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Automation systems and integration — Key performance indicators for manufacturing operations management —

Part 2: Definitions and descriptions

Systèmes d'automatisation industrielle et intégration — Indicateurs de la performance clé pour le management des opérations de fabrication —

Partie 2: Définitions et descriptions

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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ISO 22400-2 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 planned parts, under the general title *Automation systems and integration — Key performance indicators (KPIs) for manufacturing operations management*

- Part 1: Overview, concepts and terminology
- Part 2: Definitions and descriptions
- Part 3: Workflow and activity model
- Part 4: Exchange and use

Introduction

This standard focuses on Key Performance Indicators (KPIs) for manufacturing operations management.

KPIs are defined as quantifiable and strategic measurements that reflects an organization's critical success factors. Key Performance Indicators are very important for understanding and improving manufacturing performance; both from the lean manufacturing perspective of eliminating waste and from the corporate perspective of achieving strategic goals.

Manufacturing Operations Management is defined in IEC 62264. It defines a functional hierarchy model of a manufacturing enterprise as shown in Figure 1. Figure 1 depicts the different levels of the functional hierarchy model: business planning and logistics (level 4), manufacturing operations and control (level 3), and batch, continuous, or discrete control (level 1-2). The levels provide different functions and work in different timeframes.

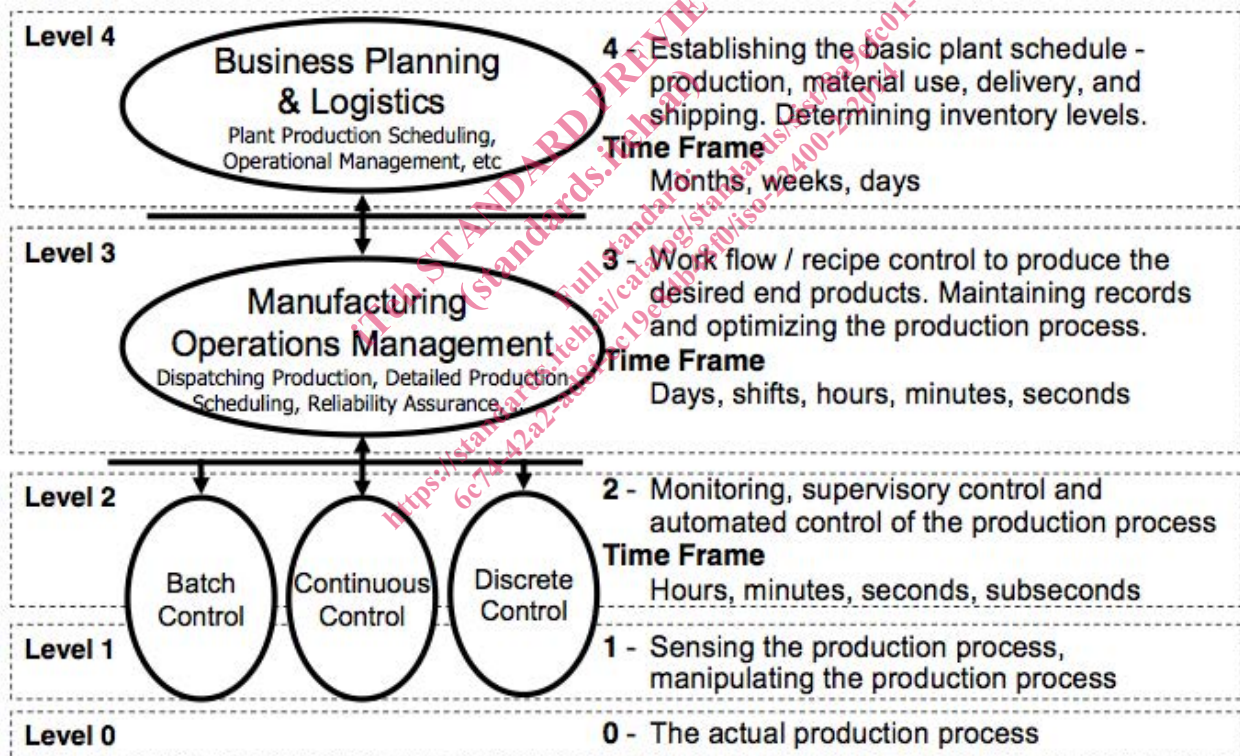


Figure 1 — Functional hierarchy (from Figure 2 in IEC 62264-3)

The IEC 62264 standard also defines an hierarchical structure for the physical equipment, see Figure 2 Enterprise, Site and areas are generic terms, whereas there are specific terms for work centers and work units that apply to batch production, continuous production, discrete or repetitive production, and for storage and movement of materials and equipment.

