GLOBAL MINING GUIDELINES GROUP

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A STANDARDIZED TIME CLASSIFICATION FRAMEWORK FOR MOBILE EQUIPMENT IN SURFACE MINING:

Operational Definitions, Time Usage Model, and Key Performance Indicators

SUBMITTED BY
The Operational Definitions and KPIs Sub-Committee

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DISCLAIMER

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1. FOREWORD

The Global Mining Group (GMG) is a network of representatives from mining companies, original equipment manufacturers (OEMs), original technology manufacturers (OTMs), research organizations, academia, regulatory agencies, consultancies, and industry associations who collaborate to tackle the challenges facing our industry. GMG aims to accelerate the improvement of mining performance, safety and sustainability and creates guidelines, such as this one, that address common industry challenges. Working group members check and approve draft documents prior to their approval by the GMG Executive Council.

Please note: if some of the elements of this document are subject to patent rights, GMG and the Canadian Institute of Mining, Metallurgy and Petroleum (CIM, of which GMG is a legal entity) are not responsible for identifying such patent rights.

2. KEYWORDS

Availability, Benchmarking, Key performance indicators, Operational definitions, Surface mining, Taxonomy, Time Usage Model, Utilization

3. INTRODUCTION

This guideline provides a classification framework for operational activity that will enable meaningful performance analysis and industry-wide comparison.

The core content of this framework is outlined in Section 8. It includes the following:

- Recommendations for the consistent classification of common surface mining operational activities, statuses, and events into standard time categories.
- A Time Usage Model, which is a visual representation of the recommended classification framework identified above.
- Recommended definitions for common industry operational key performance indicators (KPIs) for reporting mining asset availability and utilization.

The time categories, Time Usage Model, and KPI definitions outlined in this guideline are not intended to be industry standards; these are recommendations for recording and understanding operational performance. The framework documented in this guideline will support further collaboration aimed at developing additional KPIs and definitions.

Note on capitalization: references specific to the time categories defined in Section 8.3, the KPIs defined in Section 8.5, and the GMG Time Usage Model are capitalized to avoid confusion with similar terms that are used more generally.

4. BACKGROUND

The development of this guideline was a collaborative effort led by the GMG Data Access and Usage Working Group, a group of mining industry stakeholders whose objective was to identify and document the on- and off-board data requirements for mine management and operation.

The mining industry comprises a wide range of users who represent different needs and perspectives related to data usage. Historically, the industry has faced challenges with making performance comparisons and benchmarking externally or even within their own organizations. These difficulties have often been due to inconsistent terminology, data, information, and reporting. For example, the meaning of the term "operating hour" varies throughout the mining community. For the mining industry to achieve digitalization, interoperability, and system integration, it is important for it to establish consistent terminology and data. The ability to share and use information from various platforms requires that there be a common information platform and a common language or taxonomy.

A dedicated project group was created to establish standard definitions for mining operational data. For the initial scope to be more manageable, it was narrowed down to the most common operational KPIs for surface mining and the data required to support them.

The initial industry consultation was based on the KPI definitions time model from the Surface Mining Association for Research and Technology (SMART, ca. 1999), which reflect the commonly-accepted definitions and time model as published in Pfleider (1968). The consensus among the participants is that most companies are using versions of the KPI definitions that were not likely to change. However, industry benchmarking and performance comparison is possible by focusing on identifying operational activities, statuses, and events and then classifying them into agreed time categories from which standard KPI definitions can be generated. Industry-wide comparisons are possible using these agreed standard definitions while individual companies can continue using their classifications and KPI definitions.

5. SCOPE

This guideline covers the most common surface mining activities, associated status and event descriptions, and the time categories needed to classify the activities and generate the most widely used mining operational KPIs.

The scope does not include:

- Maintenance activity capture and classification
- Underground mining operations
- Processing and fixed plant operations

While the current framework does not include a detailed classification of maintenance activity, it will be considered in future work by the GMG Asset Management Working Group. The current GMG Time Usage Model is primarily an operations tool that captures overall asset operational time and downtime. Computerized maintenance management systems (CMMSs) and work order systems would be more effective than the Time Usage Model for capturing maintenance information, such as downtime reasons, work classification, and failure causes.

Underground mining and processing operations will also be considered in future work (see Section 9).

6. BUSINESS CASE

Mining companies are interested in measuring and tracking performance in order to improve their operations. This guideline supports this process by proposing common performance metrics and a common framework for identifying the types of activities, statuses, and events that should be consistently reported. This will enable the type of information and data sharing that will enable meaningful comparisons across the industry.

The benefits of this time classification framework are outlined in the following subsections.

