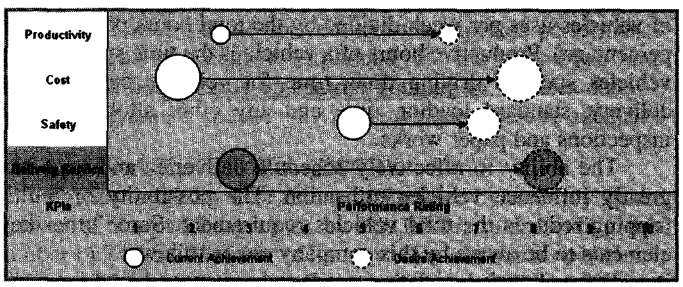

Figure 1: Gap analysis

The size of the bubble represents the weight that the KPI carries, i.e. the bigger the bubble, the management has indicated that it is a relatively important KPI. This is translated from CPM analysis that was shown in Table 1. From Figure 1, it can be illustrated as cost is the most important KPI that the management is looking at and followed by delivery service. This can be further explained from Table 1 that both cost (price competition) and delivery service (delivery) are assigned with relatively high weightage. However, it is also identified that the company did badly in both of these areas having a gap of 6 and 5 units respectively for cost and delivery performance.

Product quality has the highest weightage, however not identified as one of the four core areas of KPI for logistics operations. Product quality will affect performance if the above KPI's, although not directly, as quality product will reduce the need of running extra trips to deliver substitute product (eliminate rework) which will enhance operational cost usage and improve delivery reliability.

The gap between current achievement and desire achievement was a summary from CPM analysis and also and internal factor evaluation of the four main KPI's. The position of current achievement bubble was placed at the average performance rating assigned by management and employee as shown in Table 1. The desire achievement ratings are being set at:

- 9 – 10 : Higher than BOC and industrial standard
- 8 : BOC global standard
- 7 : Local industry highest standard
- 6 : Average standard

Table 1: CPM analysis for the company and its competitors

No.	Critical Success Factor	Weight	Respondent Company		C1		C2		C3	
			Rating		Score		Rating		Score	
1	Advertising and Marketing	0.15	3	0.45	3	0.45	3	0.45	2	0.3
2	Product Quality	0.2	4	0.8	4	0.8	3	0.6	2	0.4
3	Price Competition	0.15	2	0.3	5	0.75	4	0.6	4	0.6
4	Product and Operational Safety	0.1	5	0.5	2	0.2	2	0.2	2	0.2
5	Financial Position	0.05	5	0.25	3	0.15	3	0.15	1	0.05
6	Customer Loyalty	0.1	3	0.3	4	0.4	3	0.3	3	0.3
7	Global Expansion	0.05	4	0.2	2	0.1	2	0.1	2	0.1
8	Market Share	0.05	4	0.2	2	0.1	1	0.05	1	0.05
9	Delivery	0.15	3	0.45	3	0.45	5	0.75	5	0.75
	TOTAL	**1**		**3.45**		**3.4**		**3.2**		**2.75**

In lined with the management strategy to work on cost reduction as well as improve delivery performance, the author will focus in these two areas and work out a more specific performance measurement tools to monitor the performance of these two KPI's closely. Later, all four KPI's will be integrated into the overall performance matrix to demonstrate the department's overall performance.

4.3 Relations Between Key Performance Indicators

In order to study the relation between the department's key performance indicators (KPI's), some historical data has been extracted and a correlation text has been conducted. The result is as in Figure 2.

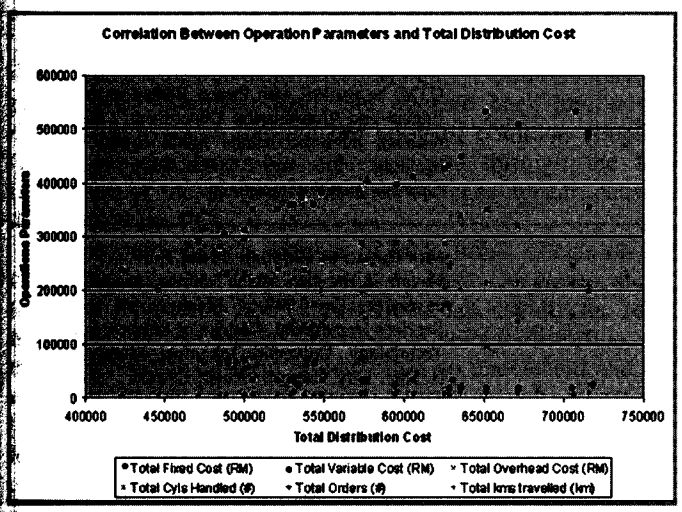

Figure 2: Correlation between operation parameters and total distribution cost

The analysis shows that total variable cost, total number of cylinders handled, total distance traveled and total overhead cost have a positive correlation with total distribution cost. This means, higher number of cylinders being handled and more distance traveled will incurred cost directly to the total distribution cost overall. Among these four parameters, total variable cost has the strongest correlation with total distribution cost. Another observation to be made is that the total orders seem to have neutral correlation with total distribution cost while total fixed cost is having negative correlation with total distribution cost. Table 2 list the correlation factor and R-square value for the relations for the operations parameters.

