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Manufacturing operations management — Key performance indicators —

Part 1: Overview, concepts and terminology

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 22400-1 was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration and architectures of automation systems and applications*.

ISO 22400 consists of the following parts, under the general title *Manufacturing operations management — Key performance indicators*

Part 1: Overview, concepts and terminology

Part 2: Definitions and descriptions

Part 3: Exchange and Use

Part 4: Relationships and dependencies

Introduction

Measure about performance enables an enterprise to quantify aspects of operations and thereby monitor the impact of changes in operational activities. This International Standard will focus on the measure found to be particularly meaningful for the monitoring of operational performance improvement. The performance measures can be achieved through combining measurements from operations and forming "key performance indicators", abbreviated as KPI. The performance they monitor is specific to identified objectives of the enterprise and they are most useful when their values can be used to identify trends toward a particular operational objective.

Within an enterprise, the various operations areas such as sales, manufacturing, engineering, marketing, and other business support functions have different sets of performance indicators. These various performance indicators are used together to monitor realization of enterprise's business goals.

An International Standard for KPIs is beneficial for comparing enterprise operations over extended periods of time and for comparing similar operations of enterprises within an industry.

The management of manufacturing operations is normally associated with some intermediate level within the functional hierarchy of a manufacturing enterprise. In IEC 62264, the International Standard for Enterprise-control system integration, the intermediate level (Level 3) is referred to as the Manufacturing Operations Management (MOM) domain. The MOM domain, is the intermediate domain between the business domain (level 4) and the process control domain (Level 1-2).

The KPIs defined in this standard are intended to be calculated based on data from the process control domain (level 1-2) and to provide both the business domains and the manufacturing operations domain with decision support information to manage the manufacturing operations domain of the enterprise.

This part of the standard (Part 1) will present Overview, concepts and Terminology for KPIs. Other parts of the standard will cover guidelines for computing and for measuring the components of a KPI (Part 2), definitions for the content and context of the exchange and the use of KPIs (Part 3) and specifications of relationships and dependencies among KPIs (Part 4).

Manufacturing operations management — Key performance indicators — Part 1: Overview, concepts and terminology

1 Scope

This part of ISO 22400 specifies an industry-neutral framework for defining, composing, and using key performance indicators (KPI) at the level of Manufacturing Operations Management. This part of the standard:

- provides an overview of what a KPI is and how KPIs can be used,
- presents concepts of relevance for working with KPIs including a criteria for constructing KPIs, and
- specifies terminology related to KPIs.

In this standard the KPIs are focused on company's internal processes at the level of Manufacturing Operations Management. The KPIs are, if not noted otherwise, applicable to all types of industries; batch continuous and discrete.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62264-1:2003, Industrial-process measurement, control and automation — Enterprise-control system integration — Part 1: Models and terminology

IEC 62264-3:2007, Industrial-process measurement, control and automation — Enterprise-control system integration — Part 3: Activity models of manufacturing operations management.

ISO 13053-1:2011, Quantative methods in process improvements – Six Sigma –Part1: DMAIC Methodology.

ISO 18435-1: 2009, Industrial automation systems and integration -- Diagnostics, capability assessment and maintenance applications integration -- Part 1: Overview and general requirements

3 Terms and definitions

For the purposes of this document the following terms and definitions apply. Terms and definitions given in IEC 62264 and ISO 18435-1 also apply and are given below for convenience.

3.1 Definitions

3.1.1 Capability

ability to perform actions

NOTE definition includes attributes on qualifications and measures of the ability, as in the definition of capacity

[IEC 62264-1:2003]

3.1.2 Integration

state or condition wherein two or more entities are able to form and be observed as a single entity which exhibits a structure, a behavior, and a boundary that are determined by the interoperability properties of the forming entities

3.1.3 interoperability

state or condition wherein two or more entities are able to exchange items or information in order to perform their respective tasks.

Note: the entities may be devices, equipment, machines, people, processes, applications, software units, systems or enterprises. The items of exchange may be information, material, energy, control, assets, or ideas.

3.1.4 Key performance indicator

one or several related values that provide a proxy understanding of a business or manufacturing process.

3.1.5 Key result indicator

The larger set of all measures that are of importance for the current and future success of an organization/enterprise.

3.1.6 Manufacturing operations management

activities within Level 3 of a manufacturing facility that coordinate the resources, such as, equipment, personnel and materials within the facility

[IEC 62264-3:2007]

3.1.7 Manufacturing resource

physical or logical entity that enables a (manufacturing) process

NOTE Manufacturing resources include (but are not limited to) manufacturing assets such as equipment, machinery, software, automation units, control devices, instrumentation, tooling, and other resources, e.g. operators, materials, fuels and the physical plant wherein the resources are deployed.

[ISO 18435-1:2009]

3.1.8 Performance indicator

measure defined by an organization for use in determining how well it is making progress towards achieving a particular objective

NOTE Key performance indicators are chosen by an organization based on a specific criteria determined by its mission, operating plans and continual improvement procedures.