6.1 Standardized Definitions

Standard data element definitions prevent differing and disparate interpretations of the data they describe. Consistent data definitions:

- Allow for the exchange and sharing of data across different operating functions, platforms, and systems, thus enabling interoperability and integration.
- Provide consistency in reporting and classifying operational activities. This consistency will provide a common basis for internal and external trend and performance comparisons between different equipment and fleet types.
- Provide clarity between the users and suppliers of data. A common data model, dictionary, and taxonomy will aid in clarifying information requirements from equipment vendors and third-party technology providers. It will also establish a common ground for information requirements so that third-party vendors will not need to reconfigure systems for individual users. This can result in reduced customization, lower systems implementation costs, and reduced implementation time frames.

6.2 Common Classification of Operational Activity

The guideline provides a common framework for identifying activities, statuses, and events in order to clarify how these factors are reported and classified. Agreeing on a common industry framework for classifying operational activity enables performance comparison among industry peers.

6.3 Time Usage Model

The guideline proposes a common Time Usage Model, which is a tool that classifies activities, statuses, and events so that the operations and management personnel can understand, monitor, and manage time usage in their operation. Managing time provides a foundation for operational excellence.

6.4 Key Performance Indicators

The identification and classification framework in this guideline can be used to generate KPIs that are commonly used in mining. Effective KPIs provide insights into operational performance and identify opportunities for improvement. The process of generating and identifying common performance definitions and KPIs is more effective when activities, statuses, and events are consistently defined and assigned to time categories.

The KPIs for availability and utilization in the guideline are considered "outcome KPIs"; these are high-level measures that are concerned with overall performance.

Leading indicators, or "process KPIs," such as the number of loads, weight per load, and types of delay are used to guide actions so as to make sure that the KPIs reflect the desired results. Identifying and classifying events and, in particular, delays provides indicators that can be used to gauge the efficiency of operational processes.

6.5 Benchmarking

Performance improvement requires that operations have both an understanding of current performance and the ability to find improvement opportunities. Operations can meet these requirements through benchmarking, which is the practice of comparing performance metrics against other similar operations to identify industry leaders and best practices. Benchmarking can result in superior performance when operations study industry leaders in order to understand and learn from the processes, practices, enablers, and factors that contribute to their success. When operations compare leading practices to their own, they can identify and implement changes that will result in improved performance.

Benchmarking contributes to improved collective industry performance by promoting collaboration toward continuous improvement and raising performance expectations. Establishing a common baseline for comparing existing performance will accelerate industry innovation by providing an understanding of the activities that contribute to improved and exposing where there are gaps and areas for improvement.

While there is industry interest in benchmarking, it is challenging to do without the common, clear, and consistent definitions and rules that will enable valid comparisons between performance metrics and results that they track. The common metrics and common classification framework in this guideline will enable comparisons to be made between similar processes and operations.

6.6 Comparing Conventional and Autonomous Operations

A common taxonomy and classification framework will enable improvements to be made to conventional operations through comparisons to autonomous systems.

Autonomous operations depend on continuous feedback of data from various integrated sources that results in a wealth of real-time data on equipment condition and performance. The improved data collection capability of autonomous systems will provide more complete and accurate operating data, including data that can be used to more accurately identify and define delays.

Comparisons between conventional and autonomous operations will help identify avoidable operator-caused delays and performance gaps, which will allow conventional operations to reset performance expectations in order to eliminate avoidable delays.

6.7 Common Industry Model

A key benefit of this framework is that operations looking to establish metrics and set up production data collection and reporting systems will have guidance on which to base these systems. This benefit is particularly relevant to startup operations that are in the process of configuring their production data collections systems, which are often fleet management systems. The data provided by the Time Usage Model will also be valuable in supporting maintenance systems and establishing activity-based costing and performance reporting systems. Standard definitions will also help new operations establish vendor agreements and facilitate external comparisons and benchmarking.

7. METHODOLOGY

This classification framework and Time Usage Model are based on commonly used industry models. The project group used the SMART (ca. 1999) KPI definitions and time model based on Pfleider (1968) as the basis for their initial industry consultations. Consultation began by circulating the SMART model and KPIs and inviting feedback. GMG member companies were invited to submit their own KPIs and time models, including definitions of all of their activities, statuses, and events. From the feedback received, a consensus-based time classification was generated based on the following:

- Descriptions of activities, statuses, and events
- Time categories and definitions
- Definitions of availability and utilization KPIs
- The intent, specifics, and ideas behind the time models that were submitted

The resulting draft framework, which included the activity list, Time Usage Model, and KPI definitions, was circulated within the GMG community for feedback. Following the initial GMG response, targeted feedback was solicited from the contributing companies and others that expressed an interest in providing detailed review and feedback.

