

Hierarchy of Manufacturing Metrics: Connect Manufacturing and Supply Chain Performance

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By: Simon Jacobson

Initiatives: [Manufacturing Strategy](#); [Supply Chain Transformation](#)

Manufacturing strategy leaders are challenged to measure productivity while supporting optimized business performance. Use this Hierarchy of Manufacturing Metrics as a framework to identify, create and deploy a portfolio of metrics for a complete view of operational performance.

Overview

Key Findings

- The importance of manufacturing operations' role in supporting multiple business models and the increasingly variable customer demand — atop increasing complexities of different product portfolios, markets and assets — makes it critical to have the right set of metrics in place.
- Mounting pressures to optimize costs, improve flexibility and manage complexity in manufacturing operations surface the need for a consistent way of managing performance.
- Often, companies have an abundance of metrics and objectives. Friction occurs from metrics and objectives that are inconsistently defined and categorized and not aligned with one another.
- Manufacturers face difficulty identifying the right metrics, understanding their interdependencies and knowing where to focus to accurately portray production's contribution to overall supply chain performance.

Recommendations

- Use the Hierarchy of Manufacturing Metrics to identify and align key metrics by focusing on those that boost productivity without increasing costs or hurting service levels.
- Eliminate inconsistencies and redundancies regarding the volume, type and calculation of metrics by mapping your current metrics to the categories in the Hierarchy of Manufacturing Metrics.
- Create alignment and balance between manufacturing operations and supply chain objectives by setting targets based on defined objectives and value drivers. This requires identifying and managing the interdependencies between metric categories and submeasures.
- Focus on achievement of target first and then initiate root cause analysis to understand any barriers to achieving goals, and do not use raw data to compare metrics across plants. Rather than striving for best-in-class performance across all operational measures.

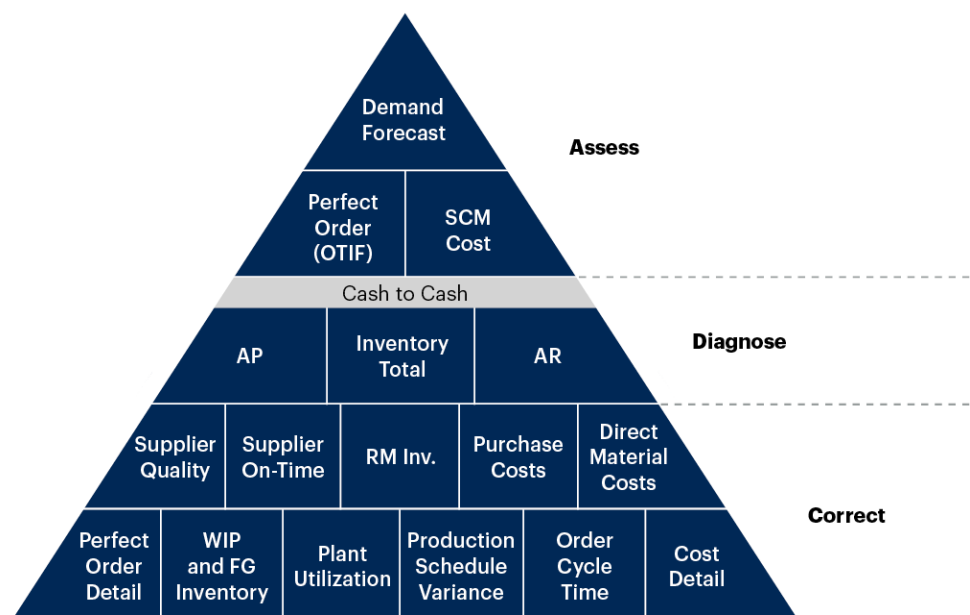
Introduction

Organizations are striving to improve their understanding of how to use metrics to improve service levels and simplify, integrate and, ultimately, optimize operational output. Doing so paints a clearer picture of manufacturing's contribution to the intended outcomes of the end-to-end supply chain. An inability to achieve this can result in a costly, suboptimized, push-driven operation that does not achieve the desired outcomes.

The Hierarchy of Supply Chain Metrics is a portfolio of the right metrics that companies can use to help optimize end-to-end supply chain outcomes by more effectively managing performance (see [Hierarchy of Supply Chain Metrics: Focus on Key Metrics to Improve Operational Trade-Off Decisions](#)). That portfolio, shown in Figure 1, contains metrics spanning multiple supply chain functions — plan, source, make and deliver.

