PART I
Linking ADM, job autonomy & service work: an attempt at conceptual embedding

3. AI in the work process

What are the distinctive technological features behind the widely used term *AI*? What are the peculiarities of looking at AI from the perspective of work organization? How to deal systematically with AI and its influence on work processes? These introductory questions are addressed in Chap. 3. The first step is to sharpen the terminology, moving away from the fuzzy term AI to *algorithmic decision-making* (Chap. 3.1). In addition, an overview of previous approaches to understanding which tasks at work are influenced by ADM allows for insights into the functional spectra of such technical systems that are currently assumed (Chap. 3.2). These considerations lead to the outline of three ADM categories, which illustrate the possible intervention depth of ADM systems in work processes (Chap. 3.3). A final excursion into the actual prevalence and use of ADM systems helps to assess the extent to which ADM-supported work is (or is not) impacting workers today (Chap. 3.4).

3.1. From AI to algorithmic decision-making

While research into AI dates back to the 1950s, the debate about AI tools in the workplace has reached new heights in recent years. More than 60 years ago, computers did not show the performance required to process complex operations. The early 1980s became known as *AI winter* as the development of functional AI systems was still too costly (Agrawal et al., 2018, p. 32). The qualitative and quantitative expansion of available data and computer performance enabled a renaissance of research and the application of AI that has grown considerably since 1990 (Cockburn et al., 2018, pp. 34–37).

Agrawal et al. (2018, p. 9) explain why AI has experienced such an upswing in recent years with the simplest of economic connections: When the price of a good falls, more of it is consumed. And indeed, powerful processors and access to substantial amounts of data have become much more accessible over the past 15 years. However, declining returns on investment in data and machines are already evident today (Agrawal et al., 2018, p. 51). Additionally, this proclaimed renaissance is often limited to research developments (and their scope of financing) and less to the actual diffusion and use of AI systems in economic activities.

Based on the influential essay "Minds, brains, and programs" by the U.S. philosopher John R. Searle (1980), Nilsson (2010, pp. 388–389) names *strong* and *weak* AI as the currently dominating scientific distinctions. Strong AI defines the rather theoretical existence of human-like abilities, including conscious thinking. Regarding weak AI, the technical system can fulfill selected work tasks, but intelligence is only simulated.

Since this thesis intends to focus on AI applications that are already being used in the workplace, the operational definition of AI is based on that of weak AI. Nilsson's (2010, p. 13) definition of AI explicitly refers to the ability of those systems to function in their respective environments: "Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment". With this approach, the classification as AI depends on the extent to which one is willing to attribute appropriateness and foresight to a system (Stone et al., 2016, p. 12).

However, there is no universal definition of AI, but a plethora of overlapping definitions by private, scientific, or public actors, such as the European Commission (2018, p. 1):

> Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g. voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g. advanced robots, autonomous cars, drones or Internet of Things applications).

The German Bundestag (2020, p. 51) adds its perspective on AI:

> AI systems are intelligent systems designed by humans, consisting of hardware and/or software components, which aim to solve complex problems and tasks in interaction with and for the digital or physical world. To this end, AI systems collect, process, and analyze data and exhibit suitable behavior to solve and fulfill the respective problems and tasks. If the AI interacts physically with its environment through a technical body, e.g., as a robot, this is referred to as embodied AI.[17]

17 Own translation of "KI-Systeme sind von Menschen konzipierte, aus Hardware- und/oder Softwarekomponenten bestehende intelligente Systeme, die zum Ziel haben, komplexe Probleme und Aufgaben in Interaktion mit der und für die digitale oder physische Welt zu lösen. Dazu erfassen, verarbeiten und analysieren KI-Systeme Daten und zeigen ein geeignetes Verhalten zur Lösung und Erfüllung der jeweiligen Probleme und Aufgaben. Interagiert die KI durch einen technischen Körper physisch mit ihrer

Although these definitions of AI systems emphasize their dependence on their human creators along with their virtual and physical presence, they are extremely broad and potentially encompass a range of technical applications. These superficial references require further specification.

However, due to the high international dynamics of research and development, the elaboration of a generally applicable definition of AI, on which this work might be based, does not seem appropriate. Rather, it is important to understand how AI tools intervene in work processes, to what depth they do so, and which work tasks are accessed in the process. Translated into a sociological perspective, the discussion of AI addresses the depth of intervention in existing work processes, the change in the division of labor, the organizational mechanisms that support or hinder the intervention of AI, or the changing ways in which people engage with each other and technology. Without going into detail about all possible definitions of AI, the following is a working description that defines the basic boundaries of the technical systems discussed in this thesis: The basis of AI systems are algorithms, whereby an algorithm by itself does not form AI. Following Zweig (2019, p. 50), algorithms are based on logical and mathematical procedures that serve as optimized instructions for action.[18] In other words, an algorithm describes an instruction that solves a defined mathematical problem. The formulation of this problem determines which solution possibilities may apply, whereby a certain relationship between input and output is also clearly defined with the problem (Zweig, 2019, p. 50).

The term "algorithm" is only valid if the formulated action instruction is so clearly defined that it can be implemented by a machine and completed in finite time (Zweig, 2019, pp. 51–52). The output of this process is always to be interpreted according to the respective context and is to be evaluated against the background of the specific data use, modeling, and operationalization (Zweig, 2019, p. 80). AI systems consist not only of data, algorithms, and models but also of physical components that can intervene in work systems. Bound to actuators, algorithms transfer and implement actions into the physical world. To answer spe-

Umwelt, z.B. als Roboter, spricht man von verkörperter KI ('embodied AI')" (Deutscher Bundestag, 2020, p. 51).

18 The foundation for research on AI was laid by Alan M. Turing (1950) with his influential essay "Computing Machinery and Intelligence", in which he formulated what is now known as the Turing thesis, namely that any action that follows clear rules can also be mechanized and thus imitated by a machine. The core of Turing's work was the principle of the algorithm, which by definition does not allow any deviations and thus provides a specific solution path to a defined goal.

cific questions in this way, programming algorithms alone is often not sufficient. It is part of the modeling process, just as the calculated mathematical solution must be interpreted in relation to the question posed (AlgorithmWatch, 2016).

A fundamental distinction is made between *rule-based* and *learning AI systems*. The former (also known as symbolic AI) is based on the formulation of rigid algorithmic rules and expert knowledge, so that overall there is a high level of transparency (i.e., white box models) with regard to the input and output of the systems (Deutscher Bundestag, 2020, pp. 51–52). These systems are still comprehensible to workers, as they are largely based on the formulation of logical rules such as if-then procedures. It is important to note that rule-based systems use predefined rules based on clearly limited amounts of data (expert knowledge).

The latest progress in AI usually refers to Machine Learning (ML), also called subsymbolic AI, as the ability of novel systems to generalize from experience (i.e., data), learn, and continuously improve without executing explicit instructions, i.e., without having been programmed to do so (overview in Alpaydin, 2016, p. 10). In general, three ML methods are distinguished (Castelluccia & Le Métayer, 2019, p. 4): Supervised learning is based on labeled data, i.e., a recognition pattern and goal are given and used to classify data, e.g., images. Unsupervised learning does not use previously labeled data. It is a method of pattern and structure recognition in data. Reinforced learning uses feedback mechanisms to improve its function. ML algorithms develop their full potential by analyzing, structuring, and feeding back large amounts of data, continuously improving their performance, and thus finding increasingly better solutions for specified (supervised learning, e.g., finding a specific optimum) or unspecified (unsupervised learning, e.g., pattern recognition) problems.

In recent years, it is particularly Deep Learning (DL) that has established. DL is a subfield of ML that focuses on using Artificial Neural Networks (ANN) to extract complex patterns from data. It has broad applications in areas such as image recognition, natural language processing, and autonomous systems. The necessary pre-structuring of data is largely eliminated, which the system takes over as part of the learning process (Deutscher Bundestag, 2020, pp. 51–52). This type of AI model is also known as a *black box model* because its functions are no longer fully comprehensible to humans. There are various approaches for developers to increase explainability. From the user's point of view, however, it is usually difficult to make these systems transparent (Kraus et al., 2021, p. 3).

The transparency-related difficulty lies in dealing with ML algorithms that "jump directly from hypothesis to prediction as if the hypothesis were a fact"[19] (Zweig, 2019, p. 41). However, this is only true if it has been tested. According to Zweig (2019, pp. 196–197), the success of ML depends on the availability of an adequate amount of data for training in both quantitative and qualitative terms, the existence of measurable ground truth, and causal relationships between input and desired output. The output of ML is considered transparent if, among other things, an appropriate quality measure has been selected for testing and sufficient feedback data is available for continuous improvement of the output.

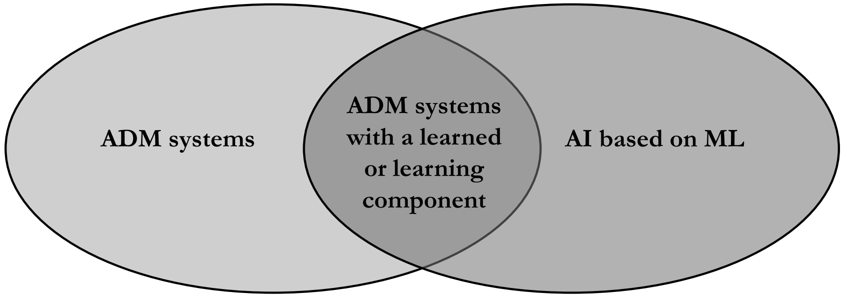
As in earlier hype phases, the use of the term "Artificial Intelligence" (as a synonym for ML) is a source of controversy. In some cases, the term is associated with promises for the future that may or may not be realized; in other cases, using the term merely serves advertising efforts that expect greater success from AI. AlgorithmWatch (2019, pp. 7–8) points to the blurring and overvaluation of the term in public discourse. Pure digitalization efforts and AI are sometimes indistinguishable.

As a result, the term "*algorithmic decision-making* (ADM)" has become established in professional circles, which more clearly indicates the functions performed by the current systems in question: Humans delegate the preparation or implementation of decisions to machines (AlgorithmWatch, 2019, pp. 7–8). AlgorithmWatch (2019, p. 9) further defines those systems as a socio-technical complex consisting of a decision-making model and algorithms that translate this model into computer language, training, and analysis data sets. This is the unique aspect of this definition, the political and economic ecosystem in which ADM systems are embedded. ADM may refer to simple digitalization steps or AI applications as they are currently understood, i.e., learning applications (AlgorithmWatch, 2019, p. 7). According to AlgorithmWatch (2019, p. 3), most ADM systems that make decisions about or for people today are not based on AI but are "usually just more or less complex software applications that calculate, weight, and sort data using sets of rules"[20]. Common examples of ADM systems cover the improvement of general knowledge (e.g., drug discovery, climate forecasts), digital services (e.g., risk scoring, client targeting, predictive police), and physical systems (e.g., autonomous robots, cars, transport systems) (Castelluccia & Le Métayer, 2019, p. 6).

19 Own translation of "direkt von der Hypothese zur Vorhersage [springen], als wäre die Hypothese ein Fakt" (Zweig, 2019, p. 41).

20 Own translation of "meist nur mehr oder weniger komplexe Softwareanwendungen, die anhand von Regelwerken Daten miteinander verrechnen, gewichten und sortieren" (AlgorithmWatch, 2019, p. 3).

Figure 2: Distinction between ADM systems and AI based on ML



Source: Algorithm Accountability Lab [Prof. Dr. K. A. Zweig].

It is important to understand that ADM systems and ML can overlap, but they do not necessarily represent the same system complexes (Figure 2). Most ADM systems are considered to be expert systems that operate rule-based. However, if a learning or learned component is added, there are overlaps between ADM and ML.

Building on this understanding, Krafft and Zweig (2018, p. 472) formulate the following central definition of ADM systems:

> Algorithmic Decision Making Systems (ADM systems) contain an algorithmic component that – based on the input – makes a decision regarding an issue, i.e., calculates a single value. If the algorithm was developed by experts, it is called an expert system. There are also those that derive the rule system independently from data with the help of machine learning.[21]

This clarifies that ADM systems can include rule-based or learning elements (also Castelluccia & Le Métayer, 2019, p. 3). They may contain aspects of ML but do not have to. In addition, the Gesellschaft für Informatik e.V. (2018, p. 17) points out that a decision-making system is called an ADM if the decision-maker is an algorithm.

21 Own translation of "Algorithmische Entscheidungssysteme (Algorithmic Decision Making Systems – ADM-Systeme, die) enthalten eine algorithmische Komponente, die – basierend auf der Eingabe – eine Entscheidung bzgl. eines Sachverhaltes trifft, dh., die einen einzigen Wert berechnet. Wenn der Algorithmus von Experten erarbeitet wurde, spricht man von einem Expertensystem. Daneben gibt es solche, die das Regelsystem mit Hilfe von maschinellem Lernen aus Daten selbstständig ableiten" (Krafft and Zweig, 2018, p. 472).

