INTERNATIONAL STANDARD

ISO 18828-4

First edition
2018-06

Industrial automation systems and integration — Standardized procedures for production systems engineering —

Part 4: Key performance indicators (KPIs) in production planning processes

Systèmes d'automatisation industrielle et intégration — Procédures normalisées pour l'ingénierie des systèmes de production —

Partie 4: Indicateurs de performance clé dans les processus de planification de la production

Reference number
ISO 18828-4:2018(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration,* Subcommittee SC 4, *Industrial data.*

A list of all parts in the ISO 18828 series can be found on the ISO website.

Introduction

Ever-growing demands, such as increasing product and process complexity (recognizable by the high number of versions, short product lifecycles and greater time and cost pressures), define the key challenges faced by modern manufacturers. As a result, companies resort to ever-more sophisticated tools for managing complexity and improving transparency. Performance management systems provide aggregated quantitative depictions of the current situation via key performance indicators (KPIs), thereby creating the basis for improvement and decision-making processes. Consequently, the aim of using KPIs is to consistently analyse current production processes in order to control and manage them after start of production (SOP). In this way, KPIs provide a base of information for understanding and improving manufacturing performance.

NOTE 1 See for example ISO 22400.

Beyond the uniform set of core key indicators, many companies already successfully utilize performance management based on a self-defined, comprehensive range of measurable values. In this process, a target-oriented, company-specific interpretation of key indicators is often performed.

Considering the product development process in greater detail and taking into account the planning tasks before SOP, it is recognizable that the definition and establishment of standardized key indicators focuses on the phase after SOP. Figure 1 details the key tasks in this area based on the product lifecycle.

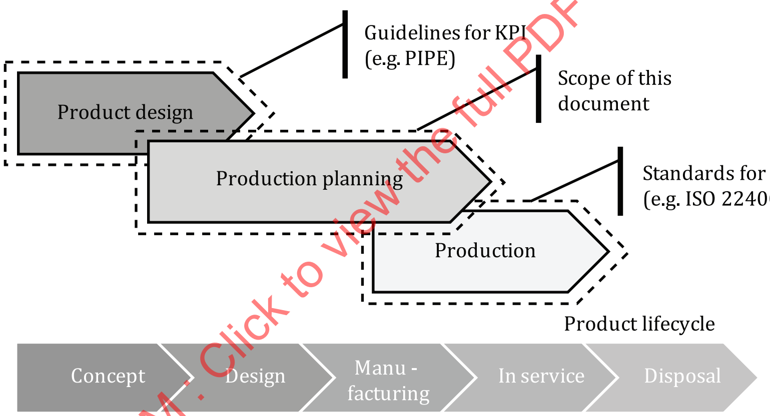

Figure 1 — Quantitative depiction of use of key performance indicators in product lifecycle

The range of process management indicators available in the production planning phase is quite small, as indirect planning tasks have rarely been recorded or managed up to this point. Consequently, there is no standardized set of basic key planning indicators before SOP.

The lack of adequate control parameters necessitates the development of a framework to monitor and improve production planning processes. Key indicators described in this document concern performance tracking of planning processes for engineering production systems.

NOTE 2 This is based on the planning disciplines and stage of development of the planning process in accordance with ISO 18828-2.

The KPIs for production planning generally help to advance the process of standardizing the quality of production process monitoring. The key indicators are abstracted in such a way that they can be consistently applied, according to their definition, in the various planning areas and, if properly adapted, in other areas as well. The key indicators by themselves cannot be used to measure process performance. They can only be set in relation to, and used for, the purposes of continuous comparison with process improvement if thresholds are defined and applied. Definition of the relevant thresholds therefore depends on the particular company. Regarding the production planning processes, it is necessary to pay more attention to the system boundaries of the analysis in order to ensure proper performance management. Key indicators often have a general trend, in terms of optimization taking place in general, or even a theoretical optimum existing. However, they require in particular an examination in relation to the company specifically and an application-based interpretation carried out previous to their utilization.

Industrial automation systems and integration — Standardized procedures for production systems engineering —

Part 4: Key performance indicators (KPIs) in production planning processes

1 Scope

This document specifies a set of key performance indicators in production planning, which allow comparison and monitoring of the production planning process in a standardized framework.

As a first step, the utilization of the KPIs is elaborated in order to organize the indicators in a multi-level system taking different ranges of the planning process into account. This development of a multi-level system represents the core of this document. The scope of the planning processes discussed in this document is limited to production planning for products in series production. Only tasks carried out within the production planning process are considered in this approach.

All key indicators presented are recommendations and can also be used in accordance with the general validity of the reference process from ISO 18828-2 and relate to the content described in this document.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
key performance indicator
KPI
quantifiable level of achieving a critical objective

Note 1 to entry: The KPIs are derived directly from, or through an aggregation function of, physical measurements, data and/or other KPIs.

[SOURCE: ISO 22400-1:2014, 2.1.5]

3.1.2
area type rate
ATR
ratio of a specific area type in relation to total area

Note 1 to entry: Examples of specific area types are storage area and assembly area.

3.1.3
area utilization rate
AUR
ratio of required production area and allocated area

3.1.4
bottleneck information rate
BIR
amount of critical information in relation to all information, which causes delays if it is not available

3.1.5
container
general transport container

EXAMPLE Blister packs; lattice boxes; small parts containers.

