AI literacy requirements according to Art. 4 AI Act

Legal analysis and practical measures

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AI literacy requirements according to Art. 4 AI Act – Legal analysis and practical measures

Whitepaper

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Management Summary

With the adoption of Regulation (EU) 2024/1689 (the ‘AI Act’), European legislators have firstly created a binding legal framework for the risk-appropriate use of artificial intelligence (AI). In addition to technical and organizational requirements, Art. 4 of the Regulation contains an explicit obligation to ensure a sufficient level of AI literacy among those involved in the development, operation and use of AI systems. The obligation applies to providers and deployers of such systems and must be fulfilled “to their best extent”.

This Whitepaper provides a systematic analysis and practical operationalization of the AI literacy requirements standardized by Article 4 AI Act. The aim is to provide guidance, particularly for small and medium-sized enterprises (SMEs), on the structured implementation of the regulatory requirements. To this end, the legal basis is thoroughly examined and translated into an integrated competence model that distinguishes between individual (micro-) and organizational (macro-) dimensions.

The focus is on a two-stage process model for identifying and developing AI literacy: a bottom-up analysis of individual abilities is systematically combined with a top-down comparison of organizational requirements. In addition, a morphological box for classifying AI-relevant role profiles is introduced, which enables a structured assignment competence requirements and measures.

This work thus contributes to the normative, methodological and practical foundation of the obligation to ensure competence in the field of AI established by Article 4 AI Act. It is intended as a guide for corporate and public actors who not only want to meet regulatory requirements but also want to translate them into strategically sound competence development.

Table of Contents

1

Preface

1 Preface

The relevance of artificial intelligence (AI) for society, the economy and administration has grown significantly in recent years (Mayer et al. 2025). AI is no longer understood exclusively as a technological innovation, but has a profound impact on everyday life, social coexistence and corporate value creation processes. Companies therefore feel an increasing responsibility to use AI systems not only efficiently, but also in a manner that complies with standards, is ethically acceptable, and appropriate for the target audience.

With the enactment of the Regulation (EU) 2024/1689 – better known as the 'AI Act' – the European Union has firstly created its legal framework for the risk-appropriate use of AI. In addition to technical and organizational requirements, Art. 4 AI Act also includes an explicit obligation to promote so called 'AI literacy' among the actors involved. This obligation addresses providers and deployers of AI systems and requires them to take measures to ensure "to their best extent" that all persons involved in the development, deployment, or use of AI have an appropriate level of skills, knowledge, and understanding in dealing with AI.

The term AI literacy encompasses not only technical knowledge, but also procedural skills and critical thinking abilities. Companies are therefore required to collect, evaluate and develop both individual and organizational competence profiles in a differentiated manner. SMEs in particular have a great need for practical support in order to meet abstract regulatory requirements with implementable measures.

The aim of this Whitepaper is therefore to support companies in the systematic operationalization of the competence requirements set out in Art. 4 AI Act. It provides a legally sound and practice-oriented classification of the provision, translates the regulatory requirements into verifiable competence dimensions (micro- and macro- levels) and identifies specific options for action in terms of skills development. Particular focus is placed on the two-stage competence model that has been developed and on linking legal requirements with organizational implementation perspectives. The white paper was made possible by hessian.AI.

We hope that this work will make a substantial contribution to clarifying the requirements raised by the AI Act. It is intended to accompany companies on their path to responsible, legally compliant and future-oriented use of AI systems – and to help them combine regulatory requirements with organizational capability.

2

Legal Analysis

2 Legal Analysis

2.1 Overview of the AI Act

As an EU regulation, the AI Act applies directly across the entire European Union (EU). The objective of the Regulation is, on the one hand, to promote the EU's capacity for innovation in the field of AI and, on the other hand, to effectively control the risks associated with the use of these technologies. The AI Act follows a so-called risk-based approach (cf. Wendt and Wendt 2025, § 3, paras. 38–46): the higher the potential risk of harm posed by an AI system to fundamental rights, safety, or health, the stricter the regulatory requirements.

At the core of the AI Act are provisions governing the development, use, and monitoring of AI systems, particularly those classified as 'high-risk AI system' under Article 6 AI Act. These include, for example, AI applications in the fields of critical infrastructure, human resources, law enforcement, or education; as well as safety components and products regulated by other European legal acts, such as medical devices. Providers and deployers of such systems are subject, for instance, to obligations regarding data quality, transparency, documentation, human oversight, and cybersecurity. Other AI systems are completely prohibited in the EU under Article 5 AI Act due to the high level of risk associated with their use. These include, for example, systems that engage in so-called 'social scoring' or that deliberately employ manipulative or deceptive techniques. In addition, the AI Act sets out transparency obligations in Article 50 for certain AI systems, regardless of their specific level of risk.

However, the AI Act goes beyond purely technical and organizational requirements. With Article 4 AI Act, the Regulation explicitly acknowledges that the responsible use of AI requires appropriate literacy on the part of the individuals involved, regardless of the level of risk associated with the deployment of the AI systems in question (Wendehorst 2024b, para. 3; Wendt and Wendt 2025, § 4, paras. 1 et seq.; Wendt 2025, para. 3; Rappenglück and Vonthien 2025, p. 400; Möller-Klapperich 2025, p. 194).

Article 4 AI Act has been applicable since 2 February 2025 pursuant to Article 113(a) AI Act. The European Commission has announced that national authorities will

monitor compliance with Article 4 AI Act as of 3 August 2026 (European Commission 2025a).

2.2 Scope of the AI Act

2.2.1 Definition of the 'AI system'

One of the central concepts of the AI Act is that of the 'AI system', since the Regulation applies exclusively to such systems. The AI Act defines the term AI system in Article 3(1) AI Act as a machine-based system designed to operate with varying levels of autonomy and that may, after being deployed, adapt its behavior. In addition, the system must be able to generate outputs such as predictions, content, recommendations, or decisions based on the inputs it receives, which can influence physical or virtual environments. This definition is technologically neutral and broadly framed – it covers both classical algorithmic systems as well as modern machine learning models. The decisive factor is not the method used but rather the system's ability to perform certain functions based on inputs, functions that typically mimic human decision-making or problem-solving. This makes it clear that even systems with only limited complexity or decision-making capacity may fall under the definition – which requires companies to carefully assess whether their deployed digital solutions qualify as AI systems within the meaning of the AI Act. A central point of reference in this regard is provided by the guidelines published by the European Commission in February 2025 (European Commission 2025b), which explain in detail which systems are covered by the AI Act, as well as by the legal literature published to date (Wendt and Wendt 2025, § 2, paras. 8–19; Kirschke-Biller and Füllsack 2025, paras. 7 et seq.; Wendehorst 2024a, paras. 3 et seq.; Hilgendorf and Härtlein 2025, para. 3).

2.2.2 Territorial scope

The scope of application of the AI Act is broad and initially covers all AI systems that are placed on the market, put into service, or used within the EU, regardless of whether the responsible actors are established inside or outside the EU. The only decisive factor is whether an AI system is offered on the European market or used within the EU. In this respect, the AI Act follows the so-called country-of-destination principle, which is already familiar from the GDPR (General Data Protection Regulation). Through this broad

scope, the Regulation seeks to ensure that its protective effect remains effective in a global market, since companies worldwide must comply with uniform minimum standards if they wish to deploy and distribute their AI systems in the EU.

2.2.3 Personal scope

The AI Act distinguishes between different actors along the lifecycle of an AI system, each of whom is assigned specific obligations. **Providers** (Article 3(3) AI Act) are those who develop an AI system or place it on the market under their own name. They bear the main responsibility for conformity, risk assessment, and technical documentation. **Deployers** (Article 3(4) AI Act) are natural or legal persons who use an AI system in a professional context – for example, companies that integrate an acquired system into their processes. **Importers** (Article 3(6) AI Act) place an AI system from a third country on the EU market, while **distributors** (Article 3(7) AI Act) resell or distribute AI systems without having been involved in their development. In addition, **authorized representatives** (Article 3(5) AI Act) act on behalf of providers established outside the EU in dealings with supervisory authorities. The distinction between roles is important because the applicable legal obligations – for example, regarding cooperation with authorities, monitoring, or documentation – differ significantly. The obligation of Art. 4 AI Act only applies to providers and deployers of AI systems. In practice, an organization may also assume several roles simultaneously, which requires a careful analysis of responsibilities.

2.3 AI literacy under Article 4 AI Act

2.3.1 Objective of Article 4 AI Act

With Article 4 AI Act, the EU legislator pursues the objective of ensuring solid AI literacy along the entire AI value chain. All actors involved – in particular providers and deployers, but also end-users subordinate to them – are to be enabled to make well-informed decisions in dealing with AI systems. This is intended not only to improve the implementation and enforcement of legal requirements but also to protect health, safety, and fundamental rights. In addition, the promotion of AI literacy aims to contribute to the improvement of working conditions and to pave the way for innovation-friendly and trustworthy AI development in Europe (cf. Recital 20 AI Act). The measure is thus a central element of the European strategy to strengthen the responsible and human-centered use of AI.