Figure 1: The Gartner Hierarchy of Supply Chain Metrics

The Gartner Hierarchy of Supply Chain Metrics



Source: Gartner
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Gartner

The bottom layer of Figure 1 can be used to describe, at a high level, manufacturing's contribution to supply chain performance. For example, low "plant utilization" can result from high production schedule variance. This, in turn, can be caused by poor forecasting (which is then poorly translated into work orders), supply variability (e.g., suppliers' inability to provide raw materials or intermediate products to a site) or manufacturing variability (e.g., unplanned downtime). Beyond this point, determining the ultimate root cause of the low plant utilization problem requires a deeper set of metrics specific to manufacturing operations.

The Right Metric Categories for Manufacturing

Often, companies have an abundance of metrics for managing operational health/performance, but these are either inconsistently defined or not aligned with one another — let alone the supply chain. In other instances, organizations have narrowly focused on a small set of metrics, such as cost, quality or overall equipment effectiveness, which alone do not tell the full story of manufacturing's performance. While it is useful to understand the performance of each metric, it's very hard to take action in isolation. It's the relationships and interdependencies between the categories of metrics and their submeasures that make metrics actionable.

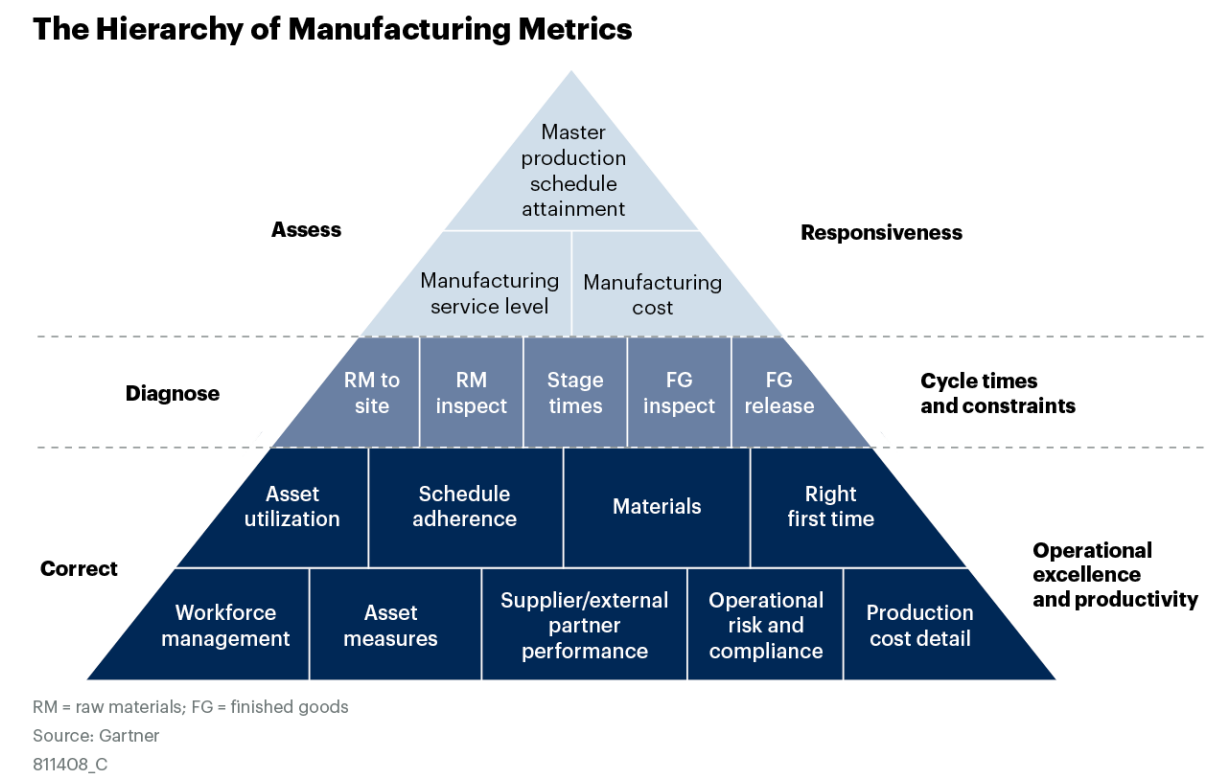
The Hierarchy of Manufacturing Metrics is a portfolio of the right metric categories that companies can use to help improve manufacturing operations’ performance. The portfolio contains metrics that span manufacturing subfunctions, including maintenance, quality, production planning and scheduling, and continuous improvement.