Based on these approaches to a specification of ADM, the working definition of ADM systems refers to *rule-based or learning technical systems that have an algorithm at their core as a decision-maker*. This understanding of ADM systems applies in particular to the theoretical as well as empirical contributions of this thesis. However, other authors and contents are cited as indicated, whereby the distinctive features of *learning ADM* are highlighted if considered appropriate.

The novelty of these ADM systems, as already indicated, lies less in their pure rule-based approaches and more in their experience-based learning perspective, which allows them to (partly) operate in unknown situations. "The prerequisite for this is that they can draw their own conclusions from structured and unstructured data, adapt their machine actions to the environment, and make decisions about optimal ways to achieve goals related to previously defined parameters"[22] (Hirsch-Kreinsen, 2020, p. 141). The importance of delegating decision-making and its support to ADM systems must be emphasized even further as employees are mostly confronted with complex decision-making situations on a daily basis (Ernst et al., 2018, pp. 1–2) and the demand for decision-making skills on the labor market continues to grow (Deming, 2021, p. 31). The automating, augmenting, or assisting character of technology usage is at the heart of sociological and economic debates considering the effects of technology on work. ADM systems are no exception to this logic.

3.2. Differentiating affected tasks

The influence of technological change, especially automation, on tasks and employment is strongly influenced by the Anglo-American perspective of economists. Its transferability to work logics in other countries and general understanding of substitutability and automation are debatable, but some useful insights into the relationship between technology and tasks do emerge: According to the economic perspective, the purpose of technological progress has been the simplification of human labor in terms of muscular exertion, safety, and routine tasks (Autor, 2015, p. 10). Facing financial gains from the investment in automation, companies experienced shrinking benefits from workers whose skills are replaceable by machines.

22 Own translation of "Voraussetzung hierfür ist, dass sie eigenen Schlussfolgerungen aus strukturierten und unstrukturierten Daten ziehen, ihr maschinelles Handeln an die Umgebung anpassen und Entscheidungen über optimale Wege zur Zielerreichung bezogen auf zuvor definierte Parameter treffen können" (Hirsch-Kreinsen, 2020, p. 141).

The broad economic consensus has been that automation particularly affects routine tasks. It draws on the so-called Task-based Approach (TBA) of Autor et al. (2003), which distinguishes between routine and non-routine tasks, i.e., between substitutable and non-substitutable tasks. Based on the TBA, numerous studies have attempted to isolate which tasks are particularly affected by automation and thereby quantify employment effects from using new technologies (e.g., Nedelkoska & Quintini, 2018; Bonin et al., 2015; Dengler & Matthes, 2021).

It is a common perception, with clear origins in the employment developments of the 1980s, 1990s, and early 2000s, that it is those tasks characterized by a routine nature, fulfilling repeating steps in a predefined order, that are influenced by the automating tendencies of technological progress. Determining the first condition for the presence of job polarization[23], the employment share of routine labor, which is predominantly assigned to medium-skilled jobs in this logic, for example, in production, declines. In contrast, non-routine, cognitively demanding occupations experience employment gains due to their complementary relationship with automation (e.g., Autor et al., 2003; Autor, 2015). In total, Autor et al. (2003, pp. 1–6) and Autor (2015, pp. 11–12) define three task profiles: first, routine tasks that can be automated and therefore substituted by a machine. These operations are characterized by structured, repetitive procedures with a need for precision and constant environmental circumstances – typical for middle-skilled employment. Second and third, non-routine abstract and manual tasks that cannot be substituted instantly.

According to this understanding, machines are only able to fulfill tasks that feature a certain arrangement of codifiable steps. The most challenging jobs to be automated are those requiring creativity, common sense, and intuition. So far, these qualities were unique to workers (Autor, 2015, pp. 11–12), or as Polanyi (1966, p. 4) framed it, "We know more than we can tell," which refers to procedures humans implement tacitly without being able to define their distinct rules. Within this chain of arguments, three engineering bottlenecks are frequently cited as prevent-

23 The term job polarization, first introduced by Goos and Manning (2007), describes the incidence of a rising employment share of both high- and low-skilled occupations at the expense of middle-skilled jobs. As a phenomenon frequently observed in industrialized countries, job polarization is linked to technological progress in terms of automation. However, automation and digitalization do not necessarily result in a long-term increase in unemployment among middle-skilled workers. To date, a plethora of literature has emerged on the subject of technological unemployment – often with a dystopian tone that foresees the end of human labor, see, for example, Ford (2016) and Rifkin (1995).

ing the automation of certain tasks (Papsdorf, 2019, p. 108): Firstly, it is the execution of tasks in complex, unstructured environments and the reactions in these situations that are difficult to implement by machines. Second, machines have so far been denied the ability to act innovatively and creatively, i.e., to create something new and generate ideas. Thirdly, machines are not capable of socially intelligent behavior, i.e., of acting appropriately and situationally when interacting with people.

Today's research on ADM systems partly attempts to invalidate this assumption by giving machines the ability to adapt and learn by recognizing patterns and issuing feedback based on big data and higher computer performance (also "Polanyi's Paradox" in Autor, 2014). Recent studies refute previous assumptions that lower- and medium-skilled employees in particular may be affected by substitutional trends in automation and learning ADM.

As M. Lane and Saint-Martin (2021, pp. 22–24) summarize studies by Brynjolfsson et al. (2018), Felten et al. (2019), and Webb (2019), the occupations most exposed to AI, including learning ADM, now comprise white collar occupations such as chemical engineers, accountants, or clerks, while physical occupations, e.g., cleaners, fitness trainers, or massage therapists, are less exposed. M. Lane and Saint-Martin (2021, p. 22) conclude that high-skilled occupations are among those most affected by ML. These findings are in marked contrast to the previous scientific consensus.

Agrawal et al. (2018, p. 28) attribute this change in particular to the novel prediction capabilities of learning systems. Prediction is understood by the authors as a process of filling information gaps (with data). Agrawal et al. (2018, p. 81) specifically assume that these prediction machines are already able to produce qualitatively better and faster results than humans in certain situations and that these predictions are an essential component of decision-making in uncertainty. The ability to influence decision-making thus seems to be, as the name suggests, the most critical component of new AI systems, i.e., ADM. However, Agrawal et al. (2018, p. 81) do not ignore the fact that prediction is only one part of the decision-making process: "The other components are judgment, action, outcome, and three types of data (input, training, and feedback)". This also suggests an increasing importance of the complementary rather than the substitutive relationship between workers and technology.

M. Lane and Saint-Martin (2021, p. 19) agree that AI, also referring to learning ADM, is capable of intervening in some non-routine cognitive tasks and emphasizing the problem-solving, reasoning, and perceptual abilities of these systems but still gives workers clear advantages in the areas of creativity and social intelligence. M. Lane and Saint-Martin (2021, p. 35) further assume that the primary impact of those applications will be visible in the reorganization of tasks. This reorganization may be considered in connection with job autonomy in many respects, but what effect the use of ADM will have in the future remains unclear. Moreover, studies on the specific impact of learning ADM on job autonomy in the service sector are scarce. More indirectly, the growing importance of service tasks is highlighted, emphasizing the social-emotional skills that technical systems have so far been unable to replicate.

In total, M. Lane and Saint-Martin (2021, pp. 20–21) accurately summarize the economic discourse specifically around ML: It is too often reduced to an automating technology. The related discussion on the distinction between complementary and substitutive relationships in the division of labor between humans and machines may be useful, but it underestimates the versatility of work.

Especially the valuation of routine and non-routine tasks has been criticized in many other social sciences. According to Pfeiffer and Suphan (2015a, pp. 4–7, 2015b, pp. 23–24), this approach does not do justice to the complexity of work tasks and their organization. Therefore, it systematically overestimates the potential for substitution. The importance and scope of informal work steps and experiential knowledge as a counterpart to formally recordable and thus substitutable tasks must be emphasized. Since the performance of routine tasks may also have a relieving effect and, moreover, can only become a real routine by means of the accumulation of experience, the objective of eliminating all routine tasks from work processes must be questioned (Huchler, 2019, p. 163).

Pfeiffer and Suphan (2015a, pp. 11–12) further criticize the distinction between routine and non-routine tasks for the lack of a deeper examination of the concept of routine. According to the authors, the canonical TBA focuses on routine as a kind of repetitive, monotonous work that is only related to the transferability to machines. Dengler et al. (2014, p. 17) state that the distinction between routine and non-routine, which is predominantly used in the Anglo-American area, does not correspond to the understanding of *routine* in the German-speaking area, namely habitual subconscious actions, but the dissolution of a work process into formalizable and automatable tasks.

This is where the question arises as to what extent new methods of ADM, especially its ML capabilities, can also replace tasks that require experience. An alternative is not to refer to routine and non-routine tasks, but to distinguish between formalizability and non-formalizability (e.g., Huchler, 2019, p. 155). This approach considers the non-formalizability of subjectifying action, i.e., operating in a creative or innovative way, interacting with other people, in unknown environments, or in contradictory situations (Huchler, 2019, pp. 163–164). The genesis around the understanding of routine and non-routine tasks helps to assess the automatability of tasks. Formalizable tasks can be performed in the familiar logic of rule-based ADM systems. A considerable innovation of experience-based learning ADM systems, however, is the potential to include previously less formalizable tasks in the set of automation possibilities.

The predominantly Anglo-American economic discourse and its critics make clear that it must always be asked anew which tasks are to be assessed as automatable and which intuitive, experience-based, or subconscious tasks cannot be represented by this concept. This is especially true for the service sector, which is based on interaction work that is, to a large degree, unpredictable.

The automation characteristics of ADM systems are visible. However, Daugherty and Wilson (2018, p. 2), among others, also emphasize the *augmentative* characteristics of those systems by stating that "AI systems are not just automating many processes, making them more efficient; they are now enabling people and machines to work collaboratively in novel ways". Furthermore, Zuboff's (1988, pp. 10–11) conceptualization of digitalized work draws a distinction between the functional characteristics of modern information technology according to the terms "automate" and "informate". The automating character of these technologies thus traditionally entails a substituting effect in relation to work, while the informing function is to be regarded as the result of a higher quantity and availability of information. The effects of using ADM at the workplace seem to have three parallel features on a task level: automation, augmentation, and assistance of tasks. The approaches presented for differentiating automating systems according to the tasks they may affect are adopted below to categorize ADM systems according to the depth of intervention in work processes.

3.3. Towards a categorization of ADM systems

Focusing on the interference of ADM in the working sphere of humans and its embedding in work processes, the following considerations lead to an approach for categorizing ADM systems that is intended to provide a simple description of their intervention depth in work processes. These categories of ADM systems reflect both gradations according to the degree of decision support, i.e., also the level of automation, and a distinction according to their influence on the work of employees at the task level (automation, augmentation, and assistance of tasks).

The aim of this exercise is to make the actual functions and possibilities tangible beyond the diffuse definitions of AI. The ADM categorization follows the differentiation of tasks influenced by ADM (Chap. 3.2) and draws on selected models and concepts of human-computer interaction and automation levels, according to Parasuraman et al. (2000), Sheridan (1991), and Bitkom (2017).

In short, Parasuraman et al. (2000, pp. 288–289) distinguish between four different classes of functions in the interplay of both humans and computers:

- Information acquisition automation: The systems can collect and display information. This information can be emphasized or filtered according to the user's preferences.
- Information analysis automation: The systems can process and prepare data and use it to perform analyses or predictions.
- Decision automation: The system can show decision alternatives, filter them according to preference, or make a preselection.
- Action automation: The system can perform actions. Depending on the level of automation, control remains with the user or is transferred entirely to the machine.

The authors thus draw a central distinction between the less invasive function of computer support in terms of work processes such as data collection or analysis and the decision-making support that builds on this in a complementary relationship. The approach cumulates in action automation, in which control[24] over a work process can ultimately be handed over to the technical system.

Sheridan (1991) and Bitkom (2017) provide additional approaches towards a categorization of ADM. Sheridan (1991, p. 5) describes ten different levels of automation, from the first stage, in which no automa-

24 When workers hand over responsibility for processes entirely to machines and fail to detect faulty systems, the so-called *control problem* is assumed. Zerilli et al. (2019, p. 557) argue that especially risky and safety-critical decisions should not be made by ADM systems unless the reliability of the system is proven to be better than that of humans. The reason lies in the failure to detect faulty systems when workers hand over responsibility for processes entirely to machines, either because they trust the machine too much or because they are negligent (Zerilli et al., 2019, p. 556). With reference to Bainbridge (1983), Zerilli et al. (2019, pp. 560–562) describe four problems that can be regarded as causal for the control problem in human-machine interaction: the capacity problem (cognitive limitations in the comprehensibility of machine decisions), the attentional problem (decreases in attention with passive monitoring of systems), the currency problem (gradual decay of human skill), and the attitudinal problem (assumption and reliance on the error-free functioning of the machine).

tion takes place, to the tenth, in which a fully autonomous machine acts (Table 2). Particularly valuable for the following analysis are the intermediate levels, which describe different forms of provision of action alternatives for humans. From levels five and six, it becomes clear that the responsibility for action is largely transferred from the human to the machine. Though the author generally describes automation and not decision-making.