3.1.6
container type rate
CTR
ratio of stored containers as a percentage of all containers used within the scope of the defined observation period

3.1.7
information type rate
ITR
ratio of a specific information type in relation to all information types taken together

Note 1 to entry: Examples of specific information types are missing information and used information.

3.1.8
information procurement time
t_{IPT}
time required to procure information while planner actively searches

3.1.9
information fulfilment rate
IFR
ratio of information provided by the actual process over the information required by the target process

3.1.10
information supply rate
ISR
ratio between the amount of existing information and required information for a planning task

3.1.11
information utilization rate
IUR
ratio of information used in relation to the appropriate amount of information available

Note 1 to entry: It is a measured value that describes the amount of available information used for the planning process.

3.1.12
information waiting time
t_{wait}
time spent waiting for information that is required for the planning process to continue

3.1.13
storage container rate
SCR
ratio of stored containers as a percentage of all containers used within the scope of the defined observation period

3.1.14
planning procedure alternatives
PPA
ratio of planning tasks that can be handled at the same time in relation to all tasks required

3.1.15
planning type rate
PTR
ratio of specific planning types to all planning types

Note 1 to entry: Examples of specific planning types are digital planning and workshop.

3.1.16
planning iteration number
PIN
number of iterations of a specific planning task

EXAMPLE Revision after a first successful performed planning task.

3.1.17
planning iteration rate
PIR
ratio of repeated planning tasks

EXAMPLE All tasks performed twice.

3.1.18
planning cycle time
t_{CT}
cycle time required for processing a particular planning task

3.1.19
planning work in progress
PWP
aggregated number of pending work tasks in the process scope

3.1.20
process detail level
PDL
number of sub-process steps planned for a process

EXAMPLE Specifying the description of an assembly process.

3.1.21
response time
t_{RT}
time between receipt of a planning request and start of planning operation

3.1.22
sub-process
process step that is part of a higher-level process

EXAMPLE Assembly and pre-/final assembly.

3.1.23
transport plan rate
TPR
ratio of the number of planned transportation plans to the number of all theoretically

3.1.24
time type rate
TTR
ratio of time types in relation to total working time

Note 1 to entry: Examples of time types are waiting and searching.

3.1.25
work plan rate
WPR
ratio of scheduled work plans to the work plans used in manufacturing operations

Note 1 to entry: An example of a scheduled work plan is for representative product variants.

3.1.26
work plan homogeneity level
WHL
measure for homogeneity or equal distribution in terms of duration of sub-process steps in relation to one another

3.2 Symbols and abbreviated terms

A_{all}	total area
A_{alloc}	allocated area
A_{ass}	assembly area
A_{req}	required area
A_{san}	sanitary area
A_{sto}	storage area
A_x	set area
C_{all}	total number of containers
C_{dim}	number of containers; size: S/M/L
C_{ext}	number of supplier containers
C_{int}	number of internal containers
C_{spec}	number of special containers
C_{stand}	number of standard containers
C_{sto}	number of containers stored

C_x specific container type

D_{all} all planning tasks required

D_{coop} planning tasks performed in team/workshop etc

D_{dig} planning tasks performed with digital planning support

D_i number of pending planning tasks

D_{local} planning tasks performed by the planner (team, department, etc.)

D_{real} planning tasks actually implemented at the same time

D_{same} planning tasks that can be handled at the same time

D_{stand} planning tasks performed in line with standard workflow

D_x planning tasks performed with specific planning type

I_{acc} accepted information

I_{act} information supplied from actual process

I_{all} total of all information

I_{avail} available information

I_{crit} critical information

I_{dig} digital information

I_{pri} primary information

I_{req} information required

I_{sec} secondary information

I_{targ} required information from target process

I_{used} information used

I_x specific information type

L_{TP} level of detail of transport plan

L_{WP} level of detail of work plan

M_{Ei} number of planning cycles due to errors

M_i number of planning cycles

M_{Ri} number of planning cycles after release of planning result

N_{sp} number of sub-processes

P_{all} total number of all process elements

P_{Ei} number of iterated process elements due to errors

P_i number of iterated process elements

t_{end} end time of planning process (planning task completed)

t_i expected time for pending planning tasks

t_{ini} time representing receipt of the planning request

T_{plan} number of scheduled transport plans

t_{search} search time

t_{sp} duration of a sub-process

$t_{sp,all}$ total duration of process

$\bar{t}_{sp}$ mean duration of sub-processes

t_{start} start time of planning process

T_{used} number of transport plans used in manufacturing operations

t_{value} value-added time

t_{work} work time (not including contingency allowances, contingencies, etc.)

t_x specific time type

W_{plan} number of work plans created

W_{used} number of work plans used in manufacturing operations

SOP start of production

4 Key performance indicators in production planning processes

4.1 Production planning KPI system

The production planning KPIs have been organized in a multi-level KPI system which provides different key indicator levels for processes. Those levels range from evaluation of the planning processes in process-oriented key indicators, e.g. through the analysis of time data, process types, and information requirements, to evaluation of the specific planning task results. In this organizational structure, the more process-oriented key indicators on the one hand are valid across different disciplines. On the other hand the result-oriented key indicators tend to relate strongly to the predefined planning disciplines of the production planning processes. In this way, for example, key indicators such as floor space utilization or ratio of container types are used to evaluate the planning results of the planning disciplines of layout and logistics planning based on the application of the concepts developed in the planning process. Figure 2 provides an overview of the structure of the KPIs in production planning.

