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# Key AI Competences by 2035: A Taxonomy for Firms

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## Introduction

In this paper, we report on initial results from a research project that seeks to understand the key competences that firms need to be prepared for Artificial Intelligence (AI) and the transformations that AI systems are expected to produce. The term 'Artificial Intelligence' currently points to multiple technological developments and can be defined in a variety of ways (cf. Benbya et al., 2021). For this reason, this paper takes up here a broad definition of AI, one proposed by the OECD and adopted by OECD member states: 'An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy.' (OECD, 2019)

Our research examines the transformative changes that AI systems already bring about and are projected to cause in the future. These transformations are often referred to as 'a fourth industrial revolution' (Schwab, 2016; cf. Brynjolfsson & McAfee, 2014; Raisch & Krakowski, 2021). For the purposes of this foresight exercise, we assume that AI is likely to be a 'general-purpose technology' (Brynjolfsson et al., 2019; cf. Lipsey et al., 2005), similar to technologies such as the steam engine, electrification, and computing. The overall research questions that this project aims to address are: What are the effects of AI on companies by 2035? Does the advent of AI necessitate changes in the organisational design of companies? What are the corresponding key competences that companies need? In this paper, we propose a taxonomy that addresses the last question: what are the key competences for firms on an organisational level to be prepared for AI systems? We will first introduce our theoretical framework, review the main issues and relevant literature, and then report on our preliminary conclusions, next steps and how we plan to refine this taxonomy.

## Theoretical framework

Competences are here defined as the organisational capacities that companies have or that they can mobilise that give them a competitive advantage over other firms. Competences include but go beyond individual skills of employees. Instead, competences encompass the ensemble of tangible and intangible resources and assets that companies can draw on to refine and differentiate their business processes and outputs. In short, competences are intangible capacities on a firm-level and need to be managed dynamically. For this reason, this paper draws on the intellectual capital dynamic value (IC-dVal) approach (Bounfour, 2003a) that develops other theoretical frameworks in the field of strategic management, which were developed in the 1980s and 1990s. The IC-dVal framework adapts these earlier approaches to rapidly changing business contexts shaped by new technologies and digital transformations. These earlier approaches emerged in response to work on competitive advantage (after Porter, 1985) and stressed the role of resources (e.g. Itami, 1987; Barney, 1991; cf. also Penrose, 1959) – especially intangible resources (e.g. Bounfour, 2003b) – as essential to organisational competitiveness. In a resource-based view of the firm, resources are 'those (tangible and intangible) assets which are tied semi-permanently to the firm' (Wernerfelt, 1984, p. 172). In this sense, competences as intangibles are key to firm performance and have been defined as corporate 'routines' (Nelson and Winter, 1982). In response to fast-changing conditions, the 'dynamic capabilities' approach (Teece et al., 1997) draws attention to 'exploiting existing internal and external firm-specific competences to address changing environments.' (ibid., p. 510). The related notion of 'core competence' of a company highlights 'the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies.' (Hamel and Prahalad, 1990) Developing these insights to value-creation and learning within firms, we build on the IC-dVal approach (Bounfour, 2003a) to examine which specific competences are needed for companies to successfully adapt to the expected expansion of AI systems. Our framework (see Figure 1) stresses competences in addition to the strategic tangible and intangible resources that firms possess. We view AI-related competences as transversal, i.e. they mobilise, coordinate and combine a range of business resources and processes. Competences and resources are required to carry out generic corporate processes as well as business-specific processes (cf. Bounfour, 2011), which lead to the production of certain kinds of outputs. These outputs correspond to the value that firms produce, such as products or services that are sold or offered to their respective (external) markets. However, firms also produce other outputs (typically intangibles, e.g. patents) for themselves and other stakeholders. These intangible outputs are (internal) assets for the firm that in turn can be used within the company as resources for value creation in its business model. This is the dynamic value and 'the dual character of the intangibles' (Bounfour, 2003b, p. 84).

In this current research on the impact of AI and its technologies, we highlight the dual roles that outputs such as data or algorithms have for firms: both as assets and as resources that can, for example, help optimise the firm's own business processes and, in turn, lead to new technical solutions or outputs. One question is how these resources can be best mobilised across business processes and how processes are organised, which is where the issue of competences for AI could become key.