Table 2: Levels of automation in Sheridan (1991)

Level	Description
1	Computer offers no help, the human must do it all.
2	Computer offers full set of action alternatives, and
3	narrows the selection to a few alternatives, or
4	suggests one, and
5	executes suggestion when human approves, or
6	allows the human a restricted time to veto before automatic execution, or
7	immediately executes automatically, then necessarily informs the human, or
8	informs human after execution only if human asks, or
9	informs human after execution if it, the computer, decides to.
10	Computer decides everything autonomously, ignores human.

Source: Sheridan (1991, p. 5), or more detailed in Sheridan (1992).

An approach with reference to decision-making at the workplace is provided by Bitkom (2017, pp. 21–23). The authors present a model of decision-making automation that describes technical systems according to the degree of intervention in human decision-making processes (Table 3). In addition to the initial stage, in which no automation takes place, a total of five stages of decision support are assumed, whereby, in the transition from stage three to stage four, the active role of the human decision-maker is changed to a passive one. The authors describe that the transitions between the respective levels are fluid, and boundaries can be difficult to identify. Nevertheless, this model provides a valuable starting point for the formulation of a categorization of ADM systems in the work context. Such categories help to systematically analyze the intervention of ADM at the task level of employees.

The following categorization of ADM systems is intended to describe how deeply ADM systems can intervene in employees' work processes, i.e., what kind of support they may provide. In later chapters, this categorization allows for a supplementary description of possible changes in job autonomy and is thus intended to do justice to the different degrees

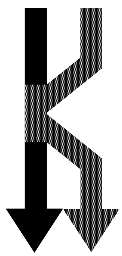
Table 3: Levels of automation in decision-making in Bitkom (2017)

Level		Description
0	Human decides	No automated support
1	Assisted decision-making	Preparation and better processing of information
2	Partial decision-making	Decisions dependent on human preferences; activation incumbent on humans
3	Audited decision-making	Selection and prioritization of decision-making alternatives; activation is incumbent on humans
4	Delegated decision-making	Takeover of control of a predefined situation; human can intervene or leave control to the system
5	Autonomous decision-making	Permanent takeover of complex application situations; manual operation by humans possible

Source: Bitkom (2017, pp. 21–23).

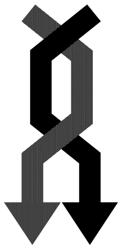
of automation that are used in practice. Based on these preliminary considerations and approaches to the automation of functions, processes, and, finally, decision-making, three categories of ADM systems are isolated: assisting-informing ADM, augmenting-complementing ADM, and automating-substituting ADM. As it is an ideal-typical differentiation, it is likely that in practice the functions of ADM systems fall into several or even all categories. The following attempt to categorize ADM is therefore less technical and more organizational in nature, which should facilitate work process analysis of ADM. A rule-based ADM can inform, complement, and automate. A learning ADM can inform, complement, and automate. This perspective on ADM should explicitly focus on the workers and their work processes.

Assisting-Informing ADM



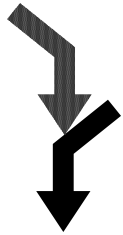
The ADM system assists workers in decision-making and executing work tasks essentially through its informative character. It supports data processing, displays them according to preferences, or provides information on request. This information enables employees to weigh up alternatives independently. These can be software solutions that sort, visualize, and analyze data based on mathematical rules or chat bots that present specific information on demand. The processing of this information is entirely the responsibility of the workers. Decision support depends on the quantity and quality of the available information. The supportive character of assisting-informing ADM systems may also extend to the selection of working methods or tools. In this way, a higher overall information density helps in the fulfillment of work tasks, especially if search processes for this information are minimized. Incorrect information or the preparation of this information can lead to an improper choice of method or the false execution of a task. Assisting-informing ADM may be classified as learning ADM by providing feedback (e.g., manual selection of specific information) to the system from which its informative capabilities improve. The question of assisting-informing ADM systems influencing various dimensions of job autonomy probably overlaps in many aspects with the effects of digital tools in the workplace in general.

Augmenting-Complementing ADM



The ADM system augments the decision-making process of workers and thus has a complementary effect on the performance of work tasks. A distinction can be made between partial and verified decision-making. In the case of partial decision-making, the decision is made based on predefined action chains that must be actively initiated. Thus, the machine only executes something if the worker confirms the command beforehand. However, the ultimate decision-making power and, thus, responsibility for work results remain with the worker. In the case of verified decisions, the system independently develops decision suggestions from a predefined situation, which can be selected by the employee. The system recognizes patterns in given data frames and uses them as the basis for decision scenarios. The employee makes the final decision. The complementary effect at task level may depend on the degree of formalization of the work process that the system requires. Likewise, depending on the system in question, the path that the system takes to the decision proposal can be (in)transparent and correspondingly (less) comprehensible for the worker. The use of augmenting-complementing ADM systems may have ambivalent consequences for different dimensions of job autonomy as they are strongly dependent on organizational embedding. If the system can modify work processes and take over parts of them, effects on various autonomy dimensions can be expected. They specifically pose risks due to their monitoring and non-transparent tendencies while interacting with workers.

Automating-Substituting ADM



The ADM system automates complete work steps and thus has a substituting effect on work tasks. In this sense, automation is defined as the machine execution of (partial) work processes with little or no human intervention. A distinction can be made between delegated decision-making and completely autonomous decision-making. In the first case, workers give the system control over a predefined situation. Deploying these systems usually requires a high degree of formalization and standardization of work processes. When the adaptability of the system to its environment reaches its limits, workers may again have to prove their adaptability to the system. Failures and imponderables of automating-substituting ADM, be they of a technical or organizational nature, can hardly be excluded. According to this understanding, workers' intervention does not become obsolete. It is less dispensable than necessary in the case of malfunctions and failures, as well as the execution of wrong decisions. The necessity of this situation-related action depends largely on the decision quality of the respective ADM system, which can currently still vary greatly. In systems with high decision quality, the ADM system should generally request the worker's confirmation or inform if the worker explicitly requests its involvement. The difference to purely autonomous decision-making is that even in the case of unexpected situations, adequate decisions can be made by the system, making workers' intervention completely obsolete. In this context, machines can perform the same tasks as them, but in a different way (Huchler, 2019, pp. 161–162). The decisive factor is the fulfillment of the common work objective.

3.4. Excursus: Digitalization, ADM, and AI in figures

The relevance of ADM, both economically and socially, must be assessed in light of the current and future dissemination of these systems. It emerges quickly that the presence of the topic in scientific and public discourse is hardly compatible with the current diffusion of ADM systems. This does not imply that the potential use of modern technologies will not have a considerable, some would say disruptive, impact on work and society. Nevertheless, it remains to be pointed out that ADM systems are often used in specific cases or by specific workers and do not yet affect the broad mass of employees.

The diffusion and potential use of ADM in the German service sector are partly reflected in the degree of digitalization among companies, which serves as a benchmark for the fundamental ability to use ADM systems. Compared to the primary and secondary sectors, selected service branches generally lead the statistics on the degree of digitalization (e.g., Bundesministerium für Wirtschaft und Energie [BMWi], 2018, p. 21). The widespread assumption that the services sector is lagging far behind in terms of digitalization can only be partially substantiated, as will be shown in the following remarks: The most digitized sectors in Germany primarily include ICT, knowledge-intensive service providers, finance, and insurance. In contrast, transport and logistics and the healthcare sector have the lowest level of digitalization (BMWi, 2018, p. 13).

The relative frontrunners in the use of information processing technology for the independent solving of problems with computers, as a proxy for ADM, are in services (BMWi, 2020, pp. 2–3), namely ICT (18 % of companies), financial services (12 %), and business-related services (e.g., media, consulting, R&D, 11 %). However, these technologies are used less frequently in other services (e.g., security services, cleaning, other business services, 3 %), transport and logistics (2 %), and wholesale (1 %). Overall, only a fraction of other service companies are already using those applications (BMWi, 2020, p. 3). The status of learning systems is still in its infancy in Germany. Although companies expect them to play a significant role in the future, only 9 % of them use AI, probably referring to ML, themselves in 2022 (Bitkom, 2022). Overall, studies on the usage rates of AI in German companies differ greatly. They range from a few percent to 25 % of large companies (overview in Giering, 2022, pp. 57–58).

A closer look at individual sectors reveals a clear divide in the services sector in terms of the spread and depth of digitalization and using digital devices (BMWi, 2018, pp. 21–33): This digital divide is most evident in terms of the proportion of highly digitalized internal business processes and digital services. Transportation, logistics, and healthcare lag far behind other branches. However, the aforementioned differences in the degree of digitalization are much less pronounced when considering the number of companies in which all employees use mobile or stationary devices (BMWi, 2018, pp. 32–33). Although ICT (65 % and 80 %, respectively), financial and insurance services (66 % and 88 %, respectively), and knowledge-intensive services (46 % and 85 %, respectively) are also in the lead here, the differences are not as severe as, for example, in the degree of digitalization of internal processes. If companies that only partially equip their employees with mobile or stationary devices were included, the sectors considered would converge further. For example, around 70 % of healthcare workers use stationary digital devices and 37 % use mobile devices – which puts them in the middle of the pack in purely statistical terms.

These remarks on the degree of digitalization in companies make some points clear: On average, some service branches are ahead of the manufacturing sector when it comes to digitalized work processes or the diffusion of digital devices in the workplace. However, a digital divide within the service sector becomes apparent, which plays out between typical white collar, i.e., knowledge and information-intensive branches that are usually linked to office activities, and personal or object-related services. It is equally clear that the digitalization of processes and the use of digital tools have not yet reached all companies and, therefore, not all employees, regardless of the branch. This fact must be constantly kept in mind when dealing with the current use of ADM applications in the service sector.

What remains is the realization that specifically learning ADM simply does not yet play a role in a large number of companies, which seems quite debatable in view of the presence of the topic in the media and science (Giering, 2022, p. 59). As with digitalization, this argues for an incremental spread of learning systems in companies rather than a disruptive one (Hirsch-Kreinsen, 2018, p. 6). However, it is also possible that the actual use of AI applications, including ADM, is underestimated. Exemplary, Giering et al. (2021, p. 786) find that 20 % of the employed report using ML themselves, but if these systems are only described in terms of their functions, twice as many affirm. Again, fuzzy definitions of AI, ML, and ADM complicate the discussion of the topic.

S.-C. Meyer et al. (2022, p. 319) confirm that almost three quarters of all employees never use AI, whereby the definition refers more to learning ADM systems and adds the aspects of task complexity, occupational field, age, and sex to the perspective on the spread of those applications: Accordingly, the use of those systems generally increases with the complexity of the tasks. Unsurprisingly, IT and scientific service professions show the highest usage rates (although 61 % still never use AI). In person-related services, about one fifth are users (S.-C. Meyer et al., 2022, p. 324). There is a minor difference regarding sex and age (S.-C. Meyer et al., 2022, p. 323).

Supplementary data is provided by the DGB-Index (2022b, p. 16): This survey confirms that most employees, whether in the service sector or outside it, never use independent learning programs in their day-to-day work. However, a split is already apparent between more active industries and more restrained branches. For example, those learning systems are used particularly little in public administration, education, healthcare, and social services, while information and communication services, finance, trade, and logistics use them more frequently at work.

Likewise, the trade union ver.di attempted to quantify the potential impact of using AI, meaning independently learning systems, including ADM, at work for employees in a prospective survey (Zanker et al., 2019, p. 24). This initially confirmed the previous hypothesis of a split in using those systems by branch. The service branches with relatively high usage rates include information and transport, as well as financial and insurance service providers. The lowest usage rates were once again reported by trade, healthcare, and social services. The affirmative votes in terms of learning system use are predominantly located in large companies and less in small and medium companies (Zanker et al., 2019, p. 25). The primary areas of application are in all areas, from service provision to external communication and internal administrative activities. Interestingly, among the companies using them, learning elements of technical systems are most often deployed in sales. This is also where a high proportion of interactions with clients can be assumed, i.e., AI applications are already influencing core activities in the service sector (Zanker et al., 2019, pp. 25–26).

Using ADM systems to provide services initially leaves open how exactly these procedures intervene in work processes. These brief insights into the nature of ADM in the services sector, despite all the conceptual ambiguities with digital systems and AI, confirm the previous assumptions about a digital divide that also translates into an ADM divide. Once again, it is the knowledge-intensive sectors, i.e., those with a particularly substantial number of highly qualified employees, often in data-related activities, whose work and environment are particularly digitized. This means that different starting points in the branches must be considered regarding the possible use of ADM. It is likely that this digital divide will be reproduced regarding the use of ADM systems, as these indicators can be considered catalysts for ADM use. On the one hand, this may suggest that implementation takes longer in less digitized areas, but even more importantly, it implies that employees who already work with little technology support may be overburdened or at least restricted by the possible use of ADM, which can also have a considerable impact on job autonomy.