2.3.2 Addressees

Article 4 AI Act addresses providers and deployers of AI systems. They must ensure AI literacy among certain groups of persons, namely ‘staff’ and ‘other persons dealing with the operation and use of AI systems on their behalf’.

The term ‘staff’ is not defined under European law; however, there are strong reasons to interpret it as covering all employees as well as freelancers and, for example, interns of the provider and the deployer (Wendt 2025, para. 13; Rappenglück and Vonthien 2025, p. 399).

With respect to the ‘other persons dealing with the operation and use of AI systems on their behalf’, a contractual obligation is required, in most cases service contracts – for example, in the context of outsourcing functions (Wendt 2025, para. 15; Rappenglück and Vonthien 2025, p. 399; European Commission 2025a, p. 2; Möller-Klapperich 2025, p. 194). The concept of operation and use is to be understood as requiring an independent use of the AI system (Wendt 2025, para. 16); there must be a ‘relationship of proximity’ (Fleck 2024, p. 102). However, the responsibility of providers and deployers may also extend to third parties, insofar as they act in their interest (Rappenglück and Vonthien 2025, p. 399; Möller-Klapperich 2025, p. 195).

2.3.3 Definition „AI literacy“

The term ‘AI literacy’ is defined in Article 3(56) AI Act as ‘the skills, knowledge and understanding that allow providers, deployers and affected persons, taking into account their respective rights and obligations in the context of this Regulation, to make an informed deployment of AI systems, as well as to gain awareness about the opportunities and risks of AI and possible harm it can cause’.

This definition contains three core elements, namely (1) knowledge, (2) skills, and (3) understanding (Fleck 2024, p. 100; Wendt and Wendt 2025, § 4, para. 3). Knowledge primarily refers to general and subject-specific expertise, while skills denote the ability to act and the practical application of that knowledge. Understanding, in turn, refers to the ability to correctly interpret the available information in specific situations and to properly assess and weigh the consequences. Thus, the three core elements build on one another: without knowledge there can be no skills, and without skills no understanding

(Wendt 2025, para. 17).

This definition deliberately refrains from prescribing a uniform or rigid level of literacy applicable to all actors alike. Instead, Article 4 refers to a 'sufficient level' of AI literacy – thereby allowing the requirements to be shaped in an individual and practice-oriented manner. What qualifies as a sufficient level of AI literacy thus largely depends on the specific system, its context of use, and the respective user groups (Wendt 2025, para. 18; Wendt and Wendt 2025, § 4, para. 5; Möller-Klapperich 2025, p. 195; Fernandes et al. 2024, p. 198). Companies are therefore required to assess and build the necessary literacy in a differentiated and needs-based way, rather than relying on a generic one-size-fits-all solution. Useful guidance in this regard is provided by the FAQs on Art. 4 AI Act published by the European Commission (European Commission 2025a), the Living Repository of AI Literacy Practices initiated by the European Artificial Intelligence Office (2025), as well as the guidance paper issued by the German Bundesnetzagentur (*Federal Network Agency*) (Bundesnetzagentur 2025).

2.3.4 General AI literacy

Despite the deliberately flexible approach of the AI Act, it remains clear that a certain minimum level of skills, knowledge, and understanding in dealing with artificial intelligence is indispensable (Wendt 2025, para. 19; Wendt and Wendt 2025, § 4, para. 6; Fleck 2024, p. 101; Cipierre, p. 262). These fundamental requirements may also be referred to as 'general AI literacy' (Wendt 2025, paras. 19–20; Wendt and Wendt 2025, § 4, para. 6). The point is not to be able to technically trace every step, but rather to understand basic mechanisms and to be aware of risks, including regulatory ones (Wendt 2025, para. 25). In particular, the risk of placing too much trust in the results of AI should be prevented or counteracted (Möller-Klapperich 2025, p. 195). This general AI literacy includes basic knowledge in several areas (Wendt 2025, para. 21; Cipierre, p. 262):

1. Identification, classification, and correct application of AI systems
    - Understanding of the legal definition of an AI system in Art. 3(1) AI Act (see section 2.2.1**Fehler! Verweisquelle konnte nicht gefunden werden.**);

- The ability to identify an AI system within the meaning of the AI Act;
- Basic knowledge of such AI systems and models;
- Basic understanding of the role and significance of data as the foundation of AI systems;
- Basis understanding of AI interfaces and user front-ends;
- Basic knowledge of the organizational environment in which AI is deployed, in particular its technical and operational integration as well as the regulatory framework applicable to AI systems;
- Ability to interact effectively with the deployed AI system (e.g. providing inputs and interpreting outputs);
- Ability to use AI as a targeted tool in everyday professional practice.

2. Overview of the position and function of the organization along the AI value chain
   - Knowledge of the different roles and requirements under the AI Act, in particular:
     - Role and obligations of providers of (high-risk) AI systems (Art. 3(3), Art. 16 AI Act);
     - Role and obligations of deployers of (high-risk) AI systems (Art. 3(4), Art. 26 AI Act);
   - Ability to correctly situate one's own activities within the context of the various sets of obligations.
3. Understanding the opportunities, risks, and potential harms associated with the use of AI systems
   - Knowledge of the different risk classes under the AI Act and the related compliance obligations, in particular the distinction between high-risk AI systems and regular AI systems;
   - Sufficient knowledge of the tasks and activities for which human oversight is required for deployers under Article 14(4) AI Act.

2.3.5 Specific AI literacy

Beyond general AI literacy, specific AI literacy may be required depending on the type of AI system deployed or provided, as well as its intended purpose. This involves more advanced expertise, enhanced skills, and a deeper understanding of the application and compliance with the requirements of the AI Act (Wendt 2025, para. 26; Wendt and Wendt 2025, § 4, para. 7). Accordingly, the literacy requirements differ significantly depending on the field of application:

An AI system used in the legal sector entails different requirements in terms of expertise, risk assessment, and regulatory implementation than an AI system used in the financial sector, such as in banking or insurance. The degree of necessary understanding also largely depends on the complexity of the system and its specific purpose. The more complex and risk-prone a system is, the higher the requirements typically are for the specialized personnel involved – for example, regarding data literacy, model interpretation, or legal evaluation (Wendt 2025, para. 26; Schippel 2025, p. 123).

2.3.6 Measures

The flexible system for ensuring AI literacy enshrined in Article 4 AI Act can be implemented in different ways. The AI Act does not prescribe which specific measures are required; instead, this depends on the individual case and should be guided by the actual needs within the company (Bundesnetzagentur 2025, p. 1). When determining appropriate measures for the development of AI literacy, both objective factors – in particular the AI system provided or deployed, its risk class and intended purpose, and the group(s) of persons for whom the AI system is intended – as well as subjective aspects should be considered. According to the wording of Article 4 AI Act, the latter include the technical knowledge, experience, education, and training of the persons involved with the AI systems, which should be identified and documented (Wendt 2025, paras. 30 et seq.).

Even though the AI Act does not explicitly state this, the most sensible measure to achieve AI literacy is the implementation of training programs (Wendt 2025, para. 36; Wendt and Wendt 2025, § 4, paras. 9 et seq.; Fleck 2024, p. 102). These can be conducted either internally or externally (Wendt 2025, para. 43; Wendt and Wendt 2025, § 4, para. 11; Fleck 2024, p. 103; Rappenglück and Vonthien 2025, p. 402; Bundesnetzagentur

2025, p. 1), and they should also convey sufficient technical knowledge of AI systems (Wendt 2025, p. 103; Wendehorst 2024b, para. 22).

In addition to conducting suitable training programs, organizations may also consider introducing the role of an AI officer and/or establishing working groups or task forces, such as an AI Center of Excellence. While the introduction of such a role is not mandatory – unlike other functions such as a data protection officer or an anti-money laundering officer (Bundesnetzagentur 2025, p. 2) – it can, however, be strongly recommended for practical reasons once an organization reaches a certain size (Rappenglück and Vonthien 2025, p. 404). Furthermore, the development of internal policies and work instructions can also contribute to fostering AI literacy (Wendt 2025, para. 48; Wendehorst 2024b, para. 43; Rappenglück and Vonthien 2025, p. 404).

2.3.7 'To their best extent'

Providers and deployers of AI systems are obliged to take measures to ensure a sufficient level of AI literacy – and to do so 'to their best extent'. This wording is rather unusual in EU law and leaves room for interpretation (Wendt und Wendt, § 4 Rn. 5; Rappenglück and Vonthien 2025, p. 400; Möller-Klapperich 2025, p. 195). The AI Act itself does not specify which standard should be applied; however, the Commission's FAQs indicate that Article 4 AI Act establishes a specific 'obligation to take measures' (European Commission 2025a). At the same time, the formulation 'to their best extent' introduces a noticeable relativization of the obligation. Providers and deployers of AI systems are therefore not required to take every conceivable step to ensure a sufficient level of AI literacy (Möller-Klapperich 2025, p. 197). Rather, this formulation implies a criterion of reasonableness that considers the individual circumstances. Companies are thus only required to take those steps that are reasonable and feasible considering their size, human and financial resources, type of operation, and specific circumstances (Wendt 2025, para. 49; Fleck 2024, p. 101; Möller-Klapperich 2025, p. 197).