Analysis

The Hierarchy of Manufacturing Metrics

The Hierarchy of Manufacturing Metrics is divided into three tiers: responsiveness, cycle times and constraints, and then the foundation of metrics representing the processes and measures in place for operational excellence and productivity in manufacturing. These three tiers provide the basis for determining the health of manufacturing operations and whether “manufacturing excellence” and the foundations for reliable supply is being achieved (see Figure 2). See Note 1 for the definitions of each metric category, and their alignment with the Hierarchy of Supply Chain Metrics.

Figure 2: The Hierarchy of Manufacturing Metrics



Responsiveness

In the top tier of the Hierarchy of Manufacturing Metrics, three metrics allow companies to assess the overall health and responsiveness of manufacturing operations. These metrics provide the ability to accurately schedule production to meet demand while balancing service and cost — and deliver a profitable, perfect order from production.

Together, these three metrics can directly impact the top level of the Hierarchy of Supply Chain Metrics, specifically: perfect order and supply chain management (SCM) cost (see Figure 1).

Master Production Schedule Attainment

Master production schedule (MPS) attainment is at the very top of the Hierarchy of Manufacturing Metrics. Often, MPS is measured as an input — focusing on its accuracy, stability or feasibility. All of which contribute to/impact efficiency and productivity down to unit-level operations.

The accuracy and feasibility of MPS directly affects the planning and forecasting, and allocation of available capacity and resources (for example, material, labor and utilities) down to granular, unit-level operations. The stability and accuracy of MPS reflects how well the business translates demand into forecasts and then into the master production schedule for sites to execute work orders from. It is influenced by sales and operations planning-driven trade-offs, forecasts, rough-cut capacity planning and master data. Stability is also impacted by frozen periods/zones and what organizational policy is for adjusting the MPS.

How a single plant or a grouping of facilities can detect these shifts and evaluate how to synchronize production with these changes in demand impacts schedule adherence, cycle times and inventory levels. Also, when examined with a supply chain lens, they impact plan, plant utilization and order cycle times — which in turn impact attainment.

Manufacturing Service Level

This is manufacturing operations' contribution to the total perfect order. Manufacturing's service level is defined by the manufacturing perfect order that measures and confirms that all quality, cost, compliance and timing requirements are sufficient for sites to provide a finished or intermediate good into the network, channel or customer location to fulfill demand. This aligns site-level performance with the synchronization of networkwide operations performance to achieve the overall profitable perfect order (see [Maximize Business Value With 3 Actions for Cost-Optimized Manufacturing](#)).

Achieving the right service level requires an understanding of how changes in demand, customer and supplier lead times, as well as varying types of changeovers and events (both planned and unplanned), impact production output.

Manufacturing Cost

Manufacturing costs reflect the financial details tied to the production of a finished or intermediate product. These include fixed and variable costs associated with operating facilities (e.g., example utilities), interfacility transportation costs and connects with more detailed submeasures on the bottom right of the model. Associated costs can include labor certification and training, raw materials conversion costs, and product holds (see [Table 1](#) in Note 1).

Cycle Times and Constraints

This middle tier of metrics represents how quickly a plant, a cluster of plants with similar capabilities or the manufacturing network can convert the demand for capacity and resources into a profitable response. In addition to providing insight into manufacturing flexibility and bottlenecks, these metrics can influence work-in-process inventory levels, complementing cost and service-level metrics that reflect responsive supply.

Companies might be aware of standard takt times for individual processes or procedures, like changeovers or assembly steps. Not all companies combine the various time-based measures (for example, incoming inspection, materials preparation/kitting, actual production stems [unit operations] and final inspection) to effectively gauge end-to-end manufacturing cycle times against customer or supplier lead times.

Consider the scenario stemming from raw materials or unreliable supply (from a supplier or external manufacturing service provider) causing issues downstream that result in product holds or scrapping batches with costly raw materials. This is also a challenge for vertically integrated organizations as a lack of intrasite collaboration can create similar issues/constraints. A feeder site and assembly or packaging site — as well as the logistics processes for moving materials and intermediates between the two — might be tracked differently and in isolation.

