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Information technology — Artificial intelligence — Process management framework for big data analytics

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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 document 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 or www.iec.ch/members_experts/refdocs).

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 42, *Artificial intelligence*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

This document provides a process management framework for using big data analytics (BDA) across most functions of an organization. The quantum of data, the collection, storage, utilization, technology, the speed of data generation, structure and variety of data cannot be handled by the conventional data handling methods and frameworks.

This document provides a BDA process reference model (BDA PRM) and then provides process assessment model (BDA PAM). The BDA PAM are composed of two dimensions: process dimension that includes processes based on a set of PRMs including the BDA PRM and capability dimension based on process measurement framework (PMF).

This document defines a PRM and PAM as part of the framework for big data analytics, in accordance with the requirements of ISO/IEC 33004:2015 and ISO/IEC 33020:2019, for use in performing a conformity assessment in accordance with the requirements of ISO/IEC 33002:2015.

Primary audiences of this document are implementers of BDA in organizations as well as BDA capability assessors. This document provides five process categories such as organization stakeholder, competency development, data management, analytics development, and technology integration.

This framework can be used for:

— managing the processes that are considered to be best practices;

— enabling risk determination and process improvements of the incumbent organization.

Value delivered through automation, either prediction, or decision-making support or both using BDA is valuable to organizations. Implementing, improving, and assessing BDA processes based on this document expect benefits such as:

— competitive advantages;

— better decision-making;

— improve customer experiences;

— sales improvement;

— responsiveness to opportunities and threats;

— mistakes and errors reduction;

— cost reduction.

Clause 5 provides an overview of PRM and Clause 6 details out the specific processes under each process categories for the PRM. Clause 7 provides an overview of the PAM and Clause 8 provides details of process attributes and process performance indicators and Clause 9 provides process capability indicators.

Information technology — Artificial intelligence — Process management framework for big data analytics

1 Scope

This document provides a framework for developing processes to effectively leverage big data analytics across the organization irrespective of the industries or sectors.

This document specifies process management for big data analytics with its various process categories taken into account along with their interconnectivities. These process categories are organization stakeholder processes, competency development processes, data management processes, analytics development processes and technology integration processes. This document describes processes to acquire, describe, store and process data at an organization level which provides big data analytics services.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO/IEC 33001:2015, *Information technology — Process assessment — Concepts and terminology*

ISO/IEC 33003:2015, *Information technology — Process assessment — Requirements for process measurement frameworks*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 33001:2015 and the following apply.

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

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

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

3.1
big data
extensive datasets, primarily in the data characteristics of volume, variety, and either velocity or variability or both, that require a scalable technology for efficient storage, manipulation, management and analysis

Note 1 to entry: Big data is commonly used in many different ways, for example as the name of the scalable technology used to handle big data extensive datasets.

[SOURCE: ISO/IEC 20546:2019, 3.1.2, modified]

3.2
data analytics
composite concept consisting of data acquisition, data collection, data validation, data processing, including data quantification, data visualization, and data interpretation

Note 1 to entry: Data analytics is used to understand objects represented by data, to make predictions for a given situation, and to recommend on steps to achieve objectives. The insights obtained from analytics are used for various purposes such as decision-making, research, sustainable development, design, planning, etc.

[SOURCE: ISO/IEC 20546:2019, 3.1.6]

3.3
data governance
development and enforcement of policies related to the management of data

Note 1 to entry: ISO/IEC 38500 specifies six principles of information technology governance: responsibility; strategy; acquisition; performance; conformance; human behaviour. These principles also apply to data.

[SOURCE: ISO 8000-2:2022, 3.16.1]

3.4
benefit
advantage to the organization of the actionable knowledge derived from an analytic system

Note 1 to entry: It is often ascribed to big data due to the understanding that data has potential benefit that was typically not considered previously.

[SOURCE: ISO/IEC 20546:2019, 3.1.1]

3.5
strategic plan
document specifying how data management is to be aligned to the organizational strategy

Note 1 to entry: This term has the same meaning as strategic asset management plan (SAMP) defined in ISO 55000:2014 with data point of view.

3.6
base practices
BP
activities that contribute to achieving a specific process purpose and fulfil the process outcomes when consistently performed

3.7
process attributes
PA
process features that can be evaluated on a scale of achievement to provide a process capability measure

3.8
capability level
set of process assessment indicators that together describe an ability to operate and perform a process at a given capability level

3.9
process attribute rating
judgement of the degree of achievement of the process attribute for the assessed process

3.10
process
process attribute rating
means of assessing the capabilities addressed by the defined process attributes

3.11
outcome
observable result of the successful achievement of the process purpose

4 Abbreviated terms

BDA	big data analytics
PRM	process reference model
PAM	process assessment model
PMF	process measurement framework
BDAP	big data application provider
BDFP	big data framework provider
BDSP	big data service partner
PaaS	platform as a service
SaaS	software as a service
DevOps	development and operations
IP	information product
PoC	proof of concept
MDM	master data management
EDW	enterprise data warehouse
API	application programming interface
FMEA	failure modes and effects analysis
ER	entity relationship
SIPOC	supplier input process output customer
CTQ	critical to quality
KRA	key result area
KPI	key process indicator
BSC	balance score card
RACI	responsible accountable consulted informed
CRM	customer relationship management
ERP	enterprise resource planning
PoS	point of sale
HRMS	human resource management software

PIM	product information management
MSE	mean squared error
MAPE	mean absolute percentage error
MoM	minutes of meeting
BFSI	banking financial services and insurance
AMC	annual maintenance contract
CSM	customer service management
OSP	organization stakeholder processes
CDP	competency development processes
DMP	data management processes
ADP	analytics development processes
TIP	technology integration processes
GP	generic practices

5 Overview of process reference model

ISO/IEC 33001:2015 defines process reference model (PRM) as a model comprising definitions of processes described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes. To define a process reference model, the requirements specified in ISO/IEC 33004:2015 should be met. ISO/IEC 33004:2015, Annex A provides detailed requirements. ISO/IEC 33004:2015 requires that processes included in a PRM satisfy specific requirements.

A process description shall meet the following requirements:

a) a process shall be described in terms of its purpose and outcomes;

b) the set of process outcomes shall be necessary and sufficient to achieve the purpose of the process;

c) process descriptions shall not contain or imply aspects of the process quality characteristic beyond the basic level of any relevant PMF in accordance with ISO/IEC 33003:2015.

Figure 1 details the key process categories for advancement of data analytics in an organization. These key process categories interplay with each other in terms of the readiness of an organization to implement and deploy big data analytics.

There are 5 process categories such as organization stakeholder processes, competency development processes, data management processes, analytics development processes and technology integration processes which stand on the foundation of technology infrastructure and are guided by the organizational leadership strategy and culture. The big data analytics processes and their categories are not based on any particular organization and it is not mandated to implement them.

Organization stakeholder processes - organization top management is a key facilitative force in various ways – starting from creating shared understanding for the requirements of data analytics to mapping the benefit of embarking on such projects to strategic goals of the organization. Assignment of decision rights and accountabilities to stakeholders is key to overall success of long-term data analytics projects. The top management should also enable identification of the key data providers, data consumers, application requirements and data quality and management rules to kick start the data analytics

journey. Defining a data centric culture and mitigation of resistance to change in such a situation should also be addressed.

Competency development processes - data analytics projects need capabilities related to big data application provider (BDAP), big data framework provider (BDFP), big data service partner (BDSP) defined in ISO/IEC 20547-3. These capabilities can either be outsourced or developed from within. If outsourcing is preferred, then one needs additional competency to manage the outsourcing. Hence, relevant capability build-up and continuous maintenance and enhancement is critical for data analytics projects success.

Data management processes - data requires strong management and governance, preferably integrated with IT, information and information security management and governance which includes monitoring of emerging data sources, measurement of data quality metrics and data ownership roles. Privacy, security, policy compliance should be ensured. Specific legal requirement can apply.

Analytics development processes - data analytics development processes include data exploration, data diligence (outlier and missing value), algorithm adjustment and customization, algorithm development, algorithm validation, algorithm fine-tuning, evaluation of population stability index, etc. Analytics development processes, throughout their life cycle, rely on close cooperation with IT function of organization.

Technology integration processes - relevant technology infrastructure is required to implement data analytics. Ensure the results are formatted and optimally presented to target consumers or stakeholders. Capability should be integrated with the functional architecture. Processes to select these functional components and integrating them into the overall data analytics architecture are crucial. These processes include technology maturity evaluation, implementation approach (e.g. leveraging PaaS or SaaS) definition, and configuration or version management (e.g. DevOps).

Figure 1 shows process categories and processes of big data analytics.

