

Plant level performance measurement: an exploratory case study of a pharmaceutical encapsulation company

By: [Vidyaranya B. Gargeya](#)

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Abstract:

Over the last few decades, hundreds of books and articles have been written on performance measures in manufacturing companies. A good number of those works has focused on overall organizational performance at the corporate level, business unit performance, and individual performance. Barring a few studies, there has been very little work reported on what specific performance measures are used at the plant and department level at a manufacturing facility. This exploratory research, through a case study of a pharmaceutical encapsulation company addresses those issues. Results show that the managers use a wide variety of measures primarily for meeting corporate targets and implementing a gain-sharing plan. There are not many common measures of performance used by managers for decision-making. None of the managers specifically linked the performance measures to the competitive priorities of the products made at the plant. A few propositions and suggestions for future research are made in the paper.

Keywords: Performance measures | Plant performance | Case study | Pharmaceutical encapsulation company

Article:

1. Introduction

It has been well recognized that one of the important tenets of good manufacturing practice is the appropriate use of performance measures. There has been quite a bit of literature published in the form of books and articles on the subject of measuring performance in manufacturing companies. Measuring performance has existed from the time of building the pyramids. It has been well accepted that measuring performance impacts human behavior. Goldratt (1990) went so far as to say 'Tell me how you measure me, and I will tell you how I will behave' (p. 28). A lot of research has focused on organizational performance at the corporate and business unit level (Simons, 2000), and individual performance (Ilgen and Pulaskos, 1999). While performance

measures at the corporate and business unit level are more related to marketing and profitability (such as total sales growth, market share, return and investment, return on sales, etc.), individual performance measures are task and job related (individual worker efficiency and effectiveness, etc.). Ittner and Larcker (1998) provided a substantial account of the current research on performance measurement. The focus of this paper is performance measurement at the plant level.

It has been noted that a specific plant level performance measure could be computed in several different ways. For example, deviation from due date in some organizations is construed as the number of days of delay beyond the promised date to the customer. In some organizations, the same measure is computed as the deviation from the due date within a G2 day time window. Hence, it is imperative that not only should academics and practitioners understand what specific measures are used at the plant level, but also focus on how the computation (of the measure) is worked out.

Different individuals (in the plant) collect data on the performance and use it for different purposes. It is expected that some collect performance data for the purpose of improving competitiveness and customer satisfaction (on the dimensions of quality, delivery speed, delivery reliability, etc.), some collect it for cost control, some others for continuous improvement, etc. Hill (2000) strongly urged that performance measures should be linked to competitive priorities (in the form of order winners and qualifiers). It is important to find out the reasons why certain measures are used. Depending on the use to which the data is being put to, the frequency of the data collection also would change. It has been noted that some performance measures have goals and some may not have goals. It has been well recognized that managers place a higher importance on measures with goals than on those without. Hence, it is imperative to know which measures have goals and which do not.

Most of the studies (Dixon et al., 1990; Vokurka and Fleidner, 1995; Vora, 1992 to name a few) that have looked at plant level performance measures have focused on the issues of which performance measures are of importance to plant level managers and their (the managers') perceptions on whether improvement has been achieved on those measures. None of the studies have specifically asked plant level managers (in the quality, material management, production control, and such functions) which specific performance measures they use, how those measures are computed, why data on those measures is collected, which of the measures have specific goals, and who sets the goals for those plant level measures.

In this research, an exploratory case study approach is used to find out the answers to the above questions. Through focused interviews of the plant manager and 10 other managers from different departments at the plant level and study of company documents of ABC Company (name of the pharmaceutical encapsulation firm has been disguised to maintain confidentiality), this research attempts to create a framework for future research. This study, a first step on research on plant level performance measures, would lay the ground work for more multi-plant, multi-national, multi-industry comparisons. The next section provides a brief review of the literature on performance measures. Section 3 describes the research methodology and the company being studied. Section 4 presents the findings from the study and develops some propositions. Section 5 concludes with an agenda for future research.