Individual feedback was incorporated into the draft model, which was then validated by eight mining companies. At the same time, the model underwent a limited trial using actual production data. Minor modifications were made following the review in order to reflect the feedback that related to the data collection processes and requirements that are driven by the autonomous environment.

Following release of the draft in 2019, feedback was received from fleet management system (FMS) providers several operations in various stages of updating or configuring their time model or fleet management system.

8. TIME USAGE MODEL AND DEFINITIONS

This section covers the core content of this guideline and includes the following:

- A description of the logic behind the classification framework (Section 8.1)
- A description of the Time Usage Model (Section 8.2)
- Definitions of the standard time categories reflected in the model (Section 8.3)
- Guidelines for using the model (Section 8.4)
- Definitions of the availability and utilization KPIs that can be generated by using the model (Section 8.5).

8.1 Logic

The generalized flow of operational information for this classification framework is represented in Figure 1. The basic time elements that are used to describe and record operational activity generally include types of activities, equipment statuses, delays, and events. These basic time elements are recorded and classified into time categories that describe the nature of the activity in terms of the value and impact it has on the operation. The time categories and their relationship to each other are depicted in the Time Usage Model (Figure 2), which reflects all operational activities.

8.2 Time Usage Model

The Time Usage Model (Figure 2) presents a graphical representation of how productive and non-productive activities, statuses, and events that occur in a mining operation are classified.

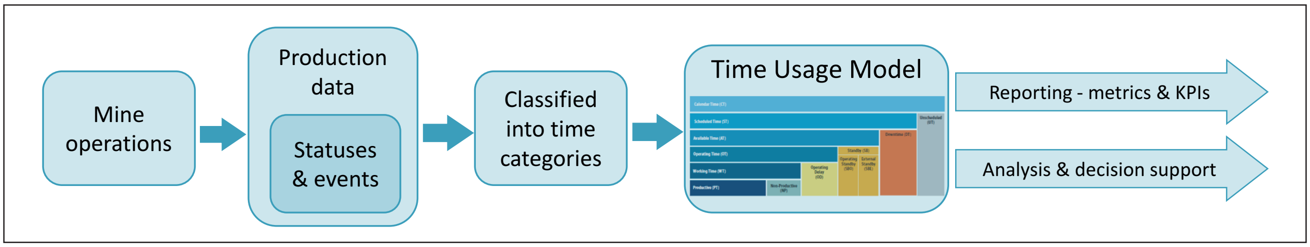

Figure 1. Operational Data Flow for the Time Classification Framework

This Time Usage Model is based on the premise the operation should account for all time. By identifying and eliminating non-productive time, operations can make the best use of their assets and thereby improve efficiency and equipment effectiveness, resulting in immediate performance improvement.

The time categories reflected in the model provide insight into how time is being used; this enables analysis, decision support, and the development of the relevant KPIs. These categories also provide the basis for calculating the common KPIs that are identified in Section 8.5. By identifying and eliminating non-productive time, operations can make the best use of their assets and thereby improve efficiency and equipment effectiveness.

The activities and the associated statuses and events that are captured in the course of operation are recorded and classified into the established time categories. Non-productive time elements are typically classified and subtracted from productive time categories.

Improvements in data collection and classification capability have enabled operations to better define losses and delay events, which results in the better resolution and understanding of actual productive time. Drilling down into the model vertically enables the improved capture of delays and more accurate reflections of productive time usage.

The model reflects the traditional classifications of Gross Operating Hours (GOH) and Net Operating Hours (NOH) as Operating Time and Working Time respectively. Enhancements to data collection capability enabled by improved configuration of fleet management systems and inherent in autonomous systems can allow operations to isolate the non-productive element of Working Time, resulting in the added classifications of Productive and Non-Productive Time. One of the benefits of distinguishing between Productive and Non-Productive Time is the ability to measure the amount of on-productive time incurred by each operator.

The model is intended to be flexible in terms of reporting to the level that represents an operations' data collection capability. While more accurate performance comparisons would be made at the lowest level of the model, this model and the resulting comparisons may be applied at the lowest time category for which the operation can practically collect data. For example, operations that do not identify Non-Productive activities and events would roll those activities and events into Working Time, and Operating Delay would be the lowest level at which they could capture delays. Comparison to other operations would then be made at the Working Time level.