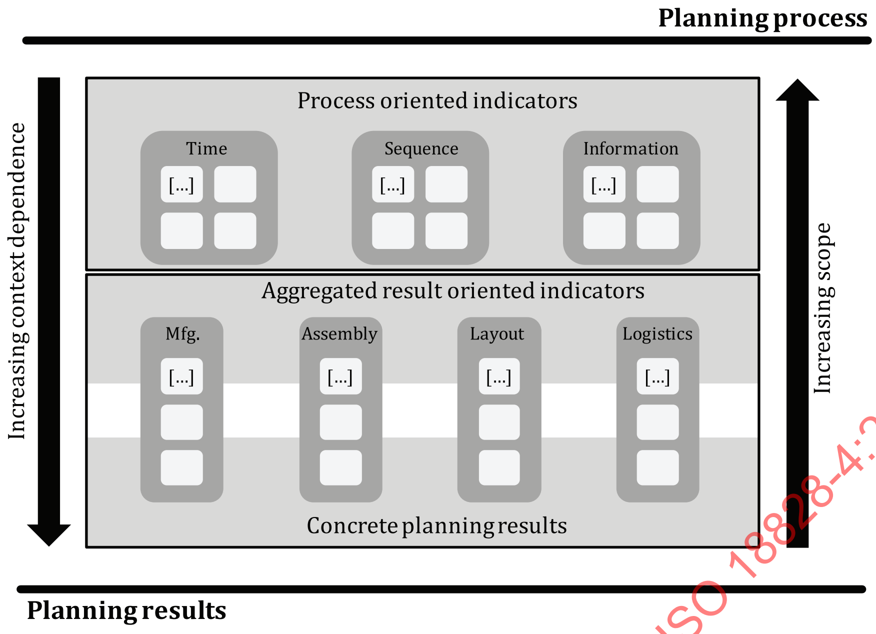

Figure 2 — Structure of the KPIs

The defined structure will be filled with sample key indicators on all levels. A consistent documentation of these indicators is ensured by use of a standardized key indicator template (see 4.2). Process-oriented key indicators can be identified by their broad scope of use, as they are neither discipline-specific nor specific to the individual stage of development. They are assigned to a specific context when adjusted to the user's planning processes requiring evaluation. Process-oriented key indicators such as these may represent for instance the iteration rate of a particular process. Another example for process-oriented key indicators might be ratios adjusted to a specific use case. In one scenario the information type rate mirrors the rate of digital information compared to a total amount. In another scenario the KPI compasses missing information instead. However, iterations taking place as part of the planning (e.g. revision work in production) a positive or negative trend cannot be assigned directly because, the reasons for a planning iteration (e.g. updated or new planning information, external or internal requirements) may vary in practice. Interpretation of the planning iteration depends on the context, such as observed planning phase and planning scope, and requires a thorough check. As the definition already resolves, key indicators based on concrete planning results are far more dependent upon the context and have a narrow, predefined scope of validity. Based on the core planning disciplines identified in the reference planning process, sample result KPIs can be derived for use in these domains.

NOTE Based on the planning disciplines and stage of development of the planning process in accordance with ISO 18828-2.

4.2 Formal definition of key performance indicators

The planning disciplines within this reference process are manufacturing, assembly, logistics and layout planning. These disciplines act, in this respect, as a base for the comparison of various production planning processes and a cross-discipline comparison. This document enhances options for performance management within a company and, if required, across multiple companies. Simultaneously, a distinction between key indicators in relation to the reference object needs to be drawn. In the first place, key process indicators are described presenting the planning processes that are clearly present and reveal possible ways to analyse the efficiency of the processes. Secondly, the planning quality, e.g. process output quality, is assessed using different key indicators in certain cases. The basic structure used to define key indicators is divided into three different parts. Table 1 presents an abridged version.

NOTE This is based on the structure of key indicators from ISO 22400-2.

Table 1 — Structure of KPI description

Description	
Name	
Planning discipline/process step	
Use case/application context	
Definition	
Formula	
Unit/dimension	
Range	
Variation	
Input parameters/variables	
Parameter 1	
Parameter 2	
...	
Parameter *n*	
Comments	
Result/interpretation/specification	
Point of Contact	

The first part describes the respective key indicator containing its name, planning discipline/process step and use case/application context, the latter of which defines, for example, the standard disciplines of manufacturing planning, assembly planning, logistics planning and layout planning, or process steps the key indicator is used in.

The details of the key indicator are defined in the second part. This includes the explicit formula and corresponding unit/dimension as well as the range. Respective, generally valid input parameters and variables form the next part of the table. If necessary, a description of possible variations of the key indicator that can also be used, and that expand on the range of key indicators, is also provided.