Accordingly, a structured needs assessment is first required if providers and deployers are to ensure AI literacy among the actors involved in the most targeted manner possible. This assessment should consider both objective and subjective factors – as set out in Article 4 AI Act. The analysis may be carried out internally within the company or outsourced

to qualified third parties (Wendt 2025, para. 50). It should be documented, including its results, and repeated both on a regular basis and on an ad hoc basis where appropriate (Wendt 2025, para. 52; Bundesnetzagentur 2025, p. 4).

2.3.8 Sanctions

A violation of the requirements set out in Article 4 AI Act – in particular with regard to insufficient measures to promote AI literacy – may entail legal consequences. Pursuant to Article 99(1), first sentence, AI Act, the EU Member States must adopt provisions for effective, proportionate, and dissuasive sanctions. In addition, non-compliance with Art. 4 AI Act may also be relevant under liability law (Wendt 2025, para. 6; Wendehorst 2024b, para. 6; Rappenglück and Vonthien 2025, p. 401; Möller-Klapperich 2025, p. 195; Bundesnetzagentur 2025, p. 2), for example if damage could have been prevented through adequate training measures. Companies and organizations are therefore well advised to systematically implement and document appropriate training and qualification measures to minimize legal risks and to ensure the responsible use of AI (Bundesnetzagentur 2025, p. 2).

3

Implementation prospects from practice

3 Implementation prospects from practice

3.1 Definition and dimensions of AI literacy

The analysis of Article 4 AI Act makes it clear that EU legislators are not limiting themselves to establishing technical standards and organizational frameworks but are making the acquisition of individual skills a binding legal requirement for all groups of actors involved in the development, deployment and use of AI systems.

However, the practical implementation of these normative requirements remains the responsibility of the organizations committed. This requires a methodologically sound translation of regulatory requirements into operable structures, processes and measures that take account of the institutional realities of operational practice. Against this background, this chapter addresses the tension between legal requirements and organizational implementation prospects from the perspective of information systems.

As a scientific discipline with a pronounced socio-technical focus, information systems offers a suitable interface for translating regulatory requirements into practice-oriented competence models, differentiated role profiles and structured procedures for needs assessment and skill development. The aim is to specify the content of the mandate contained in Art. 4 of the AI Act to ensure sufficient AI literacy, to operationalize it methodically and to systematically prepare it for business application. Small and medium-sized enterprises in particular are faced with the task of translating the rather abstract requirements into concrete learning objectives, role profiles and testing processes – and doing so under typical constraints of scarce resources and limited expertise.

In German-language discourse, the term ‘KI-Kompetenz’ has become established as the translation of the term ‘AI literacy’ used in the AI Act. However, this term often refers primarily to application-related skills in dealing with AI systems, whereas the English term also encompasses critical-reflective and ethical dimensions of dealing with artificial intelligence (Gimpel 2024). Based on the definition of AI literacy enshrined in the AI Act as the interplay of knowledge, ability and understanding (see section 2.3.3), we take up this concept of literacy from an information systems perspective and expand it to include three central design principles.

These should take into account the particular complexity and dynamics of organizational practice in dealing with AI systems. The focus is not only on cognitive or technical requirements, but also on practical, normative and organizational dimensions. The following three core ideas illustrate this expanded approach to competence and form the conceptual basis for the following explanations:

1. Socio-technical perspective – technical know-how alone is not enough: human, organizational and regulatory aspects are equally important.
2. Action-oriented approach – competence is demonstrated through practical implementation, not just a certificate.
3. Continuous learning – due to rapid progress, AI literacy is not a static goal, but an ongoing development process.

In order to systematize and operationalize the requirements formulated in the ordinance text, some of which are abstract and unspecific, a conceptual frame of reference is used to integrate two dimensions of information systems (Gimpel 2024; Pinski and Benlian 2023). The aim is to enable the practical implementation of the regulatory requirements and to facilitate the structured derivation of concrete action steps in an organizational context.

The **micro-dimension** encompasses the individual perspective according to Pinski and Benlian (2024):

1. Knowledge: Self-perception of the AI process steps (input, processing, output) as well as the specific opportunities and risks in each step.
2. Ability: Self-interpretation of the roles of humans and AI, including responsibility, control mechanisms and decision-making limits.
3. Understanding: Practical comprehension (‘ability’) in dealing with AI tools that generate implicit knowledge.

The **macro dimension**, on the other hand, contains organizational perspectives according to Gimpel (2024):

1. Fundamentals in information systems
2. AI technology literacy
3. AI application literacy
4. AI development & operations literacy
5. AI management literacy
6. AI reflection literacy

The micro and macro dimension are considered in an integrated manner and are interlinked: only when employees contribute their knowledge, ability and understanding (micro) to clearly defined roles, governance structures and business processes (macro) does organization-wide AI literacy emerge. Conversely, strategic AI programs remain ineffective without personally anchored competences.

A two-stage approach is therefore recommended:

1. Bottom-up analysis of the individual skills of all employees (skills inventory, self-assessments, observation of real work processes)
2. Top-down comparison with the six macro dimensions to identify gaps in strategy, governance or infrastructure (needs assessment, role profiling, assignment of measures)

This integrated approach forms the basis for the subsequent chapters of the whitepaper, which provides a uniform vocabulary, facilitates the prioritization of training measures and provides test criteria for the measures required by the AI Act to ensure AI literacy 'to their best extent'. First, the micro- and macro-dimensions of AI literacy are classified.

3.2 Micro dimension: Classification of individual AI literacy

While the AI Act primarily addresses organizational processes and technical requirements, Art. 4 AI Act explicitly focuses on people as a key success factor. These individual micro-dimensions are also referred to as 'general AI literacy' and comprise three closely

interlinked sub-skills: knowledge, ability and understanding. Together, these describe how individuals can understand, question and use an AI system responsibly. These three micro-dimensions are explained in more detail below.

The combination of these terms gives rise to the ‘holistic empowerment’ that the AI Act requires of stakeholders: a competence profile that combines technical insight, a sense of responsibility and practical experience. By systematically recording and developing these three micro-dimensions, companies lay the foundation for the responsible, efficient and legally compliant use of AI.

3.2.1 Process knowledge

Process knowledge refers to an understanding of the key functional steps of an AI system: data input, algorithmic processing and result output. Those with a strong understanding of processes recognize which data sources a model requires, where distortions can arise and how data quality affects the result. Equally important is the know-how of how a model is trained, validated and monitored: Which algorithms are suitable? Which performance metrics are useful, and how are they correctly interpreted? Finally, process knowledge also includes the ability to critically read results – i.e., to correctly classify probabilities, explanations or visualizations and to recognize the limits of their significance. For small and medium-sized enterprises, this knowledge is a prerequisite for fulfilling the documentation and reporting requirements of the AI Act on the one hand, and for identifying malfunctions or compliance risks at an early stage on the other. In short, process knowledge turns employees into informed sparring partners for data scientists and credible intermediaries towards management, customers and supervisory authorities.

3.2.2 Abilities

The abilities of actors focus on the interaction and distribution of roles between humans and AI systems. The focus is on key questions regarding the functional division of tasks: Which decisions can be made automatically, and which must remain the responsibility of humans? Actor knowledge also includes an understanding of the control and escala-

tion mechanisms required to identify, prevent and appropriately address incorrect decisions. And who ultimately bears responsibility if something does goes wrong? A distinction is made between understanding the technical characteristics of AI and awareness of human roles, rights and obligations (Pinski et al. 2024a). On the technical side, it is important to be able to assess typical weaknesses such as bias, lack of explainability or overfitting. On the human side, the question is whether humans act ‘in’, “on” or ‘out of the loop’; in other words, whether they make decisions themselves or whether this is done independently by AI, and how this choice of role affects liability, governance and ethics. For SMEs, clearly defined stakeholder knowledge is essential because it forms the basis for assigning responsibilities transparently, training employees in a targeted manner and managing expectations towards stakeholders realistically. At the same time, it promotes a culture in which technological opportunities and risks can be discussed openly.

3.2.3 Understanding and experience of interaction

Finally, understanding and experience of interaction describes the practical skills tested in dealing with specific AI tools and applications. This refers to skills that are often difficult to teach in seminars and can only be acquired through repeated practice. This includes formulating a prompt for an AI system in such a way that the desired results are achieved or recognizing when a model needs to be retrained. Interaction experience is essentially implicit knowledge: it is acquired ‘on the job’, cannot be fully captured in checklists, and only becomes apparent in practical situations (Pinski et al. 2024a). The more positive, but also critical, use cases employees experience themselves, the more likely they are to develop a reliable sense of a system's strengths and weaknesses. This experience is particularly relevant in SMEs, which rarely have large specialist departments: it shortens training times, reduces operating errors and creates the basis for rapid, evidence-based improvements, for example by learning directly from usage and error logs and adapting processes.