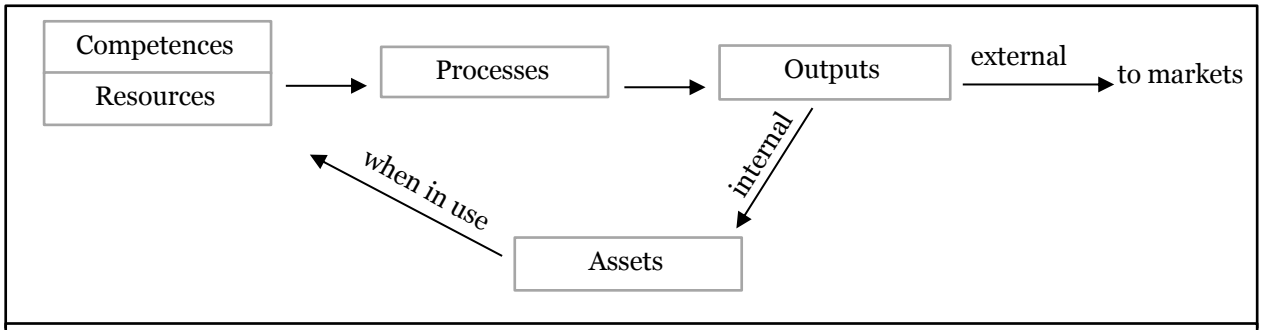


**Figure 1. Conceptual framework**

## The impact of AI on companies

Taking a half-generation perspective, 2035, it is still currently considered unlikely that artificial general intelligence will be attained (cf. Glikson and Woolley, 2020). So-called 'narrow' AI – that is specific applications of AI technologies based on machine learning, data analytics, natural language processing, and forms of automation, including robotic process automation – is expected to remain the form that AI will take. In any case, there will be varying levels of transformative impact. Currently, a few technology companies, especially big platforms, dominate the market for AI systems, such as Google, Amazon, Meta, Microsoft. Such online platforms have gained a powerful economic position in this emerging AI landscape through the strategic exploitation and concentrated control of data, algorithms and associated digital technologies (Bounfour et al., 2022). Many other firms are not yet prepared for the anticipated transformations that AI systems are projected to cause. Yet, the anticipated impact and market value of AI systems is expected to be immense. Firms need to respond to the challenges that current trends of platformisation present. In a recent volume, Bounfour (2022, p. 203) highlights one of the key issues in this context, namely that firms need to continuously adapt their business models and organisational processes to drive value creation, and outlines the competences that firms need: 'cognitive (modelling, understanding), technological (especially to react to the behavior of global platforms), and behavioral/regulatory (to address ethical issues in the use of data)' (ibid., p. 204). Other companies, especially SMEs, are faced with structural, organisational challenges in adopting and making use of AI technologies. These firms typically do not yet have the necessary technical specialists, infrastructural resources or organisational capacities to make the most of AI systems. This is important because many recent studies demonstrate that efficient data management and analytics is one important means for businesses to remain competitive (cf. Cybulski & Scheepers, 2021; Gregory et al., 2021; Hartmann & Henkel, 2020; Janssen et al., 2020; Sjödin et al., 2021). Yet what is still missing is more empirical evidence on specific issues that different sectors face in relation to AI.

The integration of AI systems into the value chain of firms does not only require new technologies, data, and a workforce with relevant technical AI skills; but it also necessitates broader organisational change, leadership and strategic decisions (Brock & von Wangenheim, 2019). Firms need to analyse their existing value chains and business models: their current and needed competences, resources and assets, processes as well as outputs. Due to current anxieties around job losses in the context of AI systems and processes of automation (cf. Willcocks, 2020), firms need to establish a clear, common vision for AI and communicate the relevance of AI adoption to employees who might be resistant and fear that their jobs are at stake. Thus, the main challenges for many firms are currently both a lack of technical AI expertise and a lack of clear AI strategies that are integrated in the current business model with different time horizons. Although some firms invest in pilot AI projects, many of these projects are expensive to set up and often do not (yet) obtain

satisfactory returns. Additionally, it is not to be expected that a few individual employees with specialist AI skills can alone capture the business value of AI for the entire company. Rather, employees at all levels need to have varying understandings of AI systems, and a process of upskilling across the entire workforce is likely needed (Jaiswal et al., 2022). For instance, executives need to understand how AI systems might impact value chains and how to realise the potential of AI technologies. The existing workforce with domain expertise and intimate knowledge of current business processes needs to develop an understanding of AI to collaborate with technical AI specialists who implement AI solutions (Brock & von Wangenheim, 2019). Such technical specialists can advise on appropriate AI projects that can, in the short and medium term, return business value and instil trust and familiarity with AI systems in the existing workforce. But there is a deskilling risk: a risk that current business experience and tacit knowledge gained over time can be lost or side-lined because of changes to business models (Raisch & Krakowski, 2021). Appropriate skills need to be retained; especially as other types of non-technical skills are needed to complement technical ones. Firms need to develop multidisciplinary sets of competences to address changes in their core business models and long-lasting successful adaptations to AI systems.