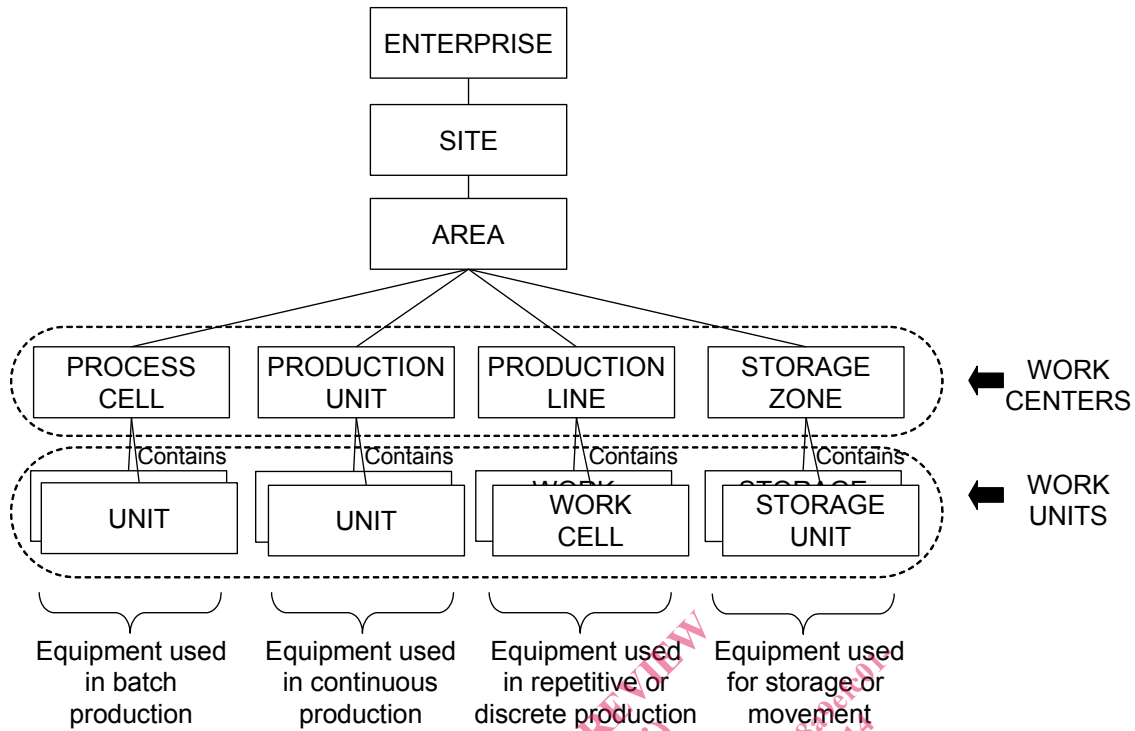


Figure 2 — Operation cluster hierarchy

This standard defines the KPIs “residing” at Level 3, i.e., related to manufacturing operations management. These KPIs are generated/calculated within Level 3. Some of these KPIs are forwarded to Level 4 for further usage. In order to generate these KPIs, parameters from level 2 and 1 might be needed.

Manufacturing Operations Management, sometimes referred to as Manufacturing Execution Systems (MES), is modeled using four information categories: production operations management, maintenance operations management, quality operations management, and inventory operations management. The KPIs in this standard are presented according to these information categories.

The KPIs in this standard use the most generic terms possible, i.e. work centers and work units, instead of industry specific terms.

KPIs also reside at Level 4. i.e., KPIs related to business planning and logistics. Level 4 KPIs are often related to economic, business, logistic and financial factors. These KPIs are used to assess the progress or extent of compliance with regard to important objectives or critical success factors within a company. Economic KPIs serve as a basis for decisions (problem identification, presentation, information extraction), for economic control (target / actual comparison), for financial documentation and for coordination (behaviour management) of important facts and relationships within the company

Manufacturing Operations Management, sometimes referred to as Manufacturing Execution Systems (MES), is modelled using four categories: production operations management, maintenance operations management, quality operations management, and inventory operations management. Each category is further detailed by an Activity Model. Each 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. Analysis is the performance of calculating KPIs using information from other activities. Workflows can be used to illustrate the important events and steps needed in the calculation process for KPIs.

