Performance Assessment and Efficiency Analysis for a Material Processing Center

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Abstract

This paper presents research conducted with a government operated material processing center (MPC). The objective of the study was to analyze the efficiency of the MPC. An outcome of the research study yielded a detailed analysis of the MPC and a performance measurement analysis that identified specific areas for process improvement. A review of distribution performance metrics was analyzed for the research project as well. Performance metrics for the MPC were identified and utilized in the construction of a balanced scorecard. The findings of this analysis concluded the need for material handling/flow improvements at the MPC. It was also determined that using a balanced scorecard approach incorporating critical MPC performance metrics was found to be a beneficial tool for improving the operations at the MPC.

Keywords

Performance Measurement, Balanced Scorecard, Efficiency Analysis

1. Introduction

The purpose of this research project was to analyze the ongoing operations within Government Operated Material Processing Centers (MPC), and to identify improvement opportunities. One of the primary objectives of the project was to identify the critical metrics which would be used as performance indicators for process improvement. A performance measurement system using Kaplan and Norton's balanced scorecard approach was developed to recommend process improvement changes for the operation based on measurable performance criteria.

For our team to better understand the operation of the MPC, a thorough analysis of the efficiency of such support to customers is necessary. Examination of the strategic, tactical, and operational effectiveness of the MPC's design and operation provide insight into process improvements and recommendations. Such areas of improvements may be beneficial for other government operated MPCs located across the United States. In order to engage in the research process, one MPC facility (MPC/VA) was selected for evaluation. The primary focus for our research project was to examine the current policies and procedures of the MPC/VA. In particular, we focus on how the MPC receives incoming material, stores materials, conducts order picking, and organizes sortation. The MPC/VA facility supplies its customers commercial repair parts, clothing and textiles, medical supplies, and industrial electronic components. The center serves customers of the United States as well as customers across the globe. Within the 325 million cubic feet of MPC storage space, the MPC/VA serves the eastern portion of the United State's distribution operations.

This research paper presents the findings of the research team during observations, interviews, and data analysis for the MPC project. The team's methodology, resources, and collected data have been summarized within this document and may be applied to future project phases or as a source of system documentation. The conclusion of this paper provides a listing of critical metrics used in a balanced scorecard which proved to be an effective tool for process improvement for the MPC/VA facility.

2. BSC Performance Measurement Method

Using previously published work (Youngblood and Collins, 2002 and 2003; Dhodapker, 1999; English, Landers and Mendoza, 1998) we identified recommendations for process improvement change based on measurable performance criteria. Such criteria are often referred to as performance metrics and may be applied to various industries. Metrics may be established to more specific areas of an industry in order to gain a better understanding of the effectiveness of a process.

To measure the performance of a system, it is important to define the system in question and to identify variables of interest. For this project, it was desired to identify metrics for the distribution center process. Our team initially identified metrics of possible application to the MPC and the current system. The initial list of metrics contained thirty-five applicable performance metrics. The initial metrics are listed below in Tables 1 through 4.

Based upon this compilation of initial metrics, the personnel at the MPC assisted in the determination of which metrics are pertinent in measuring the performance of the MPC system. We reduced the metrics to a smaller listing based upon knowledge of similar operations (see Table 5). In order to decrease the number of possible metrics, the team prioritized the initial listing of performance metrics. The metrics are classified by group/subgroup, units, and supply chain phase (S, D, T, R, F where S = Sourcing, D = Distribution, T = Transportation, R = Reverse Logistics, and F = Full Stream). The metrics are typical to the distribution industry and measure the performance of the critical metrics in a distribution system.