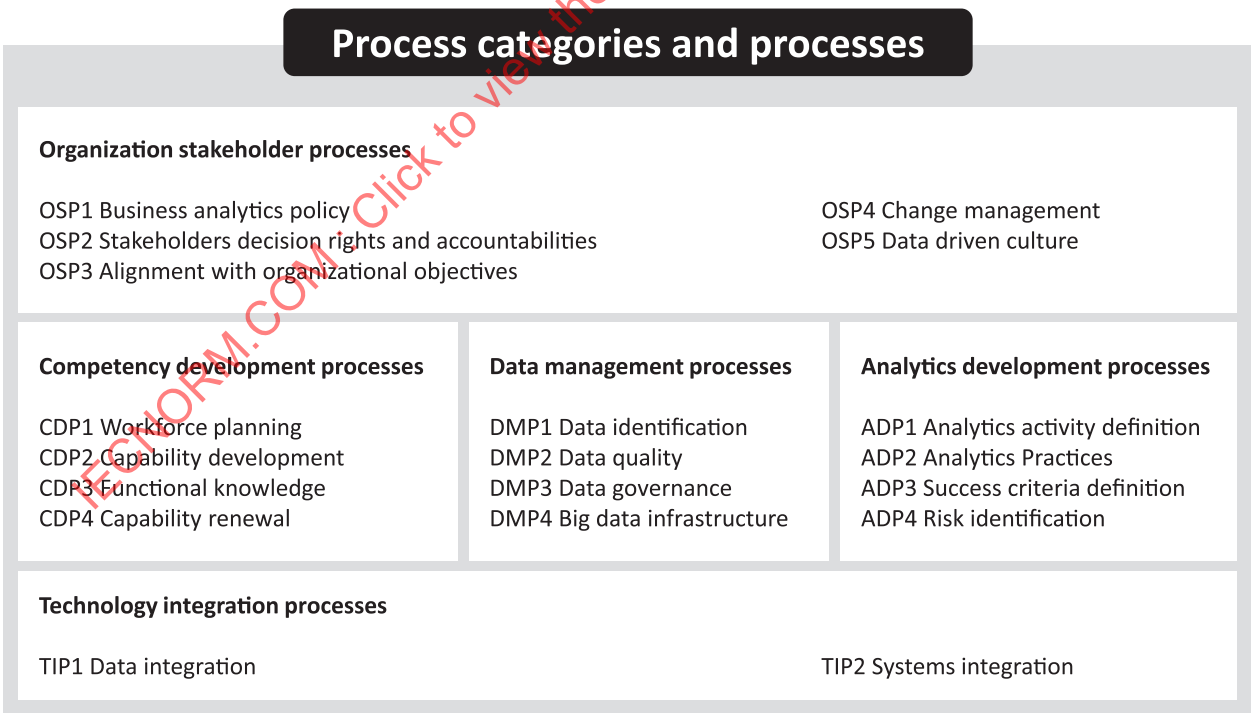

Figure 1 — Big data process categories and processes

6 Process reference model

6.1 General

Tables 1 to 19 contain the following descriptive elements according to ISO/IEC/IEEE 24774 for each process in the PRM. The individual processes are stated in terms of process name, process purpose and process outcomes:

a) name: the name of a process is a short noun phrase that summarizes the scope of the process, identifying the principal concern of the process, and distinguishes it from other processes within the scope of the PRM;

b) context: for each process, a brief overview describes the intended context of the application of the process;

c) purpose: the purpose of the process is a high level and overall goal for performing the process;

d) outcomes: Outcomes are measurable, tangible technical or business results that are achieved by a process. They are observable and assessable.

6.2 Organization stakeholder processes

Tables 1 to 5 contain the relevant processes related to organization stakeholders:

— Table 1: OSP1 Business analytics policy;

— Table 2: OSP2 Stakeholders decision rights and accountabilities;

— Table 3: OSP3 Alignment with organizational objectives;

— Table 4: OSP4 Change management;

— Table 5: OSP5 Data driven culture.

Table 1 — OSP1 Business analytics policy

ID	OSP1
Name	Business analytics policy
Context	This process covers establishing business objectives and strategies for the organization specific to big data analytics. This involves analysing the external environment and finalizing the strategic goals and business objectives of the organization.
Purpose	The purpose of the OSP1 process is to define a policy for big data analytics initiatives, roadmap and a guideline to implement these initiatives.
Outcomes	The outcomes of this process include: a) business objectives, direction and strategies are defined and shared to the organization and relevant stakeholders; b) strategic roadmaps are developed within the constraints of the service provider resources.

Table 2 — OSP2 Stakeholders decision rights and accountabilities

ID	OSP2
Name	Stakeholders decision rights and accountabilities
Context	This process covers the assignment of stakeholders who are responsible, accountable, consulted and informed for successful implementation of big data analytics projects and initiatives.
Purpose	The purpose of the OSP2 process is to identify and assign specific responsibilities to key stakeholders.
Outcomes	The outcomes of this process include: a) key stakeholders are identified with expertise in big data technology and process or domain knowledge; b) assignment of roles and responsibilities are done; c) accountability of the stakeholders is defined; d) succession plan of the roles based on responsibilities are defined.

Table 3 — OSP3 Alignment with organizational objectives

ID	OSP3
Name	Alignment with organizational objectives
Context	This process covers the alignment of the big data analytics with the overall organization objectives. This is to ensure proper mobilization of resources, planning and arrive at actionable from the recommendations out of analytics outcomes or inferences.
Purpose	The purpose of the OSP3 process is to align an organization's big data analytics initiatives with its business strategy.
Outcomes	The outcomes of this process include: a) big data analytics initiatives, specific to relevant departments or processes are arrived; b) each of the initiatives is aligned with the stated objectives of departments or processes; c) the high-level initiatives are published across the organization with relevant stakeholders.

Table 4 — OSP4 Change management

ID	OSP4
Name	Change management
Context	This process covers the change management amongst the internal stakeholders of the organization.
Purpose	The purpose of the OSP4 process is to identify and manage people who are impacted by business analytics initiatives and manage the changes, including resistance and workarounds.
Outcomes	The outcomes of this process include: a) big data analytics initiatives or projects are subjected to progress monitoring and reviewed against expected outcomes; b) progress is communicated to stakeholders; c) the impact of the changes, issues and improvement is analysed and reported; d) awareness sessions and trainings are organized across the organization for different roles of stakeholders regarding big data analytics.

Table 5 — OSP5 Data driven culture

ID	OSP5
Name	Data driven culture
Context	This process covers the organizations shared values and mission statements depicting the data driven decision making.
Purpose	The purpose of the OSP5 process is to create decision making processes based on data, analytics and related set of fact-based systems to attain better strategic intelligence capability.
Outcomes	The outcomes of this process include: a) process or business performance always measured in metrics; b) the metrics comprise of leading and lagging indicators; c) quantitative analysis is encouraged with possible statistical correlations; d) possible big data analytics initiatives or projects are discussed and explored on problem or opportunity areas during reviews; e) quick wins or successful initiatives on big data analytics should be rewarded and communicated; f) a framework for piloting ideas exploring big data analytics for current processes or new areas of business should be rolled out (similar to a Kaizen framework in many organizations).

6.3 Competency development processes

Tables 6 to 9 contain the relevant processes related to competency development:

— Table 6: CDP1 Workforce planning;

— Table 7: CDP2 Capability development;

— Table 8: CDP3 Functional knowledge;

— Table 9: CDP4 Capability renewal.

Table 6 — CDP1 Workforce planning

ID	CDP1
Name	Workforce planning
Context	This process covers the talent forecasting and resource estimation of the organization for executing big data analytics projects and initiatives.
Purpose	The purpose of the CDP1 process is to arrive at plans to ensure availability of workforce and other resources for executing big data analytics projects and initiatives.
Outcomes	The outcomes of this process include: a) identify future leaders in big data analytics; b) align relevant responsibilities and craft succession plans in critical roles; c) recruit the right talent.

Table 7 — CDP2 Capability development

ID	CDP2
Name	Capability development
Context	This process covers the empowerment and training of employees of the organization for executing big data analytics projects and initiatives.
Purpose	The purpose of the CDP2 process is to support people throughout the organization to achieve their plans, objectives and targets through capability enhancement.
Outcomes	The outcomes of this process include: a) understand and develop the underlying capabilities of the organization; b) evaluate the set of results achieved to improve future performance and provide sustainable benefits to all their stakeholders; c) recognize their efforts and achievements in a timely and appropriate manner

Table 8 — CDP3 Functional knowledge

ID	CDP3
Name	Functional knowledge
Context	This process covers the identification and deployment of industry domain workforce as part of the big data analytics teams at all levels.
Purpose	The purpose of the CDP3 process is to encourage the BDA leaders to learn quickly and rapidly respond with accountability in their individual enhanced role.
Outcomes	The outcomes of this process include: a) encourage stakeholders to participate in activities that contribute to the wider acceptance to big data analytics initiative across the organization; b) use approaches to understand, anticipate and respond to the different needs and expectations from big data analytics implementation team; c) promote a culture which supports the generation of new ideas and new ways of thinking to encourage innovation though big data analytics.

Table 9 — CDP4 Capability renewal

ID	CDP4
Name	Capability renewal
Context	This process covers identification, analysis and understanding of external indicators, such as global and local economic, market or societal and technology trends, which can affect the organization and translate these into potential future scenarios for big data analytics initiative.
Purpose	The purpose of the CDP4 process is to use a structured approach for generating and prioritizing creative ideas and allocating resources to execute them innovatively within appropriate timescales with updated tools and techniques of big data analytics.
Outcomes	The outcomes of this process include: a) identify, evaluate and develop new and emerging technology portfolio to improve the agility of organization; b) establish and manage learning and collaboration networks to identify opportunities for creativity, innovation and improvement in technology and human resources.

6.4 Data management processes

Tables 10 to 13 contain the relevant processes related to data management:

— Table 10: DMP1 Data identification;

— Table 11: DMP2 Data quality;

— Table 12: DMP3 Data governance;

— Table 13: DMP4 Big data infrastructure.

