DS/PAS 2500-1:2020

Artificial Intelligence

Part 1: Transparency

DANISH STANDARDS

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DS/PAS 2500-1:2020,
Artificial Intelligence – Part 1: Transparency

DS/PAS 2500-1:2020
Project number M393730
Graphic design: Jenni Søndergaard
Editor: Jenni Søndergaard
Printed by: Danish Standards, Published 2025
First edition

Published by Danish Standards,
Göteborg Plads 1
DK-2150 Nordhavn

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This is a POD publication, printed in Denmark

Images: Colourbox and IStockphoto.

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Foreword

DS publication type

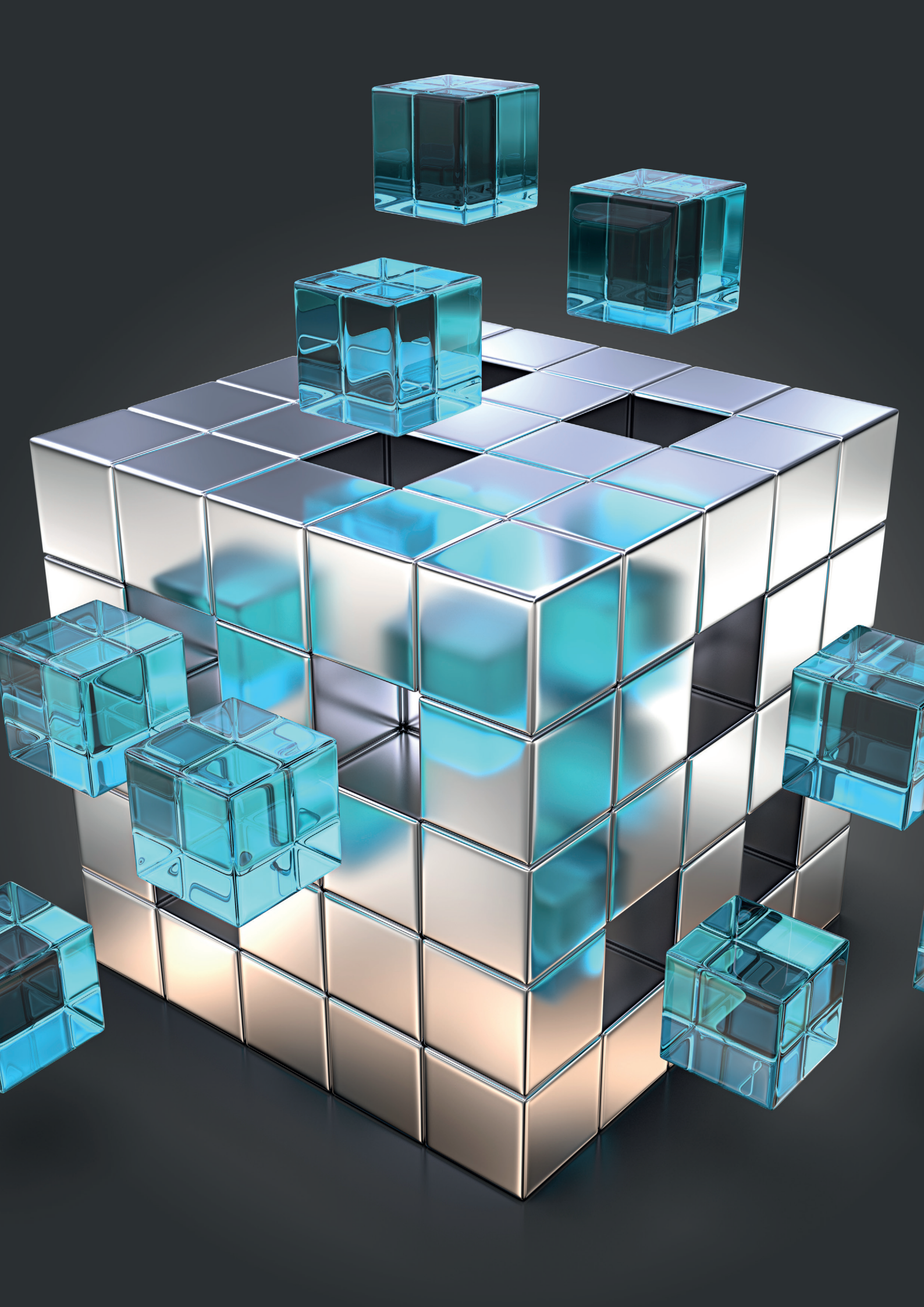
All designations for publications published by Danish Standards begin with DS followed by one or more prefixes and a number, e.g. DS 282, DS/EN 5414 etc. If the publication is part of a series, this will be indicated with a hyphen followed by the number in the series, e.g. DS/PAS 2500-1 and DS/PAS 2500-2. A series is a non-prioritised sequence of publications, each of which can be read individually but addresses the same topic.