3.3 Macro dimension: Classification of organizational AI literacy

From an information systems perspective, AI literacy is not only to be found at the indi-

vidual level but should also be understood as a multidimensional organizational capability that integrates technical, application-related, organizational and ethical-reflexive components (Gimpel 2024). The following system in Figure 1 differentiates six central areas of AI literacy that together form the foundation for the responsible and effective use of AI systems in organizations: (1) Basic literacy in business informatics (2) AI technology literacy, (3) AI application literacy, (4) AI development & operations literacy, (5) AI management literacy, (6) AI reflection literacy.

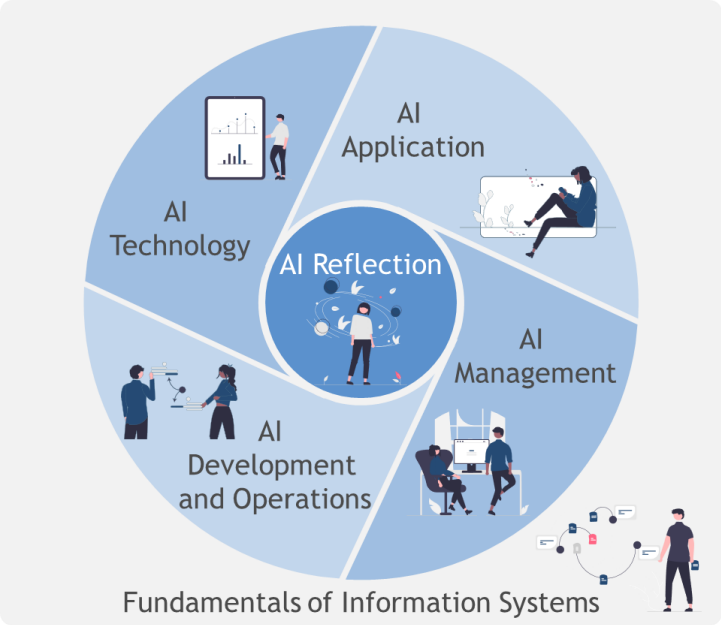


Figure 1: Overview of organizational AI literacies according to Gimpel et al. (2024)

3.3.1 Fundamentals in information systems

The fundamentals in information systems describes the ability to understand and design digital technologies – in this case AI systems – in their economic, organizational and information technology contexts. This forms the foundation for an all-round perspective on the use of AI systems in operational and public contexts and ensures connectivity between expertise application knowledge, technical implementation and strategic control.

Essentially, this competence means understanding information systems as an interplay between technology, people and organizations. It includes a fundamental knowledge of how IT infrastructures, software and deployment processes are interconnected. People

with basic information systems literacy can analyze digital processes, support collaboration between departments of expertise and IT, and link technological development specifically to the company's goals.

This competence is crucial for working with AI, as AI systems do not operate in isolation but are embedded in complex information systems and business processes. A fundamental understanding of business process modelling, data management, system integration and IT architecture is required to implement AI technologies effectively and sustainably. Equally relevant is knowledge of system development, project management and IT governance methods, which are crucial for the introduction and support of AI-based solutions. Basic information systems literacy also forms a bridge to business and management-related issues of digital transformation.

This makes it possible to evaluate technological innovations from the perspective of efficiency, cost-effectiveness and strategic benefits and to embed them in corporate decision-making processes. In relation to AI, this means identifying suitable areas of application, further developing business models and designing digital services in a customer- and process-oriented manner.

The importance of this cross-cutting competence is increasingly being emphasized in academic discussions. Gimpel et al. (2024) identifies it as a separate area of competence within a comprehensive competence model for dealing with AI. They emphasize that basic information systems literacy not only promotes technical understanding, but also strengthens the ability to mediate between expertise, technology and organization, thereby driving forward integrated digitalization.

This competence is also relevant from the perspective of the AI Act. The requirements of Article 4 of the AI Act to ensure sufficient AI literacy relate not only to expertise knowledge, but also to an understanding of the organizational embedding of AI systems. Individuals who are able to recognize and shape systemic relationships make a significant contribution to the implementation of legally compliant, effective and sustainable AI applications.

In summary, it can be said that the fundamental competence of information systems is

an integrative, system-oriented and cross-application skill. It creates the conceptual basis for AI to be understood not as an isolated technology project, but as part of a comprehensive digital transformation, and to be implemented responsibly.

3.3.2 AI technology literacy

Technological competence in the field of AI forms the knowledge-based foundation of any qualified examination of AI systems. AI technology literacy refers to the ability to understand, classify and transfer the conceptual, methodological and technical fundamentals as well as the systemic functioning of machine learning processes and knowledge-based AI approaches to specific areas of application. This dimension of competence is essential in that it creates the conditions for individuals and organizations to understand the structure, logic and performance of AI systems and to make informed decisions about their development, use and control.

A central component of this competence is an understanding of the key paradigms of machine learning. This includes the distinction between supervised, unsupervised and reinforcement learning methods, knowledge of typical model architecture such as decision trees, support vector machines, neural networks or transformer-based language models, as well as fundamental principles of algorithmic optimization and model validation.

This knowledge does not necessarily have to be at a formal mathematical level, but should cover the principles, application potential and limitations of the respective methods. Another key aspect concerns data-related requirements and challenges. Technological competence enables the assessment of requirements for data quality, data representation, pre-processing and model training. This includes an understanding of typical pitfalls such as overfitting, bias in training data, insufficient generalizability and suitable evaluation metrics. These abilities are essential for critically assessing the validity and significance of the outputs generated by AI systems. Knowledge of technical opacity, non-deterministic nature and context-dependent adaptability of AI systems is also becoming increasingly important. Such systems do not behave in a static, functional manner, but act probabilistically and dynamically. The ability to deal with knowledge-related uncertainty and potential model errors (e.g. hallucinations of generative models) is therefore an integral part of AI technology literacy.

In addition to this, AI technology literacy is part of a detailed understanding of AI literacy in a socio-technical sense (Pinski and Benlian 2023). This is defined as 'technical literacy' – one of six dimensions of competence that include both declarative knowledge and application-oriented experiential knowledge. This dimension is not limited to technical roles, but also forms the cognitive basis for interaction, control and decision-making skills in dealing with AI for experts and management personnel. Furthermore, AI technology literacy is significant from an organizational law perspective: it is a professional indicator of whether providers and deployers of AI systems are fulfilling their obligation to ensure sufficient qualification within the meaning of Art. 4 AI Act. Only those who understand the basic technological features of a system can assess its risks and avoid liability-relevant misuse.

From a strategic perspective, AI technology literacy is not just an individual qualification, but an organizational resource. In modern organizations, it contributes to the innovation-oriented management of AI initiatives, especially where technological potential needs to be identified, evaluated and integrated into business models. Managers with the appropriate basic competence can make informed decisions about investments, system selection and resource allocation – a prerequisite for strategic action in the context of disruptive AI transformation.

In summary, AI technology literacy is a differentiated, dynamic and interdisciplinary ability that goes far beyond mere methodological knowledge. It is a prerequisite for critical judgement, regulatory maturity and strategic capacity to act in the age of algorithmic systems and thus forms the indispensable foundation for all other dimensions of AI-related literacies.

3.3.3 AI application literacy

Application literacy in the context of AI describes the ability to use AI systems appropriately, purposefully and responsibly in specific professional situations. This competence relates to understanding how AI applications work, the conditions under which they can be used and their effects and enables individuals to integrate these systems effectively into their work processes. AI Application literacy thus represents a central bridge be-

tween technological innovation and practical value creation in the everyday life of organizations. Without this competence, technological innovations remain at the conceptual level – their potential cannot be tapped and thus no sustainable value creation can be realized.

At the heart of this competence lies the asset to interpret and classify the results of AI systems and translate them into operational decision-making processes. This requires a fundamental understanding of the underlying model logic, such as how probabilities are calculated, how decision proposals are generated and what uncertainties need to be considered. At the same time, users must be able to recognize potential risks and limitations of the systems – such as incorrect classifications, biased recommendations or incomprehensible results. Prompt engineering – the ability to effectively control AI systems through targeted inputs (prompts) – also plays a special role in this context. Depending on the wording, level of detail and contextual relevance of a prompt, the outputs of an AI system can vary considerably. AI Application literacy therefore also includes knowledge of suitable prompt techniques and the ability to design inputs in such a way that they lead to reliable, relevant and comprehensible results. Prompt engineering thus forms a central interface between technical system logic and human competence in the practical use of AI.