Table 1. Balanced Scorecard Financial Perspective Metrics

SUBGROUP	Metric	Units	S	D	T	R	F
COST	Cost Per Transaction	Cost/Transaction	S	D	T	R	
	Material Hdlg. Rate	Mat. Hdlg. Expense/Mat. Hdlg. Asset Value	S	D	T	R	
	Inventory on Hand	Cost of Inventory by Location	S	D		R	

Table 2. Balanced Scorecard Cycle Time Perspective Metrics

SUBGROUP	Metric	Units	S	D	T	R	F
DISTRIBUTION & FILLING	Cycle Sub-time-Distribution	Distribution/Filling Time	S	D	T		
	Fill Rate	#Lines Filled/#Lines Requested in Order		D			
	Stock-to-Non-Stock- Ratio	% Material Shipped by Regular Stock		D			
FULL STREAM	Cycle Time-Total (Full Stream)	Elapsed Time Order Entry (Material Available & Visible in Computer)					F
	Days in Inventory by Item	Units in Inventory/Average Daily Usage	S	D	T	R	F

Table 3. Balanced Scorecard Resource Perspective Metrics

SUBGROUP	Metric	Units	S	D	T	R	F
PRODUCTIVITY	Pack Rate	Distribution/Filling Time	S	D	T		
	Pick Rate	#Lines Filled/#Lines Requested in Order		D			
	Receiving Rate	% Material Shipped by Regular Stock		D			
	Shipments per Associate or Emp.	Elapsed Time Order Entry (Material Available & Visible in Computer)					F
UTILIZATION	Shipping Rate	Units in Inventory/Average Daily Usage	S	D	T	R	F
	Time to Unload Trailer	Time to Unload/Item			T		
	Asset Utilization	Capacity Used/Capacity Available	S	D	T	R	
	Labor Utilization	Total Used/Total Planned	S	D	T	R	
	Ratio of Inbound to Outbound	Inbound Transactions/Outbound Transactions		D	T		

Table 4. Balanced Scorecard Quality Perspective Metrics

SUBGROUP	METRIC	UNITS	S	D	T	R	F
DEFECT-FREE	Claims Ratio	# Shipment Claims/Total Shipments			T		
	Complete Orders	#Complete Orders/Total Orders		D			
	Correct Destination	#Orders Delivered to Correct Dest./Total Orders			T		
	Perfect Order	#Perfect Orders/Total Orders					F
	Quantity Correct	#Orders with Correct Quantity/Total Orders	S	D			
	Return Percentage	#Shipments Returned/Total Shipments	S	D	T		
INFORMATION INTEGITY	Data Entry Accuracy	#Errors/#Transactions	S	D	T	R	
	Document Accuracy	#Orders with Accurate Documentation/Total Orders	S	D	T	R	
	Forecast Accuracy	MAD, MSE, Bias	S	D	T	R	
	Inventory Accuracy	%Stock Parts Same Contents Quantity/Items As Records	S	D		R	
	Record Accuracy	#Erroneous Records/#Records	S	D	T	R	
	Tracking Accuracy	#Entries in Known Status/Total Entries	S	D	T	R	F
ON-TIME	On-Time Delivery	#On-time Deliveries/Total Orders			T		
	On-Time Entry(System)	#On-Time Entries/Total Orders	S	D	T		
	On-Time Loading	#On-Time Loading/Total Orders	S	D	T		
	On-Time Marshalling	#Orders Ready on Time/Total Orders		D			
	On-Time Pick-up	#On-Time Pick-ups/Total Orders			T		
	On-Time Put-Aways	#On-Time Put-Aways/Total Orders		D			

Table 5. Sample Performance Metrics

Subgroup	Metric	Units	S	D	T	R	F
Financial Group							
Cost	Inventory On Hand	Cost of inventory by location	S	D		R	
Quality Group							
Defect-Free	Quantity Correct	#Orders with correct quantity/total orders	S	D			
	Return Percentage	#Shipments returned/total shipments	S	D	T		
Information Integrity	Data Entry Accuracy	#Errors/#transactions	S	D	T	R	
	Inventory Accuracy	%Stock pts same contents quantity/items as records	S	D		R	
	Tracking Accuracy	#Entries in known status/total entities	S	D	T	R	F
Percent Making Cut-off	Same day delivery	Fraction of items shipped same day delivery					
On-Time	On-time delivery	#On-time deliveries/total orders			T		
Cycle Time Group							
Distribution/Filling	Fill rate	#Lines filled/#lines requested in order		D			
Full Stream	Cycle time-total (full stream)	Elapsed time order entry					F
Resource Group							
Productivity	Pick Rate	Pieces/person-hr, lines/person-hr, orders/person-hr		D			
	Time to Unload Trailer	Time/Piece			T		
Utilization	Labor Utilization	Total used/total planned	S	D	T	R	

One particular metric to note is the *Percent Making Cut-Off* metric that will document the fraction of materials that are shipped the same day. This metric is considered to be a customer centered metric by measuring the facility's customer service in shipping. Applying this metric in assessing a distribution center's shipping record and improving performance may also lead to an improved customer service level.