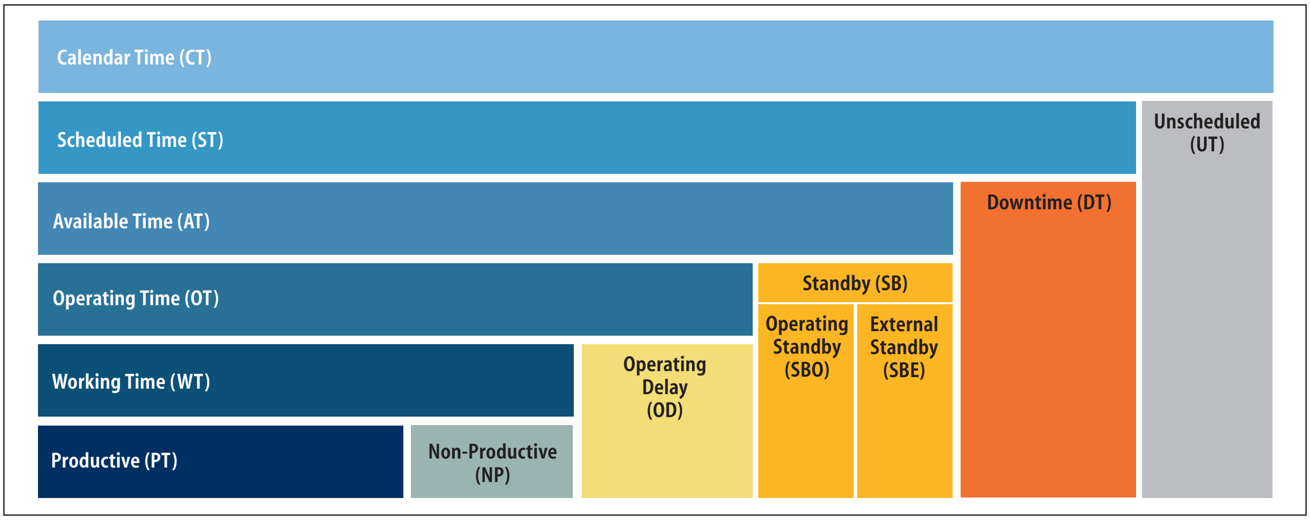

Figure 2. Time Usage Model

8.3 Time Categories

The time categories defined below reflect common classifications that the industry has adopted over time and that have been updated to reflect input from project participants.

Calendar Time (CT): The total time available.

- Although any time period can be used, Calendar Time normally equates to 8,760 hours (8,784 hours in a leap year); 365 (or 366) days per year × 24 hours per day
- For comparison purposes, the difference that results from a leap year is 0.27% of the total hours available, which is deemed negligible for the purpose of the framework.
- This category is commonly referred to as "nominal time"

Scheduled Time (ST): The equipment is required to meet business plan objectives and is assigned to an operation, project, or job.

Scheduled Time = Calendar Time – Unscheduled Time

Unscheduled Time (UT): The equipment is not scheduled or assigned in the system because it is not required due to external events.

- Time the equipment is in an inactive state because it is not required or, in the case of a contractor, time during which no work exists
- Staturatory holidays or a planned shutdown
- Equipment assembly, mobilization, and demobilization
- Equipment that is undergoing a major rebuild which is intended to bring the unit back to near new functionality

Downtime (DT): The equipment is required but is not in a condition to perform its intended function.

- While this framework does not currently provide subcategories for Downtime, many models distinguish between unscheduled and scheduled maintenance activities. Because there is currently little consensus on how to classify these, further collaboration is required before including these in a way that will help operations perform benchmarking.

Available Time (AT): The equipment is required and is in a condition to perform its intended function.

Available Time = Scheduled Time – Downtime

Standby (SB): The equipment is available but is not operating.

Standby = Operating Standby + External Standby

Operating Standby: The equipment is available but not operating, and there is no immediate intent to operate due to a management decision or reasons within management control.

External Standby: The equipment is available, required, and committed to a project or site, but it cannot be operated for reasons that are out of the immediate influence of operating management control.

- Time during which the work area is not available for reasons such as water or wall control issues, shovel out of digging, drill waiting for drill area, and workforce shortage
- Would apply to a contractor if the client requests that the equipment be shut down due to a temporary lack of work but requests that the equipment is available for work when needed (i.e., time during which the unit would be "off hours" for purposes of collecting billing hours).

Operating Time (OT): The equipment is available and under the control of a human or system.

Operating Time = Available Time – (Operating Standby + External Standby)

- Commonly referred to as "gross operating hours (GOH)"

Operating Delay (OD): The equipment is operating but temporarily stopped or prevented from performing work due to delays that are inherent to the operation or the immediate physical and environmental conditions.

- Generally within the control of the operator or operating supervision in a conventional operation, or it is within the control of the operating system in an autonomous operation

Working Time (WT): The equipment is operating as assigned, performing its intended function, and carrying out activities that do and do not directly contribute to production.