AI application literacy includes not only cognitive abilities, but also practical skills. This refers to the ability to meaningfully embed AI systems into one's own work context – e.g. in customer service, personnel recruitment, medical diagnostics or public administration. This also includes knowledge of the requirements for human control and correction options and how these can be implemented in practice. Competence therefore also encompasses the confident handling of so-called ‘hybrid decisions’, in which humans and AI jointly arrive at a result. An essential element of AI application literacy is awareness of responsibility when dealing with algorithmic support. Users must be aware that decisions based on AI recommendations must ultimately be supported and accounted for by humans. The ability to critically reflect on recommendations, question automated suggestions and document deviations is therefore a fundamental part of this competence.

In research, this competence is captured as a separate dimension in models of AI literacy. AI Application literacy is therefore directly related to both the acceptance and effectiveness of AI systems. It depends not only on training and prior experience, but also on the organizational context – for example, the culture of error management, the availability of support structures, and the transparency of the systems used.

In summary, it can be said that AI application literacy represents an action-oriented, practical approach to the use of AI. It enables employees not only to work with algorithmic systems, but also to actively and responsibly integrate them into their professional routines – an essential prerequisite for the successful digital transformation of the economy and administration.

3.3.4 AI development & operations literacy

This competence in developing and operating AI systems encompasses the ability to design, implement and manage them responsibly throughout their entire life cycle, from a conceptual, technical and organizational perspective. This encompasses both methodological and practical knowledge and skills required to develop AI systems in a targeted manner, maintain them on a long-term basis and integrate them into existing socio-technical infrastructures. This competence is central to the safe, robust and economically viable application of AI technologies in professional contexts (Gimpel 2024).

In the development process, this competence initially refers to the structured implementation of AI projects – from problem formulation to data preparation, model selection and training, to validation and optimization. This requires individuals to be able to select suitable models and systematically adapt them to specific application problems. This includes both algorithmic and technical expertise as well as project-related skills in using frameworks and tools such as TensorFlow, PyTorch, Scikit-learn and MLflow. In addition, this skill encompasses the ability to transfer AI systems to productive environments. This includes aspects of deployment (e.g. API design, edge computing, containerization), monitoring (e.g. performance tracking, concept drift detection) and continuous model maintenance (e.g. re-training, hyperparameter tuning).

It is crucial to understand that AI systems are not one-off products, but dynamic components that require maintenance in a changing technological and organizational context. Particularly relevant in this context is the ability to create the technical, organizational and regulatory framework conditions for the long-term and compliant operation of AI systems. This includes issues of IT security, data availability and sovereignty, documentation requirements and compliance with relevant norms and standards.

Current research considers the ability to develop and operate AI to be a separate area of expertise. Gimpel (2024) describes this as an interface between technology, management and application expertise, combining a deep understanding of AI-specific development logic with practical implementation skills. This makes it important not only for developers, but also for those roles responsible for quality assurance, lifecycle management or regulatory compliance. Last but not least, this competence is relevant from a strategic perspective. Organizations that want to use AI technologies in a sustainable and scalable manner need reliable processes for development, operation and maintenance. Individuals with the appropriate expertise make a key contribution to ensuring technical performance, reducing operational risks and establishing robust innovation processes. In doing so, they create the prerequisites for organizational learning ability and continuous improvement in the use of AI.

In summary, it can be said that the competence to develop and operate AI is a practice-oriented, process-oriented and compliance-relevant skill. It enables organizations not only to implement AI systems technically, but also to operate them in a stable, responsible and strategically effective manner over the long term.

3.3.5 AI management literacy

Management competence in the context of AI describes the ability to shape the strategic, organizational and economic framework for the introduction, use and further development of AI systems. This competence enables managers, project managers and strategic decision-makers to recognize the potential and risks of AI use, assess them appropriately and translate them into sustainable control structures. As an interface between technology, organization and regulation, this competence is of central importance for the strategic capacity of organizations to act in the digital transformation.

A key component of AI management literacy is the ability to strategically evaluate AI initiatives. Managers must be able to identify specific areas of application, weigh the expected benefits against the costs and risks, and select suitable projects. This also includes understanding the prerequisites for successful AI implementations, for example regarding data availability, IT infrastructure, staff qualifications and regulatory framework. This competence encompasses both analytical and creative skills – in other words, the ability to observe technological developments with foresight and actively shape them. In addition, AI management literacy includes the ability to establish suitable organizational structures, responsibilities and processes.

This includes, for example, setting up interdisciplinary teams, implementing agile project management, defining governance guidelines for AI systems, and integrating AI-specific risks into operational risk management. In larger organizations in particular, the ability to coordinate different interest groups and mediate between technical expertise and business objectives is of central importance. Another aspect concerns the ability to control regulatory and ethical requirements. Managers must ensure that AI systems not only function technically, but are also used in a legally compliant, non-discriminatory and socially acceptable manner. This includes responsibility for training measures as well as the establishment of processes for ethical review, transparency and traceability of algorithmic decisions.

From a research perspective, AI management literacy is identified as a critical success factor for the value-adding and responsible introduction of AI (Pinski and Benlian 2023). Studies show that the ability of top management teams to understand technological developments and classify them strategically is a decisive factor in determining whether AI initiatives will have a long-term impact. It is also emphasized that management competence is not limited to individual leaders but is increasingly team-based and context-dependent (Pinski et al. 2024a; Pinski et al. 2024b).

In summary, AI management legacy describes the ability not only to use AI operationally, but also to integrate it strategically and sustainably into value creation and control. It forms the basis for organization-wide design capability in dealing with AI and is therefore indispensable for a sustainable and legally compliant digital transformation.

3.3.6 AI reflection literacy

Reflective competence in the context of AI describes the ability to recognize and critically analyze the social, legal and ethical implications of using AI systems and to incorporate them into business decisions. This competence forms the normative foundation for the responsible use of AI and is particularly important in areas of application where automated systems play a role in decisions concerning personal data, access opportunities or security-related aspects. As a cross-cutting competence, it complements the technological, application-oriented and management-oriented perspective with a conscious examination of the fundamental values, risks and side effects of algorithmic systems.

The central components of AI reflection literacy are, first and foremost, an understanding of the typical risk dimensions associated with AI use. These include issues of discrimination through algorithmic bias, loss of human control, transparency of decision-making processes, and potential incapacitation through automated systems. People with a high level of reflective competence are able to identify and address such risks and initiate appropriate measures to minimize them – for example, through technical design, organizational frameworks or conscious limitation of AI use. Furthermore, this competence includes the ability to distinguish between technological possibilities and social acceptability. Reflective competence means not automatically evaluating everything that is technically feasible as desirable, but rather systematically reflecting on potential conflicts of interest – for example, between efficiency and fairness, automation and autonomy, innovation and sustainability. This requires a willingness to view AI systems not only in functional terms, but also to question them from the perspectives of power relations, social justice and democratic control.

In science, reflective competence is increasingly understood as a central element of comprehensive AI literacy. Pinski and Benlian (2023) understand this with the term ‘critical literacy,’ which describes the ability to critically evaluate the effects of AI systems in a social context. It is becoming apparent that this competence not only strengthens individual judgement, but is also a prerequisite for value-driven, participatory AI design in organizations.

From an organizational perspective, reflective competence helps to promote a critical

and responsible culture of use in dealing with AI. It strengthens the ability to address normative questions in interdisciplinary teams, to develop guidelines for the ethical use of AI, and to communicate with internal and external stakeholders. Finally, it is a central element of trust-building governance structures, for example in the context of ethics boards, compliance processes, or participatory decision-making procedures.

In summary, AI reflection literacy is a normative, interdisciplinary and context-related skill. It enables organizations and individuals to combine technological innovation processes with social responsibility, thereby facilitating the use of AI in a way that is not only efficient but also legitimate, fair and sustainable.

3.4 AI literacy assessment methodology for needs analysis

The effective implementation of the obligation to ensure sufficient AI literacy, as stipulated in Article 4 of the AI Act, requires a differentiated analysis of existing AI literacies. From a company perspective, a methodologically sound analysis that considers both individual and organizational competence dimensions is recommended for assessing needs. Depending on company size, technological maturity and domain-specific application context, the status quo of existing skills can vary considerably – and with it the specific need for training, development and control measures.

Against this background, this subchapter addresses the question of how companies can systematically record the knowledge, understanding and practical skills their employees currently have in dealing with AI systems and to what extent these competencies are appropriate in relation to the technologies used, the respective task profiles and the regulatory requirements.

The key questions addressed in the following discussion are therefore:

- What individual AI literacies are necessary in the company and to what extent are these already present in the workforce?
- How do role profiles differ in terms of their skill requirements and how can these requirements be identified and grouped?
- What recommendations for action can SMEs follow to permanently meet the requirements of Art. 4 AI Act?

To answer these questions, a combined approach is proposed that combines two perspectives: a bottom-up analysis to identify the individual skills of individual employees and a top-down analysis to derive organizational competence requirements. Both analysis paths are divided into three phases and, when combined, provide the methodological basis for a systematic, evidence-based needs analysis that meets the requirements of Art. 4 AI Act.