4. Facets of job autonomy in service work

The intention of Chap. 4 is to formulate a definition of job autonomy on which this thesis is based. The requirements for this concept are demanding, as it is supposed to do justice to the complexity and diversity of modern work constellations but at the same time being as intuitively understandable and operationalizable as possible for the empirical contributions. Following the attempt in the introductory chapters (1.3 and 1.4) to embed job autonomy in the organization of work and to describe its relevance, the importance of reformulating the concept is presented (Chap. 4.1). Seven dimensions of job autonomy are both defined and placed in the context of the research question by consulting selected empirical findings (Chap. 4.2). These seven dimensions of job autonomy should be understood as a proposal and a starting point for further conceptual considerations around the term.

4.1. Call for conceptual renewal

Regardless of the perspective – science, politics, or art – there is a broad disagreement on the conceptualization, evaluation, and measurement of autonomy (overview in Franzen et al., 2014). Considering autonomy in relation to work, research approaches that emerged in the 1970s and 1980s as a reaction to Taylorist work systems, i.e., motivation-reducing and alienation-promoting tendencies in job redesign (Hackman & Oldham, 1975; Sims et al., 1976), do not give the concept of job autonomy much dimensionality. These concepts evolved along Taylorist production work and their transferability to service work or other forms of work (e.g., project work or group work) must at least be questioned (M. Frey, 2009, p. 25). Little attention was paid to job autonomy outside Breaugh's (1985) dimensions of method, scheduling, and criteria autonomy. Sovereignty over working hours, task-related degrees of freedom, flexibility with respect to the place of work, or dependencies on third parties are hardly discussed. Job autonomy is often found in today's research attempts as an aggregated concept that lacks conceptual clarity.

The starting point for reformulating the concept of job autonomy is Moldaschl's (2001, p. 136) idea on *autonomy of action* (Handlungsautonomie):

> Autonomy of action at work, understood in psychological approaches as scope for action, decision-making or disposition, in the English control de-

bate as 'job control' (i.e., control at work), refers to the possibilities of determining own goals and partial goals, deciding independently on ways and means, etc.[25]

To this end, Ulich (1988, as cited in Ulich, 2001, p. 175) adds the scope of task as a "multidimensional construct consisting of scope for action, scope for design, and scope for decision-making"[26]. The scope for action refers to all degrees of freedom for action in the execution of work tasks (e.g., scheduling, selection of procedures) (Hacker, 1978, p. 72). Scope for design implies the possibility of self-determination in approaching and structuring tasks, i.e., task variability. Finally, the scope for decision-making encompasses the given decision-making competence in the performance of tasks (Ulich, 2001, p. 175). Ulich names the scope for decision-making as particularly decisive for job autonomy – which also indicates the delicate relationship between ADM and job autonomy.

Building on both concepts, the understanding of job autonomy in this thesis *describes autonomy at work, i.e., the possibility of determining the courses of action in relation to an individual's own work processes.* These self-determined courses of action encompass various dimensions, as clarified in the next chapter.

The demand for a new concept of job autonomy is generally supported by several authors (e.g., M. Frey, 2009; Moldaschl, 2001). "The concept of autonomy must be redefined in terms of content and operational aspects so that 'modern' contradictions become more comprehensible"[27] – more than 20 years ago, Moldaschl (2001, p. 161) formulated the call for a redefinition of the concept of job autonomy. In addition, M. Frey (2009, p. 24) questions "the adequacy of the still strong fixation on the paradigmatic field of Taylorized work per se, production work in the

25 Own translation of "Handlungsautonomie in der Arbeit, in psychologischen Ansätzen gefasst als Handlungs-, Entscheidungs- oder Dispositionsspielraum, in der englischen Kontrolldebatte als 'job control' (das heißt als Kontrolle *in* der Arbeit), bezieht sich auf Möglichkeiten, eigene Ziele und Teilziele zu bestimmen, selbstständig über Mittel und Wege zu entscheiden etc." (Moldaschl, 2001, p. 136).

26 Own translation of "mehrdimensionales Konstrukt, das sich aus dem Handlungs-, dem Gestaltungs- und dem Entscheidungsspielraum zusammensetzt" (Ulich, 1988, as cited in Ulich, 2001, p. 175).

27 Own translation of "Der Autonomiebegriff ist inhaltlich und operational so neu zu bestimmen, dass 'moderne' Widersprüche fassbarer werden" (Moldaschl, 2001, p. 161).

male-segregated core sectors of industry"[28]. Both authors assume that the premises of job autonomy, which were developed in the context of industrial work, are not easily transferable to other, more decentralized or interaction-related forms of work, such as the service sector. Lallement (2015, p. 235) further argues that in "a society where the service sector employs the vast majority of the working population, autonomy is no longer gained through opposition to hierarchy. [...] It interacts with supervisors, peers, multiple company stakeholders, and, of course, customers". He thus understands job autonomy as the anchor point for the reorientation of work organization within a service society.

More decentralized forms of work as well as service activities are generally assumed to have greater job autonomy, i.e., more freedom of action and organization (M. Frey, 2009, p. 25; Moldaschl, 2001, p. 133). This assumption also implies that these forms of work are characterized to a large extent by self-determined work (M. Frey, 2009, p. 25). However, as Frey continues, an opposite development seems to be empirically observable in current employment relationships. Many employees are experiencing an increase in the pressure to meet deadlines and higher workloads, which is also reflected in the decay of health (e.g., DGB-Index, 2019, pp. 16–18).

On this matter, Moldaschl (2001, p. 133) doubts that job autonomy within decentralized organizational forms of work can guarantee more autonomous action without conflict. His work points to the fact that "'modern' labor harbors new relations of freedom and coercion"[29]. The author assumes that job autonomy cannot be absolute but rather describes a specific relationship between demands and opportunities for action (Moldaschl, 2001, p. 143).

Particularly new workload constellations are, according to Moldaschl (2001, p. 160), closely related to the emergence of *recursively instrumentalized autonomy* (rekursiv instrumentalisierte Autonomie) – the transfer of responsibility for action to employees, which grants them more freedom of action regarding individual aspects of work but also serves restricting moments through performance-based constraints. In this respect, Moldaschl attributes positive effects to Tayloristic work systems in that there are predetermined performance and goal criteria

28 Own translation of "die Angemessenheit der noch immer starken Fixierung auf das paradigmatische Feld Taylorisierter Arbeit schlechthin, der *Produktionsarbeit* in den *männlich segregierten Kernsektoren* der *Industrie*" (M. Frey, 2009, p. 24).

29 Own translation of "'Moderne' Arbeit birgt neue Verhältnisse von Freiheit und Zwang" (Moldaschl, 2001, p. 133).

that create overall negotiation autonomy. In contrast, decentralized forms of organization rely on performance and work criteria being constantly renegotiated between employees and employers.

This idea finds recognizability in the concept of the *Entreployee* (Arbeitskraftunternehmer) following Voß and Pongratz (1998, pp. 11–18): Under the premises of global capitalism, workers are forced to develop the character traits of entrepreneurs themselves, which imply increased self-control, planning, and monitoring of their work performance. Performance control is transferred from management (directly) to employees (indirectly). Following Moldaschl's (2001, p. 136) example, the thesis of expanding autonomy of action for the employed applies once again. This new scope for action may also be accompanied by new implicit constraints, consisting of the desire to achieve corporate objectives and the associated individual sense of responsibility. The discussion of job autonomy as a means of organizing work is taken up centrally in the following Chap. 5.

However, these collected remarks on the criticism of outdated approaches to job autonomy or concepts that are merely assigned to production work highlight three issues: First, the concept of job autonomy lacks the dimensionality to reflect the modern world of work characterized by services. Second, job autonomy is a concept marked by conflict, which can no longer be regarded merely as the antithesis of restrictive principles of traditional work organization but has opened up into a field of conflict between freedom and coercion at work, revealing both low and high job degrees of autonomy in relation to control mechanisms. Third, job autonomy, even if related to the subjective perspective of employees, cannot be considered detached from the work and actions of others (e.g., colleagues, service recipients), but always moves in a tangle of interests and demands. An essential element of this thesis is therefore to achieve a broader conceptual understanding of job autonomy that is more appropriate to modern work relationships, and conflicts.

4.2. Seven dimensions of job autonomy

The following remarks reformulate existing conceptions of job autonomy, which are intended to do justice to the current characteristics of work. This step is necessary because, on the one hand, research on the transformation of job autonomy (in the wake of digitalization and the use of ADM) is often limited to generalizations of the whole economy or with a focus on production work (e.g., Butollo, Jürgens, & Krzywdzinski, 2018; Giering & Kirchner, 2021; Menz et al., 2019; Nies, 2021), resulting in limited translation potential to service work. On the other hand, existing concepts of job autonomy lack dimensionality. They are often limited to task latitude at work, i.e., methodical and time-related factors in the execution of tasks (e.g., Kirchner et al., 2020; S.-C. Meyer et al., 2019).

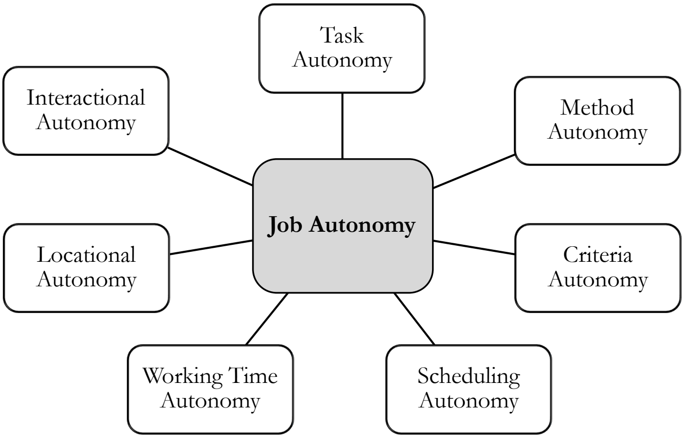
The present reformulation of job autonomy complements these concepts and leads to a more coherent picture of the term. It is intended that the following autonomy dimensions are neither tailored to service work nor to the use of ADM, so that their applicability to other scientific contexts is maintained. It is equally important that the subject perspective of the individual dimensions is preserved. This means that it must always be asked in a practical way whether workers can relate to the concept regarding their specific work task, whether it affects them, and if the individual aspects of a dimension have a corresponding closeness to the work process.

The following seven dimensions of job autonomy (Figure 3) are initially derived from existing research approaches in sociology, economics, business administration, and psychology. Hence, the following remarks also take the form of a research status. The term "autonomy" is less prominent in most studies. Rather, it is a matter of identifying and analyzing factors that can potentially be subsumed under this term. This exercise is designed not only to achieve an overview of the various aspects of job autonomy as well as their empirical relationship with digital work tools and ADM, but also to use these aspects for a later conceptualization of job autonomy in Part II and Part III.

The job autonomy dimensions mentioned refer to the concept of autonomy of action following Moldaschl (2001, p. 136). Thus, they refer to the task level, which functions as the level of analysis for the influence of ADM on job autonomy. The seven dimensions identified include Task Autonomy, Method Autonomy, Criteria Autonomy, Scheduling Autonomy, Working Time Autonomy, Locational Autonomy, and Interactional Autonomy. Although one or more of these dimensions have already been extensively analyzed in previous studies, they have not been considered in the same combination as the following.

The presentation of this reconception of job autonomy starts with a brief definition of the respective dimension, followed by a discussion of selected empirical findings relating to its characteristics. Wherever possible, reference is made to specific empirical findings from the service sector. Since empirical findings on individual aspects of job autonomy and ADM are very incomplete, reference is made to results from the context of digitalization and the more generic term AI.

Figure 3: Dimensions of job autonomy



This research state (marked as *in context*) is intended to show rather broad contours and tendencies in individual dimensions of job autonomy. However, it will once again become apparent that a systematic quantitative and qualitative examination of the relationship between job autonomy and ADM, as aimed at in this thesis, is necessary. Studies on the analysis of possible changes in working conditions in companies that are already working with ADM are scarce – not least because the deployment rate is still very low in many branches. Unsurprisingly, some studies assume that automated language, image or text processing, or the retrieval of expert knowledge, as the most common application for ML, does not have a fundamental impact on working conditions and link the major levers to its embedding in given technical and organizational structures (e.g., Giering & Kirchner, 2021, p. 574).

More differentiated results regarding the effects of AI on job autonomy are often expressed in the form of ambivalent expectations. In a survey by Meinungsmonitor Künstliche Intelligenz (2020, p. 6), one quarter of respondents either expect to have less autonomy at work or are undecided. Almost half do not expect less job autonomy. In contrast, almost 60 % of respondents in Zanker et al. (2019, p. 28) believe that the use of learning systems will reduce their scope for action. This ambivalence possibly reflects a future polarization scenario. Some employees lose job autonomy using ADM, while others gain. In this case, it is important to identify which tasks, occupational groups, or even branches are affected by one or the other.