EXAMPLE The KPI "planning iteration number", whose variations can occur in different phases of process planning, provides an example of a key indicator variation. Variations provide a possibility for companies to specify a KPI in accordance with their environment. Companies are advised to maintain the variations used for a KPI in order to keep consistent results, e.g. for benchmarks or comparative methods. The KPI itself is, for example, useful in the phase of developing a concept to specify the number of revisions needed after a successful performed task simulation. However, in the phases of rough and detailed planning, variations of the KPI (planning iteration error number or planning iteration revision) can prove more beneficial in handling process errors or adjustments. In addition, there are two different types of variations influencing the structure of the tables. If the variation affects the formula as a whole, it is categorized in the second part of the table "Definition". If the variation affects only a parameter of the formula, the variation is listed in the third part "Input parameters/variables".

The last part of the key indicator description provides notes on the key indicator, which shall be considered in relation to the result, interpretation or specification in order to ensure use as intended. The process manager, who has direct influence over the key indicator and who should be the main point of contact with regard to collection or optimization, is also named.

Annex A provides an overview of the described KPIs.

5 Descriptions of key performance indicators

5.1 General

The production planning KPIs are organized in a multi-level KPI system providing different key indicator levels for processes. Definitions and details of the individual KPIs are provided in Tables 2 to 24.

As illustrated in Figure 3, in order to provide a systematic classification for the KPIs, a distinction is drawn between process-oriented, aggregated and concrete indicators. Within process oriented indicators, the three factors of time, sequence and information are distinguished. Users choose a KPI which best suits their point of interest. KPIs represent a generic option to measure quality, time or cost.

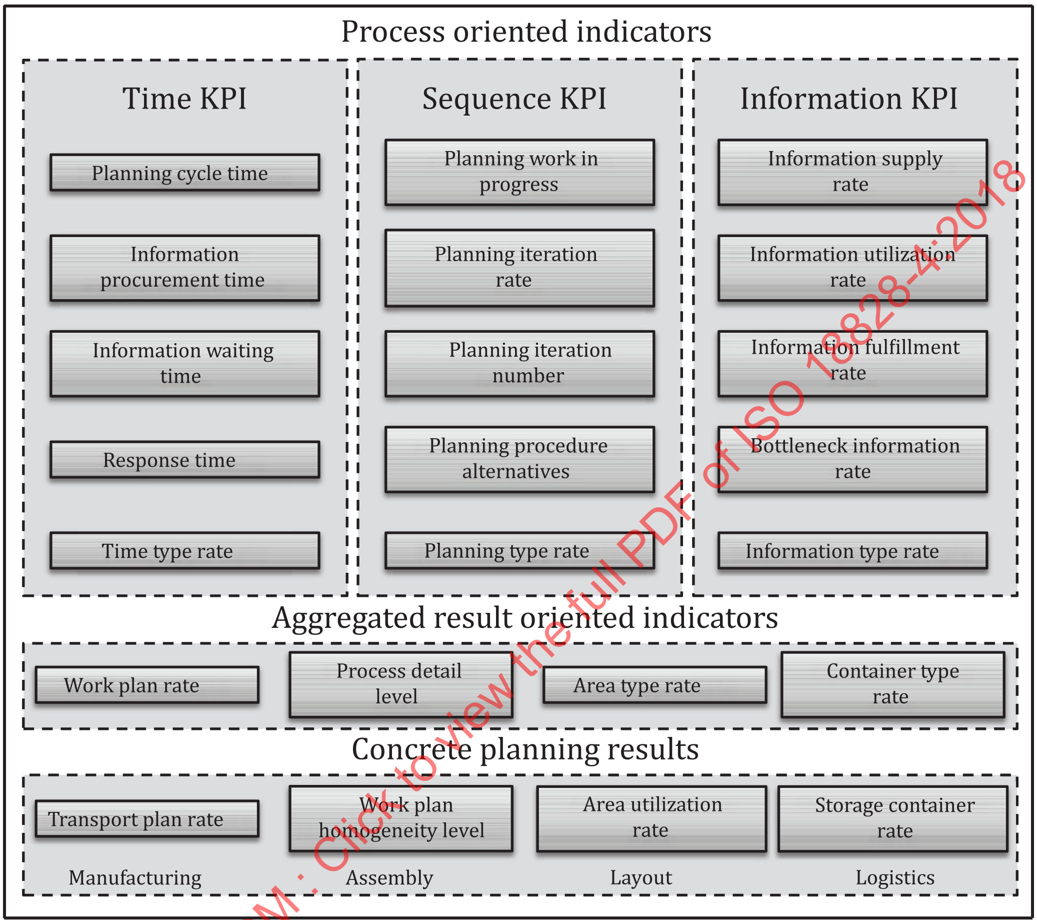

Figure 3 — Key performance indicators for production planning

5.2 Process-oriented key indicators

5.2.1 Time indicators

Table 2 — Description of planning cycle time (t_{CT})

Description	
Name	Planning cycle time
Planning discipline/process step	All
Use case/application context	Cycle time required for processing a particular planning task.
Definition	
Formula	$t_{CT} = t_{end} - t_{start}$
Unit/dimension	[h]/hours
Range	— Min: 0 [h] — Max: infinite
Input parameters/variables	
Parameter 1	— t_{start}: Time representing start of planning process in [h]/hours
Parameter 2	— t_{end}: Time representing end of planning process (planning task completed) in [h]/hours
Variation	— t_{start}: Time representing identification of requirement at start of a planning task in [h]/hours
Comments	
Result/interpretation/specification	Trend: The shorter the better; Periods of absence, vacations, etc. shall be taken into account; Can be applied in re-planning and change planning; Iteration of change planning could be triggered via updated information; Use of standardized time scale to consider national differences.
Point of Contact	Planner