2. Review of the literature

There has been a lot of research focused on financial and managerial accounting measures of an organization's performance. The recent work of Gunasekharan et al. (2003), Gupta and Galloway (2003) are just two examples (in a plethora of articles) that focus on using financial and cost based performance measures in manufacturing operations. Kaplan and Norton (1996), in a normative fashion, suggested the 'Balanced Scorecard' approach using financial and non-financial measures for competitive advantage. Over the last few years, a few organizations have been attempting to incorporate this method into their day-to-day operations. However, there are no systematic studies to find out the extent to which the 'Balanced Scorecard' approach has been implemented. Systematic and detailed study of non-financial plant level performance measures (such as quality, delivery speed, delivery reliability, flexibility, etc.) at the plant level is non-existent.

There has been some work done on finding out from plant level managers the extent to which they used, placed emphasis/importance on, and found improvements on specific plant level performance measures. Fry and Cox (1989), based on a case study of a manufacturing company that produces electrical switches and control, reported that the plant manager was primarily concerned with return on investment, the product managers were evaluated by due date performance (orders shipped on time), and shop floor supervisors and machine operators were evaluated by standard efficiency measures (units produced versus standard). Scudder and Hill (1998) identified 24 empirical (survey, case, database, and panel) studies published in the 1986–1995 period that have focused on performance and productivity. Of those studies, there are only six articles (Kenny and Dunk, 1989; Vora, 1992; Fry, 1995; Lockamy and Cox, 1995; Vokurka and Fleidner, 1995; Wisner and Siferd, 1995) that have specifically addressed plant level performance measures.

Kenny and Dunk (1989) reported on the usefulness of 42 measures of unit performance to 155 production managers from organizations that each employed more than 100 persons. Variance between planned 'output' and actual 'output', machine output rates, and machine down time were the top three performance measures in terms of usefulness.

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Fry (1995), through a survey study, reported on the results from eight plants (in Japan) of five Japanese companies. There were 13 respondents from top level management, 62 respondents from upper middle level management, 57 respondents from lower middle level management, and 75 respondents from direct labor operators in that study. The respondents were asked to identify the performance criteria used by them and relative importance of those criteria, the performance criteria by which they were individually assessed. The study showed that generally top level managers reported profit and loss, and middle (upper and lower) level managers and direct labor operators reported quality as their most important criteria.

Lockamy and Cox (1995), using a multiple case study of six manufacturing plants, collected detailed information on division and plant strategic objectives, performance measurement systems, and performance measurement system linkages. They identified seven principles of linking performance measurement systems to strategic objectives.

Vokurka and Fleidner (1995) reported how a company developed a measurement system based on strategic goals, combined financial and non-financial measures (such as cost of quality, variances in expenses, delivery, inventory turnover ratio, safety, expense reductions, physical inventory, cycle time, and profit contribution), and adapted to changes in conditions, strategies, and priorities. Wisner and Siferd (1995), through a questionnaire study of 132 plant level managers (who were subscribers of Modern Machine Shop), asked the importance they placed on 29 different performance measures related to costs, quality, delivery, flexibility, etc. The managers were not asked whether they specifically used/collected data on any of the measures. Dixon, Nanni, and Vollmann (1990) presented the findings of a multi-year, multi-company, field study on performance measurement. Findings included the results from several plants from each one of the companies. Their study primarily focused on the importance of 42 performance measures and how much emphasis is placed on the each of those measures.

Lockamy and Spencer (1998), using a case study approach, examined the application of a performance measurement system in one company that had adopted the Theory of Constraints (TOC) method since 1989. In their research, Lockamy and Spencer interviewed the division and plant staff members and found that in the TOC environment, the measurement system proposed does successfully link local performance measures to the global goals of the organization. They also stated that the performance measurement system (proposed in the firm that has implemented a TOC approach) enables managerial decisions to be made which promote the global utilization of organizational resources. Based on their findings in the firm studied, Lockamy and Spencer proposed that measures which are inconsistent with organizational goals must be eliminated prior to adopting TOC measures, and financial accounting systems are still required to complement the TOC performance measurement system.

Previous research on plant level performance measurement primarily focused on the importance that plant level managers placed on the different performance measures. None of the studies, barring the works by Fry and Cox (1989), Fry (1995), Lockamy and Spencer (1998), specified whether different measures were used (1) at different levels within the plant and (2) within different functions within the same organization/plant. In addition, no study in the past has focused on (1) how the measures are computed, (2) who collects data the measures and who uses them, (3) the reasons why the data on the measures are collected, (4) the frequency of collection of the data on the measures, (5) which of the measures have goals, and (6) who sets the goals for the measures. These are the research issues in the current study.