KPIs alone are not sufficient factors to perform the necessary management and execution operations for an enterprise. For many of the indicators, a company specific threshold is defined. When the value

of the indicator exceeds or falls below the threshold, actions are initiated to improve efficiency or quality. Often it is necessary to define warning and action limits. Warning limits help to detect the trends in process and equipment changes before company-specific thresholds are violated.

The KPIs gathered in this part of the International Standard have been used in various production situations for many years. Although these KPIs were collected in a simple and readily understandable form, different interpretations of these terms can exist.

To improve the productivity of the manufacturing resources, information provided by industrial automation systems and control devices about process, equipment, operator, and material can be more effectively used in providing critical feedback through KPIs.

A standardized schema for the expression of these KPIs is intended to:

- a) facilitate the specification and procurement of integrated systems, in particular, the interoperability requirements among MES applications;
- b) provide a means to categorize productivity tools that can be used across applications.

ISO 22400 provides an overview of the concepts, the terminology, and the methods to describe and to exchange key performance indicators (KPIs) for the purpose of managing manufacturing operations. The audience are factory managers responsible for production performance, software suppliers developing KPIs for factory management, engineers engaged in process planning of products, planners and designers of manufacturing systems, and equipment and device suppliers.

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Automation systems and integration — Key performance indicators for manufacturing operations management —

Part 2: Definitions and descriptions

1 Scope

The scope of ISO 22400 is to give a clear and unique definition of Key Performance Indicators (KPIs) used in Manufacturing Operations Management (MOM).

This part presents a selected number of KPIs in current practice. The KPIs are presented by means of their formula and corresponding elements, their time behavior, unit/dimension and rating. It also indicates the User group where the KPIs are used and to what production type they fit.

2 Conformance

To be compliant with the requirements of ISO 22400-2, KPIs shall conform to the relevant descriptions in clause 8 and clause 9.

3 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 60050-191 ed1.0 International Electrotechnical Vocabulary. Chapter 191: Dependability and quality of service

IEC 62264-3, Industrial-process measurement and control – Enterprise-control system integration – Part 3: Activity models of manufacturing operations

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

4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

4.1

Drill down

Examine the source of the data used to calculate a performance indicator

EXAMPLE

Within the OEE index the quality rate is to be analyzed. The drill down presents a direct indicator with reference to workplace, product and time period as well as possible errors. This is a quick analysis which supports a most rapid efficiency improvement by corrective actions, and thus reduces errors.

4.2

Enterprise Resource Planning

Business process of a company involving the enterprise-wide planning and business support functions, such as, procurement, human resource management, customer support, finance and accounting, master data management, etc.

4.3

Timing

Property of a KPI that shows how often an application can examine the value of the KPI

EXAMPLE

Categories include: Demand-oriented – determined by an operator; Periodic – calculated by system per specified time intervals; Event-driven – updated whenever data changes and displayed immediately

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5 Symbols (and abbreviated terms)

\bar{x}	Arithmetic Average
$\bar{\bar{x}}$	Average of average values
σ	Estimated deviation
ADET	Actual unit delay time
ADOT	Actual unit downtime
AOET	Actual order execution time
APAT	Actual personnel attendance time
APT	Actual production time
APWT	Actual personnel work time
AQT	Actual queueing time
ASUT	Actual set up time
ATT	Actual transport time
AUBT	Actual unit busy time
AUPT	Actual unit processing time
CI	Consumables inventory
C_m	Machine capability index
CM	Consumed material
C_{mk}	Critical machine capability index
CMT	Corrective maintenance time
C_p	Process capability index
C_{pk}	Critical process capability index
DAY	Day
EPC	Equipment production capacity
FE	Failure event
FGI	Finished goods inventory
GP	Good part
GQ	Good quantity
IGQ	Integrated good quantity
IP	Inspected part
LSL	Lower specification limit
LT	Loading time
MEPC	Maximum equipment production capacity
MOM	Manufacturing operation management
NEE	Net overall equipment effectiveness index
NOT	Net operating time
OC	operation cluster
OEE	Overall equipment effectiveness index
OL	Other loss
OPT	Operating time
PBT	Planned busy time
PL	Production loss
PMT	Preventive maintenance time
PO	Production order
POET	Planned order time
POQ	Order quantity
POS	Production order sequence
POT	Planned operation time
PQ	Produced quantity
PRTU	Planned run time per unit
PSQ	Planned scrap quantity