Table 3 — Description of information procurement time (t_{IPT})

Description	
Name	Information procurement time
Planning discipline/process step	All
Use case/application context	Time required to procure information (while planner actively searches).
Definition	
Formula	$t_{IPT} = t_{end} - t_{start}$
Unit/dimension	[h]/hours
Range	— Min: 0 [h] — Max: infinite
Variation	Average information procurement time $\left(\bar{t}_{IPT}\right)$ $\bar{t}_{IPT} = \frac{\sum_{j=1}^{m}\left(t_{end,j} - t_{start,j}\right)}{m}$ The defined process scope can contain individual process elements as well as process chains; Average values should not be compared with different statistical degrees of precision; Quantification of information in the defined scope is necessary.
Input parameters/variables	
Parameter 1	— t_{start}: Time representing start of information procurement in [h]/hours
Parameter 2	— t_{end}: Time representing end of information procurement (planning task completed) in [h]/hours
Parameter 3	— m: Number of time measurements
Parameter 4	— j: Indexed variable for a specified time measurement
Comments	
Result/interpretation/specification	Trend: The shorter the better; Periods of absence, vacations, etc. shall be taken into account; Use of standardized time scale to consider national differences; Information type and process complexity shall be taken into account; Key indicators can be influenced by other activities (priority shall be considered).
Point of Contact	Planner

Table 4 — Description of information waiting time (t_{wait})

Description	
Name	Waiting time for information
Planning discipline/process step	All
Use case/application context	Time spent waiting for information which is required for the planning process to continue.
Definition	
Formula	$t_{wait} = t_{end} - t_{start}$
Unit/dimension	[h]/hours
Range	— Min: 0 [h] — Max: infinite
Variation	Average information waiting time $\left(\bar{t}_{wait}\right)$ $\bar{t}_{wait} = \frac{\sum_{j=1}^{m}\left(t_{end,j} - t_{start,j}\right)}{m}$ The defined process scope can contain individual process elements as well as process chains; Average values should not be compared with different statistical degrees of precision; Quantification of information in the defined scope is necessary.
Input parameters/variables	
Parameter 1	— t_{start}: Time representing start of information procurement in [h]/hours
Parameter 2	— t_{end}: Time representing end of information procurement (planning task completed) in [h]/hours
Parameter 3	— m: Number of time measurements
Parameter 4	— j: Indexed variable for a specified time measurement
Comments	
Result/interpretation/specification	Trend: The shorter the better; Periods of absence, vacations, etc. shall be taken into account; Use of standardized time scale to consider national differences; Information type and process complexity shall be taken into account; KPI can be influenced by other activities (priority shall be considered).
Point of Contact	Planner

Table 5 — Description of response time (t_{RT})

Description	
Name	Response time
Planning discipline/process step	All
Use case/application context	Time between receipt of a planning request and start of planning operation.
Definition	
Formula	$t_{RT} = t_{start} - t_{ini}$
Unit/dimension	[h]/hours
Range	— Min: 0 [h] — Max: infinite
Variation	$\bar{t}_{RT} = \frac{\sum_{n=1}^{m}\left(t_{start,j} - t_{ini,j}\right)}{m}$ Mean response time
Input parameters/variables	
Parameter 1	— t_{ini}: Time representing receipt of the planning request in [h]/hours
Parameter 2	— t_{start}: Time representing start of planning process in [h]/hours
Parameter 3	— m: Number of planning requests
Parameter 4	— $t_{ini,j}$: Time representing initiation of planning request in time measurement j in [h]/hours
Parameter 5	— $t_{start,j}$: Time representing start of planning process in time measurement j in [h]/hours
Parameter 6	— j: Indexed variable for a specified time measurement in [h]/hours
Comments	
Result/interpretation/specification	Trend: The shorter the better; Periods of absence, vacations, etc. shall be taken into account; receipt of the planning task corresponds to the acknowledgement of the task by the planner; Use of standardized time scale to consider national differences; Key indicators can be influenced by other activities (priority shall be considered).
Point of Contact	Person placing change request, planner

Table 6 — Description of time type rate (TTR)

Description	
Name	Time type rate
Planning discipline/process step	All
Use case/application context	Ratio of time types (e.g. waiting, searching etc.) in relation to total working time.
Definition	
Formula	$TTR = \frac{t_x}{t_{work}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Input parameters/variables	
Parameter 1	— t_x: Specific time type in [h]/hours
Parameter 1	— t_{work}: Work time (not including contingency allowances, contingencies, etc.) in [h]/hours
Variation	Characteristic examples: — $t_x = t_{wait}$: waiting time in [h]/hours — $t_x = t_{search}$: search time in [h]/hours — $t_x = t_{value}$: value-added time in [h]/hours
Comments	
Result/interpretation/specification	The defined scope may vary in different dimensions (time period, planning task, planning department, etc. taken into account); The definition of the work time shall consider company-specific regulations and the regional laws; If the defined work time is used for comparisons, this shall be kept constant.
Point of Contact	Planner

5.2.2 Process indicators

Table 7 — Description of planning work in progress (PWP)