3. Research methodology

Most of the previous empirical works on performance measures have used a survey methodology with one respondent per organization/unit surveyed. Using this technique, previous research has compared how performance is measured, evaluated, and rewarded across organizations, divisions, and individuals. With this approach, an assumption is made that the single respondent

best represents the organization/unit being surveyed. Also, with the survey methodology, the respondents are asked to rate and/or rank the specific measures used in their organizations. In general, in the past work, the researcher has provided the respondent with the listing of the measures. With the list being provided to him/her, there is a good possibility that the respondent would check the measures irrespective of whether specific data is being collected on the measures or not. The current research uses a structured, open-ended, focused interview approach to capture the data.

This research is descriptive (as opposed to predictive and explanatory) and exploratory. Since little is known in terms of the specific non-financial plant level performance measures (such as quality, delivery speed, delivery reliability, flexibility, etc.) used in firms, that a case-based research methodology is appropriate at an exploratory stage of the research as noted by Flynn et al. (1990), McCutcheon and Meredith (1993), Meredith (1998). In general, case studies are the preferred strategy when 'how' or 'why' questions are posed and when the focus is on a contemporary phenomenon within some real-life context (Yin, 1994). The case-study methodology has the unique strength in its ability to deal with a full variety of evidence-documents, artifacts, interviews, and observations. A case study is an empirical investigation that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 1994). This condition is especially true in this investigation. The performance measures functional managers in a manufacturing company use at a plant level are very difficult to study independent of the context in which the issues evolve and transpire. Through a case study of one plant of a multinational pharmaceutical encapsulation company, the research has been carried out. Six sources of evidence are considered in a typical case study design (Yin, 1994). These are documentation, archival records, interviews, direct observation, participant-observation and physical artifacts. This research has been carried out by studying plant level documentation and structured and focused interviews (with the plant level executives) to develop a meaningful insight into the issues under investigation.

Structured and focused interviews (Merton et al., 1956) of the plant manager and every individual who directly reports to the plant manager were carried out in this research. Each of the managers in the focused interview (which lasted anywhere from 30 min to 2 h) were asked to respond to the following questions:

- (1) What measures do you use and come in contact with for making decisions?
- (2) How are the measures computed?
- (3) Who collects data on those measures and who uses them?
- (4) Why is the data on the measures being collected?
- (5) How frequently are the measures collected?
- (6) Which of the measures have goals?

(7) Who sets the goals for the measures?

Table 1
Order winners, qualifiers, order losing sensitive qualifiers for the products made at the manufacturing facility of the ABC company

Competitive priority	Pharmaceutical products	Nutritional products
Customer access to the ABC company and ABC company's communication with the customers	Qualifier	Qualifier
Delivery speed	Qualifier	Qualifier
Delivery reliability	Qualifier	Qualifier
Quality	Order-losing sensitive qualifier	Order-losing sensitive qualifier
Cost/price	Order winner (50%)	Order winner (100%)
Value adding services (supply chain services)	Order winner (50%)	

The same structured interview process was used for each of the interviewees. The researcher held an initial meeting with the plant manager and the other managers to describe the purpose of the research. At the meeting, it was clarified to the interviewees that the research was neither being funded by the company nor was it a consulting project. This enhanced the 'openness' and 'candidness' with which the interviewees responded to the questions. It was emphasized that the researcher was not interested in evaluating the performance of the plant. The responses by each of the interviewees were corroborated with documentation and responses from other interviewees. The managers (and their responsibilities are included in parentheses) included in the study are: Vice President and General Manager of Operations (overall plant management), Controller (financial and accounting reporting), Director of Manufacturing (production management), Safety and Environmental Administrator (regulatory requirements), Systems Analyst (maintenance of information systems), Associate Project Manager (new product introduction), Human Resources Manager, Director for Quality Control (chemical analysis and testing of quality of incoming materials and finished products and chemical analysis of new products), Director for Quality Assurance/Validation (measurement of yields and process quality), Director of Plant Engineering (maintenance of physical facilities and productivity improvement projects), and Materials Manager.