Working Time = Operating Time – Operating Delay

- Commonly referred to as "net operating hours (NOH)"

Non-Productive Time (NP): The unavoidable activities that do not directly contribute to production but are required to enable continued safe and efficient operation.

- Examples include face cleanup, moving trailing cables, and other utility work

Productive Time (PT): The equipment is performing its intended function and is carrying out activities that directly contribute to production.

Productive Time = Working Time – Non-Productive Time

- Includes all of the necessary elements of the loading / haulage cycle

Note: if Non-Productive Time cannot be isolated and reported as such, it may be combined with Productive Time, and they can be reported together as Working Time.

Table 1. Summary of Time Category Definitions

Term	Definition
Calendar Time (CT)	The total time available.
Scheduled Time (ST)	The equipment is required to meet business plan objectives and is assigned to an operation, project, or job. ***Scheduled Time = Calendar Time – Unscheduled Time***
Unscheduled Time (UT)	The equipment is not scheduled or assigned in the system because it is not required due to external events.
Downtime (DT)	The equipment is required but is not in a condition to perform its intended function.
Available Time (AT)	The equipment is required and is in a condition to perform its intended function. ***Available Time = Scheduled Time – Downtime***
Standby (SB)	The equipment is available but is not operating.
Operating Standby (SBO)	The equipment is available but not operating, and there is no immediate intent to operate due to a management decision or reasons within management control.
External Standby (SBE)	The equipment is available, required, and committed to a project or site, but it cannot be operated for reasons that are out of the immediate influence of operating management control. ***Standby = Operating Standby + External Standby***
Operating Time (OT)	The equipment is available and under the control of a human or system. ***Operating Time = Available Time – (Operating Standby + External Standby)***
Operating Delay (OD)	The equipment is operating but temporarily stopped or prevented from performing work due to delays that are inherent to the operation or the immediate physical and environmental conditions.
Working Time (WT)	The equipment is operating as assigned, performing its intended function, and carrying out activities that do and do not directly contribute to production. ***Working Time = Operating Time – Operating Delay***
Non-Productive Time (NP)	The unavoidable activities that do not directly contribute to production but are required to enable continued safe and efficient operation.
Productive Time (PT)	The equipment is performing its intended function and is carrying out activities that directly contribute to production. ***Productive Time = Working Time – Non-Productive Time***

8.4 Basic Time Elements

Basic time elements are the types of activities, equipment statuses, delays, and events used to describe and record operational activity. Table 2 presents how these are classified into the time categories.

Table 2. Basic Time Elements

Productive Time	Non-Productive Time	Operating Delay	Standby		Unscheduled Time
			Operating Standby	External Standby	
Dragline – Fill – Swing – Dump – Return **Shovel** – Load – Swing – Dump – Return **Trucks** – Spot – Load – Haul loaded – Dump **Loaders** – Load – Position – Dump **Dozers** – Production Push **Drills** – Drilling	– Training – Commissioning **Dragline** – Rehandle – Pad construction – Reposition **Shovel** – Face prep and cleanup – Cable reposition (by shovel) – Reposition – Rehandle – Wait for trucks **Trucks** – Training – Stop at intersection – Reposition – Travel empty – Wait at loading unit – Wait at ore dump / breaker – Wait at waste dump **Loaders** – Cleanup – Tramming – Rehandle – Wait for trucks **Dozers** – Dump support – Road work – Cleanup – Ripping – Tow – Misc. assistance – Wait for trucks (dump) – Travel **Graders** – Road work – Pit floor cleanup – Spoil cleanup – Tow **Drills** – Position – Move hole to hole – Redrill – Clean hole – Steel change – Bit change **Other** – Roads – sanding – Roads – dust suppression – Dewatering – Pit cleanup – Clearing – Grubbing – Ditching – Excavation – Equipment move	– Fuelling – Lube – Blasting – Weather – if operator remains on unit – Incident – scene frozen (operator in unit) – Stuck – Power loss – in pit (unspecified cause) – Power loss – due to blast – Re-route cable in pit – operator stays in unit – Change operator – Boarding machine / Receiving instruction – Survey / ore control delay – Clean cab / windows – Spill cleanup – operator on board – Wait for assignment / instruction – Wait for shovel bucket cleaning – Communications system delay – Loss of GPS – Loss of site wireless network connectivity – Stop work – safety – Stop work – environmental **Draglines** – Cable changeover – Bucket cleaning – Wait for pad cleanup / prep – Move/walk **Shovel** – Cable changeover – Bucket cleaning – Waiting for face cleanup equipment – Shovel move **Trucks** – Shovel move – Cable move on loading unit – Shovel down – Box cleaning – Stopped for pit cleanup – Stopped for road cleanup – Tire overheat – Studies / tests – Wait for ground engaging tools (GET) change on shovel – Stop for object detected – Ore dump / breaker down **Loaders** – Move – Travel **Dozers** – Travel – Cleaning tracks – Cleaning blade – Wait at shovel (to do cleanup) – Manned – waiting for work – Move **Graders** – Travel – Wait for work area **Drills** – Water fill – Pattern cleanup – Wait for pad cleanup – Move for blast – Move between patterns **Other** – Manned – waiting for work	– No operator – Shift change – Lunch / coffee breaks – Equipment checks – Safety meeting – Crew meeting – Training – Stop work – public relations – Re-route cable in pit – operator removed from unit – Investigation – operators removed – Spill cleanup – operators removed – Personal break – Prayer – Safety stand down	– Not required – Work suspended due to workforce shortage – Delayed crew arrival – Site-wide weather outage – Primary power loss to site (< 12 hours) – Site-wide loss of high voltage power – Loss of site access (< 12 hours) – Work suspension by owner – Loading unit out of digging – Waiting for drill pad (not available for cleanup) – Work area unavailable (geotechnical, water) – Loss of GPS – Loss of site wireless network connectivity	– Scheduled shutdown – Statutory holiday not worked – Inventory management shutdown – Labour dispute – No work – Mobilization / demobilization – Acts of God – Force majeure – Major site power interruption (> 12 hours) – Significant environmental event (> shift) – Loss of site access (> 12 hours)

