



Integrated Measurement Framework for Manufacturing Performance Improvement

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Abstract

This paper explores the development and implementation of an integrated performance management system to achieve operational excellence in the manufacturing sector. It emphasizes the importance of setting strategic objectives and adopting Key Performance Indicators (KPIs) to align performance goals across organizational, functional, and individual levels. The paper addresses key challenges, such as the lack of data-driven approaches, decentralization of data, and laborious data management processes. By establishing standardized KPIs and a structured reporting system, manufacturing organizations can enhance decision-making, monitor progress, and continuously improve. The ultimate goal is to achieve and sustain an Operational Excellence Score of 80%, thereby ensuring long-term success and competitiveness.

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1. Introduction

Setting strategic objectives is the essential step that transitions the planning process from the strategic plan level to the business plan level.

Strategic objectives are measurements for firms to monitor the achievement of their strategic goals. These metrics must be aligned with the overall strategy. Strategic objectives may vary across different hierarchical levels of the organization and should correspond to the objectives relevant to each level [1].

Strategic objectives translate the business's vision and mission into actionable goals that further focus strategic planning. These objectives serve three primary purposes:

- a) **Alignment:** They help align actions across the business' parts and down its organizational layers. They support consistency in decision making and remind decision-makers continually of the business's commitment to its future.
- b) **Measurement:** They provide a basis for measuring the effectiveness of a strategy, whether it is a business or operations strategy
- c) **Motivation:** They motivate all members of the organization to achieve and surpass these goals

The integrated measurement model shown in figure 1 is a tool that can help ensure that strategic goals are carried down into the strategies and tactics of the organization.

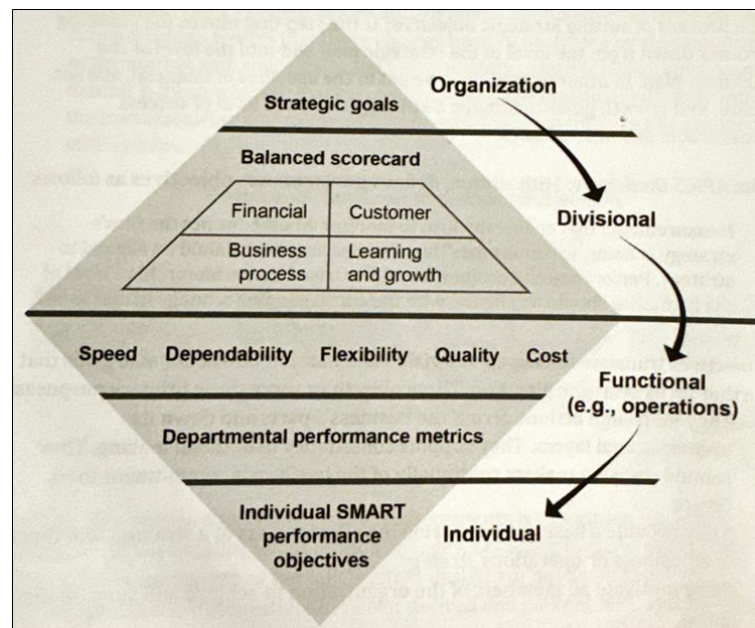


Fig 1: Integrated Measurement Model [1]

The model demonstrates how an organization's performance at all levels—from strategic (the boardroom) to operational (the work environment)—is aligned through performance objectives. This serves as a high-level example of a KPI tree, where key performance indicators (KPIs) become more specific at lower levels but can be aggregated to provide summary information at higher levels.

Performance objectives cascade through the organization, encompassing organizational, functional, and individual levels. At the organizational level, performance objectives might include revenue targets (both in aggregate and for individual product/service families), market share percentages, or successful entry into new lines of business or geographical regions.

At the divisional level, a balanced scorecard system can be utilized to set objectives. Kaplan and Norton's balanced scorecard includes perspectives on financial, customer, business processes, and learning and growth. Organizations may also develop their own customized set of balanced performance objectives [1].