Table 2

Performance measures of interest to the vice president and general manager of operations (plant manager)

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	Yield	Percentage of capsules released (completed) compared to the capsules made (started and put into the system)	Director of manufacturing	Monthly	Yes. Plant manager in consultation with other managers in the plant and corporate headquarters sets the goals for the year	Analyzing the overall performance. Gain-sharing plan
2	Machine run time	Average number of hours per day each machine is making capsules	Director of manufacturing	Monthly	Same as item (1) above	Same as item (1) above
3	Expenses	Amount of money spent (on salaries, supplies, rent, electricity, etc.) in running the plant	Controller	Monthly	Same as item (1) above	Same as item (1) above
4	Raw material inventory turnover ratio	Ratio of cost of raw material in goods sold in the month to average raw material inventory value	Materials manager	Monthly	Same as item (1) above	Same as item (1) above
5	Schedule attainment	Percentage of orders released (completed) for shipment on before the scheduled (promised) date	Materials manager	Monthly	Same as item (1) above	Same as item (1) above
6	Safety	Worker days lost due to accidents/injury	Safety and environmental administrator	Monthly	Same as item (1) above	Same as item (1) above
7	Returns	Number of lots rejected by customers for quality defects	Director (quality assurance/validation)	Monthly	Same as item (1) above	Same as item (1) above
8	Waste	Value of all material the plant throws away, gel loss, rejects, and disposal fee	Controller	Monthly	Same as item (1) above	Gain-sharing plan
9	Net reclaim	Amount of money saved by recycling gel netting	Controller	Monthly	Same as item (1) above	Gain-sharing plan
10	Environmental citations	Number of environmental citations served by the city and local government	Safety and environmental administrator	Monthly	Yes. Should have zero violations. State mandated	State mandated

The plant manufactures both pharmaceutical (prescription and over-the-counter) and nutritional products. Each of the two product groups has different set of order winners (OWs); however, the qualifiers (Qs) and order losing sensitive qualifiers (QQs) are similar. The competitive priorities (in the form of order winners, qualifiers, and order losing sensitive qualifiers) as per Hill (2000) for the products are given in Table 1.

4. Findings and propositions

Data was collected from 11 managers (including the Plant Manager). Nine out of 11 managers do make use of specific performance measures. Summaries of the findings from the nine managers are presented in Tables 2–10. The Plant Manager (Vice President and General Manager of Operations) is interested in the maximum number of measures (10 in number). He is interested in financial measures (such as expenses) and non-financial measures (such as schedule attainment, environmental citations, machine run time, etc.). Most of the managers (nine out of 11) are interested in at least one measure for performing their work. The frequency of usage of measures seen in Tables 2 and 10 leads us to the following proposition:

Proposition 1. The Plant Manager and the Controller make use of the most number of performance measures in their day-to-day activities.

Many of the managers make use of the measures on a monthly basis for making decisions. For the measures that have goals, the goals are assessed and revised annually. Most of the managers at the ABC Company are aware of which manager is responsible for collecting the data on which measure. For many of the measures, they were consistent in their understanding of the specific computations of the measures. There is slight discrepancy in whether schedule attainment is percentage of orders released (completed) for shipment on or before the scheduled (promised) date or percentage of orders released (completed) for shipment on or before the scheduled (promised) date G2 days. This indicates that if one department was using the former computation and another department was using the latter, then data across departments would be inconsistent. This underscores the fact that it is imperative that survey research (that uses single respondent per firm approach) on performance measures should be validated with two or more respondents from each firm. It has also been found with the structured interview approach carried out in this research that operations management terminology on performance measures (on due date performance, process quality and yields, etc.) does not transcend industries and sometimes even plants within the same company.