8.5 Application of the Time Usage Model

The value of the Time Usage Model as a tool to manage time and report on and compare performance relies on how well discrete events are identified, recorded, and captured. Data collection capability determines how well losses are defined. For example, more effective data collection provides a higher level of detail on the nature of the losses. For the Time Usage Model to be most effective, it depends on the following:

- **A name or label for anything that happens** and the capability to record events and identify losses and delays within the operation. This accuracy will allow the Time Usage Model to reflect operational statuses at a higher level of granularity.
- **Consistent event descriptions and classification to time categories** that enable meaningful internal and external performance comparisons. Using a consistent taxonomy for describing events will enable data trending and performance comparison.
- **Precise event data** from data collection processes and systems that capture precise event start and end time-stamps will make calculating metrics more exact.

The process and method of data collection will have a significant impact on its efficacy. Manual data collection is possible; however, inaccurate event descriptions, durations, and classifications are more likely to occur when using this method. A digital data collection system will provide more precise data if it captures the time-stamp of the event in real time. If a digital data collection system is used, then it should be properly configured so that it collects data in a manner consistent with the Time Usage Model. The highest degree of precision should result from autonomous systems.

8.6 Key Performance Indicators

Operations can use the Time Usage Model to generate common availability and utilization KPIs. The KPIs in this section can be classified into three main groups:

- Measures of asset availability
- Measures of asset utilization
- Measures of effectiveness

Table 3 summarizes the KPI definitions and identifies the formulas for calculating them by using the time categories defined in Section 8.3. These definitions are in common use in the industry, and many of the contributors to the guideline use them—or variations of them—in their operations. While some operations may use variations of these KPIs, consistent time classification and the use of common external definitions of KPIs is valuable for purposes such as benchmarking. The time classifications allow operations to create additional KPIs that are relevant to their interests and priorities.

8.6.1 Measures of Asset Availability

The definitions of availability in this guideline are based on the definitions of availability that can be found in the first and second editions of *Surface Mining* (Pfleider, 1968; Kennedy, 1990). This guideline, however, uses the term "Operating Time" where the source material uses "Working Time."

Uptime measures the total time a unit is available to operate, whether or not it is required.

Physical Availability measures the time during which the unit is available as a percentage of the total time that the equipment is required, whether or not it is being operated. This KPI reflects the impact of Standby Time. The Physical Availability formula offered in this guideline follows the formula found in the second edition of Surface Mining (Kennedy, 1990), which incorporates the impact of unscheduled time.

Mechanical Availability represents the time during which the equipment is available as a percentage of the time it is required by the operation (Pfleider, 1968). This KPI can be used to identify the impact of maintenance on the operation.

These definitions of mechanical and physical availability are relatively consistent among the contributors to the guideline.

8.6.2 Measures of Asset Utilization

Utilization measures the use of the asset, and the following KPIs provide different ways of measuring this.

Use of Availability measures how well an operation makes use of available equipment (Pfleider, 1968).

Asset Utilization measures the overall use of the asset as a percentage of the total time it is available (i.e., Calendar Time). Measuring the overall use of the asset provides an indicator of how well capital assets are being utilized.