MPC/VA personnel further analyzed the condensed version of the metrics list after the assessment. Our goal was to have a concise listing of 8-12 metrics for the finalization of the list. The final performance metrics were generated based upon past and present data and further validated by additional observations and data collection. We used the current illustration of metrics to generate MPC/VA specific metrics. Informative feedback by MPC/VA personnel as well as site observations facilitated the identification of the MPC specific metrics.

The traditional method of performance measurement focused on historical accounting data and was an inefficient planning tool for the determination of future performance. Kaplan & Norton (1992) developed four different perspectives from which a company's activity can be evaluated by performance metrics:

- Financial perspective – "How do we view our shareholders?"
- Customer perspective – "How do we view our customers?"
- Process perspective – "In what processes should we excel to succeed?"
- Learning and innovation perspective – "How do we maintain our ability to continually improve?"

A balanced score card is applicable for the MPC to monitor relevant performance metrics for the operation. A balanced scorecard application is helpful in identifying the goals and expectations of a center's performance. The balanced score card is designed to incorporate pertinent operation performance measures, which are assigned weights for evaluation. The performance measures as well as the weights should be decided upon through collaboration between key decision makers in order to ensure that there is an agreement upon common expectations and levels of importance.

Assigning weights to the categories of the scorecard should yield balanced values for the metric subgroups. In the *sample* MPC scorecard (Table 6), the four subgroups have been assigned a weight of 0.25 each. Furthermore, a metric weight should be assigned to the metrics that make up the subgroup. The sum of these assigned weights should be equal to one and may be adjusted as goals shift or as decision makers deem necessary.

Table 6: Sample MPC Balanced Scorecard

Subgroup	Metric	Metric Weight
Financial Perspective	**Category Weight = 0.25**	
Cost	Inventory On Hand	0.5
	Cost per Transaction	0.5
Customer Perspective	**Category Weight = 0.25**	
Defect-Free	Quantity Correct	0.15
	Return Percentage	0.1
Information Integrity	Data Entry Accuracy	0.1
	Inventory Accuracy	0.1
	Tracking Accuracy	0.2
Percent Making Cut-off	Same day delivery	0.15
On-Time	On-time delivery	0.2
Internal/Business Perspective	**Category Weight = 0.25**	
Distribution/Filling	Fill rate	0.2
Storage Dwell Time	Time in Storage	0.5
Full Stream	Cycle time-total (full stream)	0.3
Learning/Growth Perspective	**Category Weight = 0.25**	
Productivity	Pick Rate	0.35
	Time to Unload Trailer	0.3
Utilization	Labor Utilization	0.35

The current weights assigned to the metrics were assumed to be proportionate with the goals of the MPC. The Financial subgroup cost metrics were assigned equal weights, since only two metrics were identified. The other subgroup metrics were examined and assigned weights, which were assumed to be representative to the importance of the particular metric. Based upon the analysis of the data and the review of relevant literature, the team has presented their findings and recommendations in the following section.

4. Conclusions

The categorization and sorting of performance metrics contributed to the development of a balanced scorecard system for the MPC/VA. Initial performance measures were identified and pared down to a set of critical metrics for the scorecard. Weighting factors were established through a selection process using experts from the MPC/VA facility.

The implementation of other project objectives such as monitoring the performance of cost models developed in the project for the MPC/VA, material handling assessment and performance, and the need for facility re-engineering activities could be driven from the results of the balanced scorecard. Such implementations may be monitored by use of the provided metrics and balanced scorecard shown in Table 6 above. This will provide measurable performance criteria for the process as well as a basis of comparison to past performance of the system. The metrics may also be refined for the analysis of specific MPC tasks and used for comparison of the MPC/VA to other MPC locations.

References

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