This makes it challenging to characterize the specific time it takes to produce an intermediate or finished good — or simply managing and improving response times for agility purposes — as part of end-to-end supply chain performance (see [Table 2](#) in Note 1).

Operational Excellence and Productivity

This lower tier of metrics reflects the foundation of methods, procedures and business processes in place supporting the reliability and responsiveness of production. This tier is also where manufacturers have the greatest abundance — and often misaligned metrics.

Transparency to these metrics and to performance is essential. The metric categories shown in the hierarchy represent those most applied across different industries, process types (batch or discrete) or styles (make to stock or make to order). While identified at a high level, they require additional levels of submeasures and business processes to ensure that the right methods and procedures are in place.

Here, many companies have the most complexity — that is, an abundance of similar, or “like,” measures for the same metric that makes focusing on performance a challenge. In turn, this is a barrier to consistently understanding quality levels, how manufacturing supports agility, or effectively leverages buffers to balance trade-offs between inventory and capacity, and/or simply comparing performance across sites (see [Tables 3, 4 and 5](#) in Note 1).

Three Guiding Points to Initiate Your Usage of the Hierarchy of Manufacturing Metrics

The Hierarchy of Manufacturing Metrics is an organizing framework that helps companies focus on the right categories — and volume of individual metrics — to assess, diagnose and improve manufacturing operations’ performance.

It allows companies to do enough root cause analysis so they can see where they need to dig further. Instead of targeting detailed functional metrics first and then trying to make sense of them, companies can start with the objectives and key results (OKR) and work their way back to identify the level of detail necessary. This might involve examining the touchpoints with — and going deeper into — metrics used for other supply chain functions. Here are three key guiding points to get started:

Mapping Metrics to Categories

Define how manufacturing performance can/will impact end-to-end supply chain performance, and identify where metrics are needed. Map your current metrics to the corresponding categories in the hierarchy; this gives a good visual of where your opportunities are to add, rationalize and align metrics.

Identify and Manage Interdependencies Against Objectives

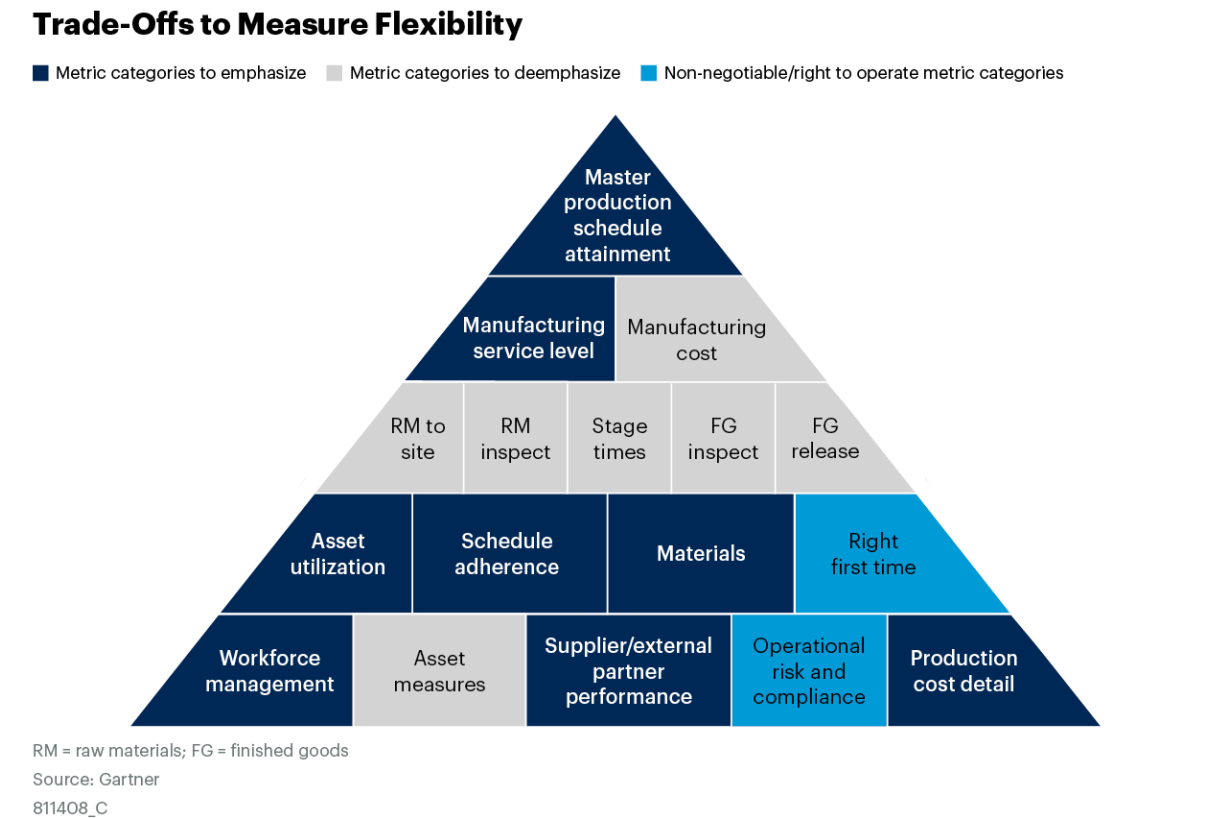
The value of this hierarchy framework does not lie just with the metrics themselves. Leverage the structure of the model to look at the interdependencies between the metric categories, rather than looking at each metric in isolation. By understanding the inputs and interdependencies, rather than measurement in isolation, companies can make faster decisions on how to fix a problem, and how targets should be set in the first place will be clearer.