Operating Utilization measures the use of the asset when it is required or scheduled to operate.

Effective Utilization measures the time the asset is being used for its intended function.

8.6.3 Measures of Effectiveness

Operating Efficiency measures how effectively the operation is using the asset, which reflects the impact of delays incurred during operation.

Production Effectiveness measures the time the asset is directly contributing to production.

Table 3. Key Performance Indicators

Term	Definition	Formula
	Availability KPIs	
Uptime*	The total time the equipment is capable of operating, whether it is scheduled or not	$\text{Uptime} = \dfrac{\text{Available Time}}{\text{Calendar Time}}$
Physical Availability	The percentage of time the equipment is available to perform its intended function over a defined period when it is required by the operation	$\text{Physical Availability} = \dfrac{\text{Available Time}}{\text{Scheduled Time}}$ Or $\text{Physical Availability} = \dfrac{(\text{Operating Time} + \text{Standby})}{\text{Scheduled Time}}$
Mechanical Availability	The time the equipment is available as a percentage of the time it is required by the operation	$\text{Mechanical Availability} = \dfrac{\text{Operating Time}}{(\text{Operating Time} + \text{Downtime})}$
	Utilization KPIs	
Use of Availability	The time the equipment is operated as a percentage of the available time	$\text{Use of Availability} = \dfrac{\text{Operating Time}}{\text{Available Time}}$
Asset Utilization	The time the equipment is being operated as a percentage of the total time available	$\text{Asset Utilization} = \dfrac{\text{Operating Time}}{\text{Calendar Time}}$
Operating Utilization	The percentage of time the asset is being operated when it is required to operate	$\text{Operating Utilization} = \dfrac{\text{Operating Time}}{\text{Scheduled Time}}$
Effective Utilization	The time the equipment is used to perform its intended function as a percentage of the time that it is scheduled to work	$\text{Effective Utilization} = \dfrac{\text{Working Time}}{\text{Scheduled Time}}$
	Effectiveness KPIs	
Operating Efficiency	The time the equipment is performing its intended function as a percentage of the time that it is operating	$\text{Operating Efficiency} = \dfrac{\text{Working Time}}{\text{Operating Time}}$
Production Effectiveness	The time the equipment is directly contributing to production as a percentage of the time that it is operating	$\text{Production Effectiveness} = \dfrac{\text{Productive Time}}{\text{Operating Time}}$

*Calendar Availability is a suggested alternative to Uptime that eliminates the impact of unscheduled time. It is measured with the following formula: (Calendar Time – Downtime) / Calendar Time

9. FUTURE WORK

There are several areas identified for future GMG work on operational definitions and KPIs. These involve validating and expanding the existing framework, adapting the framework to underground and fixed plant operations, and potential new work in related areas.

9.1 Validation of Existing Model

- Validate the application of the current Time Usage Model in conventional and autonomous applications, including the list of operational activities, statuses, and events.
- Confirm that the Time Usage Model is supported by existing fleet management systems.
- Confirm that event triggers are identified and aligned among fleet management systems.
- Confirm and validate the standard definitions for the time categories and the operational KPIs.

9.2 Review and Update Content

- Incorporate the time categories for Value Productive and Production Loss and develop a common methodology to calculate them. Figure 3 shows where these would fit in the Time Usage Model.
  - A working definition of Value Productive would be equipment that is performing its intended function and operating capacity. This is measured as the actual productivity, such as actual tonnes or bank cubic metres (BCM) per hour relative to what was forecasted. Some operations classify this as "quality loss".
  - A working definition of Production Loss is equipment that is operating at intended function but at a reduced capacity (productivity) due to equipment functional deficiencies, inefficient setups, or other operating inefficiencies. It is measured as the loss in production, such as tonnes or BCM per hour relative to what was forecasted.