Key Performance Indicators (KPIs)

Businesses across all sectors, from emerging coffee roasters to billion-dollar e-commerce enterprises, are committed to monitoring their progress, identifying successful strategies, and addressing areas for improvement. Key Performance Indicators (KPIs) are essential tools in this process. Once strategic goals have been established, regularly measuring these objectives through KPIs facilitates informed decision-making and enhances overall business outcomes [2].

Key performance indicators (KPIs) are quantifiable metrics employed to evaluate a company's long-term performance. Organizations utilize KPIs to monitor their progress towards key business objectives.

KPIs facilitate the assessment of a company's strategic, financial, and operational accomplishments, particularly in comparison to other businesses within the same industry. Additionally, they serve as a means to evaluate progress or achievements against established benchmarks or historical performance [3].

Benefits of key performance indicators

Implementing KPIs offers a wide range of benefits as stated below:

- a) **Encourage actionable goals:** Effective tracking and analysis of KPIs necessitate a clear understanding of the desired outcomes. This encourages businesses to establish specific, actionable goals and develop systems designed to achieve those goals, rather than creating systems without a defined purpose.
- b) **Data-Driven Solutions:** KPIs provide valuable insights to management, helping identify specific issues and determine appropriate solutions. This data-driven approach offers quantifiable information that is essential for strategic planning and ensuring operational excellence.
- c) **Improve Accountability:** KPIs hold employees accountable by providing statistically supported metrics that are unbiased and non-discriminatory. When implemented appropriately, KPIs can motivate employees by highlighting the importance of their contributions and the close monitoring of their performance.
- d) **Measure Progress:** KPIs link business objectives to actual operations. Setting targets is futile without the ability to track progress towards achieving them. KPIs enable companies to set objectives and monitor their progress, ensuring that business plans are effectively realized [3].

Problem Statement

Manufacturing teams often face the absence of standardized infrastructure, systems, and processes required to make data-driven decisions and improvements. This initiative aims to address three primary issues:

- a) **Lack of data-driven approach:** The absence of quality data collection methods impedes the ability to process and analyze data effectively for informed decision-making. This limitation hinders the capacity to monitor, measure, identify, analyze, and report performance data.

- b) **Decentralization:** Operational data is collected individually by manufacturing teams across multiple systems. The lack of centralized information is a critical issue that this project seeks to resolve.
- c) **Laborious data management:** Currently, data collection and processing are predominantly manual, leading to inaccuracies, time inefficiencies, and decreased motivation among team members. Automating data management processes is essential to improve accuracy and efficiency.

Objectives

The following objectives were identified and aligned to help any early-stage manufacturing organization to achieve and improve operational excellence.

- a) **Develop and define an integrated performance management system:** Create a cohesive framework that integrates various performance metrics and processes, aligns with strategic goals, and fosters continuous improvement.

- b) **Establish standardized kpis to collect, measure, and compare performance:** Define consistent and relevant KPIs, ensure standardization in data collection, implement robust methods, set benchmarks, and create a structured reporting system to track progress and enable informed decision-making.

2. Methodology

To ensure alignment with a business's desired outcomes and strategic goals, KPIs should be established with clear, defined objectives. It is crucial that KPIs are measurable, specific, and time-bound. The following steps outline the process for setting up effective KPIs:

- a) **Determine strategic goal:** First step in the process is to identify and define the strategic goal for manufacturing organization. In this case, the Strategic objective is to achieve and maintain Operational Excellence Score of 80% every month within manufacturing. Operational Excellence Score is a north star metric which states and communicates the overall health and performance of manufacturing organization.