4.2.1. Task Autonomy

Definition

The majority of research approaches to the concept of Task Autonomy refer to the freedom of workers to choose how a work task is performed (e.g., Battistelli et al., 2013, p. 29; Langfred & Moye, 2004, p. 934; Wielenga-Meijer et al., 2012, p. 6). It is therefore referred to as job autonomy with respect to the method of task execution. In the following, from this partial conceptual blurring is deviated as far as a distinction between Task and Method Autonomy of employees is conducted. This separation follows the assumption of Langfred and Moye (2004, p. 935), who stated that a job consists of a number of tasks to which different degrees of autonomy can be attributed.

According to Sichler (2006, p. 247), the possibility of shaping work tasks contributes substantially to the understanding of autonomy. Task Autonomy refers to the possibility for workers to select (or reject) work tasks from a set of tasks and thus construct an individual composition of tasks. Workers would therefore also have a say in the quantity of work they do and the task variability through this approach. Task variability comprises the variety of tasks that need to be completed at work, which contrasts with monotonous and repetitive work processes. Likewise, the completeness of a work task is counted as Task Autonomy, which specifies that tasks can be carried out and accompanied from start to finish. Thus, the execution of individual tasks that are detached from the overall work goal or missing information within the work process disagrees with the potential of Task Autonomy. Task Autonomy thus explicitly asks which tasks are completed and in what way the task range can be influenced, not how the tasks are ultimately completed.

> Characteristics of Task Autonomy: possibility to choose work tasks from task set; task variability; composition of work quantity; completeness of tasks and information.

In context

Within the context of using digital work tools and ADM, job autonomy, or more precisely, Task Autonomy, is frequently associated with a change in the amount of work and the impact on task variety, although the direction of impact is assessed quite differently. Kohlrausch (2019, p. 25), for example, describes how digitalization results in around one-third of employees having to perform more tasks in less time. In addition to the fundamental trend towards intensification that goes hand in hand with the use of digital means, there is also less influence on the amount of work. In fact, a considerable increase in the amount of work performed by workers is described in all service branches in the wake of digitalization. In some cases, well over half of the workers describe that their workload has increased, for example, in finance and insurance, education, and healthcare. Only a fraction of people believe that their workload actually decreased (Table 17 | Appendix).

Whether these developments are curbed or reversed using ADM remains questionable for the time being. At least S.-C. Meyer et al. (2022, p. 328) suggest that the probability that employees can influence the amount of work increases with learning AI systems, which includes learning ADM. How might this additional amount of work arise in the first place? The ironies of automation (Bainbridge, 1983, pp. 775–776) assume that technical rationalization processes are always associated with unintended additional costs and efforts, such as the maintenance and optimization of technical systems. Unsurprisingly, there is also evidence of a higher probability of completing new tasks when using learning systems (S.-C. Meyer et al., 2022, p. 328).

This is in contrast to Fleming et al. (2019, p. 3), whose studies assume fewer work tasks in combination with ML systems. The authors investigated tasks that are particularly suitable for ML, such as scheduling appointments, and found that occupations that meet this definition have fewer tasks to perform, i.e., their task variability is restricted.

If ADM systems are deployed and work processes are thus formalized to a certain extent so that they can be performed by such systems at all, the task variability of employees is, in essence, restricted. After all, the purpose of the application is usually to take over certain work steps entirely, or at least to support employees in carrying them out. If many tasks from the task range of employees are omitted, the number of repetitive, monotonous work steps can increase. In fact, there is some evidence that work with learning systems is interspersed with a higher probability of repetition, i.e., a higher degree of monotony, especially for personal services (S.-C. Meyer et al., 2022, p. 328, 337). Thus, the danger of increasing monotony comes with highly substitutive technical systems. With increasing monotony, the question of contradictory work requirements also arises, which is rooted in an alternation between underchallenge (monotony) and overchallenge (dealing with ad hoc disturbances) (Hirsch-Kreinsen, 2020, p. 146).

Presumably, all these effects exist in different work scenarios: increased workload and decreased workload, as well as higher task variability and more monotonous work. The direction of effect probably depends on the intervention depth of the ADM system in work processes and affects professions very differently depending on task content, qualification, and form of organization.

The issue of qualification in particular will remain exciting in the future, since augmenting systems might be capable of enabling less qualified employees to perform certain tasks in the sense of a guidance system, i.e., to expand their range of tasks (Beuschel, 1995, p. 323). However, if the use of recent technologies enables less qualified personnel to carry out certain tasks, this development often harbors the risk of polarization of qualifications.

Whether workers feel restricted in their actions by the changed task conditions ultimately depends on their need for task variety and the degree to which their workload is manageable. Thus, regarding Task Autonomy, whether the substitution of tasks is beneficial to job autonomy depends on whether they really want to be relieved of these tasks or not. It is likely that some workers perceive the relief from certain simple decision-making tasks as relieving, while others will feel deprived of their task variability. Thus, the effects of changing Task Autonomy also depend on the extent to which the use of the system is linked to constraints or is available as an optional support tool.

The holistic nature of the information provided by an ADM result must be considered questionable. It is certainly plausible that these systems could, for example, support the selection of one's own task portfolio by providing the right data in the right quantity. However, Papsdorf (2019, p. 150) poses the risk of a mismatch between the quality and quantity of information in digital systems. If employees are provided with too much or too little usable data, the possible supportive function of the system is quickly reversed, which initially leads to a higher work quantity. The usability of a system in the sense of Task Autonomy therefore depends on its functional quality.

4.2.2. Method Autonomy

Definition

There is a broad consensus that Method Autonomy serves as a core dimension of job autonomy. Early approaches to job redesign usually use some form of workers' freedom to choose the procedures and methods within their work (e.g., Breaugh, 1985, p. 556; Hackman & Oldham, 1975, p. 162; Sims et al., 1976, p. 197; more recently, Morgeson & Humphrey, 2006, p. 1323). Exemplary, Breaugh (1985, p. 556) defines this dimension as "The degree of discretion/choice individuals have regarding the procedures (methods) they utilize in going about their work".

More recent research contributions rely on similar definitions of Method Autonomy, such as Spiegelaere et al. (2016, p. 517), for which Method Autonomy "refers to the discretion of employees on how to perform the work tasks in terms of procedures and work methods". In this definition, the selection of methods to perform a work task includes not only the cognitive means to support the execution but also physical aids in the sense of (digital) tools. In the broadest sense, building competencies (Pichault & McKeown, 2019, p. 63) and having certain degrees of freedom to approach tasks experimentally (Spiegelaere et al., 2016, p. 518) can also be considered part of the Method Autonomy dimension. Method Autonomy therefore essentially questions the extent to which employees can decide for themselves the way in which they complete a work task.

> Characteristics of Method Autonomy: selection of procedures, methods, and tools to perform work tasks; possibility to build up competencies.

In context

Specific empirical findings relating Method Autonomy and ADM are rare, presumably also because many studies equate job autonomy with Method Autonomy without formulating it in concrete terms. Fundamentally, Method Autonomy is negatively related to work pressure (Schieman, 2013, pp. 277–278), so the promotion of this dimension is fundamentally desirable.

As the demand for decision-making skills increases (Deming, 2021, p. 31), the question arises as to who will make the decisions about processes, methods, and tools in the future. If Method Autonomy is explicitly concerned with the ability to determine how a work task is executed, then ADM systems centrally challenge these decision-making freedoms. Certainly, the use of ADM systems fundamentally offers an alternative course of action to their previous methodical specification. The decisive factor seems to be not necessarily what decision is affected, but who retains or receives control over the decision-making process in the course of delegating tasks to ADM systems (Koeszegi, 2021, p. 69). Depending on the system in question, it is likely that some or even all decision-making processes are transferred to the system in the case of full automation, which would minimize Method Autonomy.

Up until now, workers in the service sector have assumed that digitalization has different effects on the scope of decision-making. Although most of them do not expect any change, their perceptions of increased or decreased freedom of decision-making in the service sector do diverge. There are some branches in which up to a quarter of employees report increased freedom to make decisions (e.g., trade, information and communications services, or education). But in the financial and insurance sector and the healthcare segment in particular, these figures are offset by considerable decreases in decision-making opportunities for some (Table 17 | Appendix).

In addition, Kirchner et al. (2020, p. 16) show that the effect of using digital tools on Method Autonomy clearly depends on the content of the task. Knowledge workers benefit from the use of digital tools, while more person-related tasks, especially if they have no previous experience with digitality, are more likely to suffer moments of autonomy restriction. In the case of Method Autonomy, the elements of qualification and task content clearly come into play in the relationship between technology use and job autonomy. For example, Logg et al. (2019, pp. 31–32) describe that employees with less competence in a certain area prefer to rely on the decisions of the algorithm. This tends not to be the case for more highly qualified employees. Method Autonomy, however, is even dispensed with under certain circumstances as specific characteristics are attributed to an ADM system. The non-use of competence might be reflected in a reduction of Method Autonomy. In the last consequence, the use of ADM systems could reduce the buildup of competences.

In this context, an essential question arises regarding ADM, namely the transparency of the decision-making processes and results. It is well known that transparency is hardly given in complex systems that use ANN (Kraus et al., 2021, pp. 18–20), for example. Without this understanding of the results, which ultimately deprive employees of control over the work process, they may lack a basis for decision-making. Furthermore, the lack of information or information asymmetries may imply a certain devaluation of work.

If using an ADM system is linked to a certain degree of formalization of processes to make the system usable in the working environment, there is a danger to Method Autonomy. Papsdorf (2019, p. 53) refers to this process as the disciplining of work. It enables system planning and control, as well as transparency and reproducibility (Huchler, 2019, p. 148). If the adaptability and controllability of systems reach their limits, standardization is often relied upon, i.e., the environment is adapted to systems and not vice versa. This standardization can be interpreted at the expense of individual job autonomy, especially in the methodical sense (Huchler, 2019, p. 165).

4.2.3. Criteria Autonomy

Definition

Criteria Autonomy essentially describes to what extent workers can choose and influence the criteria for evaluating their work results and how work performance is assessed. Breaugh (1985, p. 556) describes this autonomy dimension as "The degree to which workers have the ability to modify or choose the criteria used for evaluating their performance". Thus, the dimension revolves not only around whether influence is exerted on the exact work goals, but originally on the evaluation of performance and the ability to assess work achievements. The criteria could therefore be interpreted as a type of evaluation criteria. From the current perspective, these evaluations may, of course, also involve digital or even algorithmic processes.

The idea of Criteria Autonomy is only included in a few studies on overall job autonomy. Besides Breaugh (1985), the Maastricht Autonomy Questionnaire (Jonge & Schaufeli, 1998, p. 393) and DeCotils and Koys (1980, p. 173) refer to self-determination in relation to work goals. Nicholson (1984, p. 178) extends this understanding of Criteria Autonomy to include the possibility of choosing work goals and ways of achieving them. Criteria Autonomy thus implicitly includes taking responsibility for work results and assumes that work goals are pursued consciously and intentionally.

> Characteristics of Criteria Autonomy: ability to modify or choose the criteria used for evaluating work performance; taking responsibility for work performance; possibility to set work goals and to pursue them consciously and intentionally.

In context

Although the contents of Criteria Autonomy are not often associated with autonomy in terms of definition, it is precisely in light of digital and algorithm-driven means of measuring work performance and setting work objectives that the dimension takes on considerable significance for employees. Particularly present and frequent are considerations of increased monitoring and control tendencies in the course of digitalization and ADM application at work, which imply a diametral understanding of Criteria Autonomy.

A couple of years ago, it was already noted in the service sector that control mechanisms in the workplace are changing drastically (Kratzer &

Dunkel, 2013). It is likely that these trends have increased due to the new possibilities of digitalization and the use of ADM, and that they will intensify even further. This is indicated by Ahlers (2018, p. 8, 14), who analyzes various forms of control mechanisms by industry: Work and performance control as a result of technological progress appear to be particularly high in the already highly digitalized financial and insurance sector. Many work councils surveyed in logistics, accommodation and food services, information and communication, trade, and business-related services report the same trend. The frequency of automatic recording of work steps by a computer program shows similar levels by branch. These mechanisms are less pronounced in public services and education, which in turn are presumably subject to less marketization and rationalization pressure.

In addition, Kohlrausch (2019, p. 25) notes that almost half of all workers believe that new technologies enable them to achieve better work results. At the same time, however, more than 40 % report that digitalization is increasing the monitoring and control of their own work performance. Recent surveys confirm these impressions: Depending on the branch in question, well over a third of employees often perceive increased monitoring and control mechanisms as a result of digitalization. This is particularly true for logistics, healthcare, and social services. Hardly anyone perceives a decrease in monitoring and control (Table 17 | Appendix).

According to a survey by MeMo:KI (2020, p. 6), 40 % of employees associate the use of AI in the workplace with increased monitoring by their employer. S.-C. Meyer et al. (2022, p. 327) also provide alarming evidence that the likelihood of deadline pressure at work increases sharply with constant use of learning systems. The results are particularly striking for person-related (as well as other) services, whose likelihood of suffering from deadline and performance pressure increases by more than 20 % when they work with these systems (S.-C. Meyer et al., 2022, p. 337). In this case, ADM use seems extremely negatively related to Criteria Autonomy.