The reason why total fixed cost is having negative correlation with total distribution cost is when the company started to reduce company assets (vehicle units) by engaging more contractors to manage delivery service. By doing this, the total fixed cost will be reduced while the contractors cost will be charged to total variable cost.

Table 2: Summary of correlation factor and R^2 value for the company's logistics operations parameters.

Operation Parameter	Correlation Factor	R^2 Value
Total Fixed Cost	Y = -0.1923x + 146410	0.6262
Total Variable Cost	Y = 1.0036x - 181642	0.935
Total Overhead Cost	Y = 0.1887x + 35232	0.3974
Total Number of Cylinders Handled	Y = 0.4825 - 13578	0.5377
Total Orders	Y = 0.014x – 468.33	0.5503
Total Distance Traveled	Y = 0.2554x + 40387	0.5427

Another correlation analysis done on service level performance and total distribution cost shows that service level performance (distribution only) has neutral correlation with total distribution cost, i.e. increasing amount of money spent does not guarantee a positive feedback on improving the department service level. The department service level is having almost neutral correlation with total distribution cost. It is also interesting to notice that company service level performance actually has a negative correlation with total distribution cost.

This is at a situation where a service failure caused by other department (example inventory planning mistakes, production delay etc) will cost Distribution extra cost to manage the delivery to customer as it comes under special schedule and out of network arrangement. This is shown in Figure 3.

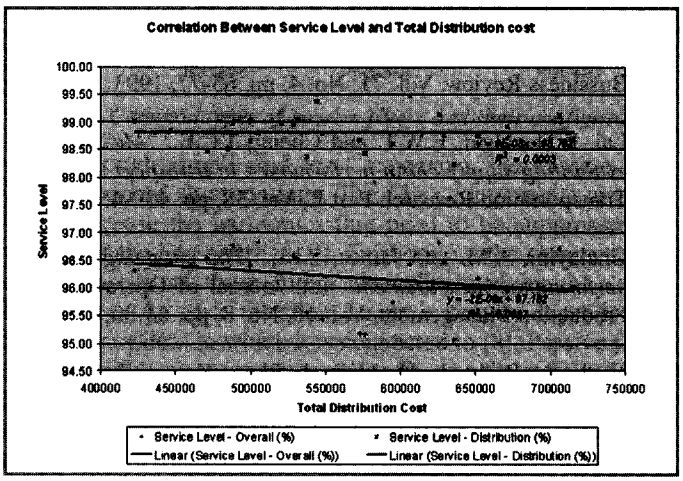

Figure 3: Correlation between service level and total distribution cost

If the service level is having neutral (if not negative) correlation with Total Distribution Cost, what are the factors that actually have an impact on the amount of money spent on delivery service?

5.0 CONCLUSION

The last issue which the authors wish to address and the company should to reconsider is to change the unit's performance measurement system. Most measurement systems were designed not for leaders but for accountants so that companies could report their financial results to shareholders and tax authorities. Same problem occurs in this company where the performance is judged by the sales revenue.

These systems were then inappropriately pressed into service to support management decision making, where for the most part they are useless. When the costs are high, sales are low, and profit is falling, then action is needed to overcome the situation. However, it is unclear what type of action the management should take.

Business are so complex and change so rapidly that gut feel for what is important is extraordinarily difficult to develop and impossible to maintain. There are relentless pressures to improve performance and to do so immediately. An organisation's measurement system should be able to reveal the sources of performance inadequacies.

The purpose of measurement is not to know how a business is performing but to enable it to perform better. To this end, a contemporary measurement system must have two basic features. First, all data must include a rationale and a purpose; people must know why things are measured, and more important, what they are supposed to do with them. Second, all measurement must be based on a careful analysis of the business, one that links the objectives of the business to the things over which managers and front-line personnel have control.

It is hope that by adopting the new performance measurement system, more staff will feel comfortable and less will feel threatened. ■

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