Table 10 — DMP1 Data identification

ID	DMP1
Name	Data identification
Context	This process covers the key step of identifying data elements. This involves identification of data elements so that the team will not lose sight of any important dimension or factor that plays a key role in the outcome analysis.
Purpose	The purpose of DMP1 process is to identify, define, classify, and collect data for all data elements available for the information flow in the context of the project or department or function.
Outcomes	The outcomes of this process include: a) data elements relevant to the process or function or department are identified; b) data elements can be classified into categories, such as unstructured, transactional, hierarchical, reference; c) meta data (operational definition) such as units, frequency, source or sources, functional definition, range, possible functional correlation, producer or consumer or ownership or steward is derived; d) new data sources are identified; e) data collection is performed.

Table 11 — DMP2 Data quality

ID	DMP2
Name	Data quality
Context	This process covers the key aspects of a practical, comprehensive, and well-managed data quality strategy that can eliminate scattershot efforts in different business units and help ensure that business users throughout an organization have access to consistent and accurate information.
Purpose	The purpose of DMP2 process is to identify that a program should address the root causes of data inconsistencies, fix errors through data cleansing, and unite separate data quality initiatives.
Outcomes	The outcomes of this process include: a) structured data has normalized relational mapping; b) unstructured data has valid references to structured data; c) data complies on the aspects of accuracy, completeness, timeliness, validity, consistency, integrity, etc; d) orphaned or inconsistent data should either be sanitized from the resulting dataset or filtered if a live dataset is used.

Table 12 — DMP3 Data governance

ID	DMP3
Name	Data governance
Context	This process covers the key steps of establishing data governance for the organization. An important aspect of data is correctly defining the ownership of the data. At times this can be a very difficult task. Many organizations think information technology (IT) should be in charge of the data because IT owns the system where the data are housed however, IT is rarely the actual owner of the data. When establishing the owner, it is important to understand who can answer questions about the data, provide definitions to the attributes, and determine the validity of the data. Those people are usually the true owners of the data. These people need to be involved in defining business rules for data cleansing, correcting the data, and matching and consolidation.
Purpose	The purpose of DMP3 process is to identify tools and define broad ranges of processes to implement an effective data governance across the organization.
Outcomes	The outcomes of this process include: a) a governing council is established; b) data stewards are identified; c) business rules associated with consolidating and updating data are defined; d) implementation and sustenance plans are defined.

Table 13 — DMP4 Big data infrastructure

ID	DMP4
Name	Big data infrastructure
Context	This process covers the key steps of implementing big data infrastructure for enabling data analytics. The big data paradigm is a rapidly changing field with rapidly changing technologies. Very few organizations operate solely on data organic to that organization these days. This means that systems that collect and analyse big data need to be able to securely and reliably interoperate and share data.
Purpose	The purpose of DMP4 process is to implement a big data infrastructure which is a system that leverages big data engineering and employs a big data paradigm to process big data.
Outcomes	The outcomes of this process include: a) Appropriate software and tools for distributed systems and storage and mining (NoSQL and relational databases, distributed file systems, and other distributed processing system) are identified; b) system implementation executed; c) big data architecture is identified and implemented; d) compliance with security and privacy aspect of big data is ensured; e) skill enablement is executed.

6.5 Analytics development processes

Tables 14 to 17 contain the relevant processes related to analytics development;

— Table 14: ADP1 Analytics activity definition;

— Table 15: ADP2 Analytics practices;

— Table 16: ADP3 Success criteria definition;

— Table 17: ADP4 Risk identification.

Table 14 — ADP1 Analytics activity definition

ID	ADP1
Name	Analytics activity definition
Context	This process covers planning the analytics activities in terms of enterprise-wide scope, targets and having a consistent perspective for analytics for the organization.
Purpose	The purpose of the ADP1 process is establish an analytics implementation plan to manage a unified big data and analytics platform.
Outcome	The outcomes of this process include: a) identification of small-scale analytics projects that suggest cross-functional or enterprise potential; b) identification of business areas that can have potential benefit from analytics; c) focus on high value and high impact targets; d) establish a priority matrix including criteria for executing projects; e) successful implementation of projects.

Table 15 — ADP2 Analytics practices

ID	ADP2
Name	Analytics practices
Context	This process covers the analytics implementation facets for the organization and develop a process to choose the combination of techniques for analytics development for or in the organization.
Purpose	The purpose of the ADP2 process is to establish consistent technology practices across the organization in implementing big data analytics projects. The process focuses on the analytics implementation and not on IT practices and data infrastructure needed for upstream and downstream integration and deployment.
Outcomes	The outcomes of this process include: a) life cycle methodology selection criteria and guidelines; b) architecture considerations and selection guidelines; c) guidelines on analytics methods selection; d) tools selection criteria and guidelines.

Table 16 — ADP3 Success criteria definition

ID	ADP3
Name	Success criteria definition
Context	This process covers defining critical success factors for implementing analytics projects, including performance baselines, target validation with stakeholders and setting the criteria for accuracy.
Purpose	The purpose of ADP3 process is to set and validate baselines for process performance, target and accuracy for project implementations.
Outcomes	The outcomes of this process include: a) baseline confirmation for the target process or function performance of project scope; b) target validation or re-set of targets in collaboration with stakeholders through a combination of diligence, proof of concept and pilot; c) accuracy determination as an outcome of project completion.

Table 17 — ADP4 Risk identification

ID	ADP4
Name	Risks identification
Context	This process covers the risks that should be addressed as part of the outcome of big data analytics projects. The stakeholders (process owners) need to be aware of the constraints and risks involved in the decision-making process after implementing big data analytics.
Purpose	The purpose of ADP4 process is to identify, classify and set boundaries of the risks involved in decision making process after implementing big data analytics.
Outcomes	The outcomes of this process include: a) identification of the constraints of scalability if any; b) criteria for decision oversight being set; c) identification of constraints of trustworthiness if any; d) any possible issues with transparency being called out; e) identification of any bias in training data set within the scope of the project.

6.6 Technology integration processes

Tables 18 and 19 contain the relevant processes related to technology integration:

— Table 18: TIP1 Data integration;

— Table 19: TIP2 Systems integration.

Table 18 — TIP1 Data integration

ID	TIP1
Name	Data integration
Context	This process covers the key aspects of implementing a consolidated data mart at an enterprise level so that key stakeholders can get a relational view and holistic understanding of the business customers, products or services and operations.
Purpose	The purpose of TIP1 process is to identify an enterprise level data warehouse and if needed with a strong MDM platform EDW (along with MDM) provides an enterprise-wide infrastructure to standardize, integrate, and establish an authoritative source for data from disparate sources (CRM or ERP or PoS or HRMS or PIM or Web etc.) of information that have either similar or duplicate or both attributes to support business operations and decisions analytics.
Outcome	The outcomes of this process include: a) identification of the EDW system and MDM (if needed); b) implementation of EDW and MDM (if needed).

Table 19 — TIP2 Systems integration

ID	TIP2
Name	Systems integration
Context	This process covers the key aspects of providing the primary interface to external components of big data analytics engine including data providers and consumers.
Purpose	The purpose of TIP2 process is to establish the mechanisms to import data from data provider for further analysis or processing and export data to consumers through APIs.
Outcome	The outcomes of this process include: a) secure data connection and access is established; b) data import is executed; c) access rights management is established; d) data export (e.g. via application programming interface, protocol or query language) is performed.

7 Overview of process assessment model

7.1 General

In ISO/IEC 33001:2015, the PAM is described as a model suitable for the purpose of assessing a specified process quality characteristic based on one or more PRM's. The PRM defined in Clause 5 establishes a PAM that provides a common basis for performing assessments on big data processes, enabling the results to be reported using a common rating scale.

A PAM combines the basic set of process descriptions from one or more PRM's in the selected PMF. The two-dimensional model, as depicted in Figure 2, consists of a set of processes defined in terms of their purpose and process outcomes, and a PMF that contains a set of process attributes related to the process capability. The process attributes apply across all processes. They can be grouped into process capability levels that can be used to characterize the process. The assessment output includes a set of process profiles and process capability level rating for each process assessed.

In order to maximize the repeatability of assessments, documented evidence justifying the ratings must be recorded and retained. This evidence is in the form of assessment indicators, which typically take the form of objectively demonstrated characteristics of Information products, practices and resources associated with the processes assessed. A PAM contains details of the assessment indicators to be used. Such assessment indicators can be documented through the use of some form of database, checklists

or questionnaires. Figure 2 shows the relationship with the PRM, assessment process, measurement framework according to ISO/IEC 33001:2015 and ISO/IEC 33002:2015. See Annex A for information on mapping of indicators to process attribute outcomes.