DS/PAS

This document is a DS/PAS. PAS is an abbreviation for 'Publicly Available Specification', which is a publication developed at the national level, that does not have the same status as an international standard. A PAS differs from an international standard, for example, by not having the same requirements for the level of stakeholder involvement or layout. A DS/PAS also does not specify requirements that must be complied with, but instead offers recommendations, information, and advice.

Development of the publication

This publication has been developed together with the Alexandra Institute and with input from Danish stakeholders through workshops, interviews, and written comments in accordance with the procedure for developing PAS publications at Danish Standards.



Introduction

Transparency is necessary for validating results and establishing trust in systems that support and make decisions. This is true regardless of whether artificial intelligence is used in a decision-making process. Nevertheless, the use of artificial intelligence has made the need for transparency more apparent.

Artificial intelligence can leverage and acquire knowledge and skills to solve (complex) problems – typically to a greater extent than human-only systems. For this very reason, systems that use artificial intelligence often require much larger amounts of data than traditional systems to make decisions or act as decision support.

If decisions cannot be rationalised, it can be difficult to trust them. Artificial intelligence is often used in collaboration with humans, who must be able to understand what is being done and why.

One way to rationalise decisions is to provide one or more explanations. Explanations can take various forms, depending on the recipient's needs. For example, the need may be a justification for an action, the relevance of a question, or an explanation of what an object is (conceptualisation).

Regardless of the type of explanation needed, transparency is usually the foundation. Transparency is therefore important for building trust in the use of systems. Transparency has also been identified as an important principle for artificial intelligence by numerous international experts.

1. Scope

This document describes transparency, a general approach to how it can be achieved, and a method for self-assessing the level of transparency. This method can also be used to specify transparency requirements. The approach and method can be applied both to systems that use artificial intelligence and those that do not.

The target group is designers, developers and users who either wish to or are required to document and/or increase transparency in their systems. A secondary target group is the stakeholders who benefit from increased transparency, such as authorities, purchasers, companies, and consumers.

This document specifies recommendations for an approach to achieve transparency in systems used for automated decision-making or decision support, including inference and the use of data. Such systems often use artificial intelligence, but this is not a requirement. Additionally, the approach can be used to assess whether the achieved transparency is at an adequate level. The document does not cover reproducibility, explanations in a broader sense, and maintenance (e.g. conceptual operation).

2. Normative references

The 'Normative References' in standards commonly specify the documents that are cited in the standard's text as required documents to comply with the standard.

This document has no normative references.

3. Terms and definitions

In this document, the following terms and definitions apply.

3.1

transparency

explanation of how a system arrived at a conclusion

Note 1 to term: Transparency can be achieved by reviewing the *inference trace* (3.5) and the *provenance* (3.10) of the data used.

3.2

justification

explanation of why a given system's answer is satisfactory to the recipient

Note 1 to term: A justification can be provided by combining *the inference trace* (3.5) with background knowledge.

3.3

relevance

explanation of why the question asked is useful

Note 1 to term: Relevance can be documented by combining the *inference trace* (3.5), a *dialogue trace* (3.6) and the *domain model* (3.7).

3.4

conceptualisation

agreement on the meaning of concepts

Note 1 to term: Conceptualisation can be achieved by inspecting the *domain model* (3.7).

3.5

inference trace

logged sequence of reasoning performed by the system to achieve a goal or answer a question

3.6
dialogue trace
logged sequence of dialogue between system and user or between system and system

3.7
domain model
explicit representation of the *knowledge* (3.9) the system has about the domain in question

3.8
artificial intelligence
a system's ability to acquire, process and apply *knowledge* (3.9) and/or skills

Note 1 to term: Artificial intelligence is generally compared to human intelligence, although this is not an exhaustive definition.