3.1.9 Performance measure

The term performance measure is used in two ways

- 1) A measure is a factor in generating an indicator; not all measures are indicators.
- 2) The performance can be measured by a performance indicator.

3.2 Abbreviations

KPI	Key Performance Indicator
KRI	Key Result Indicator
MOM	Manufacturing Operations Management
PI	Performance Indicator

UML Unified Modeling Language
URL Uniform Resource Locator
XML eXtensible Mark-up Language

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4 Overview and introduction

4.1 Value creation processes

A process consists of a set of activities performed with a set of resources to realize a goal within a specified timeline.

The goal of a production-oriented enterprise is to satisfy the market demand for products. The value creation process to reach this goal needs to be conducted in a smart, safe and sustainable manner. A set of performance indicators provides a means to evaluate the performance of the process in order to meet the target.

Managing a value creation process implies completing the process as planned and continuously improving the process. An appropriate set of performance indicators is used to determine if the process was completed as planned and the goal realized as expected. Those performance measures found to be the most useful in monitoring and evaluating improvement or degradation of performance are called "key performance indicators" As a very rough approximation and generally speaking; key performance indicators are the 20% of all performance measures that account for 80% of impacts from changes in operations

4.2 Collaborative manufacturing

The complete value creation process is both external and internal. The external processes are the value chain process, i.e., the process from suppliers to customer, and the life cycle process, i.e., the process from design to support of a product. The internal process is the enterprise-to-plant-process, i.e., the internal process transforming strategic enterprise decisions to operational plant actions. The internal and external value creation processes are further explained in Annex A (Collaborative Manufacturing). This standard has its focus on the internal processes and the internal functionalities.

4.3 Functional and physical hierarchies

The internal functionalities of an enterprise are hierarchically structured in a functional model. The different levels in the functional hierarchy model are: business planning and logistics (level 4), manufacturing operations management (level 3), and batch, continuous, or discrete control (level 1-2). The levels provide different types of functionality and work in different timeframes. The Functional Hierarchy is further explained in IEC 62264 and a brief presentation is given in Annex B (Functional and Physical Hierarchies). This standard has its focus on the Manufacturing Operation Management level (level 3).

The equipment used in the enterprise can be structured in a hierarchical structure (ref IEC 62264-1). The different levels are; Enterprise, Site Area, Work Cell, Work unit and lower equipment used in production. The hierarchy is presented in Annex B (Functional and Physical Hierarchies). In this standard the term "Operation Cluster" is used as a generic term for all levels in this hierarchy.

4.4 Manufacturing operations management

4.4.1 Categories of operations

The domain of manufacturing operations shall be composed of the following sub-domain categories of operations (ref IEC 62264-1):

- a) production operations;
- b) inventory handling operations;
- c) quality assurance testing operations;
- d) maintenance operations;
- e) rest of the other operations categories.

Each category is further detailed by an Activity Model. The categories of operations are briefly presented in Annex C (Manufacturing Operations Management). Production operation is the main type of operation whereas maintenance, inventory and quality could be thought of as complimentary type of operations.

4.4.2 Activity model

The Activity Model includes eight activities: detailed scheduling, dispatching, execution management, resource management, definition management, tracking, data collection, and analysis. These activities apply to production operations, quality operations, inventory operations and maintenance operations.

The activity model is defined in IEC 62264-3 and briefly described in Annex C (Manufacturing Operations Management). The activity called *Performance Analysis* takes care of the activities related to performance indicators e.g. definitions, calculations, presentations, and exchange of KPIs.

4.4.3 Resources

A resource is an entity that provides some or all of the capabilities required by the execution of the enterprise activities and/or business processes. The resources involved in manufacturing operational management are; personnel, material, equipment and process segments. (IEC 62264-1). The resources are further defined in Annex C (Manufacturing Operations Management).

Equipment also incorporates asset management.

Material also incorporates consumable materials like energy and additives/utility.

4.5 Concepts of production operations

4.5.1 Production methodology

There are many ways of classifying an enterprise. One way is according to the industry sector the enterprise is active within. Another way is according to the type of production process that the enterprise has. Three main types of production processes exist; continuous, discrete and batch. There are enterprises that include all three types of production processes and there are others that operate only one of them. It is common to refer to a production process according to the dominant type of process. Batch, continuous and discrete production processes are briefly described in Annex D (Production).

4.5.2 Production execution through work orders

The enterprise receives customer orders that are transformed into production orders and further refined and regrouped (merged and/or split) into executable work orders.

- Customer order = A combination of production orders (out of scope of this standard)
- Production order= a fixed quantity of a single product (out of scope of this standard)
- Work orders = a fixed quantity of a product or sub-product /intermediate (in ISA95-Part4 this is referred to as job order).

The concept of orders is very clear in discrete and batch production whereas it is more subtle in continuous production processes.

4.5.3 Physical structure

The order of equipment actually used or expected to be used in the execution of a work order is called the path. A work center is classified as single path, multiple path, or network based on its physical structure. Regardless of which structure is used, several work orders may be in progress at the same time, multiple input materials may be used, multiple finished materials may be generated, and production units may be shared input material sources and production storage. More about the physical structure can be found in Annex D (Production).