This plethora of monitoring and control tendencies gives reason to believe that control possibilities are inherent in all digital and ADM systems. Whether and how these are exploited must be assessed on a case-by-case basis. Beyond the pure monitoring and control capabilities of ADM systems, Criteria Autonomy may be viewed in the context of algorithmic management. Algorithmic management influences management tasks. Parent-Rocheleau and Parker (2022) provide an overview of the functions that algorithms are already capable of. In connection with performance evaluation, goal setting, or planning tasks, possibilities for (negatively) influencing the autonomy of management personnel are visible. Langer et al. (2021, pp. 760–761) note that satisfaction with algorithmic results is highest when superiors can still influence them and assess decision chains themselves.

The functions of algorithmic management systems are multifaceted (Gilbert et al., 2021, p. 15): They substitute for management positions, enable remote monitoring of employees, and give them instructions, thereby influencing not only the setting of work objectives but also their execution (Method Autonomy). This refers to systems in which ADM provides at least partial or complete control of work by means of work instructions and in which work objectives are also precisely calculated and specified. Gensler and Abendroth (2021, p. 532) find that workers who receive daily algorithm-based work instructions have significantly less autonomy than their counterparts. The authors explain this result by stating that the influence of algorithmic work control is perceived as effective when it is also frequently used (Gensler & Abendroth, 2021, p. 537).

Presumably, it is not only the mere work objectives that are set that have an adverse effect on the autonomy of workers, but also, as already indicated under Method Autonomy, the delegation of responsibility, this time for the work results. Complementary systems that maintain this sense of responsibility for work results and, at the same time, have a supporting effect could be interpreted as quite conducive to Criteria Autonomy. The extent to which responsibility for work results is handed over to a technical system by employees ultimately depends on the concrete work objectives, or, in the case of service employees, also on the service recipients, from whose judgment and justification workers can hardly escape.

In any case, the use of ADM systems at work, as soon as they intervene in the control and goal-setting of employees, poses a considerable threat to Criteria Autonomy, the complete, technically supported elimination of which is at least theoretically possible. Thus, the question arises: If there is no influence at all on the work objectives and criteria for evaluating one's own work, how is autonomous and independent work supposed to function?

4.2.4. Scheduling Autonomy

Definition

Scheduling Autonomy, similar to Method Autonomy, is present in a large number of studies and discussions of job autonomy. Breaugh (1985, p. 556) is quoted yet again as he understands Scheduling Autonomy as follows: “The extent to which workers feel they can control the scheduling/sequencing/timing of their work activities”. More recently, Spiegelaere et al. (2016, p. 517) name a similar definition by stating that “work scheduling autonomy refers to the discretion of employees on when to perform which work task”. Thus, the two dimensions of Scheduling Autonomy and Method Autonomy are closely related to each other in that they have the closest relations to work tasks and their execution. In early research approaches (e.g., Hackman & Oldham, 1975; Sims et al., 1976), both dimensions were therefore often considered together or not differentiated at all.

The definition of Scheduling Autonomy in reference to Breaugh (1985) and Spiegelaere et al. (2016) is extended by pace of work (e.g., Pichault & McKeown, 2019, p. 67) and break determination. They can be considered as supplementing aspects for the analysis of time-related job autonomy in the execution of work tasks by giving further insights into the intensity of the work, referring to the number of work tasks executed in a predefined amount of time.

Additionally, the definition of Scheduling Autonomy is extended to the aspects of handling interruptions and uncertainties at work. These interruptions and uncertainties may have various triggers (e.g., third parties or malfunctions of technologies) as well as considerable influence on employees’ time management. As a counterpart to the independent scheduling of work (Spiegelaere et al., 2016, p. 519), this aspect is explicitly included because interruptions at work occur particularly frequently in service branches and in dealings with customers, clients, or patients (DGB-Index, 2021b, pp. 88–89). Scheduling Autonomy thus addresses the question of the extent to which work is planned independently and whether this planning is subject to external influence. Scheduling Autonomy thereby covers, in particular, the time-intensifying aspects of work.

> Characteristics of Scheduling Autonomy: ability to decide on sequence, prioritization, timing, and speed of task completion; break determination; independent handling of disruptions and uncertainties.

In context

Similar to Method Autonomy, Scheduling Autonomy has the potential to exert a positive effect on employees’ perceived work pressure (Schieman, 2013, pp. 277–278), indicating that the importance of this dimension and the potential influence of ADM systems should not be underestimated.

Empirical findings on the interplay between Scheduling Autonomy and digital technologies, or even ADM, have rarely been conclusive. S.-C.

Meyer et al. (2019, p. 219) show that the introduction of new computer programs slightly increases the probability of planning one's own work independently. However, this connection was not found with the introduction of new manufacturing and process technologies. Furthermore, the authors report that new computer programs are negatively related to repetitive operations, while new manufacturing and process technologies make this development more likely. The authors conclude that differences in the scope for action and monotony emerge depending on the type of technology. Again, this shows the difficulty in trying to transfer knowledge about digitalization and other technical innovations to ADM.

Schaupp (2021, p. 23) aptly describes algorithms as organizational technologies that serve the structuring of work. It is precisely in this structuring sense that ADM systems are able to influence Scheduling Autonomy or to deprive workers of it. Similar to Criteria Autonomy, the core elements of algorithmic work control, in particular when work instructions are available, are of particular importance, not with regard to work goals but to planning capacities. However, systems do not necessarily have to restrict Scheduling Autonomy by issuing work instructions. It is also possible that the person giving the instructions, i.e., the supervisor or management, is replaced and implicitly more is left to one's own organization (Schaupp, 2020, p. 205), whereby the work objectives remain unchanged. Both possibilities can lead to more intensive and less autonomous work.

The clear perception of increased parallel processes at work as a result of digitization also speaks for an increasing intensification and thus less independent planning of work. In all service branches, almost half of the employees describe this development. This is particularly true of branches with an already high level of digitalization, such as information and communications services or finance and insurance (Table 17 | Appendix). The problem with a higher degree of parallelism of tasks instead of sequentially lies in the fact that there is less influence on when tasks are completed.

Regarding the use of learning systems, S.-C. Meyer et al. (2022, p. 327) share this assessment, as they also calculate a higher probability of multitasking at work when these systems are used continuously. This particularly affects person-related services, which are also less likely to be able to influence their work pace (S.-C. Meyer et al., 2022, pp. 337–338). Gerst (2019, pp. 120–121) confirms these expectations and considers them in the context of higher performance requirements. In view of the already intensive person-related services, this potential impact of the ADM system on Scheduling Autonomy must be observed with particular sensitivity.

Interruptions at work are likewise a major obstacle at work in service occupations, especially for those who are frequently in contact with customers, clients, and patients (DGB-Index, 2022a, p. 54). Service occupations show considerably higher probabilities of being interrupted at work, including when dealing with learning systems (S.-C. Meyer et al., 2022, p. 337). These expectations are shared by work councils, who, according to Zanker et al. (2019, p. 28), expect the use of learning systems to result in more difficult conditions for employees: More than half report that the intensity of work and almost as many are convinced that unplannability and disruptions at work will increase.

Interruptions and unpredictabilities, for example, in dealing with service recipients, can arise when system errors occur, the quality of results is insufficient, or the system generally cannot be relied upon. Although system errors potentially affect all autonomy dimensions, they particularly impact Scheduling Autonomy due to the need to react to these unpredictabilities (in terms of time). These occurrences must ultimately be expected in any system, since it is simply unrealistic to take into account all conditions, possibilities of influence, and changes in the planning of work processes in advance (Gerst, 2019, p. 118).

In this context, Weltz (1999) speaks of a *double reality* in companies, i.e., on the one hand, the theory of a planned work process, and, on the other hand, the reality of the usually invisible correction of this planning by workers. Considering ADM systems in relation to Scheduling Autonomy reveals such systems as part of the mechanism and possibly also the initiator, whether intentional or not, of increasingly intensified work situations.

4.2.5. Working Time Autonomy

Definition

In contrast to Scheduling Autonomy, which refers to the time dimension in relation to concrete work tasks, Working Time Autonomy determines "the discretion of employees on when to stop and start working," according to Spiegelaere et al. (2016, p. 517). In the context of job autonomy, this approach forms a comparatively new level of consideration. Its significance results from the increase in flexible working time regulations. The definition of Spiegelaere et al. (2016) implicitly encompasses the possibility and characteristics of working outside the traditional working hours and variations such as working in the evening, at night, or at weekends, as well as doing overtime.

The hours worked during the day or the week can vary just as much as the number of hours worked during those periods (Stadler, 2019, p. 61). In the broadest sense, the choice of total working hours has an equally specifying effect on this dimension. The autonomy-relevant question is to what extent this working time can be determined by workers themselves and is perceived as burdensome. A key distinguishing component in terms of job autonomy is the perspective from which working time is controlled: by the employee or by the employer (Stadler, 2019, p. 62).

Working Time Autonomy therefore centrally discusses the relationship between flexibility options (autonomous, sovereign organization of working time) and requirements (operational processes, market or industry specifications, employer demands) (Wöhrmann et al., 2016, pp. 7, 54–82). In addition to the beginning and end of working time in terms of days or weeks, Working Time Autonomy may also refer to interruptions in working time routines such as on-call duty. Backhaus (2022, p. 2) discusses this characteristic as working time variability.

These forms of routine interruptions are explicitly included in this dimension because they erode the predictability of working time for employees. In summary, Working Time Autonomy refers to the extent to which workers can influence the extent, position, and plannability of their working hours. Thus, the dimension covers, in particular, the extensifying aspects of work.

> Characteristics of Working Time Autonomy: possibility to determine the beginning and end of working time; determination of total working time and overtime; on-call duty.

In context

Findings on digitalization or even ADM in connection with the ability to influence working time are rare and often mixed with local components, namely in the context of remote work. However, aspects of working time in which ADM has a regulating effect on employees are certainly visible but rarely reflected in studies. For example, the working time of suppliers in logistics is controlled by algorithms according to their evaluated performance (e.g., Schreyer & Schrape, 2021, p. 286, 291). Nevertheless, the regulation of working time by ADM remains a largely unknown field, although the essential correlation between health and working time is scientifically undisputed.[30]

30 Exemplary, Beermann et al. (2019, pp. 3–5) describe the negative relationship between long working hours, health and safety as clearly proven by scientific studies. They are

What is well known, albeit independent of technology, is that workers have certain restrictions on the choice of their working hours. For example, it has been shown that there are people who work part-time involuntarily. Involuntary under- and over-employment situations are quantified at 2.1 million and 1.5 million people, respectively, in Germany (Statistisches Bundesamt [Destatis], 2020). Wöhrmann et al. (2016, pp. 9–11) further show that employees in Germany on average work 43.5 hours per week, presumably more than contractually agreed. Just under half of all employees would like to reduce their working hours. Only 38 % have a great deal of influence over when they start and end their work, as well as when they take a few hours off. While this fact is certainly not due to any particular technology use, but to multiple other organizational factors, it does suggest that there are a large number of workers who have little Working Time Autonomy.

It is likely that Working Time Autonomy is sensitive to changes in the other autonomy dimensions, especially Task and Scheduling Autonomy. In this regard, Hünefeld et al. (2019, pp. 77–78) report that workers who can influence the start and end of their work but who are exposed to high workloads and high work pressure are more likely to try to compensate for the intensity by working overtime. Roth (2019, pp. 40–42) confirms these findings by pointing out that employees work more hours if the amount of work would otherwise be impossible to perform or because it is a work instruction from the company. Incidentally, the same reasons apply to weekend or evening work. Again, within the dimension of Working Time Autonomy, it becomes clear that the pure flexibility of working time has nothing to do with self-determination. It depends on whether it is a matter of self-determination on the part of the employee or of external determination on the part of the company (Krug et al., 2019, p. 7).

Now, how can the influence of digital or algorithm-controlled systems be combined with Working Time Autonomy? At the very least, it is possible that networked systems can free employees from the rigidity of a specific work location (Georg & Guhlemann, 2020, p. 20) and thus possibly also open up time-related freedoms. However, if working times are completely detached from a specific framework, there is an immediate danger of delimited and unbound working time. An increase in the irregularity of working time with ADM systems spreading is quite

associated with accidents at the workplace and reduced performance. In addition, long working hours are often accompanied by other restrictions such as high work intensity or constant availability, see overall in (Wöhrmann et al., 2016; Wöhrmann et al., 2020).

foreseeable. Certainly, ADM-controlled planning functions of working time should be under observation, especially if they influence working time and thus also implicitly transmit elements of unplannability to employees. Hidden influences of ADM systems on Working Time Autonomy might also be assumed if the possible freedoms in this dimension are used to compensate for ADM-induced restrictions in other dimensions, such as the increase in the amount of work.

Another consequence of self-determined working time that should not be underestimated is the balance between professional and private life. Although a self-determined working time situation may assist in coping with private challenges (Lott, 2020, p. 38), the potential for dissolution of boundaries also exists in the case of completely self-determined working time (Lott, 2020, p. 43). Lott and Ahlers (2021, p. 5) speak in particular of the danger of entrenched traditional gender roles, in which women tend to devote themselves to care work. This development is favored when flexible working hours meet high work pressure and unplannable working hours (Lott, 2017, p. 23).