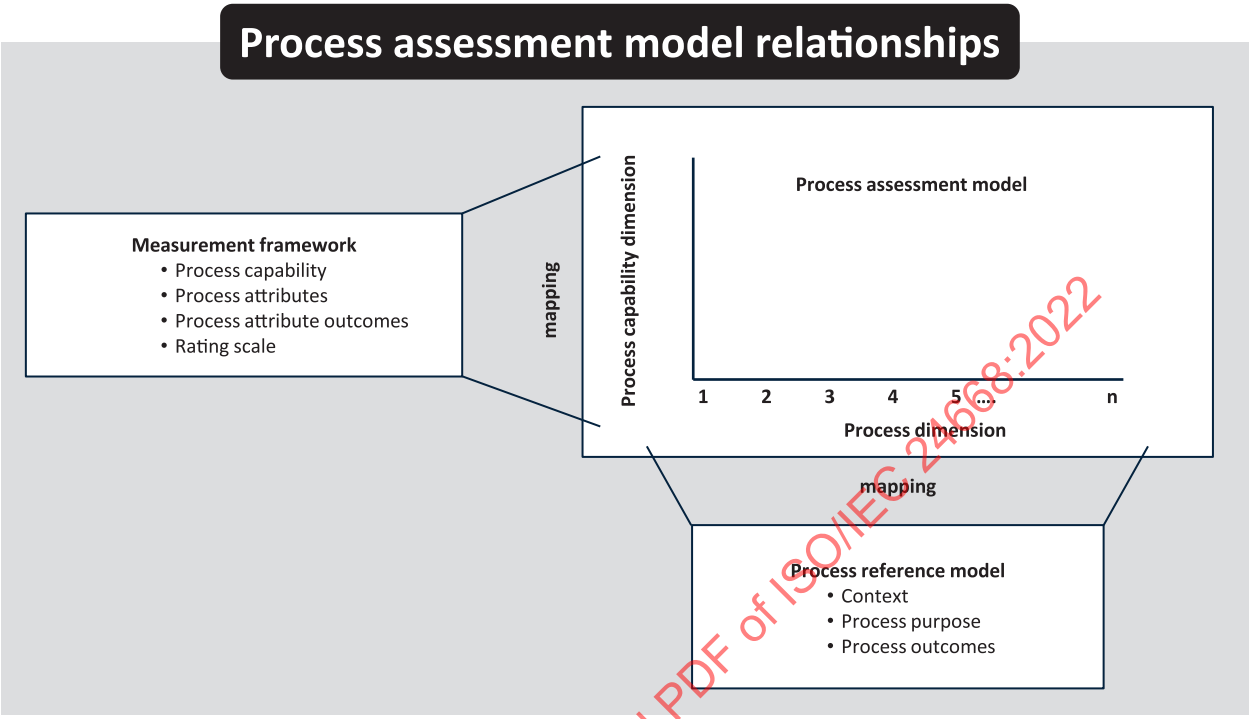

Figure 2 — Process assessment model relationships

7.2 Process dimension

Process dimension in Figure 2 is represented by processes from a set of PRMs. Each process in the PAM is described by process ID, process name, purpose, outcomes originated from the corresponding PRM process and base practices, inputs, and outputs.

Each base practice is associated to one or more process outcomes. Outputs are the results of performing base practice and are related to one or more process outcomes.

The achievement of outcome is an indicator that determines the process attribute rating, i.e. capability level 1. The set of indicators included in this document is not intended to be an all-inclusive set nor is it intended to be applicable in its entirety. Supersets and subsets that are appropriate to the context and scope of the assessment should be selected.

7.3 Process capability dimension

The PMF for assessment of process capability described in this document is expressed in terms of a set of process attributes. Each process attribute is defined in terms of a set of process attribute outcomes which can be evaluated to indicate the extent of achievement of the process attribute. The process attributes are organized into process capability levels, ranging from incomplete (in which the process does not achieve its defined process outcomes) to innovating (in which the process is continually improved to respond to organizational change). The PMF for assessment of process capability shall be in accordance with the requirements for PMF's in ISO/IEC 33003. Process capability levels and detailed definitions of the process capability levels, and process attributes are set out in Clause 8 together with the relevant process capability indicators. Process capability is expressed in the PAM by grouping process assessment indicators into capability levels. Each process attribute describes a feature of the overall capability in managing and improving process effectiveness in achieving its process purpose and contributing to the organization's business goals.

The existence or not of evidence to meet these process assessment indicators helps determine the capability levels.

7.4 Assessment indicators

A PAM shall be based on a set of assessment indicators that:

a) explicitly address the purpose and process outcomes, as defined in the selected PRM, of each of the processes within the scope of the PAM;

b) demonstrate the achievement of the process attributes within the scope of the PAM;

c) demonstrate the achievement (where relevant) of the process capability levels within the scope of the PAM.

7.5 Process attribute rating scale

Within this PMF, a process attribute is a measurable property of process capability.

A process attribute is measured using an ordinal scale as per rating scale based on ISO/IEC 33020:2019 and defined as:

N Not achieved: there is little or no evidence of achievement of the defined process attribute in the assessed process.

P Partially achieved: there is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Some aspects of achievement of the process attribute can be unpredictable.

L Largely achieved: there is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Some weaknesses related to this process attribute can exist in the assessed process.

F Fully achieved: there is evidence of a complete and systematic approach to, and full achievement of, the defined process attribute in the assessed process. No significant weaknesses related to this process attribute exist in the assessed process.

The ordinal scale can be further refined for the measures P and L as defined below.

P- Partially achieved: there is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Many aspects of achievement of the process attribute can be unpredictable.

P+ Partially achieved: there is some evidence of an approach to, and some achievement of, the defined process attribute in the assessed process. Some aspects of achievement of the process attribute can be unpredictable.

L- Largely achieved: there is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Many weaknesses related to this process attribute can exist in the assessed process.

L+ Largely achieved: there is evidence of a systematic approach to, and significant achievement of, the defined process attribute in the assessed process. Some weaknesses related to this process attribute can exist in the assessed process.

The ordinal scales defined shall be understood in terms of percentage achievement of a process attribute.

The corresponding percentages shall be:

P– Partially achieved– >15 % to ≤32,5 % achievement;

P+ Partially achieved+ >32,5 % to ≤50 % achievement;

L– Largely achieved– >50 % to ≤67,5 % achievement;

L+ Largely achieved+ >67,5 % to ≤85 % achievement;

F Fully achieved >85 % to ≤100 % achievement.

8 Processes and their performance indicators

8.1 General

This clause defines the processes and the associated process performance indicators within the PAM. The processes in this model can be directly mapped to those defined in the PRM in Clause 6. The individual processes are stated in terms of process name, process purpose and process outcomes.

Tables 20 to 76 contain the following descriptive elements in accordance with ISO/IEC/IEEE 24774 for each process and the PAM:

a) a set of base practices (BPs) defining the tasks and activities needed to accomplish the process purpose and fulfil the process outcomes; each base practice is explicitly associated to a process outcome;

b) number of information products (IPs) associated with each process and related to one or more of its outcomes;

c) characteristics associated with each information products, see Annex B for the IP_Id.

The base practices and information products constitute the set of indicators to assess process performance for a particular process.

NOTE 1 A documented assessment process and assessor judgment is needed to ensure that the process context (application domain, business purpose, development methodology, size of the organization, etc.) is explicitly considered when using this information. However, this list of information products cannot be considered as a checklist of what each organization can have but rather as an example and starting point for considering whether, given the context, the information products are necessary and are contributing to the intended purpose of the process. There are also different outputs from each process under each process categories that can also be considered as inputs for either other processes from the same process category or other process categories.

NOTE 2 The name of the information products (refer IP_Id) often do not match exactly with the one given in this document and vary from company to company but can match the characteristics as given in Annex B.

8.2 Base practices (BPs) and information products (IPs)

8.2.1 Organization stakeholder processes

Tables 20 to 34 contain the relevant processes related to organization stakeholder:

— Table 20: OSP1 Business analytics policy;

— Table 21: OSP1 Business analytics policy with base practices;

— Table 22: OSP1 Business analytics policy with information products;

— Table 23: OSP2 Stakeholders decision rights and accountabilities;

— Table 24: OSP2 Stakeholders decision rights and accountabilities with base practices;

— Table 25: OSP2 Stakeholders decision rights and accountabilities with information products;

— Table 26: OSP3 Alignment with organizational objectives;

— Table 27: OSP3 Alignment with organizational objectives with base practices;

— Table 28: OSP3 Alignment with organizational objectives with information products;

— Table 29: OSP4 Change management;

— Table 30: OSP4 Change management with base practices;

— Table 31: OSP4 Change management with information products;

— Table 32: OSP5 Data driven culture;

— Table 33: OSP5 Data driven culture with base practices;

— Table 34: OSP5 Data driven culture with information products.

Table 20 — OSP1 Business analytics policy

ID	OSP1
Name	Business analytics policy
Purpose	The purpose of the OSP1 process is to define a policy for big data analytics initiatives, roadmap and a guideline to implement these initiatives.
Outcomes	The outcomes of this process include: a) business objectives, direction and strategies are defined and shared to the organization and relevant stakeholders; b) strategic roadmaps are developed within the constraints of the service provider resources.

Table 21 — OSP1 Business analytics policy (BP)

ID	OSP1
Base practices	BP1 design the policy document for rollout of big data analytics: bring together required stakeholders to develop long-term organization objectives in terms of lines of business, growth prospects [outcome a)]. BP2 approval of the policy document by the board: take appropriate guidance and approval from the board for long term execution of the big data strategy policies in the organization [outcome b)]. BP3 institutionalization of the policy document: determine specific objectives at a business unit and department level in line with the organization objectives [outcome a), b)].