Description	
Name	Planning work in progress
Planning discipline/process step	All
Use case/application context	Aggregated number of pending work tasks in the process scope.
Definition	
Formula	$\mathrm{PWP} = \sum_{i=1}^{n} D_i$
Unit/dimension	–/–
Range	— Min: 0 [–] — Max: infinite
Variation	$\mathrm{PWP(T)} = \sum_{i=1}^{n} (D_i \times t_i)$ Planning work in progress in consideration of time-related work content of pending planning tasks
Input parameters/variables	
Parameter 1	— n: Number of process elements considered in process scope
Parameter 2	— D_i: Number of pending planning tasks in process element i
Parameter 3	— i: indexed variable for a process element
Parameter 4	— t_i: Expected time for pending planning tasks in process element i (duration) in [h]/hours
Comments	
Result/interpretation/specification	The defined process scope can contain individual process elements as well as process chains; Quantification of information in the defined scope; Work in progress does not consider prioritization and priority of tasks; Quantification of time-related work content for planning tasks is required (e.g. plan times or comparisons and estimates).
Point of Contact	Planner

Table 8 — Description of planning iteration rate (PIR)

Description	
Name	Planning iteration ratio
Planning discipline/process step/application context	All
Use case/application context	Ratio of repeated planning tasks (e.g. all tasks performed twice).
Definition	
Formula	$\mathrm{PIR} = \frac{P_i}{P_{\mathrm{all}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	$\mathrm{PIE} = \frac{P_{\mathrm{E}i}}{P_i} \times 100$ Planning iteration error rate
Input parameters/variables	
Parameter 1	— P_i: Number of iterated process elements
Parameter 2	— P_{all}: Total number of all process elements
Parameter 3	— $P_{\mathrm{E}i}$: Number of iterated process elements due to errors
Comments	
Result/interpretation/specification	The defined process scope can contain individual process elements as well as process chains; The defined scope should be kept constant if it is used for comparisons; Internal and external iterations should be considered separately; The reason for an iteration may vary (e.g. updated or new planning information); The interpretation of the iteration rate heavily depends on the planning phase under review.
Point of Contact	Planner

Table 9 — Description of planning iteration number (PIN)

Description	
Name	Planning iteration number
Planning discipline/process step	All
Use case/application context	Number of iterations of a specific planning task (e.g. revision after a first successful performed planning task).
Definition	
Formula	$\text{PIN} = \sum_{i=1}^{n} M_i - 1$
Unit/dimension	–/–
Range	— Min: 0 [-] — Max: infinite
Variation	$\overline{\text{PIN}} = \frac{\sum_{i=1}^{n}(M_i - 1)}{n}$ Average number of iterations $M_i = 1$ (an individual planning iteration): PIN = 0 This describes the error-free planning iteration by all process elements i. It can also be interpreted as first pass yield (FPY) of 100 %.
	$\text{PIN(E)} = \frac{\sum_{i=1}^{n} M_{\text{E}i}}{\sum_{i=1}^{n}(M_i - 1)} \times 100$ Planning iteration error number
	$\text{PIN(R)} = \frac{\sum_{i=1}^{n} M_{\text{R}i}}{\sum_{i=1}^{n}(\text{M}_i - 1)} \times 100$
Input parameters/variables	
Parameter 1	— M_i: Number of planning iterations in process element i
Parameter 2	— i: Indexed variable for the process chain element
Parameter 3	— n: Number of process elements considered in process scope
Parameter 4	— $M_{\text{E}i}$: Number of planning iterations in process element i due to errors
Parameter 5	— $M_{\text{R}i}$: Number of planning iterations after release of planning result in process element i

Table 9 *(continued)*

Comments	
Result/interpretation/specification	The defined process scope can contain individual process elements as well as process chains; The defined scope should be kept constant if it is used for comparisons; Internal and external iterations should be considered separately; The reason for an iteration may vary (e.g. updated or new planning information); The interpretation of the iteration rate heavily depends on the planning phase under review.
Point of Contact	Planner

Table 10 — Description of planning procedure alternatives (PPA)

Description	
Name	Planning procedure alternatives
Planning discipline/process step	All
Use case/application context	Ratio of planning tasks that can be handled at the same time in relation to all tasks required.
Definition	
Formula	$\text{PPA} = \frac{D_{\text{same}}}{D_{\text{all}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	$\text{PTA} = \frac{D_{\text{local}}}{D_{\text{all}}} \times 100$ Planning task allocation
	$\text{PAI} = \frac{D_{\text{real}}}{D_{\text{same}}} \times 100$
Input parameters/variables	
Parameter 1	— D_{same}: Planning tasks that can be handled at the same time
Parameter 2	— D_{all}: All planning tasks required
Parameter 3	— D_{local}: Planning tasks performed by the planner (team, department, etc.)
Parameter 4	— D_{real}: Planning tasks actually implemented at the same time
Comments	
Result/interpretation/specification	Trend: Maximum at 100 %, typical characteristic lower than 100 %; The defined process scope can contain individual process elements as well as process chains.
Point of Contact	Planner

Table 11 — Description of planning type rate (PTR)