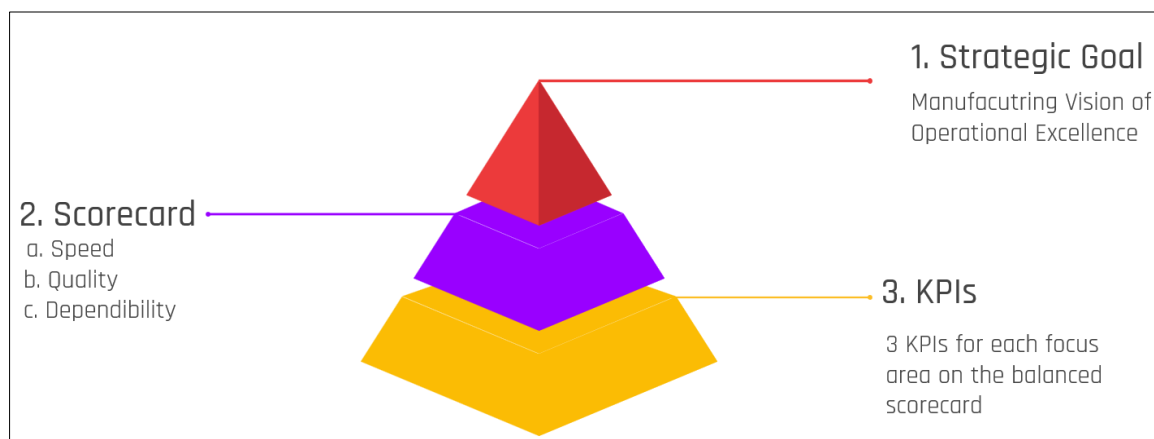


Fig 2: Integrated Measurement Framework

- b) **Define Balanced Scorecard:** Next step is to define key focus areas for the balanced scorecard. The purpose of the balanced scorecard is to combine and weigh various perspectives that help manufacturing measure all activities which create value. Three main focus areas for early-stage manufacturing were Speed, Quality, and

Dependability with corresponding weightage of 40%, 40%, and 20% respectively. For early-stage manufacturing organizations, it is recommended to limit the number of focus areas on the balanced scorecard to stay focused and avoid getting overwhelmed with too many things.



Fig 3: Balanced Scorecard

c) Establish KPIs:

Setting KPIs for each of the focus areas helps to measure, compare, and analyze the performance of every focus area. Cycle Time ratio, Defects per Product, and Service level were the three KPIs identified and defined and the respective focus areas. Again, it is recommended for an early-stage startup to keep KPIs simple and limited to avoid unwanted complexity at this stage of the company.

- **Cycle Time Ratio:** The ratio of Actual Cycle Time to Standard Cycle Time is utilized to track and measure the production rate of any given product. A ratio of 1 or less indicates that the production aligns with customer demand and production schedule. Conversely, a ratio exceeding 1 indicates delays in the production rate.
- **Defects per Product:** A quality KPI is utilized to track and record quality issues identified and addressed during

the product manufacturing process. This KPI measures process quality and the quality of work in the manufacturing process. The objective is to maintain quality control by ensuring there are three or fewer Defects per Product. Having a Defect per Product KPI of four or more defects per product indicates the need to process quality improvements.

- **Service Level:** Service Level is a KPI that indicates the likelihood of fulfilling raw material demand to manufacturing without experiencing stockouts or delays, expressed as a percentage. It reflects a logistics ability to reliably meet material and inventory requirements, thereby influencing overall production rate. A service level of 98% or higher is set as the standard to be met. Anything below 98% would mean there is a stockout or unavailable parts which results production delay.

Table 1: KPI Formulas

Focus Areas	KPIs	Measure	Standard
1. Speed	Average Cycle Time Ratio (CTR)	Average Cycle Time Ratio (CTR) = $\{\sum(\text{Actual cycle time}/\text{Standard cycle time})\}/(\text{Total number of L3 vehicles})$	Avg. CTR ≤ 1
2. Quality	Average Defects per products	Average Defects/Product = $(\sum \text{Number of Defects per Product})/\text{Total number of products}$	Avg. Defects/Product ≤ 3
3. Dependability	Average Service Level %	Average Service Level % = $[\sum(\text{Parts supplied}/\text{Total Parts Required})]/(\text{Total number of Products}) \times (100)$	Avg. Service Level $\geq 98\%$

- d) Scoring Framework:** The last step is to create a scoring framework which would tie all the above KPIs and Focus areas to the high-level strategic goal. Table 2 below shows a complete scoring framework which integrates the KPI measurement to the strategic goal of Operational Excellence Score. Every KPI is measured and

benchmarked against the defined standard and a binary score of met/not met is assigned to it. Focus Area weightage is then multiplied by that binary score to calculate the score in every focus area. At the end, summing up the focus area scores equates to the actual operation excellence score achieved in manufacturing.