Table 22 — OSP1 Business analytics policy (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_01	Market analysis report	a)	IP_05	Big data analytics (BDA) policy document	a)
IP_02	Customer objectives	a)	IP_06	BDA strategic plan	a), b)
IP_03	Case studies	a), c)	IP_07	Communication document	a), b)
IP_04	Business strategic plan	b)	IP_08	Department or unit implementation plans	b)

Table 23 — OSP2 Stakeholders decision rights and accountabilities

ID	OSP2
Name	Stakeholders' decision rights and accountabilities
Purpose	The purpose of the OSP2 process is to identify and assign specific responsibilities to key stakeholders.
Outcomes	The outcomes of this process include: a) key stakeholders are identified with expertise in big data technology and process or domain knowledge; b) assignment of roles and responsibilities are done; c) accountability of the stakeholders is defined.

Table 24 — OSP2 Stakeholders decision rights and accountabilities (BP)

ID	OSP2
Base practices	BP1 identify big data analytics stakeholders: identify key stakeholders for the big data analytics initiative within the organization [outcome a)]. BP2 assign decision rights: assign appropriate rights to the stakeholders for the big data strategy execution in the organization [outcome b)]. BP3 define measures of accountability: determine specific measures and metrics at various levels and specific to decision rights [outcome c)].

Table 25 — OSP2 Stakeholders decision rights and accountabilities (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_06	BDA strategic plan	b), c)	IP_10	Organization BDA RACI matrix	a), b)
IP_09	Stakeholder list	a)	IP_11	Function or department RACI matrix	a), b)
IP_08	Department or unit implementation plans	b), c)	IP_12	BDA targets	c)

Table 26 — OSP3 Alignment with organizational objectives

ID	OSP3
Name	Alignment with organizational objectives
Purpose	The purpose of the OSP3 process is to align an organization's big data analytics initiatives with its business strategy.
Outcomes	The outcomes of this process include: a) big data analytics initiatives, specific to relevant departments or processes are decided; b) each of the initiatives are aligned with the stated objectives of departments or processes; c) the high-level initiatives are published across the organization with relevant stakeholders.

Table 27 — OSP3 Alignment with organizational objectives (BP)

ID	OSP3
Base practices	BP1 publish organization initiatives for big data analytics: communicate with stakeholders the big data analytics initiatives with high level goals and functional mapping [outcome a), c)]. BP2 align big data initiatives with organization strategy: ensure each initiative is aligned with the organization and department goals [outcome b)].

Table 28 — OSP3 Alignment with organizational objectives (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Department or unit implementation plans	a), b)	IP_15	Department BSC - BDA project alignment	a), b)
IP_12	BDA targets	a), b)	IP_12	Revised BDA targets	a), b), c)
IP_06	BDA strategic plan	a), b)	IP_08	Updated department implementation plan	a), b), c)
IP_13	Department strategic plans	a), b)	IP_16	Communication to stakeholders	a), b), c)
IP_14	Department BSC performance (balanced score card)	a), b)	-	-	-

Table 29 — OSP4 Change management

ID	OSP4
Name	Change management
Purpose	The purpose of the OSP4 process is to identify and manage people who are impacted by business analytics initiatives and manage the changes, including resistance and workarounds.
Outcomes	The outcomes of this process include: a) big data analytics initiatives or projects are subjected to progress monitoring and reviewed against expected outcomes; b) progress is communicated to stakeholders; c) the impact of the changes, issues and improvement is analysed and reported; d) awareness sessions and trainings are organized across the organization for different roles of stakeholders with regards to big data analytics.

Table 30 — OSP4 Change management (BP)

ID	OSP4
Base practices	BP1 analyse the impact of changes due to big data analytics initiatives: identify the impacts in short term and long term for big data analytics projects implementations plan to manage the change within the organization and any external impact [outcome a), c)]. BP2 organize training and awareness to demonstrate benefits of new practices: make appropriate plans to organize awareness and training sessions among stakeholders for an effective change management and seamless implementation across organization [outcome b), d)].

Table 31 — OSP4 Change management (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_15	Department BSC - BDA project alignment	a)	IP_17	Project progress update	a), b)
IP_12	Revised BDA targets	a), b)	IP_18	Risk analysis FMEA	c)
IP_08	Updated department implementation plan	a), b)	IP_19	Awareness workouts plan	d)
IP_16	Communication to stakeholders	b)	IP_16	Communication to stakeholders	d)
-	-	-	IP_19	Awareness workouts progress	d)

Table 32 — OSP5 Data driven culture

ID	OSP5
Name	Data driven culture
Purpose	The purpose of the OSP5 process is to create decision making processes based on data, analytics and related set of fact-based systems.
Outcomes	The outcomes of this process include: a) process or business performance always are measured in metrics; b) the metrics comprises leading and lagging indicators; c) quantitative analysis is encouraged with possible statistical correlations; d) possible big data analytics initiatives or projects are discussed and explored on problem or opportunity areas during reviews; e) quick wins or successful initiatives on analytics and big data analytics should be rewarded and communicated; f) a framework for piloting ideas exploring big data analytics for current processes or new areas of business should be rolled out (similar to a kaizen framework in many organizations).

Table 33 — OSP5 Data driven culture (BP)

ID	OSP5
Base practices	BP1 practice of data-driven management reviews for key performance areas: ensure performance reviews are based metrics that are revised in timely manner [outcome a)]. BP2 identify and define lagging and leading indicators: every process or function should have set of leading and lagging metrics for performance reviews at different levels to enable proactive actions for any performance leading to unexpected outcomes [outcome b)]. BP3 integrate data-driven decision-making with Big data analytics: implement big data analytics as appropriate for decision making in organization [outcome a), c), d)]. BP4 actions on analytical inferences and recommendations: ensure appropriate actions are determined and taken on recommendations coming out of analytics and rewarded appropriately [outcome e)]. BP5 insights on new and emerging areas for top line growth: determine specific objectives at a business unit and department level in line with the organization objectives [outcome f)].

Table 34 — OSP5 Data driven culture (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Department or unit implementation plans	c)	IP_22	BSC performance review action plan	a)
IP_12	BDA targets	a), b), d)	IP_23	Leading lagging metrics tagging	b)
IP_06	BDA strategic plan		IP_24	Project analysis review report	c), d)
IP_13	Department strategic plans	a), b)	IP_25	Pilot projects, execution plan, progress report	d), e)
IP_14	Department BSC performance (balanced score card)	a), b), c)	IP_26	Organization process framework for identification of projects	f)

8.2.2 Competency development processes

Tables 35 to 46 contain the relevant processes related to competency development:

— Table 35: CDP1 Workforce planning;

— Table 36: CDP1 Workforce planning with base practices;

— Table 37: CDP1 Workforce planning with information products;

— Table 38: CDP2 Capability development;

— Table 39: CDP2 Capability development with base practices;

— Table 40: CDP2 Capability development with information products;

— Table 41: CDP3 Functional knowledge;

— Table 42: CDP3 Functional knowledge with base practices;

— Table 43: CDP3 Functional knowledge with information products;

— Table 44: CDP4 Capability renewal;

— Table 45: CDP4 Capability renewal with base practices;

— Table 46: CDP4 Capability renewal with information products.

Table 35 — CDP1 Workforce planning

ID	CDP1
Name	Workforce planning
Purpose	The purpose of the CDP1 process is to arrive at plans to ensure availability of workforce and other resources for executing big data analytics projects and initiatives.
Outcomes	The outcomes of this process include: a) identify future leaders in big data analytics; b) align relevant responsibilities and craft succession plans in critical roles; c) recruit the right talent.

Table 36 — CDP1 Workforce planning (BP)

ID	CDP1
Base practices	BP1 define the right skills at different levels: identify the skills needed at different levels to form a big data analytics team [outcome a), b)]. BP2 align people plans with the organizational big data analytics structure: align key stakeholders with the big data analytics team either as sponsor, champion, support or active full-time role [outcome b)]. BP3 manage talent recruitment and management: ensure effective processes for managing internal talent and recruiting external talent [outcome c)].

Table 37 — CDP1 Workforce planning (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Department or unit implementation plans	a), b), c)	IP_63	BDA Stakeholder list	a), b)
IP_12	BDA targets	a), b), c)	IP_64	KRA or KPI alignment of BDA stakeholders with BDA targets	a), b)
IP_06	BDA strategic plan	a), b), c)	IP_65	Recruitment plan and status	a), c)
IP_13	Department strategic plans	a), b), c)	IP_66	BDA talent gap analysis	b), c)
IP_62	Talent management plan repository	a), b), c)	-	-	-

Table 38 — CDP2 Capability development

ID	CDP2
Name	Capability development
Purpose	The purpose of the CDP2 process is to support people throughout the organization to achieve their plans, objectives and targets through capability enhancement.
Outcomes	The outcomes of this process include: a) understand and develop the underlying capabilities of the organization; b) evaluate the set of results achieved to improve future performance and provide sustainable benefits to all their stakeholders; c) recognize their efforts and achievements in a timely and appropriate manner.

Table 39 — CDP2 Capability development (BP)

ID	CDP2
Base practices	BP1 define skills and competencies: identify right skills and competency to sustain the big data analytics initiative across the organization [outcome a)]. BP2 attract, develop and retain talent: take appropriate actions to attract, develop and retain talent within and outside organization [outcome b)]. BP3 develop skills and competencies: determine skills and talent development program [outcome a), b)]. BP4 maximize talent contributions: evaluate performance and set up processes for appropriate guidance, mentoring and recognition of effort and achievements [outcome c)].