4.2.6. Locational Autonomy

Definition

A relatively new dimension of job autonomy is Locational Autonomy. In this sense, it shall not imply that the possibility for employees to freely choose their place of work has only recently become established. Rather, the discussion of work locations considers the increased importance of this option for certain groups of workers. Locational Autonomy is linked to the extent to which employees can determine the place where they carry out their work. Reference is often made to home-based work.[31] Spiegelaere et al. (2016, p. 517) fit in with their definition that "locational autonomy refers to the discretion of employees on where to perform the work tasks". This definition may also include considerations on the specific extent of work outside the regular workplace, i.e., frequency and duration.

31 Prospectively, other forms of mobile work need to be considered as well. After all, around a quarter of all employees consider mobility to be an essential part of their work, which takes place at frequently changing work locations. These forms of mobility can include long-distance traveling to work, employees with telecommuting agreements, the need for overnight stays away from home, and business trips (Wöhrmann et al., 2020, p. 5).

Locational Autonomy essentially refers to the spatial sovereignty of employees, who, due to novel ICT, choose their place of work according to their needs and in consultation with their employer. This location may also refer to the digital workplace (Bundesministerium für Familie, Senioren, Frauen und Jugend [BMFSFJ], 2021, p. 91).

However, Locational Autonomy does not solely represent the local component in the sense of working outside the usual workplace (*macro-locality*). Equally relevant is autonomy regarding the location within the regular workplace (*micro-locality*). This refers to the freedom to choose the location for carrying out individual tasks at the regular workplace, for example, the change of rooms in the office or on the shopfloor. In summary, Locational Autonomy essentially addresses the extent to which employees can influence the place in which they perform their work.

> Characteristics of Locational Autonomy: possibility to determine the place where work tasks are executed within (micro-locality) or outside (macro-locality) the usual workplace.

In context

Location-flexible work is probably the aspect of a transforming working world that has changed the most in the recent past. However, there is a deep rift between service branches. Typical white collar services with a high proportion of information-related tasks generally permit working from home more frequently (Brenke, 2016, p. 99). In contrast, the content of work does not permit working from home for a comparatively high proportion of employees in trade or consumer-related services. Yet, the focus of Locational Autonomy lies not on the quantity of remote work but on the extent to which they can choose their place of work in a self-determined manner.

Working from home is considered particularly relevant, as it is generally assumed to have a positive impact on employees' sense of autonomy as well as being beneficial for work-life balance (e.g., Beermann et al., 2019, p. 8; Gajendran & Harrison, 2007). However, there are also voices that report considerable overtime, conflicts with said work-life balance, and, ultimately, productivity issues in home-based work (e.g., Gibbs et al., 2021, pp. 12–16).

Considering this background, studies on the connection between ADM systems and Locational Autonomy are not highly informative. This finding should not be confused with the fact that digital technologies are, of course, a key enabler of many location-independent activities (e.g., DGB-Index, 2022b, p. 26). But what role does the self-determination of employees play when work can be performed away from the usual workplace? First of all, it is well known that many employees would like to work from home. Of those employees whose jobs generally allow them to work from home, almost two-thirds would like to be able to work from home across all sectors (Brenke, 2016, p. 99).

However, there are also employees who clearly reject working from home. According to Grunau et al. (2019, p. 1), around two-thirds of employees who do not work from home also reject it in principle. In addition to the obvious argument that the professional occupation does not permit work from home, the reasons for rejecting it in the pre-COVID-19 period were mainly in the professional field (Grunau et al., 2019, pp. 6–8): There is a culture of presence that is appreciated by superiors, collaboration with colleagues is considered more difficult, or the basic technical requirements are not met. In the private sphere, many employees state that they want to separate their professional and private lives spatially. Although home office users often report that this experience is positive, they also state that the two are becoming increasingly intermingled.

It becomes apparent that it is primarily individual preferences and organizational requirements that determine employees' Locational Autonomy. Can ADM systems also influence and, if necessary, support employees' self-determination regarding the place of work? According to Georg and Guhlemann (2020, p. 20), networked systems are at least capable of detaching employees' work from a specific work location. This would appear to be a supportive function in the sense that the technical option is provided in certain situations. However, it is difficult to make generalizations about the interaction between ADM systems and the macro-locality of employees.

There are certainly systems that coordinate the work location, especially in the sense of micro-locality, as a kind of control system. One might think of logistics, for example, but also of route planning in the care sector or in food services. However, it is also possible that ADM could provide support in making information available in the right place. It is possible that using ADM systems will have less of an impact on the degree of freedom in the choice of mobile work options (macro-locality) and more of an influence on the Locational Autonomy of service employees at their usual place of work or within their usual radius of activity (micro-locality).

Interestingly, spillover effects on other autonomy dimensions from Locational Autonomy must not be underestimated. It is evident, for example, that employees who work on the move not only have greater Locational Autonomy (or Working Time Autonomy), but also greater autonomy regarding the content and approach of work tasks. For example, more mobile employees can determine the sequence of their work themselves (77 %), make many decisions themselves (80 %), and plan and schedule their work themselves (75 %) than in-house employees (66 %, 61 %, and 60 %, respectively) (Waltersbacher et al., 2019, p. 94). They are more often able to plan work independently and have greater influence over working hours. However, these new freedoms are also accompanied by more paid and unpaid work or the expectation of being available outside traditional working hours (DGB-Index, 2021a, pp. 2–6). Locational Autonomy is, therefore, inherently characterized by ambiguity.

4.2.7. Interactional Autonomy

Definition

Interactional Autonomy marks a comparatively more complex and newer job autonomy dimension. The idea of Interactional Autonomy is intended to represent the influence of interactions with third parties (e.g., colleagues, superiors, service recipients) on job the autonomy of workers. Interactional Autonomy explicitly asks where there are dependencies on other people inside or outside the organization and to what extent these dependencies influence the sense of autonomy in the execution of work.

Earlier concepts relating to the scope for action were criticized for neglecting the social context of work action (Vieth, 1995, p. 119). Alioth (1980, pp. 19–20) therefore supplemented the scope of interaction with the concept of job autonomy at an early stage. However, this addition hardly appears to have gained acceptance because interactions are hardly found in today's considerations of job autonomy. Theoretical considerations on this subject are difficult to identify. As far as intra-organizational dependencies are concerned, the relationship between the team and the individual is often the subject of debate: Haberstroh and Wolf (2005, pp. 20–23) initially state that several team characteristics influence individual autonomy: team size, uncertainty and difficulty of the team task, professional competence of the team members, and the urgency and importance of the team task. Further research approaches point to partly contradictory relationships between individual autonomy and team autonomy. Jønsson and Jeppesen (2013, p. 78) write that team autonomy is positively related to individual autonomy.

In contrast, Langfred (2000, p. 581) notes that job autonomy is in conflict at the individual and team level when the organization tries to give more autonomy to both the individual and the team. However, in a later study Langfred (2005, p. 524), concluded that "the optimal combination of individual and team autonomy depends on the level of task interdependence in a team". Van Mierlo et al. (2006, p. 294) add that especially social support as a moderating variable can mediate between team and individual autonomy in a positive sense. Even if the effect direction is not entirely clear, it is reasonable to assume that the integration into an organization, or more precisely, a team, and the cooperation of this team are components that influence job autonomy.

Regarding the collaboration with extra-organizational actors, the concept of interaction work according to Böhle and Weihrich (2020) comes to the fore (also Chap. 1.5). Given scope for action is considered a central prerequisite for interaction work, especially its situational and informal elements (Böhle & Weihrich, 2020, pp. 18–19; Tisch et al., 2020, p. 49). The distinctive feature of interaction work is that work is carried out on a living subject whose subjectivity is often indispensable for the success of the service (Böhle & Weihrich, 2020, p. 15). Here, a conflict line emerges regarding job autonomy: In the performance of interaction work, there is a relationship of dependency between service worker and recipient, whereby the core idea behind Interactional Autonomy is to examine to what extent this relation can be determined by workers themselves.

Interactional Autonomy asks about the dependence of workers on other people, be they colleagues, superiors, or service recipients. Of particular importance is the extent to which employees themselves can influence the degree of dependency, i.e., the degree of cooperation.

> Characteristics of Interactional Autonomy: dependency on third parties; relation to team autonomy; possibility to determine extent of collaboration with third parties.

In context

While there is more empirical evidence on other job autonomy dimensions, only isolated findings exist on Interactional Autonomy. When studies do cover interaction work and its conditions, they often relate to conflicts and the resulting stresses and strains for workers (e.g., Holler & Dörflinger, 2022; DGB-Index, 2018b). The possible degrees of freedom in the performance of interaction work are rarely considered – even more seldom in conjunction with the use of technology. The subsequent empirical analyses in Part II and III are thus also intended to develop and explicate this dimension. Therefore, the discussion of Interactional Autonomy also has an exploratory character.

Perhaps research on the relationship between job autonomy and ADM in interaction situations is still so limited because there is currently a broad consensus that these systems are less able to influence the emotional-cooperative skills of employees' interaction work. Tolan et al. (2021, p. 209) confirm that AI systems currently influence the abilities of searching, perceiving, and processing information rather than interaction-related abilities. Other authors (e.g., Felten et al., 2019; Webb, 2019) consider the field of action regarding novel systems to be in different areas as well. However, especially in view of the rapid development of large language models, the relevance of this argument must at least be questioned.

Regarding spatiality and digital work, some exciting insights have been gained in recent years about the changing relationship between teamwork and digital environments. For example, with the perception of more mobile work, collaboration and team activities are becoming more difficult due to less spatial proximity. Gibbs et al. (2021, p. 21) describe this development as higher costs for communication and coordination. Thus, if ADM systems were to influence the location of employees' work in this way, it is possible that the cost of collaboration may increase. Presumably, job autonomy would also suffer. However, the way and place in which employees want to collaborate with others depends on the previous working atmosphere (Mergener & Trübner, 2022, p. 477).

In the case of technically induced greater spatial independence of employees, it is likewise conceivable that the individual worker can act more independently of team structures or other third parties due to a higher and qualitatively better provision of information by the ADM system. In cases of doubt, information no longer must be requested from other parties but can be accessed as needed and according to the situation. This would allow concentration on the cooperative elements of work that are necessary in the sense of productive collaboration, and possibly unnecessary interruptions of the work of others could be avoided.

The fact that a high degree of mobile work can have a negative impact on the relationship between colleagues is also shown by Gajendran and Harrison (2007, p. 1537). The authors argue that in this case, employees have fewer interactions with colleagues and therefore receive less support. Supervisors also need to be approached more actively to receive support. A positive relationship with one's supervisor, especially when the supervisor intervenes supportively in employees' work, has been shown to have a positive impact on job autonomy and even reduce turnover intentions (Dysvik & Kuvaas, 2013, p. 15). The role of the supervisor is thereby reminiscent of previous considerations regarding the influence of algorithmic management on job autonomy. In the context of algorithmic management of work, Gilbert et al. (2021, p. 41) even assume an alienation of employees from work and team, in which they are left to their own self-management. Communication would thus become less important. However, regarding Interactional Autonomy, the direction of the effect remains ambivalent and depends on whether workers are left to organize themselves or receive specific work instructions.

The extra-organizational component of Interactional Autonomy, i.e., assessing changed interaction work with service recipients through ADM use, is carried out in particular within the following empirical work in Part III. Fundamentally, it is evident that the standardizing and formalizing tendencies of technology use in the workplace impede the peculiarities and necessities of interactional work (Böhle & Weihrich, 2020, p. 20; Hielscher, 2014, pp. 9–14; Hielscher et al., 2015, pp. 7–8). In this constellation, interaction work may adapt to the rigidity of technical conditions and present workers with new challenges. The example of care work shows that in the application of new technologies, they not only face the obstacle of familiarizing themselves with the technology but also of actively integrating it into the care process and in their interactions with patients (Hielscher, 2020, p. 41). They are therefore faced with a new work challenge in two senses.

Interaction work faces a formalization problem (Jungtäubl, 2021) – at least if the quality of the interaction is not to suffer. It is important to emphasize that although formalization is rather considered to restrict job autonomy, it does not necessarily have to go hand in hand with poorer working conditions. Jungtäubl (2021, p. 36) describes that formalization can also serve the organization of processes, quality assurance, or the creation of measurability, which may well lead to a reduction in work requirements, especially with regard to the challenge of interaction work. This argument is supported by empirical evidence that workers who perform a lot of interaction work have less job autonomy on average and are exposed to higher emotional demands (DGB-Index, 2018b, p. 18). For a number of employees, there seems to be a negative relationship between interactional work and self-determination at work. As far as the impact of ADM systems on Interactional Autonomy is concerned, it is reasonable to assume that the direction of effect depends on the consequences of using the system on the quantity, quality, or individualization of interactional services. Perhaps there is no serious connection between ADM and Interactional Autonomy at all because workers are still able to do better interaction work and thus retain sovereignty over this field of work.