Table 2: Scoring Framework

Scorecard Components	Weightage	KPIs	Standard	Measure	Met/Not met (1/0)	Calculated Score	Actual Operational Excellence
Speed	40%	Average Cycle Time Ratio (CTR)	Avg. CTR ≤ 1	2	0	0%	60%
Quality	40%	Average Defects per products	Avg. Defect/Product ≤ 3	3	1	40%	
Dependability	20%	Average Service Level %	Avg. Service Level $\geq 98\%$	98	1	20%	

$$\text{Operational Excellence Score} = \sum(\text{met/not met}) \times \text{Component Weightage} = (0) \times 40\% + (1) \times 40\% + (1) \times 20\% = 60\%$$

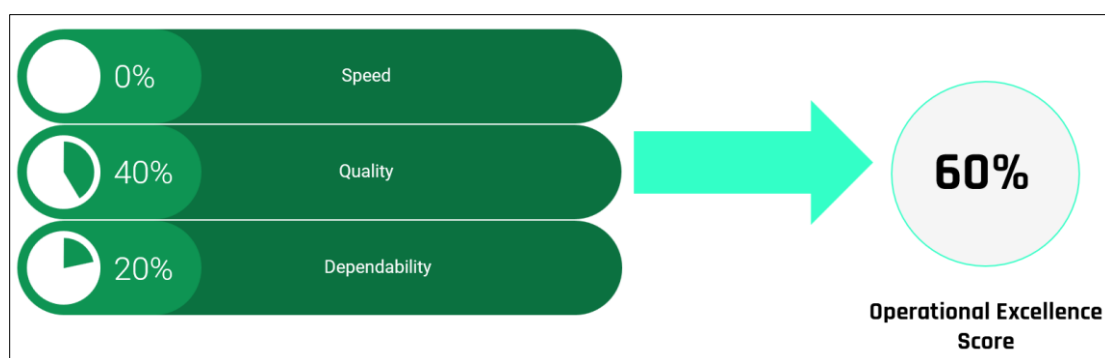


Fig 4: Balanced Scorecard

The operational excellence score of 60% is lower than the set strategic target of 80%. This implies that manufacturing organization is not performing to its full potential and there is room for improvement. To better understand the area for improvement, focus area scores need to be evaluated to identify the right focus area to improve on. In this case, it's

the focus area of speed and corresponding KPI of Average Cycle Time ratio. The manufacturing organization need to do a deep dive into products which took longer than normal to be manufactured and drill down to the root cause(s) behind the delay. Upon fixing the root cause(s), manufacturing organization will be able to improve the KPI and Focus Area

score which would be translated into a better operational excellence score.

3. Conclusions

In today's competitive manufacturing environment, the development and implementation of an integrated performance management system are crucial to achieving operational excellence. This white paper highlighted the importance of setting strategic objectives that transition the planning process from the strategic to the business plan level. The adoption of Key Performance Indicators (KPIs) as essential tools facilitates the alignment of performance objectives across organizational, functional, and individual levels.

A high-level KPI tree example demonstrated how performance objectives cascade through the organization, allowing for informed decision-making and enhanced business outcomes. By addressing the key challenges faced by manufacturing teams, such as the lack of a data-driven approach, decentralization of operational data, and laborious data management processes, businesses can significantly improve their operational efficiency.

The establishment of standardized KPIs to collect, measure, and compare performance is vital. This involves defining consistent and relevant KPIs, implementing robust data collection methods, and creating a structured reporting system. Setting clear strategic goals, such as achieving an 80% Operational Excellence Score, and defining key focus areas through a balanced scorecard, are essential steps in this process.

Implementing KPIs for each focus area, such as Cycle Time Ratio, Defects per Product, and Service Level, allows organizations to measure and analyze performance effectively. The creation of a scoring framework ties these KPIs and focus areas to high-level strategic goals, providing a comprehensive view of operational performance.

In conclusion, by addressing these critical areas and continuously monitoring and improving KPIs, manufacturing organizations can achieve and sustain operational excellence, thereby enhancing their overall competitiveness and success.

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