Table 40 — CDP2 Capability development (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_63	BDA Stakeholder list	a), b)	IP_66	Skills gap and requirement	a)
IP_64	KRA or KPI alignment of BDA stakeholders with BDA targets	a), b), c)	IP_68	Recruitment plan and status	b)
IP_65	Recruitment plan and status	b), c)	IP_69	Training plan	b)
IP_66	BDA talent gap analysis	b), c)	IP_70	Resource transition plan	a), b)
IP_62	Talent management plan repository	a), b), c)	IP_71	Engagement and appraisal methods for BDA resources	c)

Table 41 — CDP3 Functional knowledge

ID	CDP3
Name	Functional knowledge
Purpose	The purpose of the CDP3 process is to encourage the BDA leaders to learn quickly and rapidly respond with accountability in their individual enhanced role.
Outcomes	The outcomes of this process include: a) encourage stakeholders to participate in activities that contribute to the wider acceptance to big data analytics initiative across organization; b) use approaches to understand, anticipate and respond to the different needs and expectations from big data analytics implementation team; c) promote a culture that supports the generation of new ideas and new ways of thinking to encourage innovation though big data analytics.

Table 42 — CDP3 Functional knowledge (BP)

ID	CDP3
Base practices	BP1 align personal, team and departmental objectives: all relevant stakeholders in the organization should have at least part of their key responsibility area aligned with the big data analytics initiative departments or functions involved within the scope of any projects as part of the initiative should also have goals aligned [outcome a)]. BP2 business challenge orientation: organize regular business ideation on addressing current challenges with help of big data analytics [outcome a), c)]. BP3 process and functional ambassadors: all key stakeholders of the organization should encourage application of analytics in their departments or functions or processes and support the initiatives [outcome a)]. BP4 cross organization participation: ensure implementing key big data analytics projects spanning across multiple functions or departments in the organization [outcome a)].

Table 43 — CDP3 Functional knowledge (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Department or unit implementation plans	a), c)	IP_64	KRA or KPI alignment of BDA stakeholders with BDA targets	a), c)
IP_12	BDA targets	a), c)	IP_72	Ideation or Kaizen events planning	a), c)
IP_06	BDA strategic plan	a), c)	IP_73	Participation and contribution of BDA ambassadors	c)
IP_13	Department strategic plans	a), c)	IP_69	Training plan	b)
IP_62	Talent management plan repository	b)	IP_71	Engagement and appraisal methods for BDA resources	b)

Table 44 — CDP4 Capability renewal

ID	CDP4
Name	Capability renewal
Purpose	The purpose of the CDP4 process is to use a structured approach for generating and prioritizing creative ideas and allocating resources to execute them within appropriate timescales with updated tools and techniques of big data analytics.
Outcomes	The outcomes of this process include: a) identify, evaluate and develop new and emerging technology portfolio to improve the agility of organization; b) establish and manage learning and collaboration networks to identify opportunities for creativity, innovation and improvement in technology and human resources.

Table 45 — CDP4 Capability renewal (BP)

ID	CDP4
Base practices	BP1 adapt new updates and trends: understand the new trends and evolution of tools and techniques of big data analytics to plan for adapting to the changes for bigger benefits [outcome a)]. BP2 environment for successful learning and implementation: support networking and collaboration in the larger ecosystem to identify opportunities and implement new projects with latest tools and technologies [outcome b)]. BP3 create new business models: work on conceptualising, validating and piloting transformational change with big data analytics techniques and learning to create new business models if possible [outcome a), b)].

Table 46 — CDP4 Capability renewal (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Department or unit implementation plans	a), b)	IP_74	BDA enabled transformation plan	a), b)
IP_12	BDA targets	a), b)	IP_75	New trends reports	a), b)
IP_06	BDA strategic plan	a), b)	IP_76	Cross functional Engagement teams	a), b)
IP_71	Engagement and appraisal methods for BDA resources	a), b)	IP_69	Training plans	a), b)
IP_62	Talent management plan repository	a), b)	IP_62	Talent management plan repository	a), b)

8.2.3 Data management processes

Tables 47 to 58 contain the relevant processes related to data management;

— Table 47: DMP1 Data identification;

— Table 48: DMP1 Data identification with base practices;

— Table 49: DMP1 Data identification with information products;

— Table 50: DMP2 Data quality;

— Table 51: DMP2 Data quality with base practices;

— Table 52: DMP2 Data quality with information products;

— Table 53: DMP3 Data governance;

— Table 54: DMP3 Data governance with base practices;

— Table 55: DMP3 Data governance with information products;

— Table 56: DMP4 Big data infrastructure;

— Table 57: DMP4 Big data infrastructure with base practices;

— Table 58: DMP4 Big data infrastructure with information products.

Table 47 — DMP1 Data identification

ID	DMP1
Name	Data identification
Purpose	The purpose of DMP1 process is to identify, define, classify, and collect data for all data elements available for the information flow in the context of the project or department or function.
Outcomes	The outcomes of this process include: a) data elements relevant to the process or function or department are identified; b) data elements can be classified into categories, such as unstructured, transactional, hierarchical, reference; c) meta data (operational definition) such as units, frequency, source or sources, functional definition, range, possible functional correlation, producer or consumer or ownership or steward are arrived; d) new data sources are identified; e) data collection is performed.

Table 48 — DMP1 Data identification (BP)

ID	DMP1
Base practices	BP1 identify the key data elements: such as features, co-variates, factors [outcome a), d)]. BP2 classify the data elements: [outcome b)]. BP3 provide the operational definition of data elements: [outcome c), d)]. BP4 collect the data with rigor and compliance: [outcome e)].

Table 49 — DMP1 Data identification (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_27	SIPOC	a), b)	IP_32	Data collection plan	a), c), d), e)
IP_28	Process flow	b), c)	IP_33	Data operational definition	a), b), c), d), e)
IP_29	CTQ matrix	a), b), c)	IP_34	Data sample	e)
IP_30	Use case studies	c), d)	-	-	-
IP_31	Domain documents	c), d)	-	-	-

Table 50 — DMP2 Data quality

ID	DMP2
Name	Data quality
Purpose	The purpose of DMP2 process is to identify activities that must address the root causes of data inconsistencies, fix errors through data cleansing and unite separate data quality initiatives.
Outcomes	The outcomes of this process include: a) structured data has an acceptable level of normal form; b) unstructured data has valid references to structured data; c) data complies on the aspects of completeness, timelines, validity, consistency, integrity.

Table 51 — DMP2 Data quality (BP)

ID	DMP2
Base practices	BP1 data quality assurance: plan, institute and manage an effective data quality assurance program throughout the organization [outcome a), b), c)].

Table 52 — DMP2 Data quality (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_32	Data collection plan	a), b)	IP_35	ER tables	a)
IP_33	Data operational definition	c)	IP_36	Data mapping	b)
IP_34	Data sample	c)	IP_37	Data quality audit report	c)

Table 53 — DMP3 Data governance

ID	DMP3
Name	Data governance
Purpose	The purpose of DMP3 process is to identify tools and define broad ranges of processes to implement an effective data governance across the organization.
Outcomes	The outcomes of this process include: a) a governing council is established; b) data stewards are identified; c) business rules associated with consolidating and updating data are defined; d) implementation and sustenance plans are defined.

Table 54 — DMP3 Data governance (BP)

ID	DMP3
Base practices	BP1 governing council: governing council should have members from key functional leaders and stakeholders from IT team [outcome a), b)]. BP2 governing council actions: council meeting agenda and actions should align with the organization strategy and projects' implementation plan [outcome c)]. BP3 escalation plan: escalation plan should be implemented for any detection of inconsistency of data and remedial action should be taken to avoid such problems in future [outcome a), b), c), d)]. BP4 execution roadmap: execution of implementation roadmap in stages [outcome d)].

Table 55 — DMP3 Data governance (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_32	Data collection plan	c)	IP_38	Data governance council structure	a), b)
IP_33	Data operational definition	b), c)	IP_39	Data governance council action plan	c), d)
IP_34	Data sample	c)	IP_40	Data governance council review meeting actions	d)
IP_15	Department BSC - BDA project alignment	c)	-	-	-
IP_08	Updated department implementation plan	a), b)	-	-	-
IP_10	Function or department RACI matrix	a)	-	-	-

Table 56 — DMP4 Big data infrastructure

ID	DMP4
Name	Big data infrastructure
Purpose	The purpose of DMP4 process is to implement a big data infrastructure which is a system that leverages big data engineering and employs a big data paradigm to process big data.
Outcomes	The outcomes of this process include: a) appropriate software and tools for distributed systems and storage and mining (NoSQL and relational databases, distributed file systems, and other distributed processing system) are identified; b) system implementation executed; c) big data architecture is identified and implemented; d) compliance with security and privacy aspect of big data is ensured; e) skill enablement is executed.

Table 57 — DMP4 Big data infrastructure (BP)

ID	DMP4
Base practices	BP1 baseline: baseline and analyse tools and software relevance and performance [outcome a)]. BP2 training and deployment: deployment and training of tools and software [outcome a), b), e)] BP3 system configuration: system configuration and access (on-premise or cloud) [outcome b)]. BP4 big data architecture: implementation of big data architecture [outcome c)]. BP5 security aspects: implementation of security aspect of big data [outcome d)].