3.4.1 Bottom-up analysis of individual abilities

The bottom-up analysis and its individual phases, which are shown in Figure 2, aim to systematically record and classify existing individual AI literacy within the company and evaluate them in terms of organization-specific requirements. The focus here is on the perspective of individual employees, whose cognitive, procedural and reflexive skills in dealing with AI systems are understood as the basis for organizational learning and transformation processes. The analysis is carried out in a three-stage process that integrates both subjective self-assessments and objectifiable observations of real work processes.

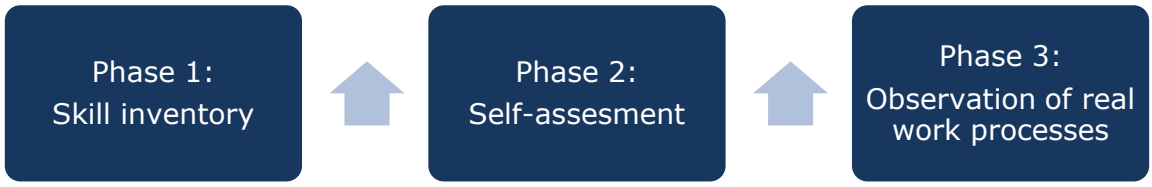


Figure 2: Bottom-up analysis of individual abilities

(1) Skills inventory: The first step is to conduct a structured survey of existing skills by a skills inventory. The aim is to gain an overview of the knowledge, abilities and skills already available within the company in relation to AI-related tasks. This inventory can draw on existing competence models and is ideally supported by standardized assessment tools, such as competence matrices or digital skill profiles. The assessment serves to initially locate individual competence levels along the micro-dimensions described in section 3.2.

(2) Self-assessment: In addition to the inventory, a systematic self-assessment is carried out by the employees. Using digital tools or standardized questionnaires, subjective assessments of knowledge, confidence in action and reflective ability can be queried and evaluated. This form of assessment not only encourages individuals to examine their own competence profile but also provides organization-wide comparable data for interpersonal differentiation. To avoid distortions, it is advisable to combine this with realistic case studies or interactive application scenarios.

(3) Observation of real work processes: Finally, supplementary validation is carried out by observing real work processes. The aim is to reveal implicit skills – especially those that cannot be reliably assessed through self-assessment alone – in a specific context of use. This form of assessment requires methodological sensitivity and can be operationalized through shadowing, peer feedback or simulations. The results enable a holistic assessment of practical competence and provide indications of discrepant self-assessment or hidden competence potential.

The three-stage bottom-up analysis process thus contributes significantly to individual and collective positioning and forms the empirical basis for targeted development measures. It allows for evidence-based differentiation of training needs, addresses specific learning paths and supports precise positioning in advanced role profiles in line with the top-down analysis of organizational competence structures described below.

3.4.2 Top-down alignment of organizational competencies

In addition to the bottom-up perspective of individual skills, a top-down analysis as shown in Figure 3 is necessary to systematically identify and operationalize existing and future requirements for AI literacy at the organizational level. The aim is to examine the strategic, structural and functional framework conditions of an organization and, on this basis, to develop binding competence profiles and derive measures. The top-down analysis is divided into three consecutive phases: needs analysis, creation of role profiles and assignment of measures.

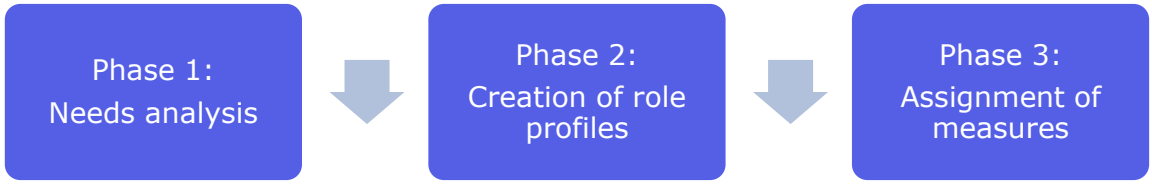


Figure 3: Top-down alignment of organizational competencies

(1) Needs analysis: The first step is to systematically assess the organization's specific competence requirements for working with AI systems. This analysis considers, among other things, the type and complexity of the technologies used, the degree of digitalization of business processes and the regulatory requirements of the AI Act. Relevant questions here are:

- In which areas are AI systems used?

- Which tasks are (partially) automated?

- Which control and management skills are required?

The needs analysis thus forms the conceptual starting point for determining functional target skills in the respective organizational context.

(2) Creation of role profiles: Based on the needs analysis, differentiated role profiles are developed in the second step, which map the relevant fields of activity, decision-making levels and responsibilities in the organization. These role profiles must be structured along the competence dimensions described in section 3.3 and evaluated in terms of their characteristics (low, medium, high). The use of simplified structuring instruments - for example in the form of a structuring grid (morphological box) - enables a systematic combination of functional features and creates the methodological basis for a precise assignment of competence requirements to organizational roles. In this way, not only existing, but also emerging or hybrid role formats can be modeled, for example in interdisciplinary AI teams or governance structures.

(3) Assignment of measures: Finally, concrete measures for competence development and their strategic anchoring in existing staff, IT or compliance structures are derived.

This includes prioritizing training formats, developing curricular building blocks, integrating them into existing training platforms, and defining eligibility criteria for recruitment and internal career development. In addition, the results can be used to fulfill documentary evidence in the context of AI compliance. The assignment of measures thus closes the loop between strategic needs, operationalized role profiles and a targeted qualification strategy.

In combination with the bottom-up analysis, an integrated competence model is created that can be used not only to take stock, but also to control organizational AI literacy development processes. This forms the basis for accessible educational strategies, sustainable personnel development and the implementation of the requirements of Art. 4 AI Act.

3.5 Domains for grouping competence measures

To operate the AI literacies presented in section 3 in your own corporate context, a morphological box can be used as a structuring and classification tool. The aim is to differentiate between different role profiles within organizations in terms of their functional characteristics, organizational embedding, and specific AI-related tasks, and to assign specific competence requirements to them.

The morphological box systematically combines independent feature dimensions that characterize a role profile in its entirety. This makes it possible to capture and compare the complexity of organizational requirements for AI literacy along structured categories and translate them into compatible development paths. On this basis, training needs, further education measures, or suitability criteria can be derived for each defined role. The individual parameters – such as functional role, decision-making level, or AI usage type – have been deliberately chosen so that they can be varied and combined independently of one another. In combination with the AI literacy dimensions, this allows both typical and new or hybrid role profiles to be generated that consider the different requirements for working with AI systems.

The box below uses the role of ‘innovation manager’ in the context of an industrial company as an example to show how the connection between organizational function and AI literacy can be operationalized. This methodological approach is suitable for developing

personas in training concepts, for strategic staff planning, and for designing and implementing organization-specific compliance measures to implement Article 4 of the AI Act.

Table 1: AI literacy with an example from the innovation department of a private medium-sized company

Parameter (feature)	Characteristics for the target role (example)
Functional role	Manager / Project Manager
Type of organization	Private sector (industrial companies, e.g. mechanical engineering)
Domain context	R&D / Digitalization / Business Development
AI usage type	Control and strategic selection of AI systems
Participation in decision-making	Strategic + budget responsibility
Fundamentals in information systems	High: Understanding of information systems, digital transformation and process integration
AI technology literacy	Low to medium: Ability to evaluate technological options and limitations
AI development and operations literacy	Low: Understanding of development processes and technical dependencies (e.g. data pipelines)
AI application literacy	Medium to high: Ability to integrate AI solutions into innovation projects
AI management literacy	High: Management of projects, teams and roadmaps, coordination with specialist departments
AI reflection literacy	High: Assessment of ethical, legal and societal implications of AI innovations

For the targeted derivation of training requirements from the developed role profiles, a systematic differentiation of the respective competence requirements is required. The competence dimensions shown in the morphological box can not only be described qualitatively but require a scalable classification in order to design didactically connectable measures. For this purpose, a three-level rating scale is used, which classifies the characteristics of the individual competences with levels low, medium and high, as shown in Table 2.

Table 2: Systematic differentiation scale for the respective competence requirements

Level of competence	Description	Didactic objective
Low	Basic understanding of principles and concepts. Comprehension possible, but not independent application.	Awareness raising, clarification of terms, understanding of context
Medium	Ability to apply knowledge in a reflective manner in typical usage scenarios. Initial operational routines in place.	Application skills, case studies, tool usage
High	Deep understanding, ability to assess, adapt or shape. Responsibility for action given.	Analytical, management or organizational skills, decision-making skills

This scale is used to qualitatively assess the necessary level of competence for each relevant dimension. It is designed in such a way that it can differentiate between different role profiles and at the same time serve as a basis for curriculum development and competence development measures. Ideally, the classification is based on externally validated competency models or standardized assessments, allowing learning objectives and paths to be tailored to the respective starting point and target position.

- The *low level* indicates a basic understanding at the conceptual level. Individuals in this competence area are able to name and classify key terms and principles, but do not yet can apply them independently. The main objectives of training measures at this competence level are to raise awareness, develop a common understanding of terms, and promote contextual understanding.