Table 3
Performance measures of interest to the controller

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	Units sold	Number of capsules sent to customers	Corporate headquarters (sales)	Monthly	Yes. Corporate headquarters sets the goals for the year	Reporting to corporate headquarters
2	Net sales	Value of capsules sent to customers based on standard	Same as item (1) above	Monthly	Same as item (1) above	Same as item (1) above
3	Expenses	Expenses incurred in each department	Compiled by the controller and verified by each head of the department	Monthly	Yes. Plant manager sets the goals in consultation with other managers (heads of departments) in the plant for the year	Same as item (1) and gain sharing plan
4	Yield	Percentage of capsules released (completed) compared to the capsules made (started and put into the system)	Director of manufacturing	Monthly	Same as item (3) above	Reporting to corporate headquarters and for gain sharing plan
5	Number of employees	Number of employees, budgeted and actual (regular and temporary) in each department	Other managers (heads of departments) in the plant	Monthly	Same as item (3) above	Same as item (1) above
6	Efficiency	Ratio of total production hours to total scheduled hours	Director of manufacturing	Monthly	No	Same as item (1) above
7	Waste	Value of all material the plant throws away, gel loss, rejects, and disposal fee	Data is provided by director (assurance/validation) and materials manager	Monthly	Same as item (3) above	Same as item (1) and gain sharing plan

Table 4
Performance measures of interest to director of manufacturing

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	Machine run time	Ratio of total capsules made by standard fill rate	Shift supervisors	Shift-wise, daily, and weekly	Yes. Plant manager in consultation with director of manufacturing and corporate headquarters sets the goals for the year	Achieving goals set for the plant and gain sharing plan
2	Machine lost time	Difference between scheduled run time and machine run time	Shift supervisors	Shift-wise, daily, and weekly	No. Ideally the machine lost time needs to be minimized	For corrective action
3	Number of machines worked	Number of machines worked	Shift supervisors	Shift-wise, daily, and weekly	No. Ideally the number of machines worked needs to be maximized	For planning and corrective action
4	Average revolutions per minute (RPMs)	Average number of revolutions per minute per machine. The data is collected at a machine level	Shift supervisors	Shift-wise, daily, and weekly	No. Ideally the number needs to be maximized	For corrective action
5	Number of capsules made	Number of softgels made	Shift supervisors and director of manufacturing	Weekly	Same as item (1) above	Achieving the goals set for the plant
6	Yield	Percentage of capsules released (completed) compared to the capsules made (started and put into the system)	Director of manufacturing compiles the data based on the information provided by the Shift Supervisors and director (quality assurance/validation)	Weekly	Same as item (1) above	Same as item (1) above

In all, 24 different performance measures are used/computed by the nine different managers at the ABC Company. Table 11 enumerates the 24 measures. Four different managers are interested in yield. Three managers are interested in schedule attainment. 22 measures are made use of by two or less managers. In fact, 14 measures are of interest to one manager apiece. Most of the performance measures are of interest to two or less managers. This indicates that not all measures are of interest to all managers. Not many managers are interested in three or more measures. This is consistent with the findings of the Fry and Cox (1989) study that the plant manager was primarily concerned with return on investment, the product managers were evaluated by due date performance, and shop floor supervisors and machine operators were evaluated by standard efficiency measures. The above discussion leads to the following propositions:

Proposition 2. There are very few performance measures that interest more than four managers at the plant level.

Proposition 3. Most managers (below the rank of plant manager) are interested in four or less measures.

Table 5

Performance measures of interest to the human resources manager

Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1 Employee turnover	Ratio of number of employees deceased/laid off/dismissed/resigned to the number of employees at the beginning of the period	Human resources manager	Monthly	No	Improvement. Reporting to corporate headquarters (for the human resources dash board)
2 Employee absenteeism	Number of employees absent	Compiled by the human resources manager from the data provided by other managers (heads of departments) in the plant	Monthly	No	Same as item (1) above
3 Demographics by age, race, and gender	Employee back ground on age, race, and gender	Human resources manager	Yearly	No	Affirmative action

Table 6

Performance measures of interest to the director (quality assurance/validation)

Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1 Yield	Percentage of capsules released (completed) compared to the capsules made (started and put into the system)	Quality assurance personnel working on a shift basis	Daily	Yes. Plant manager sets the goals in consultation with other managers (heads of departments) in the plant and the corporate headquarters for the year	Continuous improvement and gain sharing plan
2 Number of defectives (rejects)	Number of rejects as visually checked by quality assurance personnel	Same as item (1) above	Daily	No	Continuous improvement
3 Customer complaints	Number of customer complaints on quality	Director (quality assurance/validation)	Monthly	No	Corrective action and gain sharing plan