Note 2 to term: Machine learning is a subcategory of artificial intelligence.

3.9
knowledge
data, information, and skills acquired through experience or training

3.10
provenance
determining how and from where data has been collected and how data has been processed, including the quality of the dataset, where applicable

3.11
bias
prejudice in decisions or methodologically flawed data basis for decisions

Note 1 to term: Including *provenance* (3.10).

3.12
interested party
stakeholder
individual, group, or organization that can affect, is affected by, or perceives itself to be affected by a decision or activity, including the development of IT systems
[SOURCE: DS/EN ISO/IEC 27000:2020 (3.37), modified]

3.13
inference method
method or technique used to manipulate data to reach a result

Note 1 to term: The chosen method determines the type of conclusion and *transparency* (3.1) that can be achieved. The inference method goes hand in hand with the *representation* (3.14) used.

3.14
representation
structure used to organize data, information, and *knowledge* (3.9)

Note 1 to term: The choice of representation determines the type of inference and *transparency* (3.1) that can be used.

3.15
concept drift
variable that the system is trying to predict changes over time (in an unforeseen way)

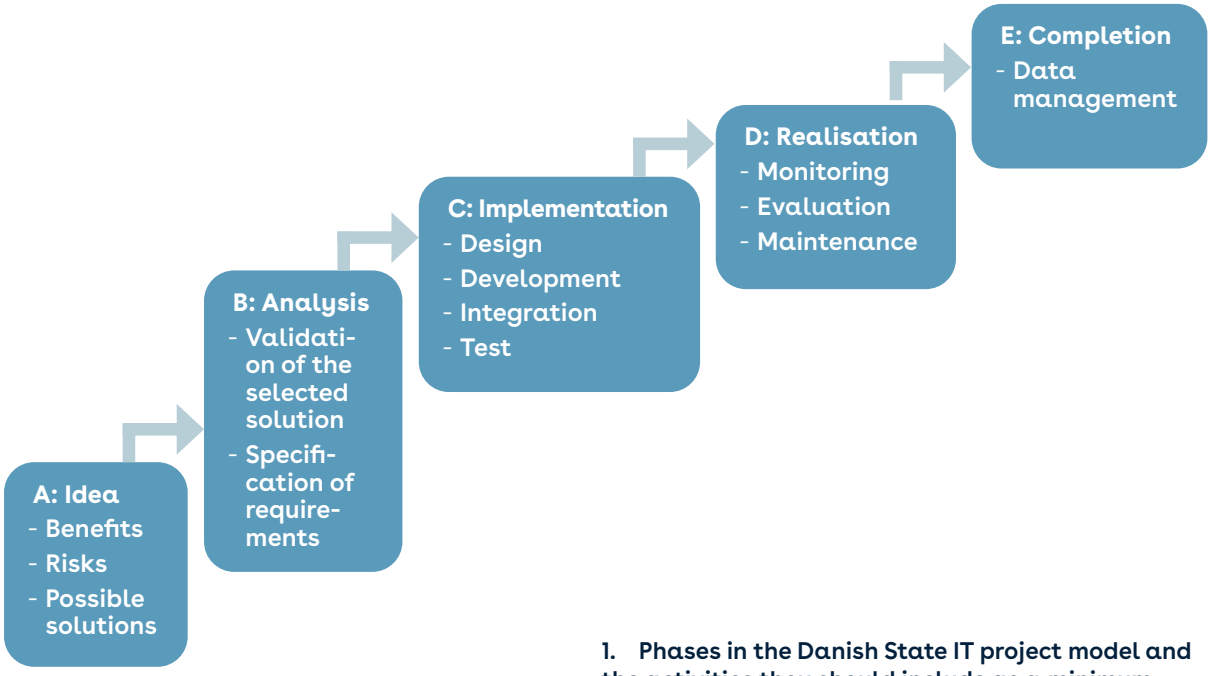
4. Recommendations for achieving sufficient transparency

4.1 Lifecycle and log

The development of systems that support transparency necessitates working on it during all stages of system development and implementation. Figure 1 provides an overview of the common phases in the lifecycle of a system. The lifecycle of a system can be roughly divided into five phases: idea, analysis, implementation, realisation, and completion. Note that if agile development is used, major parts of the analysis, implementation, and realisation phases will be considered as a single phase. This lifecycle model is based on the Danish State IT project model[1].