- The *intermediate level* represents application-oriented competence in specific professional situations. Individuals with an intermediate level of competence can use AI systems in a reflective manner, explain their basic functioning, and use them independently within clearly defined processes. Training measures at this level focus on practical knowledge transfer, tool competence, and application in exemplary usage scenarios.

- Finally, the *high level* describes an in-depth understanding of the respective competence dimensions. Individuals with this level of competence are not only able

to use existing systems, but also to evaluate, adapt, or help shape them in an organizational context. They typically take on responsibility for action – for example, in system selection, process control, or governance – and therefore require analytical, strategic, and normative skills. Training courses for this target group include in-depth content discussions, case-related reflection, and transfer-oriented practical projects.

Overall, this three-stage scale allows for a differentiated yet practical systematization of AI literacy requirements that does justice to the diverse range of roles in companies and institutions. It creates the methodological basis for using the morphological box not only as an analytical tool, but also as a strategic planning basis for education and compliance measures in accordance with Art. 4 of the AI Act.

4

Guidance for action and outlook

4 Guidance for action and outlook

4.1 Initial examination methodology

The obligation set out in Article 4 of the AI Act to ensure “to their best extent” AI literacy in companies raises considerable follow-up questions about its practical implementation. Of central importance here is how companies can validly evaluate whether individual actors have the skills required for their respective functions. The question also arises as to which procedures are suitable for assessing competence and how these can be reconciled with the organizational framework conditions, particularly in SMEs. The aim of this section is therefore to provide guidance for the operational implementation of the normative competence requirements and to systematize procedures for a practical competence assessment.

In the context of this consideration, it proves useful to introduce a three-stage ex-ante testing architecture. Accordingly, the entrepreneurial context should be examined before the individual and company-specific AI literacy of employees:

1. **Functional assessment level:** Determining which tasks the company's AI system performs and the scope of its application.

2. **Role-based assessment level:** Determining the role that the respective person plays within the organization and the responsibilities that correspond to this role.
3. **Organizational assessment level:** Analyzing the company's structural and resource-related capabilities that are relevant for the systematic development and safeguarding of competencies.

This differentiated approach considers the principle of proportionality. The question is not whether the legally standardized obligation to ensure sufficient competencies must be fulfilled, but exclusively in what form this obligation must be fulfilled in view of the respective organizational reality and reasonableness in each individual case. For SMEs, this means that the implementation requirements must always be determined in relation to the available staff, financial, and technical resources, without calling into question the fundamental mandatory nature of the norm.

Of relevance in this context is the statute stipulating that competencies must be ensured "to their best extent" On the one hand, this criteria for reasonability allows flexibility in practical implementation, but on the other hand, it requires the establishment of comprehensible and documented procedures. Furthermore, it must be ensured that all role profiles – regardless of their degree of technical specialization – have a binding basic level of knowledge, including in regulatory and data protection issues. Even highly qualified technical specialists do not necessarily have a sufficient understanding of the legal framework. This requires basic training that must be established as a minimum standard throughout the organization and completed on a mandatory basis.

4.2 Need for differentiation

The concrete implementation of the obligation to ensure a "a sufficient level of AI literacy" as stipulated in Art. 4 of the AI Act requires context-sensitive differentiation based on organizational starting conditions. SMEs and public institutions in particular face the challenge of having to meet demanding regulatory requirements under structurally limited resource conditions. The assumption of a uniformly applicable target level for all organizations not only contradicts the principle of proportionality, but also the intended risk-based approach of the AI Act.

SMEs typically do not have specialized AI departments, systematically institutionalized training programs, or formalized governance structures for technology-related compliance requirements. Technological expertise is often distributed among individuals who perform operational, strategic, and administrative functions at the same time.

As a result, training and qualification measures cannot be designed as a comprehensive rollout, but must be tailored to specific needs, modular, and integrated into existing work processes and training courses. At the same time, a generic obligation to upgrade all role profiles to a uniform "high" level of competence can lead to operational structures being overwhelmed and ultimately to the regulatory requirements not being implemented in practice.

Public institutions, especially at the municipal or state level, are also confronted with similar situations. The need for further training in this area often conflicts with restrictive

budgetary law, lengthy procurement procedures, and organizational segmentation between specialist, IT, and human resources departments. In addition, there is often a lack of overall strategic responsibility for the use of AI, with the result that skills development initiatives are either fragmented or project-based, thereby losing sustainability and scalability. In contrast to the private sector, there is also an increased expectation of accountability and legitimacy on the part of the public and political bodies, which makes questions of ethical reflection and constitutional control even more important.

4.3 Operationalization of competency requirements according to roles

Based on the obligation stipulated in Article 4 of the AI Act and the three-stage assessment architecture described above for determining the business context, a multi-stage approach to systematic skills development is recommended for determining the AI literacy of a company's employees. This approach integrates both a bottom-up analysis of individual skills and a top-down comparison of organizational competence requirements. On this basis, a role profile grid is generated, which forms the basis for differentiated measures to ensure competence.

Recommended action 1: *Introduce organization-wide basic training that ensures a minimum level of technical, regulatory and data protection literacy for all employees*.

Regardless of the specific job or qualification profile, a mandatory basic level of AI literacy must first be ensured. This includes in particular:

- a fundamental understanding of possible applications and risks,
- the ability to use AI-based tools safely and in a manner appropriate to the target audience,
- and knowledge of regulatory and data protection framework

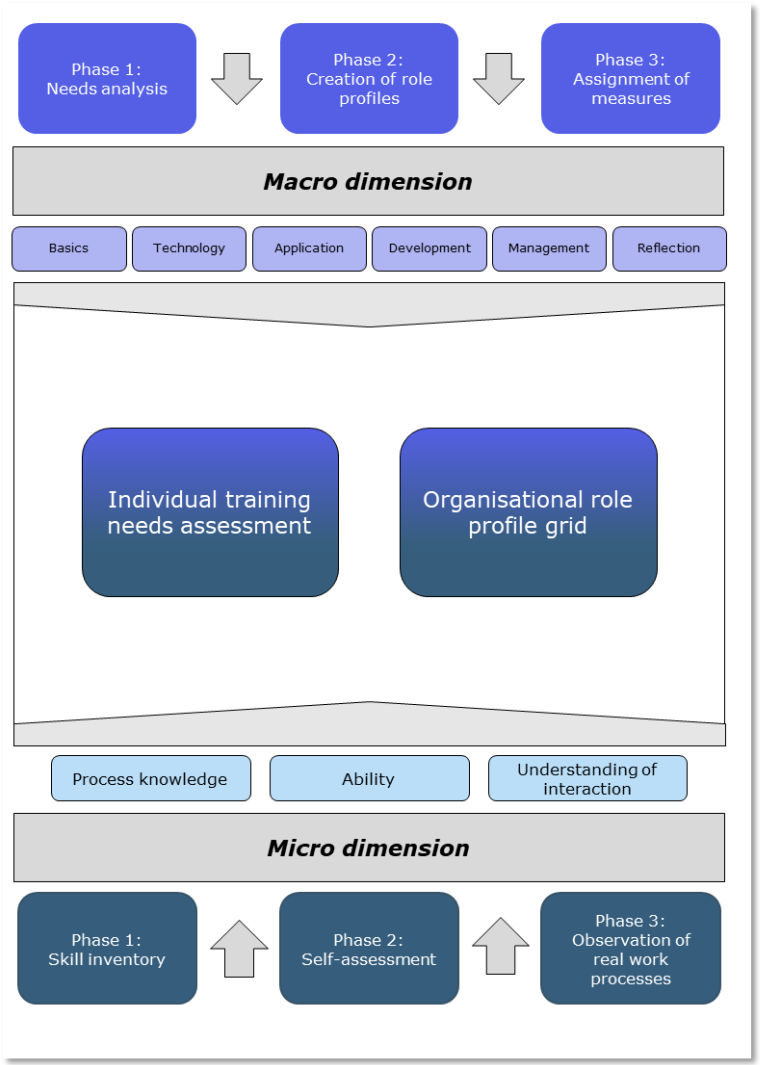
This basic training is mandatory for all employees, regardless of their level of specialization. It serves to ensure an organization-wide minimum standard that integrates both technical and legal aspects. This considers the fact that even highly qualified technical experts do not necessarily have sufficient regulatory knowledge.

Recommended action 2: *Following the basic training, differentiated role profiles – e.g. integrator and developer – should be used to determine further competence requirements in a targeted manner.*

Following the basic training, a role-related differentiation is made, which allows competence requirements to be tailored to the function and level of responsibility. As shown in Figure 4, three archetypal personas are recommended for this purpose:

- **User:** Employees who primarily use ready-made AI tools. They need skills in the secure and data protection-compliant use of standard applications, the use of data, the formulation of simple prompts and the interpretation of results.
- **Integrator:** Individuals responsible for embedding AI into existing processes. This includes **additional** skills in using low-code/no-code platforms, implementing simple use cases with existing modules, and a basic understanding of data sources and interfaces.
- **Developer:** Specialists with in-depth technical expertise who are responsible for developing, adapting, and integrating AI systems. **Additional** skills are required, particularly in working with APIs, creating and optimizing models, and embedding complex architectures.