Table 7

Performance measures of interest to the director of plant engineering

Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1 Temperature of facility	Temperature of the facility as recorded by the air conditioning units	No formal data collection	Continuously monitored	No	Health and safety preventive maintenance
2 Air quality	Air quality at the facility	Technicians	Daily	No	Same as item (1) above

Dixon et al. (1990), Wisner and Siferd (1995) asked managers to rank on 39 and 29 plant level performance measures, respectively, in terms of their importance. Of the ones in the top five (finished-goods quality, on-time deliveries, total job costs, work-in-process quality, and operator productivity) of the Wisner and Siferd (1995) study, work-in-process quality (if yield could be taken as a surrogate for that dimension) and on-time deliveries (in the form of schedule attainment) were identified by four and three managers (in the current study), respectively, as a measure of interest to them. Top level managers, middle level managers, and supervisors ranked

on-time delivery either as the most important or the second most important measure in the Dixon, Nanni, and Vollman (1990) study (p. 86). Expenses (taken as a composite and not on a per job basis) and finished goods quality (in the form of returns from customers) are of some interest to managers at ABC Company. It is interesting to note that managers at the ABC Company plant are not interested in individual operator productivity as a performance measure. As per the managers in this study, 15 of the measures have goals and 9 do not. For most the measures (for which goals exist), the goals are set by the plant manager in consultation with the other managers at the plant and the corporate headquarters.

Table 8
Performance measures of interest to the materials manager

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	Raw material inventory turnover ratio	Ratio of annual cost of goods (based on 3 periods average) to average value of inventory (3 periods average)	Materials manager	Monthly	Yes. Plant manager in consultation with the materials manager and the corporate headquarters sets the goals for the year	Gain-sharing plan. Financial performance. Continuous improvement
2	On-time delivery (schedule attainment)	Percentage of shipments made on before the scheduled (promised) date in the period to total number of shipments made for the period	Materials manager	Monthly	Same as item (1) above	Customer satisfaction. Gain sharing plan. Continuous improvement
3	Cycle count (inventory accuracy)	Ratio of number of items with actual number on hand matching the number reported in the books to the total number of items counted	Materials manager	Monthly	Same as item (1) above	Continuous improvement

Table 9
Performance measures of interest to the associate project manager

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	On-time delivery	Number of orders delivered on the promise date (\pm two days)	Associate project manager (for new products)	Monthly	The overall goal for all orders is set by the plant manager in consultation with other managers (heads of departments) in the plant for the year. There is no separate goal for new products on on-time delivery	Achieving the goals for the plant and the gain sharing plan

Table 10
Performance measures of interest to safety and environmental administrator

	Performance measure	Computation	Data collected and reported by	Frequency of data collection and analysis	Does the measure have a goal? Who sets the goal? How frequently is the goal revised?	Purpose of collecting the measures
1	Number of worker days lost	Number of worker days lost due to accidents/injuries	Safety and environmental administrator	Monthly	Yes. Plant manager in consultation with Safety and Environmental Administrator	Achieving goals set for the plant and for the gain sharing plan
2	Worker compensation premiums paid	Amount of money paid out for insurance premiums of worker compensation for accidents/injuries	Safety and environmental administrator	Monthly	No	For planning purposes in the future

Table 11
Performance measures of interest to managers

	Performance measure	Number of managers interested in the performance measure	Number of managers for which the measure has a goal
1	Yield	4	4
2	Machine run time	2	2
3	Expenses	2	2
4	Raw material inventory turnover ratio	2	2
5	Schedule attainment (on-time delivery)	3	3
6	Safety (worker days lost due to accidents/injury)	2	2
7	Returns	2	2
8	Waste (including scrap, gel loss, etc.)	2	2
9	Net reclaim	1	1
10	Environmental citations	1	1
11	Units sold	1	1
12	Net sales	1	1
13	Number of employees (by department/age/race/gender)	2	1
14	Machine lost time/efficiency	2	0
15	Number of machines worked	1	0
16	Average revolutions per minute (average RPMS)	1	0
17	Number of capsules made	1	1
18	Employee turnover	1	0
19	Employee absenteeism	1	0
20	Number of defectives (identified in the plant)	1	0
21	Temperature of facility	1	0
22	Air quality	1	0
23	Cycle count (inventory) accuracy	1	1
24	Worker compensation premiums paid due to injury	1	0