Along with the specific steps in each phase, it is important to be conscious of the decisions made throughout the process and record them in an audit log. It should also be recorded who makes these decisions. At the start of the project, a person should also be appointed to be responsible for completing checklists.

The developing organization (the producer) is responsible for integrating transparency into systems and maintaining an audit log. The producer is also responsible for involving consumers and target groups to understand their needs. Stakeholders and target groups are responsible for assessing risks and information needs.



1. Phases in the Danish State IT project model and the activities they should include as a minimum.

1 https://digst.dk/styring/projektstyring/dokumenter-og-vejledninger/ (in Danish)

There are two different types of user groups – novices and experts – both of which have a need for transparency. However, the transparency needs of these two user groups and the contexts in which they need transparency may differ.

4.2 Novice groups and their need for transparency

There are three different groups of novices, each with different needs for transparency (see Table 1). A person can belong to one or more groups at the same time.

Table 1: Novice groups and their needs[2]

Group	Need for transparency
End user: One who has direct interaction with the system. An example could be an insurance customer whose case has been settled using artificial intelligence.	Inference, data provenance, and potential bias associated with specific outcomes of using the system.
Affected party: Users who do not interact directly with the system but are affected or perceive themselves to be affected by the effects of using the system. An example could be customers whose insurance terms have been changed based on other customers' cases; cases that have been settled using artificial intelligence.	Inference, data provenance, and potential bias associated with specific outcomes of using the system.
General public: May be (indirectly) affected by the effects of the system, or the system may be used in a context of general public interest. An example could be that the general insurance terms and conditions across an industry change based on the use of artificial intelligence.	General precision of inference, data sources used, and potential bias related to e.g. population groups.

2 In most cases, novice users will require different types of explanations than transparency, usually a justification. However, other explanations are beyond the scope of this document and therefore only transparency will be addressed.

4.3 Expert groups and their need for transparency

In addition to novices, there are several different types of experts who have different needs and contexts in which they need transparency (see Table 2).

Group	Need for transparency
Developers	The characteristics of the inference method in relation to transparency, methods for handling provenance, and methods for detecting bias.
Validation and certification staff	Methods and techniques and their specific application in relation to validation and certification requirements.
Investigators	Documentation of formal requirements for system characteristics.
Legal staff	Documentation of compliance with legal requirements.

Table 2: Expert groups and their needs

4.4 Need for transparency at all stages of a system's lifecycle

For each of the five phases, there is a checklist for producers and consumers, as well as for both user groups. In certain phases, it is only relevant to have a checklist for one of the groups.

4.4.1 Phase A: The idea phase

It is important that transparency is considered from the very beginning in the idea phase, as fundamental decisions for the design of the entire system are made at this point. These decisions are crucial for documenting the system's transparency. Recipients and end users are encouraged in the idea phase to start considering the system's eventual disposal.

The producer's responsibility in the idea phase is to identify which stakeholders are involved. This includes both novices and experts. Identifying stakeholders will typically already be part of a thorough risk assessment.

4.4.1.1 Checklists for the idea phase

There are different users of the checklists for the idea phase:

I. **Producers**: The idea phase checklist is targeted at producers. The list comes in two versions: one with considerations related to novice users (see Table 3) and one with considerations related to expert users (see Table 4).

II. **Consumers and recipients**: This group does not require an explicit checklist for the idea phase, just a check to ensure that the producer has completed his checklist and what the results were. However, consumers and recipients are encouraged to create a suitable checklist for the completion phase already in the idea phase (see 4.4.5).

4.4.1.1.1 Checklist for novices in the idea phase

In general, all three novice groups (end users, affected parties, and the general public) will need transparency regarding inference and provenance to uncover potential bias. However, the specific needs may differ. For example, an end user will have a need related to the specific outcome of their use of the system, any bias in the system, and detailed understanding of the inference method. Affected parties, on the other hand, will have a need related to the impact of the system's outcomes and insight into any use of their data.