This differentiation of roles allows training and development measures to be designed in proportion to actual responsibilities and the context of use.



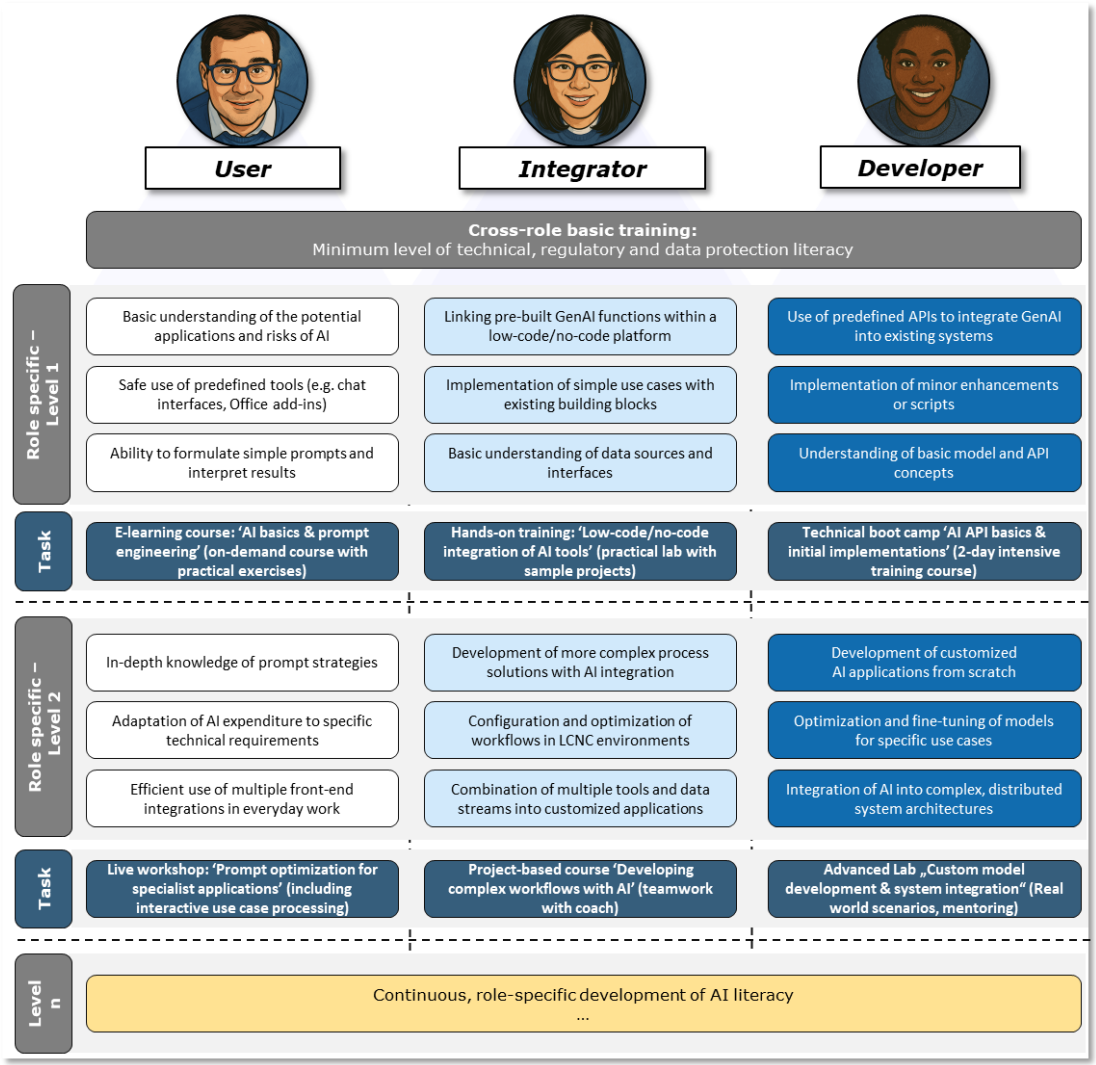


Figure 4: Role profiles for addressing Art. 4 of the AI Act

Recommended action 3: *The implementation of competence requirements must be based on the principle of proportionality and the criteria of reasonability 'to their best extent', while always maintaining the mandatory nature of the rule.*

The practical implementation of training should be based on the principle of proportionality. The decisive factor is not the abstract fulfilment of an ideal state, but the comprehensible assurance of competence development 'to their best extent'. For SMEs, this means:

- There is an indispensable obligation to ensure a basic level of competence.
- Any further specialization must be implemented in a reasonable manner, depending on the role, area of application and size of the company.
- Documented needs analyses and graduated action plans are considered suitable evidence for supervisory authorities.

Recommendation 4: *Minimum data protection standards must be systematically considered as a cross-cutting requirement in all role profiles.*

Ensuring minimum data protection standards must be established as a consistent cross-cutting requirement in all role profiles. In addition to the basic principles of data minimization, purpose limitation and transparency obligations, this includes knowledge of the lawful handling of special categories of personal data, compliance with deletion and documentation obligations, and an understanding of the interfaces between the AI Act and the General Data Protection Regulation (GDPR). Employees at all role levels are empowered to identify risks of non-compliance with data protection law and to take appropriate protective measures when introducing and applying AI systems. This applies both to technical experts, who must take data protection-compliant default settings ('privacy by design') into account when developing system architectures, and to users who process personal data during their activities. Data protection competence should therefore be understood not as optional additional knowledge, but as a mandatory core requirement for every role in the competency model.

Recommended action 5: *Ensuring AI literacy should be institutionalized as an ongoing task and continuously developed through regular needs analyses and evaluations*.

The obligation to ensure AI literacy under Article 4 of the AI Act should be understood as an ongoing and dynamic task that goes beyond one-off training measures. Companies are encouraged to institutionalize competence development within their organizations, for example by establishing permanent governance structures such as competence centers, continuously updated training programs or standardized evaluation procedures. This includes, in particular: (1) regular needs analyses that capture both individual learning progress and organizational requirements, (2) the continuous updating of role profiles considering technical and regulatory developments, and (3) the systematic evaluation of the effectiveness of training measures based on measurable criteria. Such continuity helps to develop AI literacy not only reactively but also proactively and to anchor them sustainably in the organizational structure. This also ensures that compliance with the requirements of Article 4 of the AI Act remains documentable, verifiable and adaptable to new legal or technological conditions in the long term.

4.4 Outlook and future prospects

Looking ahead, it can be assumed that securing AI literacy will require even closer cooperation between national, European and international structures in the future. Beyond the purely internal corporate perspective, issues of standardization, certification and transnational comparability of competence levels will come to the fore. Companies will have to adapt to the fact that, in addition to internal certification, external certification processes will increasingly be established to ensure regulatory connectivity and market confidence in equal measures.

At the same time, technological dynamics, particularly in the field of generative AI and multi-agent systems, are increasing demands on continuous skills development (Busch et al. 2025; Lämmermann et al. 2025). These technologies not only expand the range of application scenarios, but also create new dependencies on data quality, model transparency and governance mechanisms (Mayer et al. 2024). Organizations are therefore required to develop proactive learning and adaptation processes that go beyond pure training logic and build competence in experimental, interdisciplinary contexts. AI assistants

could also be used as learning partners to teach AI skills (Gutheil et al. 2025).

The ethical and normative dimension is also becoming increasingly important. With the growing integration of AI into socially sensitive areas, there are rising expectations that companies will not only comply with regulations but also take responsibility for fairness, explainability and social legitimacy. Future competence models will therefore not only reflect technical and regulatory knowledge but will also have to systematically incorporate skills in critical reflection, interdisciplinary cooperation and responsible decision-making.

SMEs can achieve economies of scale by actively using external support, industry-specific learning platforms and cooperative qualification models. It could prove helpful if the European Commission deliberately refrains from imposing rigid and detailed regulations, but at the same time provides clearer guidance and interpretative notes. For SMEs in particular, it is crucial to know and understand at an early stage what requirements must be met, in what form and with what resources, to create legal certainty and avoid disproportionate burdens.

In the long term, AI literacy will thus become an integral part of education and training systems throughout society (Gimpel et al. 2024). The linking of vocational training, university teaching and lifelong learning opens the possibility of understanding the requirements of Article 4 of the AI Act not only as a legal obligation, but also as a starting point for comprehensive digital maturity in Europe.

This guide provides companies with an initial methodological proposal on how to systematically address the obligation to ensure sufficient AI literacy as stipulated in Article 4 of the AI Act. It offers guidance on which steps should be prioritized – from the introduction of mandatory basic training to the differentiated design of role profiles and the ongoing institutionalization of competence development. This enables SMEs to meet the legal requirements ‘to their best extent’ in accordance with their resources and in line with the principle of proportionality, while at the same time creating a basis for the long-term development of organizational AI maturity.

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