Table 58 — DMP4 Big data infrastructure (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_32	Data collection plan	a), c), d)	IP_41	Tools analysis document	a)
IP_33	Data operational definition	a), c), d)	IP_42	BDA architecture	c)
IP_34	Data sample	b), d)	IP_43	Tools license validation	b)
IP_08	Updated department implementation plan	e)	IP_37	Data quality audit report	d)
IP_39	Data governance council action plan	a), d)	IP_44	Training and deployment review	e)

8.2.4 Analytics development processes

Tables 59 to 70 contain the relevant processes related to analytics development;

— Table 59: ADP1 Analytics activity definition;

— Table 60: ADP1 Analytics activity definition with base practices;

— Table 61: ADP1 Analytics activity definition with information products;

— Table 62: ADP2 Analytics practices;

— Table 63: ADP2 Analytics practices with base practices;

— Table 64: ADP2 Analytics practices with information products;

— Table 65: ADP3 Success criteria definition;

— Table 66: ADP3 Success criteria definition with base practices;

— Table 67: ADP3 Success criteria definition with information products;

— Table 68: ADP4 Risk identification;

— Table 69: ADP4 Risk identification with base practices;

— Table 70: ADP4 Risk identification with information products.

Table 59 — ADP1 Analytics activity definition

ID	ADP1
Name	Analytics activity definition
Purpose	The purpose of the ADP1 process is establish an analytics implementation plan to manage a unified big data and analytics platform.
Outcome	The outcomes of this process include: a) identification of small-scale analytics projects that suggest cross-functional or enterprise potential; b) identification of business areas that can have potential benefit from analytics; c) focus on high value and high impact targets; d) establish a priority matrix including criteria for executing projects; e) successful implementation of projects.

Table 60 — ADP1 Analytics activity definition (BP)

ID	ADP1
Base practices	BP1 assess likely cross functional applications: identify likely cross-functional applications Keep scope manageable, but with an eye to future expansion [outcome a), b), c)]. BP2 initiate enterprise-wide approach: initiate an enterprise-wide approach to taking systematic inventories of analytical opportunities by business area [outcome a), b), c)]. BP3 formalize project targets: formalize the process of fixing projects' targets as a collaboration among business executives, IT and analytics leaders. Ensure that the projects align with business objectives and strategic outcomes [outcome c), e)]. BP4 establish governance: establish enterprise governance of technology and architecture for analytics. Ensure multi-generation plan for projects having big scope and high value [outcome d), e)]. BP5 project Sign off: projects should be signed off by the functional leader along with CFO [outcome e)]. BP6 shape business strategy: infiltrate the strategic planning process so that big data analytics can shape (not just respond to) business strategy [outcome c)].

Table 61 — ADP1 Analytics activity definition (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_08	Updated department implementation plan	a), b), c), d)	IP_45	Prioritized project matrix	a), b), c), d)
IP_15	Department BSC - BDA project alignment	a), b), c), d)	IP_15	(Revised) Department BSC - BDA project alignment	a), b), c), d)
IP_12	BDA targets	a), b), c), d)	IP_12	(Revised) BDA targets	a), b), c), d)
IP_10	Organization BDA RACI matrix	a), b), c), d)	IP_17	(Revised)Project progress update	e)
IP_10	Function or department RACI matrix	a), b), c), d)	-	-	-

Table 62 — ADP2 Analytics practices

ID	ADP2
Name	Analytics practices
Purpose	The purpose of the ADP2 process is to establish consistent technology practices across the organization in implementing big data analytics projects. The process focuses on the analytics implementation and not on IT practices and data infrastructure needed for upstream and downstream integration and deployment.
Outcomes	The outcomes of this process include: a) life cycle methodology selection criteria and guidelines; b) architecture considerations and selection guidelines; c) guidelines on analytics methods selection; d) tools selection criteria and guidelines.

Table 63 — ADP2 Analytics practices (BP)

ID	ADP2
Base practices	BP1 establish guidelines and criteria: establish a process of setting criteria for selection of available architectures for analytics projects and guidelines [outcome a)]. BP2 establish a process setting criteria: establish guidelines and criteria for selection of life cycle development methodology for projects. Pure visual analytics and reporting development life cycle will not be the same as that of a project dealing with ad hoc reports on big data market research vs an automated real time analysis using deep learning methods [outcome b)]. BP3 evaluate tools: evaluate the tools available in the market for analytics implementation It should include open source as well as propriety tools. A tool selection guideline should be available at organization level for projects implementation Ensure that this document is updated frequently [outcome d)]. BP4 determine combination of approach: different projects across organization should deploy a combination of visual analysis, statistical significance analyses and range-based forecasts to prescriptive analytics [outcome c)]. BP5 establish a matrix: establish a matrix including the algorithms or methods most suitable for different purpose and selection criterion based on past projects [outcome c)]. BP6 pilot and proof of concept: ensure that the organization also encourages proof-of-concept (PoC) and pilot projects for "test and learn" experiments. The learnings from these projects should be incorporated in the life cycle, tools, architecture and methods or algorithm selection guidelines [outcome a), b), c), d)].

Table 64 — ADP2 Analytics practices (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_45	Prioritized project matrix	a), b), c), d)	IP_42	(Revised) BDA architecture	b)
IP_33	Data operational definition	b), c),	IP_46	Analytics tools analysis	d)
IP_42	BDA architecture	b)	IP_47	Life cycle methodology selection analysis	a)
-	-	-	IP_48	Analytics method matrix	c)

Table 65 — ADP3 Success criteria definition

ID	ADP3
Name	Success criteria definition
Purpose	The purpose of ADP3 process is to set and validate baselines for process performance, target and accuracy for project implementations.
Outcome (O)	The outcomes of this process include: a) baseline confirmation for the target process or function performance of project scope; b) target validation or re-set of targets in collaboration with stakeholders through a combination of diligence, PoC and pilot; c) accuracy determination as an outcome of project completion.

Table 66 — ADP3 Success criteria definition (BP)

ID	ADP3
Base practices	BP1 perform a study of the process or function: perform a study of the process or function along with subject-matter-experts and process owner to baseline the current performance with relevant conditions before implementing any analytics project [outcome a)]. BP2 ensure sign-off from process owner: ensure sign-off from process owner and big data analytics leader of the organization before executing analytics project and put in the project charter [outcome a)]. BP3 build-in the process performance baseline: build-in the process performance baseline effort into project schedule and effort estimate of the project [outcome a)]. BP4 conduct data and analytics method: conduct data and analytics method or algorithm diligence to validate target of analytics project at start of the project. Re-establish the target if needed in the project charter along with relevant stakeholders' sign-off [outcome b)]. BP5 build in schedule and effort estimate: build-in the data-algorithm diligence effort and schedule in the project plan [this (BP1 and BP4) can also be part of a PoC or a pilot for big scope projects [outcome b)]. BP6 ensure that accuracy measure: ensure that accuracy measure options are well communicated and explained to the process owner after the data-algorithm diligence (BP4) is over [outcome a)]. BP7 establish the accuracy: establish the accuracy in terms of MSE or MAPE or Sensitivity or Specificity or alpha-beta errors before full-scale deployment of algorithms [outcome c)]. BP8 communicate the accuracy baseline: communicate the accuracy baseline with the process owner and take a sign-off before full-scale deployment of algorithms [outcome c)].

Table 67 — ADP3 Success criteria definition (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_45	Prioritized project matrix	a), b)	IP_50	Process performance baseline	a)
IP_33	Data operational definition	a)	IP_51	Project targets revision	b)
IP_12	(Revised) BDA targets	b), c)	IP_52	Accuracy metrics	c)
IP_32	Data collection plan	a)	IP_53	Accuracy reports	c)

Table 68 — ADP4 Risk identification

ID	ADP4
Name	Risk identification
Purpose	The purpose of ADP4 process is to identify, classify and set boundaries of the risks involved in decision making process after implementing big data analytics.
Outcome (O)	The outcomes of this process include: a) identification of the constraints of scalability if any; b) criteria for decision oversight being set; c) identification of constraints of trustworthiness if any; d) any possible issues with transparency being called out; e) identification of any bias in training data set within the scope of the project.

Table 69 — ADP4 Risk identification (BP)

ID	ADP4
Base practices	BP1 identify the future scope: identify the future scope of application of the current big data implementation for the same target process or function, understand the constraints of future scalability and suggest any future approach for addressing the same [outcome a)]. BP2 identify any issues with trustworthiness: identify any issues with trustworthiness for the current scope of the project implemented [outcome c)]. BP3 identify bias: identify any bias involved with the training data set used to build the algorithm [outcome e)]. BP4 identify issues with transparency: identify issues with transparency if any in the project specially if any neural network or deep learning methods are used [outcome d)]. BP5 call out the decision oversights: call out the decision oversights needed for steady state function of the algorithm from go-live [outcome b)]. BP6 failure modes and effects analysis (FMEA) document: document BP -1,2,3,4,5 in a failure modes and effects analysis (FMEA) document and share with stakeholders for a sign-off [outcome a), b), c), d), e)].