Description	
Name	Planning type rate
Planning discipline/process step	All
Use case/application context	Ratio of specific planning types (e.g. digital planning, workshop etc.) to all planning types.
Definition	
Formula	$\text{PTR} = \frac{D_x}{D_{all}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Input parameters/variables	
Parameter 1	— D_x: Planning tasks performed with specific planning type
Parameter 2	— D_{all}: All planning tasks required
Variation	Characteristic examples: — $D_x = D_{dig}$: Planning tasks performed with digital planning support — $D_x = D_{coop}$: Planning tasks performed in team/ workshop, etc. — $D_x = D_{stand}$: Planning tasks performed in line with standard workflow
Comments	
Result/interpretation/specification	If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

5.2.3 Information indicators

Table 12 — Description of information supply rate (ISR)

Description	
Name	Information supply rate
Planning discipline/process step	All
Use case/application context	Ratio between the amount of existing information and required information for planning task.
Definition	
Formula	$\text{ISL} = \frac{I_{\text{avail}}}{I_{\text{req}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	$\text{IAR} = \left(1 - \frac{I_{\text{avail}}}{I_{\text{req}}}\right) \times 100$ (ISL < 100 %) Information accepted rate Ratio of accepted information to enable planning process to continue without delay
Input parameters/variables	
Parameter 1	— I_{avail}: Amount of existing information
Parameter 2	— I_{req}: Amount of information required
Comments	
Result/interpretation/specification	Sufficient supply of information at 100 %, higher values represent an oversupply, lower values a shortage of information; The defined process scope can contain individual process elements as well as process chains; Quantification of information in defined scope is required; The definition of required information should be given careful consideration; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

Table 13 — Description of information utilization rate (IUR)

Description	
Name	Information utilization rate
Planning discipline/process step	All
Use case/application context	Ratio of information used in relation to the appropriate amount of information available. A measured value that describes the amount of available information used for the planning process.
Definition	
Formula	$\text{IUR} = \frac{I_{\text{avail}}}{I_{\text{used}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	—
Input parameters/variables	
Parameter 1	— I_{used}: Amount of information used
Parameter 2	— I_{avail}: Amount of existing information
Comments	
Result/interpretation/specification	Can be interpreted as relevance criteria of available information; The definition of available information (particularly the reduction) should be given careful consideration and contain all relevant information; The defined process scope can contain individual process elements as well as process chains; Quantification of information in defined scope is required; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

Table 14 — Description of information fulfilment rate (IFR)

Description	
Name	Information fulfilment rate
Planning discipline/process step	All
Use case/application context	Ratio of required information from the target process which the actual process in fact provides
Definition	
Formula	$\text{IFR} = \frac{I_{\text{act}}}{I_{\text{targ}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	—
Input parameters/variables	
Parameter 1	— I_{act}: Amount of provided information from actual process
Parameter 2	— I_{targ}: Amount of required information from target process
Comments	
Result/interpretation/specification	Full information fulfilment rate at 100 %, higher value represents a fulfilment rate above 100 % (redundancy), lower value represents a fulfilment rate of less than 100 %; The defined process scope can contain individual process elements as well as process chains; Quantification of information in defined scope is required; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

Table 15 — Description of bottleneck information rate (BIR)

Description	
Name	Bottleneck information rate
Planning discipline/process step	All
Use case/application context	Amount of critical information, which leads to waits due to it not being available, in relation to all information.
Definition	
Formula	$\mathrm{BIR} = \frac{I_{\mathrm{crit}}}{I_{\mathrm{all}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	—
Input parameters/variables	
Parameter 1	— I_{crit}: Amount of critical information
Parameter 2	— I_{all}: Total of all information
Comments	
Result/interpretation/specification	Trend: Maximum at 100 %, target rate significantly lower than 100 %; Key indicator allows for prioritization of processes; The defined process scope can contain individual process elements as well as process chains.
Point of Contact	Planner

Table 16 — Description of information type rate (ITR)

Description	
Name	Ratio of information type
Planning discipline/process step	All
Use case/application context	Ratio of a specific information type (e.g. missing information, used information etc.) in relation to all information types taken together.
Definition	
Formula	$\text{ITR} = \frac{I_x}{I_{all}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Input parameters/variables	
Parameter 1	— I_x: Specific information type
Parameter 2	— I_{all}: Total of all information
Variation	Characteristic examples: — $I_x = I_{inc}$ missing information — $I_x = I_{acc}$ accepted information — $I_x = I_{pri}$ primary information — $I_x = I_{sec}$ secondary information — $I_x = I_{used}$ used information — $I_x = I_{dig}$ digital information
Comments	
Result/interpretation/specification	The defined process scope can contain individual process elements as well as process chains; Quantification of information in defined scope is required; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

5.3 Result-oriented key indicators

5.3.1 Manufacturing

Table 17 — Description of work plan rate (WPR)

Description	
Name	Work plan rate
Planning discipline/process step	Manufacturing planning, assembly planning
Use case/application context	Ratio of scheduled work plans (e.g. for representative product variants) to the work plans used in manufacturing operations.
Definition	
Formula	$\mathrm{WPR} = \frac{W_{\mathrm{plan}}}{W_{\mathrm{used}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	$\mathrm{WPS} = \frac{\sum_{i=1}^{W_{\mathrm{plan}}} L_{\mathrm{WP},i}}{W_{\mathrm{plan}}}$ Work plan specification
Input parameters/variables	
Parameter 1	— W_{plan}: Number of work plans created in the defined scope
Parameter 2	— W_{used}: Number of work plans used in manufacturing operations in the defined scope
Parameter 3	— $L_{\mathrm{WP},i}$: Level of detail of work plan i (from 0 to 100 %; evaluated in five percentage increments)
Comments	
Result/interpretation/specification	Trend: Maximum at 100 % (W_{plan} << W_{used}), target rate significantly lower than 100 %; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