Table 12
Purposes of collecting performance measures

	Manager	Number of performance measures (number of measures that have goals)	Number of performance measures (number of measures with goals) with the given purpose									
			Analyzing overall performance	Gain sharing plan	State mandated	Report to corporate office	Achieving goals	Corrective action	Continuous improvement	Customer satisfaction	Health and safety	Planning/preventive action
1	Plant Manager	10 (10)	7 (7)	9 (9)	1 (1)							
2	Controller	7 (6)		3 (3)		7 (6)						
3	Director of manufacturing	6 (3)		2 (2)			3 (3)	3 (0)				1 (0)
4	Human resources manager	3 (0)			1 (0)	2 (0)			2 (0)			
5	Director (quality assurance/validation)	3 (2)		2 (2)				1 (1)	2 (1)	1 (1)		
6	Director of plant engineering	2 (0)									2 (0)	2 (0)
7	Materials manager	3 (3)	1 (1)	2 (2)					3 (3)	1 (1)		
8	Safety and environmental administrator	2 (1)		1 (1)			1 (1)					1 (0)
9	Associate project manager	1 (1)		1 (1)			1 (1)					
10	Director (quality control)	0										
11	Systems analyst	0										

Different managers have identified different reasons for collecting the data for the measures. Table 12 summarizes the purposes why the managers are interested in the measures of performance. A majority of the managers (6 out of the 9 managers who use the measures) stated that the gain sharing plan to be the primary reason for collecting data. The primary reason advanced by the Controller for the six measures he collects is to report to corporate headquarters. Thus the next two propositions:

Proposition 4. Most of the measures that have goals are driven by gain sharing plans.

Proposition 5. Measures of interest to the Controller are driven by the corporate office.

The Director of Manufacturing, Materials Manager, Director (Quality Assurance/Validation), Human Resources Manager, and Safety and Environmental Administrator are interested in some of the performance measures for corrective action, continuous improvement, and preventive action. Contrary to what has been prescribed by Lockamy and Cox (1995), none of the managers (on their own) stated that the purpose of the measures is to improve competitiveness (in terms of order winners and qualifiers). The Materials Manager and the Director (Quality Assurance/Validation) were the only two managers who identified the purpose behind one of the measures they were interested in was customer satisfaction. For many of the managers, customer satisfaction did not appear on their 'radar' screens. This is the basis for the last proposition:

Proposition 6. Enhancing customer satisfaction is the reason for collecting the measures for only those managers (such as materials manager and quality manager) who come in contact with customers.

5. Conclusions

This paper is a preliminary effort in a stream of research on understanding more on plant level performance measures. Rather than taking an approach of aggregating the responses from a wide variety of industries, this research focuses on an in-depth study of one pharmaceutical encapsulation company. The study has thrown some light on which managers (at the plant level) use which measures for their decision-making. It has been found that most managers at a plant level do not use a substantial number of performance measures. As expected, the plant manager is the one who is interested in the most number of measures. Most of the managers do not use more than 3–4 measures. Even though 24 measures have been identified in this study, very few measures have been of interest to more than two managers. Future research needs to address whether this is true for other plants and other industries.

The current study has shown that the root sources of most of the data on plant level performance measures are the personnel in manufacturing, quality assurance, and materials management. Most of that information is primarily used by the Plant Manager and the corporate headquarters. Many of the managers are interested in the specific plant level measures primarily for executing the gain sharing plan. It appears from this study that very few managers at the plant level link the performance measures to competitive priorities (in the form of order winners and qualifiers). This study has shown that different managers are interested in the same performance measure aggregated over different time periods. For example, the yield ratio is used by the Plant Manager on a monthly basis and the same ratio is used by the Director of Manufacturing on a weekly basis to make decisions. It has also been found from this study that not all measures have goals. It is important that these findings be substantiated in other settings. Also, it would be interesting to find out whether the findings from this in-depth single plant case study would be true in plants in other countries. Hence, a more comprehensive study is being planned to include several more plants (spread in five different countries in three continents) within the same company. Future research is also planned to replicate this study in other industries (such as computer equipment manufacturing, steel making, etc.). The study reported in this article has provided some food for thought in terms of six propositions on plant level performance measurement. Future research should test these propositions with an expanded study.