Example: Trade-Offs to Measure Flexibility

An organization has made the conscious decision to offer its customers more choice in product configurations and delivery times. In doing so, it has designed increased levels of flexibility into its operations. This customer-centric approach changes the responsiveness expectations for manufacturing.

Managing quality (right first time) and mitigating operational risks (operational risk and compliance) are non-negotiable/right to operate. However, as shown in Figure 3, the emphasis of categories could shift.

Figure 3: Trade-Offs to Measure Flexibility



- Cost expectations could be lowered in favor of different SLAs, creating greater emphasis on cycle times (changeovers) while deemphasizing prior objectives of high utilization rates.
- Depending on the choice extended to the customer, the complexity of different bills of materials and specifications might increase scrutiny of days of supply and buffer sizes — making material requirements planning frequency and accuracy critical.
- Master production schedule attainment is now driven by customer lead time and impacted by frozen periods. This can impact schedule adherence at a tactical level and a backlog may be created from poor stability caused by disregard for frozen period policy. Additionally pressure extended out to the supply base may be needed to keep pace with new lead times.

Start by setting priorities and OKR for the categories that will describe performance. Once objectives are set, consider using red, yellow or green to describe certain ranges, thresholds or flags of poor performance — or what a measure might be trending toward.

Actionability

Metrics are only as useful as what companies do with them. They are not a means to an end — and that end is a business outcome. As such, metrics need to be embedded in the right manufacturing processes — for example, production planning and lead time analysis — in which trade-off decisions will be made and/or what corrective actions are needed. Be sure to keep a lens on people, process and technology — especially for decision intelligence. These are important levers to help adjust performance.

Evidence

This research is the output of over 14 years of continuous research on managing manufacturing performance. Updates since 2022 reflect shifts in performance measurement driven from ongoing research, client inquiry, evolving metric categories, KPIs and submeasures and overall changes in market direction.

Note 1: The Hierarchy of Manufacturing Metrics Definitions

Tables 1 through 5 list the definition of each Hierarchy of Manufacturing Metrics category and alignment with the Hierarchy of Supply Chain Metrics.

Table 1: Manufacturing Responsiveness Metrics Definitions

Category	Definition	Mapping to Hierarchy of Supply Chain Metrics
Master production schedule attainment	Production attainment of a weekly MPS plan, by SKU quantity. This reflects forecasts at the factory level.	Demand forecast accuracy
Manufacturing service level	On time, on quality, on quantity and compliant with customer specifications, with the necessary work processes executed right the first time.	Perfect order
Manufacturing cost	Total cost as a percentage of revenue of producing finished goods. Includes all fixed and variable costs associated with operating the plants, inbound and interfacility transportation costs, direct/indirect labor costs, and raw material costs.	SCM cost (manufacturing cost is one component of total SCM costs)

Source: Gartner

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Table 2: Cycle Times and Constraints Definition