The general public, as a whole, will have an interest in the general accuracy of the inference method, potential bias regarding, for instance, groupings, and the data sources used.

ID	Checklist for novices in the idea phase	Check
A1	**Who are the correct end user groups?**	
A2	**Does the end user have specific requirements for the characteristics of the inference method?**	
A2-1	Can the provenance of data be accounted for?	
A2-2	Can any bias be accounted for?	
A3	**Will there be a group of affected parties?**	
A3-1	Does the affected parties have requirements for the characteristics of the inference method?	
A3-2	Can the provenance of data be accounted for?	
A3-3	Can any bias be accounted for?	
A4	**Will the system be of general interest to the general public?**	
A4-1	Are there general requirements for the characteristics of the inference method?	
A4-2	Can the provenance of data be accounted for?	
A4-3	Can any bias be accounted for?	

Table 3: Checklist for novices in the idea phase

4.4.1.1.2 Checklist for experts in the idea phase

The needs of the different expert groups fall into two general types: a technical one, where developers and external validation and certification staff will need technical details; and a formal one, where external validation and certification staff, investigators, and legal staff will have needs more closely related to formalities and processes.

ID	Checklist for experts in the idea phase	Check
A5	**Who are the developers?**	
A5-1	Has the correct inference method been chosen?	
A5-2	Can data provenance be provided?	
A5-3	Can any bias be accounted for?	
A6	**Is external validation required?**	
A6-1	Does the inference method meet the validation requirements?	
A6-2	Are there validation requirements for data provenance?	
A6-3	Should any bias be validated?	
A7	**Is certification required?**	
A7-1	Does the inference method meet the certification requirements?	
A7-2	Should data provenance be certified?	
A7-3	Should any bias be certified?	
A8	**Will the system be subject to formal investigation?**	
A8-1	Are there any formal requirements for documentation of inference methods, data provenance, and bias calculations?	
A9	**Will there be specific legal requirements?**	
A9-1	Does the inference method meet the legal requirements?	
A9-2	Does the data provenance method meet the legal requirements?	
A9-3	Do bias calculations meet legal the requirements?	

Table 4: Checklist for expert users in the idea phase

4.4.2 Phase B: The analysis phase

The user groups and needs identified in the idea phase now form the basis for further detailing in the analysis phase. In this phase, decisions are now being made that affect the rest of the system's lifecycle.

The checklist has the following target groups:

I. **Producers**: The analysis phase checklist is aimed at this group and includes the needs of both novice and expert groups (see Table 5).

II. **Consumers and recipients**: This group can use the same checklist as a tool to ensure agreement with producers in terms of requirements and deliverables.

4.4.2.1 Checklist for the analysis phase

ID	Checklist for the analysis phase	Check
B1	**Do the functional and qualitative requirements meet the requirements of the novice groups?**	
B1-1	Are the specific novice group's requirements for transparency in the inference method specified?	
B1-2	Are the specific novice group's requirements for data provenance specified?	
B1-3	Are the specific novice group's requirements for bias calculation and explanation specified?	
B2	**Do the functional and qualitative requirements meet the requirements of the expert groups?**	
B2-1	Are the specific expert group's requirements for transparency in the inference method specified?	
B2-2	Are the specific expert group's requirements for data provenance specified?	
B2-3	Are the specific expert group's requirements for bias calculation and explanation specified?	
B3	**Can the design generate the desired transparency?**	
B3-1	Can the choice of method be sufficiently explained?	
B3-2	Can the choice of data sources be sufficiently explained?	
B3-3	Can the choice of system goals be sufficiently explained?	
B4	**Can the design provide the desired transparency?**	
B5	**Does the implementation meet the transparency requirements?**	
B5-1	Have the requirements for transparency in the inference method been met?	
B5-2	Have the requirements for transparency in provenance management been met?	
B5-3	Have the requirements for transparency in bias management been met?	
B5-4	Can the model's characteristics be sufficiently explained?	
B6	**Transparency tests?**	
B6-1	Have the correct tests for transparency in the inference method been developed, implemented, and applied?	
B6-2	Have the correct tests for provenance management been developed, implemented, and applied?	
B6-3	Have the correct tests for bias management been developed, implemented, and applied?	
B6-4	Does the test regime handle an update of the audit log for all relevant parts of the system's lifecycle?	