Previous research from the human resource perspective has shown that organizational culture plays a role in performance. An extension of the current study is to find whether organizational culture has an impact on the selection of performance measures. This could be accomplished by studying the plants within the same company as well as plants outside the company but within the same industry.

There is a limitation in this research. The data collected for this research is cross-sectional in nature. That is, the performance measures gathered are at one point in time. The bigger question is, do performance measures change over time? Hence, it is imperative that a longitudinal study be undertaken to address that issue.

References

- Dixon, J.R., Nanni Jr., A.J., Vollmann, T.E., 1990. *The New Performance Challenge: Measuring Operations for World-Class Competition*. Dow Jones-Irwin, Homewood, IL.
- Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A., Flynn, E.J., 1990. Empirical research methods in operations management. *Journal of Operations Management* 9 (2), 250–284.
- Fry, T.D., 1995. Japanese manufacturing performance criteria. *International Journal of Production Research* 33 (4), 933–954.
- Fry, T.D., Cox, J.F., 1989. Manufacturing performance: Local versus global measures. *Production and Inventory Management Journal* 30 (2), 52–57.
- Goldratt, E.M., 1990. *The Haystack Syndrome: Sifting Information Out of the Data Ocean*. North River Press, Croton-on-Hudson, NY.
- Gunasekharan, A., Williams, H.J., McGaughey, R.E. (2003). Performance measurement and costing system in new enterprise. *Technovation* (In Press, Corrected Proof, Available online 18 November 2003).
- Gupta, M., Galloway, K., 2003. Activity-based costing/management and its implications for operations management. *Technovation* 23, 131–138.
- Hill, T., 2000. *Manufacturing Strategy*, third ed. The McGraw-Hill Companies, Inc., New York, NY.
- Ilgen, D.R., Pulaskos, E.D. (Eds.), 1999. *The Changing Nature of Performance*. Jossey-Bass, Inc., San Francisco, CA.
- Ittner, C.D., Larcker, D.F., 1998. Innovations in performance measurement: Trends and research implications. *Journal of Management Accounting Research* 10, 205–239.
- Kaplan, R.S., Norton, D.P., 1996. *The Balanced Scorecard*. Harvard Business School Press, Boston, MA.

- Kenny, G.K., Dunk, A.S., 1989. The utility of performance measures: Production managers' perceptions. *IEEE Transactions on Engineering Management* 36 (1), 47–50.
- Lockamy III., A., Cox, J.F., 1995. An empirical study of division and plant performance measurement systems in selected world class manufacturing firms: Linkages for competitive advantage. *International Journal of Production Research* 33 (1), 221–236.
- Lockamy III., A., Spencer, M.S., 1998. Performance measurement in a theory of constraints environment. *International Journal of Production Research* 36 (8), 2045–2060.
- McCutcheon, D.M., Meredith, J.R., 1993. Conducting case study research in operations management. *Journal of Operations Management* 11 (3), 239–256.
- Meredith, J., 1998. Building operations management theory through case and field research. *Journal of Operations Management* 16, 441–454.
- Merton, R.K., Fiske, M., Kendall, P.L., 1956. *The Focused Interview*. The Free Press, Glencoe, IL.
- Scudder, G.D., Hill, C.A., 1998. A review and classification of empirical research in operations management. *Journal of Operations Management* 16 (1), 91–101.
- Simons, R., 2000. *Performance Measures and Control Systems for Implementing Strategy: Text and Cases*. Prentice Hall, Inc., Upper Saddle River, NJ.
- Vokurka, R., Fleidner, G., 1995. Measuring operating performance: A specific case study. *Production and Inventory Management Journal* 36 (1), 38–43.
- Vora, J.A., 1992. Productivity and performance measures: Who uses them?. *Production and Inventory Management Journal* 33 (1), 46–49.
- Wisner, J.D., Siferd, S.P., 1995. A survey of US manufacturing practices in make-to-order machine shops. *Production and Inventory Management Journal* 36 (1), 1–7.
- Yin, R., 1994. *Case Study Research: Design and Methods*. SAGE Publications, Thousand Oaks, CA.