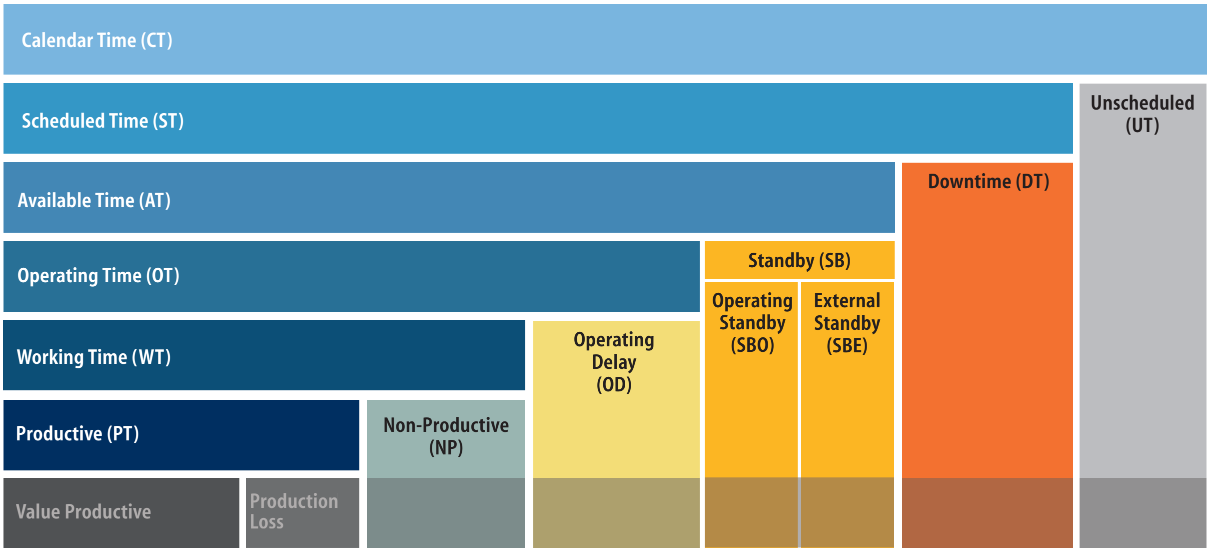

Figure 3. Time Usage Model with Value Productive and Production Loss Categories

- Develop a detailed classification of maintenance activity so that the model can reflect Downtime at a more granular level.
- Develop a standard definition of Overall Equipment Effectiveness (OEE), an overall measure of equipment condition and performance, that is applicable to surface mining.
- Expand the list of KPIs that are useful to operations.
- Share the framework with the underground and fixed plant communities to get feedback on applications in those settings while ensuring alignment and consistency with surface applications.

9.3 Feedback and Continuous Improvement

- Develop a framework for routinely evaluating information needs and create a mechanism that will enable ongoing feedback. This feedback would identify new activities, statuses, and events that are to be classified and make recommendations for changes to reporting protocols and standards so they can reflect different types of operations and any changes in operating conditions, technologies, business drivers, and stakeholder requirements.
- Expand the project group to enable review of feedback and determine other areas of interest for KPIs and definitions (e.g., safety KPIs, workforce metrics).
- Assemble a glossary of standard terminology and develop a taxonomy for the mining industry.

10. REFERENCES AND RESOURCES

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GENERAL GLOSSARY

This glossary clarifies some of the terms and language used in the context of this guideline.

Activity: Actions, tasks, or components of a process.

Asset: Property, such as equipment, that has economic value, and that is owned or controlled by an organization.

Available: When a piece of equipment is in a condition to perform its required function and is required to perform that function.

Availability: The ability of a piece of equipment to perform its required function over a given period of time.

Basic time elements: Types of activities, delays, equipment statuses, and events, that are classified into time categories.

Benchmarking: A structured comparison of performance metrics.

Classification framework: The overall system described in this guideline to classify activities, statuses, events, and delays to time categories and also to represent them in the Time Usage Model.

Contributors: The companies that provided their definitions, time models, and KPIs to be incorporated into the classification framework.

Delay: Any kind of interruption in a productive operation.

Event: A definable or describable change in status.

Key performance indicator (KPI): A measurable value that demonstrates how a business is performing in its key business functions.

Maintenance: The actions that are intended to preserve an item in, or restore it to, a state in which it can perform its intended function.

Metrics: Measures of process performance.

Operation (v): Actively carrying out the work that is involved in operating a mine.

Operation (n): An operating mine.

Operator: The person who is operating the equipment.

Participants: The project group members and individuals who provided feedback on the content of the guideline.

Process: A series of activities that take place in a definite manner in order to convert inputs into outputs.

Service meter unit (SMU) hour: A measure of the time during which a component is in operation. On larger components, such as the engine or the motor control cabinet (MCC) on electric equipment, the meter hours would represent the time the unit is running.

Status: A description of the present state of an individual, group, or asset.

Taxonomy: The process of naming and classifying things into groups that share similar qualities (based on "taxonomy" as defined in HarperCollins, n.d., and Cambridge Dictionary, n.d.)

Time: In the context of this time classification framework, refers to the continuous time in a given period (e.g., one week, one month, one year). Time can be divided into distinct categories based on how combinations of elapsed time periods (typically measured in hours) are classified based on their meaning to the operation.

Time categories: Subdivisions of time defined by classifying activities, statuses, and events so as to describe their nature in terms of the value and impact on the operation.

Utilization: A measure of the time a particular piece of equipment is being used.