Table 5: Checklist for the analysis phase

4.4.3 Phase C: The implementation phase

The tested implementation of the system now forms the basis for integration into any existing technical infrastructure, as well as for validating the system's characteristics in the production environment.

4.4.3.1 Checklist for the implementation phase

The analysis phase checklist has the following users:

I. **Producers**: The checklist for the implementation phase is aimed at this group and includes the needs of both novice and expert groups (see Table 6).

II. **Consumers and recipients**: Can use the same checklist, but with the aim of verifying whether there is an agreement with the producers on the satisfaction of requirements.

In general, the requirements for both novice and expert users are related to whether the specified requirements can be supported, even in production. Additionally, it would be beneficial, especially from the consumer's and recipient's perspective, for the system to provide transparency automatically and as an integrated part of the system's primary functionality as much as possible.

ID	Checklist for the implementation phase	Check
	Novices	
	End users	
C1	Does the system automatically provide sufficient transparency in the form of inference traces?	
C2	Does the system automatically provide sufficient transparency regarding data provenance?	
C3	Does the system automatically provide sufficient support for preventing bias?	
C4	Can any obligations regarding the use of data be documented?	
C5	Is transparency an integral part of the system's functionality?	
	Affected parties	
C6	Can the system automatically provide sufficient transparency?	
C7	Is any additional functionality regarding transparency for the affected parties sufficient?	
	The general public	
C8	Does the system automatically provide sufficient information to cover general characteristics, as defined in Table 1?	
	Experts	
	Validation and certification staff	
C9	Is documentation sufficiently transparent?	
C10	Can any obligations in relation to the use of data be documented?	
	Investigators	
C11	Is it possible to (automatically) provide necessary information?	
	Legal staff	
C12	Is it possible to (automatically) provide necessary information?	
C13	Can any obligations in relation to the use of data be documented?	

Table 6: Checklist for the implementation phase

4.4.4 Phase D: The realisation phase

In this phase, the system is in production. This phase primarily concerns monitoring, maintenance, and providing transparency to the involved parties.

4.4.4.1 Checklist for the realisation phase

The realisation phase checklist has the following users:

I. Consumers and recipients: This checklist is aimed at consumers and recipients and includes the needs of both novice and expert users (see Table 7)

II. Producers: Can use the same checklist, but with the aim of being able to relate to any delivery requirements.

ID	Checklist for the realisation phase	Check
	Novices	
	End users, affected parties, and the general public	
D1	Are there built-in automatic mechanisms to handle any changes in the applied inference or model?	
D2	Are there built-in automatic mechanisms to handle any changes in the characteristics of data sources?	
D3	Are there built-in automatic mechanisms to handle any changes in bias (e.g. concept drift)?	
	Developers	
D4	How should the system be maintained to ensure that automatic transparency for the respective groups is upheld?	
D5	How is the audit log maintained?	
	Experts	
	Validation and certification staff	
D6	Can the system (automatically) account for any changes in the applied inference or model in relation to changes in external validation?	
D7	Can the system (automatically) account for any changes in the applied inference or model in relation to changes in certification?	
	Investigators	
D8	Is the audit log properly maintained (also for run-time changes)?	
	Legal staff	
D9	Is the audit log properly maintained (also for run-time changes)?	

Table 7: Checklist for the realisation phase

4.4.5 Phase E: The completion phase

When a system is decommissioned, there are specific requirements for transparency that come into play. These requirements primarily concern whether existing data is properly decommissioned (typically in relation to legislation). This point does not include an explicit checklist, as this document does not address applicable legislation at any given time. Consumers and recipients are encouraged to create suitable checklists already in the idea phase.

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Artificial intelligence can leverage and acquire knowledge and skills to solve (complex) problems – typically to a greater extent than human-only systems. For this very reason, systems that use artificial intelligence often require much larger amounts of data than traditional systems to make decisions or act as decision support.

If decisions cannot be rationalised, it can be difficult to trust them. Artificial intelligence is often used in collaboration with humans, who must be able to understand what is being done and why. One way to rationalise decisions is to provide one or more explanations. Regardless of the type of explanation needed, transparency is usually the foundation. Transparency is therefore important for building trust in the use of systems.

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