Table 18 — Description of transport plan rate (TPR)

Description	
Name	Transport plan rate
Planning discipline/process step	Logistics planning
Use case/application context	Ratio of the number of planned transportation plans to the number of all theoretically.
Definition	
Formula	$\mathrm{TPR} = \frac{T_{\mathrm{plan}}}{T_{\mathrm{used}}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	$\mathrm{TPS} = \frac{\sum_{i=1}^{T_{\mathrm{plan}}} L_{\mathrm{TP},i}}{T_{\mathrm{plan}}}$ Transport plan specification
Input parameters/variables	
Parameter 1	— T_{plan}: Number of planned transport plans in the defined scope
Parameter 2	— T_{used}: Number of transport plans used in manufacturing operations in the defined scope
Parameter 3	— $L_{\mathrm{TP},i}$: Level of detail of transport plan *i* (from 0 to 100 %; evaluated in five percentage increments)
Comments	
Result/interpretation/specification	Trend: Maximum at 100 % (T_{plan} << T_{used}), target rate significantly lower than 100 %; Number of theoretically possible transport plans is defined by the product range; If the defined scope is used for purposes of comparison, this shall be kept constant.
Point of Contact	Planner

5.3.2 Assembly

Table 19 — Description of process detail level (PDL)

Description	
Name	Process detail level
Planning discipline/process step	Manufacturing planning, assembly planning
Use case/application context	Number of sub-process steps planned for a process (e.g. specifying the description of an assembly process).
Definition	
Formula	$\mathrm{PDL} = \left(1 - \frac{1}{W_{sp}}\right) \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	—
Input parameters/variables	
Parameter 1	— W_{sp}: Number of sub-processes
Comments	
Result/interpretation/specification	Trend: Theoretical maximum at 100 %, target rate lower than 100 %. If no sub-process is defined (N_{sp} = 1 → PDL = 0 %), or just a few (N_{sp} ≥ 2 → 50 % < PDL << 100 %), the level of detail is low. The more sub-processes are defined, the more detailed the process is (N_{sp} >> 2 → 50 % << PDL < 100 %). The maximum of 100 % cannot be achieved in practice. The details of a process shall justify the expense. The optimum process detail level shall be defined by the user.
Point of Contact	Planner

Table 20 — Description of work plan homogeneity level (WHL)

Description	
Name	Work plan homogeneity level
Planning discipline/process step	Manufacturing planning, assembly planning
Use case/application context	Measure for homogeneity or equal distribution in terms of duration of sub-process steps in relation to one another.
Definition	
Formula	$\text{WHL} = \left(1 - \frac{\sum \lvert t_{\text{sp}} - \bar{t}_{\text{sp}} \rvert}{t_{\text{sp,all}}}\right) \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Variation	—
Input parameters/variables	
Parameter 1	— $t_{\text{sp,all}}$: Total duration of the observed process in [h]/hours
Parameter 2	— $\bar{t}_{\text{sp}}$: Mean duration of the sub-processes in [h]/hours
Parameter 3	— t_{sp}: Duration of a sub-process in [h]/hours
Comments	
Result/interpretation/specification	Trend: Theoretical maximum at 100 %, target rate lower than 100 %; The less the duration of the individual sub-processes deviates from the average process duration, the more homogenous the processes will be. Duration t_{sp} of all sub-processes = $\bar{t}_{\text{sp}}$ → PHL = 100 %; duration t_{sp} highly variable PHL → 0 %; The overall goal should be to achieve the maximum level of homogeneity possible with regard to the duration of the sub-processes. The optimum work plan homogeneity shall be defined by the user.
Point of Contact	Planner

5.3.3 Layout

Table 21 — Description of area type rate (ATR)

Description	
Name	Area type rate
Planning discipline/process step	Layout planning, logistics planning
Use case/application context	Ratio of a specific area type (e.g. storage area, assembly area etc.) in relation to total area.
Definition	
Formula	$\text{ATR} = \frac{A_x}{A_{all}} \times 100$
Unit/dimension	[%]/–
Range	— Min: 0 [%] — Max: 100 [%]
Input parameters/variables	
Parameter 1	— A_x: Set area in m^2
Parameter 2	— A_{all}: Total area in the defined scope in m^2
Variation	Characteristic examples: $A_x = A_{ass}$ Assembly area rate in m^2 $A_x = A_{sto}$ Storage area rate in m^2 $A_x = A_{san}$ Sanitary area rate in m^2
Comments	
Result/interpretation/specification	Trend: Maximum at 100 %; target rate can only be defined with further specification; The defined scope may vary in different dimensions (area for machines, work stations, assembly lines, or production-specific equipment, etc.); The definition of the total area shall take account of company-specific agreements and restrictions; If the total area is used for comparisons, this shall be kept constant.
Point of Contact	Planner