Table 70 — ADP4 Risk identification (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_45	Prioritized project matrix	a), b), c), d), e)	IP_54	Project FMEA with scalability, trustworthiness, bias, transparency, decision oversight factors	a), b), c), d), e)

8.2.5 Technology integration processes

Tables 71 to 76 contain the relevant processes related to technology integration;

— Table 71: TIP1 Data integration;

— Table 72: TIP1 Data integration with base practices;

— Table 73: TIP1 Data integration with information products;

— Table 74: TIP2 Systems integration;

— Table 75: TIP2 Systems integration with base practices;

— Table 76: TIP2 Systems integration with information products.

Table 71 — TIP1 Data integration

ID	TIP1
Name	Data integration
Purpose	The purpose of TIP1 process is to identify an enterprise level data warehouse and if needed with a strong MDM platform EDW (along with MDM) provides an enterprise-wide infrastructure to standardize, integrate, and establish an authoritative source for data from disparate sources (CRM or ERP or PoS or HRMS or PIM or Web etc.) of information that have either similar or duplicate or both attributes to support business operations and decisions analytics.
Outcome	The outcomes of this process include: a) identification of the EDW system and MDM if needed; b) implementation of EDW and MDM (if needed).

Table 72 — TIP1 Data integration (BP)

ID	TIP1
Base practices	BP1 data integration: plan, implement and sustain routine operations through EDW and MDM (if needed) in the organization on an ongoing basis [outcome a), b)].

Table 73 — TIP1 Data integration (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_45	Prioritized project matrix	a)	IP_55	EDW or MDM evaluation	a)
IP_32	Data collection plan	a)	IP_56	EDW or MDM implementation	a), b)
IP_33	Data operational definition	a)	IP_57	EDW or MDM license procurement	b)
IP_42	BDA architecture	a)	-	-	-

Table 74 — TIP2 Systems integration

ID	TIP2
Name	Systems integration
Purpose	The purpose of TIP2 process is to establish the mechanisms to import data from data provider for further analysis or processing and export data to consumers through APIs.
Outcome	The outcomes of this process include: a) secure data connection and access is established; b) data import is executed; c) access rights management is established; d) data export (e.g. via application programming interface, protocol or query language) is performed.

Table 75 — TIP2 Systems integration (BP)

ID	TIP2
Base practices	BP1 interface layers: plan and implement interface layers both at EDW and Big data analytics engine [outcome a), b), d)]. BP2 data governance: implement access rights management as part of data governance [outcome c)].

Table 76 — TIP2 Systems integration (IP)

Information products					
Inputs			Outputs		
IP ID	Name	Outcome	IP ID	Name	Outcome
IP_45	Prioritized project matrix	a), b), c)	IP_58	APIs identified	a), b)
IP_32	Data collection plan	a), b), c)	IP_59	Data integration plan	a), b)
IP_33	Data operational definition	a), b), c)	IP_60	Data extraction plan	a), b)
IP_42	BDA architecture	a), b), c)	IP_61	Data extraction performance review	c)
IP_56	EDW or MDM implementation	a), b), c)	-	-	-

9 Process capability indicators (Levels 0 to 5)

9.1 General

This clause presents the process capability indicators relating to the process attributes associated with capability Levels 0 to 5 that are defined in the capability dimension of a PAM. Evidence from process capability indicators supports the judgment of the degree of achievement of the process attribute.

9.2 Process capability levels and process attributes

Process capability is defined on a six-point ordinal scale that enables capability to be assessed from the bottom of the scale, "Incomplete", through to the top end of the scale, "Innovating". The scale represents increasing capability of the implemented process, from failing to achieve the process purpose through to continual improvement to respond to organizational change.

Levels 0 to 5 further define the six-point ordinal scale of process capabilities under this category as follows:

— Process Capability Level 0 – Incomplete Process

— Process Capability Level 1 – Performed Process

— Process Capability Level 2 – Managed Process

— Process Capability Level 3 – Established Process

— Process Capability Level 4 – Predictable Process

— Process Capability Level 5 – Innovating Process

The full detailed process attribute definitions are defined in ISO/IEC 33020:2019, Clause 5.

Annex A
(informative)

Mapping of indicators to process attribute outcomes:

A.1 General

Mapping between the generic practices (GP) and the process attribute (PA) in ISO/IEC 33020:2019, Clause 5 outcomes are listed in Tables A.1 to A.3.

Table A.1 — Mapped generic practices

GP	Practice name	Maps to
PA.1.1: Process performance process attribute		
PA.1.1.GP1	Achieve the process outcomes	PA.1.1
PA.2.1: Performance management process attribute		
PA.2.1.GP1	Determine results to be achieved for the performance of the process	PA.2.1 a
PA.2.1.GP2	Determine and address risks relevant to the performance of the process	PA.2.1 b
PA.2.1.GP3	Plan the performance of the process to achieve the determined results	PA.2.1 c
PA.2.1.GP4	Control the performance of the process	PA.2.1 c
PA.2.1.GP5	Assign competent people with the relevant responsibilities and authorities for performing the process	PA.2.1 d, f
PA.2.1.GP6	Allocate and maintain resources to perform the process according to plan	PA.2.1 e
PA.2.1.GP7	Manage the interfaces between the involved parties	PA.2.1 g
PA.2.2: Documented information management process attribute		
PA.2.2.GP1	Define the requirements for the documented information	PA.2.2 a
PA.2.2.GP2	Define the requirements for documentation and control of the documented information	PA.2.2 b
PA.2.2.GP3	Identify, document and control the documented information	PA.2.2 c
PA.2.2.GP4	Review and adjust documented information to meet the defined requirements	PA.2.2 d
PA.2.2.GP5	Maintain and retain information products to demonstrate that planned results are achieved	PA.2.2 e

Table A.2 — Mapped generic practices

GP	Practice name	Maps to
PA.3.1: Process definition process attribute		
PA.3.1.GP1	Establish and maintain a standard process that will support the deployment of the defined process	PA.3.1 a
PA.3.1.GP2	Determine the inputs and outputs of the standard process	PA.3.1 b
PA.3.1.GP3	Determine the sequence and interaction of the process as an integrated system of processes	PA.3.1 c
PA.3.1.GP4	Determine the roles, competencies, responsibilities, and authorities for performing the standard process	PA.3.1 d
PA.3.1.GP5	Determine the resources for performing the standard process	PA.3.1 e
PA.3.1.GP6	Determine and maintain necessary knowledge for the operation of the standard process	PA.3.1 f
PA.3.2: Process deployment process attribute		
PA.3.2.GP1	Deploy a defined process that satisfies the context specific requirements of the use of the standard process	PA.3.2 a
PA.3.2.GP2	Deploy competent people with defined responsibilities and authorities to sup- port the performance of the defined process	PA.3.2 b, c
PA.3.2.GP3	Provide resources and information to support the performance of the process	PA.3.2 d
PA.3.2.GP4	Maintain documented information as evidence of the process achieving expected results	PA.3.2 e
PA.3.3: Process assurance process attribute		
PA.3.3.GP1	Collect and analyze data about performance of the process to identify needs for improvement	PA.3.3 a
PA.3.3.GP2	Determine suitable methods and measures to monitor and evaluate the process	PA.3.3 b
PA.3.3.GP3	Assure conformity of the defined process	PA.3.3 c
PA.3.3.GP4	Act on nonconformities to adjust the performance of the process	PA.3.3 d
PA.3.3.GP5	Improve the process based on the monitoring of the process	PA.3.3 e

Table A.3 — Mapped generic practices

GP	Practice name	Maps to
PA.4.1 Quantitative analysis process attribute		
PA.4.1.GP1	Establish process information needs, in support of quantitative business goals	PA.4.1 a
PA.4.1.GP2	Derive process measurement objectives from process information needs	PA.4.1 b
PA.4.1.GP3	Identify measurable relationships between process elements	PA.4.1 c
PA.4.1.GP4	Establish quantitative objectives for the performance of the defined process, according to the alignment of the process with the business goals	PA.4.1 d
PA.4.1.GP5	Identify product and process measures that support the achievement of the quantitative objectives for process performance	PA.4.1 e
PA.4.1.GP6	Select analysis techniques, appropriate to collected data	PA.4.1 f
PA.4.1.GP7	Collect product and process measurement results through performing the de- fined process	PA.4.1 g
PA.4.2 Quantitative control process attribute		
PA.4.2.GP1	Determine assignable causes of process variation by analyzing the collected data	PA.4.2 a
PA.4.2.GP2	Establish distributions that characterize the process performance	PA.4.2 b
PA.4.2.GP3	Identify and implement corrective actions to address assignable causes	PA.4.2 c
PA.4.2.GP4	Establish separate distributions for analyzing the process	PA.4.2 d
PA.4.2.GP5	Develop predictors for process outcomes	PA.4.2 e
PA.5.1 Process innovation process attribute		
PA.5.1.GP1	Define the process innovation objectives for the process that support the relevant business goals	PA.5.1 a
PA.5.1.GP2	Analyze data of the process to identify opportunities for best practice and innovation	PA.5.1 b
PA.5.1.GP3	Identify innovation opportunities of the process from new technologies and process concepts	PA.5.1 c
PA.5.1.GP4	Define an implementation strategy based on long-term innovation vision and objectives	PA.5.1 d
PA.5.1.GP5	Assess the impact of each proposed change against the objectives of the de- fined and standard process	PA.5.1 e
PA.5.1.GP6	Manage the implementation of agreed changes	PA.5.1 f
PA.5.1.GP7	Evaluate the effectiveness of process change	PA.5.1 g