Category	Definition	Mapping to Hierarchy of Supply Chain Metrics
Cycle times	These include the process steps necessary for transforming a raw material into an intermediate product or finished good or intermediate (i.e., the quantity per unit time needed for production steps and/or changeovers). It also includes any idle time incurred.	<ul style="list-style-type: none">■ Order cycle time■ Perfect order■ Plant utilization■ Inventory■ Cash-to-cash

Source: Gartner

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Table 3: Operational Excellence and Productivity Metrics Definitions (Part 1)

(Enlarged table in Appendix)

Category	Definition	Map to Hierarchy of Supply Chain Metrics
Asset utilization	Measures the efficiency and effectiveness of individual production units, equipment, production lines or facilities. This spans throughput, state times, changeover cycles and utilization rates.	<ul style="list-style-type: none"> ■ Plant utilization ■ Production schedule variance ■ SCM cost ■ Order cycle time
Schedule adherence	Variance between actual production items and planned production (based on forecast).	<ul style="list-style-type: none"> ■ Production schedule variance ■ Inventory ■ Plant utilization ■ Order cycle time
Materials	Total inventory days of supply, measured as the sum of raw material, work in process and finished goods, based on corporate-defined policies and accounting practices.	<ul style="list-style-type: none"> ■ Inventory (including raw material Inventory) ■ Direct material costs ■ Production schedule variance ■ Plant utilization

Source: Gartner

Table 4: Operational Excellence and Productivity Metrics Definitions (Part 2)

(Enlarged table in Appendix)

Category	Definition	Map to Hierarchy of Supply Chain Metrics
Right first time	Reflects the ability to produce a product correctly the first time versus rework to correct mistakes. Can also be reflected as first pass yield, which is a characteristic number assigned to discrete process quality regarding workplace and product (the higher the characteristic number, the higher the yield).	<ul style="list-style-type: none"> ■ Perfect order detail ■ Inventory ■ SCM cost ■ Supplier quality ■ Plant utilization ■ Direct material costs ■ Order cycle time
Asset measures	These relate to specific assets and the processes around each asset. Typical metrics used include mean time between failure (MTBF), maintenance losses and energy usage.	<ul style="list-style-type: none"> ■ Plant utilization ■ Production schedule Variance ■ Order cycle time
Supplier/external partner performance	Perfect order metrics from external partners' (i.e., suppliers and/or contract manufacturers) ability to deliver on time to the quality levels specified.	<ul style="list-style-type: none"> ■ Supplier quality ■ Supplier on time ■ Plant utilization ■ Order cycle time

Source: Gartner

Table 5: Operational Excellence and Productivity Metrics Definitions (Part 3)

(Enlarged table in Appendix)

Category	Definition	Map to Hierarchy of Supply Chain Metrics
Operational risk and compliance	Reflects conventional environment, health and safety (EH&S) metrics and company- or industry-specific compliance measures. This can include corrective and preventive action, facility audits and EH&S-related events.	<ul style="list-style-type: none"> ■ Production schedule variance ■ Plant utilization ■ Order cycle time
Production cost details	Directly supports manufacturing costs. Lists the details of costs, including the total manufacturing cost delays caused by raw materials issues, unplanned downtime and compliance events, added shifts/overtime, supplier quality issues and poor quality.	<ul style="list-style-type: none"> ■ SCM cost
Workforce management	Reflects core labor productivity (number of units per hour produced), as well as core workforce measures across the percentage of open positions filled and skills and certification/training.	<ul style="list-style-type: none"> ■ Perfect order detail ■ Plant utilization ■ Production schedule variance

Source: Gartner

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Document Revision History

[Use the Hierarchy of Manufacturing Metrics to Connect Manufacturing and Supply Chain Performance - 18 January 2022](#)

[Use the Hierarchy of Manufacturing Metrics to Connect Manufacturing and Supply Chain Performance - 9 January 2019](#)

[Use the Hierarchy of Manufacturing Metrics to Connect Manufacturing and Supply Chain Performance - 18 January 2016](#)

[Aligning Manufacturing and Supply Chain Performance, Part 2: The Hierarchy of Manufacturing Metrics - 5 May 2011](#)

Recommended by the Author

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Hierarchy of Supply Chain Metrics: Focus on Key Metrics to Improve Operational Trade-Off Decisions

Define and Align Metrics to Accomplish Business and Supply Chain Objectives

Tool: Distribution, Production and Material Supply Planning Metrics

Quick Answer: Top Metrics to Measure Quality Performance

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