In summary, to develop our proposed taxonomy of AI-relevant competences on an organisational level, we have conducted an initial literature review. We identified relevant issues as well as possible outcomes and potential risks and deduced which needs for AI competences would likely arise for firms as a result (see also Bounfour 2022, p. 202). In short, we identified these five key issues for firms in relation to AI systems: 1. Technical and technological aspects: being able to ensure the development, training, functioning, maintenance and supervision of AI systems and connected infrastructural issues, e.g., cybersecurity risks. 2. Organisational intelligence: dealing with how AI systems might impact, change or augment existing decision-making and other analytical processes within organisations, including innovation. 3. Relationships and networking: how to manage internal and external relations and ensure a productive, collaborative working environment, also between workforce and AI, as well as, e.g., ensuring upskilling. 4. Managerial leadership: being able to formulate organisational strategies, to identify goals, manage business value of AI and its applications within the firm and address any other management issues. 5. Ethics and social impacts: being able to address the ethical, legal, regulatory and socio-economic impacts of AI systems as well as other societal issues, e.g., sustainability; data governance, protection and privacy.

## Towards a taxonomy of AI-relevant key competences for firms

The proposed taxonomy (Figure 2) is a heuristic to understand the current and projected needs and demands that AI systems pose for firms over the coming decade, by 2035. The future is uncertain and subject to change, and this ongoing work assumes that requirements for skills and resources can evolve. Similarly, it is to be expected that competences do not remain static but change with new technologies and AI systems. We developed this taxonomy from a review of relevant bodies of literature (e.g. Brock & von Wangenheim, 2019; Hartmann & Henkel, 2020; Sjödin et al., 2021), taking into account other proposed taxonomies (e.g. Anton et al., 2020; Davenport, 2018; Johannessen, 2021; Kipper et al., 2021; Mikalef & Gupta, 2021). Our taxonomy takes such frameworks further (cf. Yang, 2022), and views AI-specific competences as transversal as well as complementary to existing competences, cutting across and complementing core competences and business support functions of firms. We propose the following categories of AI-relevant key competences on a firm-level:


**Figure 2. A taxonomy of AI competences: an initial approach**

**1. Technological (or material) competences:** This category refers to competences related to data, technologies and infrastructures, and other essential resources: technical infrastructures (hardware,

software), development of AI software and technologies, data management, cybersecurity and risks. **2. Cognitive competences:** These are competences concerning organisational learning, spatio-temporal positioning, emotion, recognition, reasoning, problem-solving and decision-making as well as innovation. **3. Interactional competences:** These include relational competences, both internal and external: networking or interactions with customers, companies, platforms and competences related to continuous upskilling of the current workforce, and, for instance, ensuring an alignment of employees and AI systems. **4. Strategic-organisational competences:** These are competences that traditionally fall under managerial decision-making: strategic vision and decisions, especially in relation to managing and achieving expectations from AI systems; organisation of activities; coordination of tasks; deployment and management of operational processes; as well as providing overall, managerial leadership. **5. Ethical and societal competences:** These include competences that relate to the impact of AI on societal structures and rules due to its widespread use: competences in relation to civic, ethical, legal responsibilities; compliance with regulations; sustainable development; data sharing and confidentiality.

This proposed taxonomy is integrated in a broader, dynamic theoretical framework (as suggested above). In the next steps, we aim to refine the specific sub-categories for particular sectors and test this taxonomy with the help of expert surveys, interviews and workshops and plan 1) to address wider theoretical questions such as what impacts AI systems have on the organisational design of companies; and 2) to develop practical, sectoral analyses for firms that include measures such as sector-specific maturity models.

## Conclusion

In conclusion, this paper highlighted the main issues for companies in the context of an increasing introduction and expected expansion of AI systems. We presented a framework for key competences for firms to deal with and integrate AI systems into their organisations. The proposed categories for key competences include technological, cognitive, interactional, strategic-organisational, as well as ethical and societal competences.

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