5. Job autonomy as ambivalent element of control

The consequences of job autonomy for workers, i.e., the proven connections between job autonomy and other workplace-related factors, have already been discussed (Chap. 1.4 and 4): As a motivational or stress-reducing work resource, granting job autonomy may help to shape personnel or corporate aspects such as job satisfaction, health, or productivity in a positive way. The absence of job autonomy may have corresponding diametric effects. However, it has also been argued that there is a saturation point regarding job autonomy, i.e., that once a certain extent is reached, the positive consequences of granting degrees of freedom can diminish or even be reversed. Thus, the analysis of empirical studies on the extent of job autonomy has already pointed to its ambivalence.

While these ambivalent consequences of different job autonomy levels have been discussed so far, the reasons for and attempts to explain varying job autonomy remain unexplained. The previous considerations have indicated what is dealt with in greater depth in this chapter: There are workers who have to cope with work demands with little job autonomy, and there are those who have greater scope for action but who are also subject to strong constraints with regard to their work results. Vieth (1995, p. 94) describes both states of job autonomy as a result of *execution control* in the first case and of *outcome control* in the second case. In both cases, job autonomy serves an organizational purpose. The differences are supported by numerous theoretical approaches. At the core of these considerations is usually the corporate need to exercise control[32] to solve the *transformation problem of labor* and to make the complexity of organizations controllable.

However, control is not (exclusively) antagonistic to job autonomy. Job autonomy finds application in distinct roles in the control logics of companies. The way in which technology intervenes in the utilization and exploitation of job autonomy is not completely mapped by theoretical approaches. Especially regarding new types of learning ADM, known approaches have so far hardly been sufficient to cover the implications for job autonomy and organizational embedding.

32 In the English-speaking debate, the term *control* is much broader than in German. Nies (2021, p. 480) states that in English-speaking discourse, control refers to all forms of performance management, irrespective of whether direct monitoring of behavior is involved. M. Frey (2009, p. 44) distinguishes between workers' control and management control in the German-speaking debate. Chap. 5 generally refers to a broad understanding of management control.

Essentially, two schools of thought on the interplay between digitalization, ADM, and job autonomy are dominant so far (Kirchner et al., 2020, pp. 3–5): Digital Taylorism supports the theory of a systematic decline in job autonomy and the revival of Tayloristic principles, especially by exploiting the monitoring capacities of digital and ADM tools. The opposite pole refers to increasing self-determination, i.e., more job autonomy using modern technology, which frees workers from monotonous and burdensome tasks.

Both approaches assume different organizational paradigms of work: Considerations on the spread of digital Taylorism emphasize the classical mechanisms of technology as a controlling, productivity-increasing element in the work process, which systematically restricts job autonomy. Comprehensive control mechanisms through digital tools enable almost complete traceability of individual work steps, which erases the last bits of the possibility to shape work processes (Staab & Nachtwey, 2016, p. 28).

Supporters of the liberating nature of digitality and ADM, granting individual workers more job autonomy, expect better conditions inside and outside of the workplace, not only in terms of content but also detached from the constraints of non-digital times regarding working hours and location. The possibilities offered by using digital means create new spaces for creativity and collaboration (e.g., Kirchner et al., 2020, pp. 4–5). In both cases, technology in the work process is fundamentally associated with the objectives of reducing the amount of human labor, gaining control over remaining human labor, and improving efficiency (Pfeiffer, 2018, p. 321).

Beyond these often polarizing views on new, sometimes disruptive technologies, the central question is what significance and function job autonomy assumes in different organizational patterns, what role is envisaged for workers in these respective constellations, and what influence using rule-based and learning technologies has on the utilization and exploitation of job autonomy. Hence, the objective of the following remarks is to *generate interpretations for the occurrence of different forms of job autonomy and their changes*. Low levels of job autonomy are no more synonymous with negative consequences for employees than high levels, which are invariably described as particularly good conditions at the workplace. Rather, it is the organizational utilization of job autonomy that determines its appearance and consequences.

These reflections must be elaborated and made applicable to the empirical analyses in Part II and Part III. A certain degree of abstraction is essential since the development of theory on the influence of learning ADM on work has not yet been completed and concluding findings are rare, more so regarding the service sector. The interplay of (learning) technological systems and interaction work, for example, is seldom included in sociological studies.

Thus, Chap. 5 first provides an overview of existing concepts for utilizing job autonomy in companies, especially those related to direct (Chap. 5.1) and indirect (Chap. 5.2) control logics. The application of technology does not always play a leading role in these concepts, which is why more recent theoretical developments, such as the proclamation of a new Digital Taylorism, are discussed subsequently to assess the current state of research on the integration of digital tools and ADM in the work process (Chap. 5.3). It is important to emphasize that these technologies can take the form of classic rule-based systems as well as newer ML-based learning systems. Where evidence is available, separate reference is made to the possibilities of learning systems. However, it also becomes clear that basic control instances in companies can be performed by both types. These approaches are contextualized in light of the role specific corporate strategies play in the integration of technologies in companies (Chap. 5.4). Chap. 5.5 concludes by summarizing the theoretical framework on which the following empirical considerations are based and stating some expectations regarding the relation between job autonomy and ADM.

5.1. Rationalization at its core: minimizing job autonomy and direct control

The treatment of job autonomy in the logic of classical Taylorism has hardly lost any of its significance, even from today's perspective, at least for certain branches and occupations. Especially with regard to rule-based technological systems that provide largely transparent processes for management, the analogy with Frederick W. Taylor's (1911) principles is obvious since the minimization of job autonomy and maximization of control is at the core of the Taylorist idea. Taylor described the fundamentals of an organizational paradigm that seeks precise control of work processes. Rationalization and control are simultaneous objectives and prerequisites of this organizational approach. Individual steps of the work process are precisely defined to optimize their sequence. In this sense, it is hardly surprising that automation was implemented so well in Tayloristic work systems. Ideally, rule-based, mechanized work steps are performed just as well by machines.

The ideal-typical characteristics of classic Taylorism open a constant field of tension between job autonomy and company productivity demands. The features of Taylorist work systems lie not only in the clear separation of simple and complex tasks but also in the division of the planning and execution of work processes. The Taylorist form of work organization systematically deprives workers of the possibility to independently organize work steps, for example, determining the methodical procedure for completing a work task or deciding on the sequence and speed of completion. The realization of performance goals is thus achieved by minimizing job autonomy. The technicization of work processes plays a decisive role – after all, the use of technology is the pacesetter of daily work. In the past, this applied to mechanical automation just as it does today to digital and learning systems, which, for example, specify the structure and scheduling of work processes in the form of algorithmic management systems.

Harry Braverman's (1974) *Labor Process Theory* (LPT) is still regarded as the central source of criticism for Taylorist work and ascribes job autonomy a fundamental role in its rationalization logic. According to LPT (overview in Thompson, 2010), the technicization process of work is regarded as an intensification and optimization of management control, dequalification, and degradation of workers under the imperative of maximizing the utilization of labor power. The collective term for the aforementioned control mechanisms is *direct control* (Friedman, 1977a, 1977b). Direct forms of control are relatively clearly identifiable by workers. For the most part, they are aimed at restricting job autonomy and decision-making (Gerst, 2002, p. 105). In this constellation, using ADM systems would be considered a control instrument as it fundamentally impacts job autonomy.

The need for control in the workplace is due to the incompleteness of employment contracts, which generally do not spell out the practical implementation of work processes and the disposal of labor, i.e., the transformation problem of labor. In this context, M. Frey (2009, p. 35) names job autonomy as the central descriptor of the possibilities of control in the workplace: "From a control-theoretical perspective, the relationship between autonomy and heteronomy in work addresses *the* central problem of the capitalist labor process: the transformation of indeterminate labor capacity into determinate labor performance"[33].

Specifically, the area of uncertainty in the work process must be minimized. According to Gerst (2019, p. 111), the aim on the company side

33 Own translation of "Aus kontrolltheoretischer Perspektive wird mit dem Verhältnis von Autonomie und Heteronomie in der Arbeit *das* zentrale Problem des kapitalistischen Arbeitsprozesses angesprochen: die Transformation des unbestimmten Arbeitsvermögens in bestimmte Arbeitsleistung" (M. Frey, 2009, p. 35).

is to integrate the performance of workers regardless of their personal interests, as well as to make technology choices that best bring out their control potential to dominate workers. Thus, at the core of LPT is also the minimization of opportunistic employee behavior. In the Taylorist principle, the goal of minimizing subjectivity in work prevails. Ideally, the *disruptive factor* of human labor must be minimized as far as possible, i.e., removed from work processes.

In the Taylorist organization of work, it was originally assumed that wage incentives sufficed for guaranteeing obedience to company requirements (Senghaas-Knobloch, 2008, p. 71). In this logic, even working conditions that reduce job autonomy to a minimum would be accepted – after all, workload is compensated by a corresponding wage. Implicit in this assumption of Taylorism is that workers contribute their labor power to work processes without any attachment to subjectivity (Senghaas-Knobloch, 2008, p. 72).

Today's research consensus, however, states that even under such autonomy-restricting conditions, workers attempt to incorporate subjectivity into their work. Senghaas-Knobloch (2008, p. 71) writes that the "limits of normalizability become clear in the face of subjectivity and sociality,"[34] meaning that employees inevitably bring subjectivity into every work situation – also independent of the application of technology, if normalization in this sense (i.e., formalization) is seen as a prerequisite for using technical systems. Accordingly, subjectivity relates primarily to certain coping strategies with which one reacts to given work requirements, considering personal demands on one's own work. The control problem of labor could thus never be completely solved by Taylorism.

Viewing subjectivity as a disruptive factor, as in Taylorism, even contradicts the premises of successful service work. Service work thrives on the contribution of a subjective part within the framework of interaction work. In this sense, subjectivity and service work are interwoven. If organizational or technical possibilities are exploited to further reduce the subjective share of work, the core of service work is eroded, and the appropriation of work becomes more difficult, if not impossible. The consequences of such an intervention are potentially not only new burdens but also a massive cut in the motivating factors that constitute service work. What is up for discussion with ADM systems is whether their learning properties result in new possibilities for accessing or preventing subjective engagement at work.

34 Own translation of "Grenzen der Normierbarkeit werden angesichts von Subjektivität und Sozialität deutlich" (Senghaas-Knobloch, 2008, p. 71).

Despite the considerable explanatory power of Braverman's LPT, it is precisely the neglect of the subjective part of work that has triggered several waves of criticism. In addition to the disregard for resources of the subject in the work process, critics argue that there is too strong a focus on Taylorism as the only explanatory concept of given corporate strategies. The core criticisms are those of Friedman (1977a), Edwards (1979) and Burawoy (1979).[35]

Even Thompson (2010, p. 13), as one of the leading scholars of the British branch of the LPT, admits that while the LPT can accurately describe how the control imperative is enforced in Taylorism to minimize indeterminacy, the concept, building on several waves of criticism and suggestions for improvement, has failed to provide a comprehensive theory-building around the modern transformation of the work process.

In fact, a large number of studies dating back to the 1970s, a supposed peak phase of Taylorism, point to an alternative interpretation of job autonomy. Concepts such as *responsible autonomy* (Verantwortliche Autonomie, Friedman, 1977a, 1977b), *controlled autonomy* (Kontrollierte Autonomie, Vieth, 1995; Wotschack, 1987) or *externally organized self-organization* (Fremdorganisierte Selbstorganisation, Pongratz & Voß, 1997) refer to a change in the organizational utilization of job autonomy, especially in office work at that time and in contrast to production work that was originally considered to be Tayloristic. In this context, it becomes clear that while digital and rule-based technologies create greater transparency in work processes, the control logic observed does not fit with the latter (Vieth, 1995, pp. 92–93).

The ideas of classical Taylorism are currently being revisited and expanded in the phenomenon of Digital Taylorism (Chap. 5.3). What initially remains is the realization that low levels of job autonomy point to the translation of the transformation problem of labor through direct control mechanisms and rationalization efforts in the sense of ideal-typical Taylorism. The critique of Taylor's ideas puts job autonomy in focus but also reveals that the logics of job autonomy utilization have changed or never followed Taylorist principles, especially in the service sector.

35 Likewise, the contributions by Knights and Willmott (1990) and Thompson (2010) are insightful on the course of the LPT debate.

5.2. Exploiting the subject: granting job autonomy and indirect control

Initially, Moldaschl (2001, p. 137) not only refers to outdated notions of job autonomy (Chap. 4.1) but also argues for the inclusion of *marketization* and *subjectification* tendencies in modern work environments, which often grant workers job autonomy in their self-organization but simultaneously deprive them of these freedoms by constantly renegotiating the indeterminacies and constraints of work. M. Frey (2009, p. 20) confirms that job autonomy moves and develops in an increasingly tense field between marketization and subjectification. As will be shown, the utilization of job autonomy under conditions of increasing marketization and subjectification is almost contrary to the principles of Taylorism, while the goal of exercising control remains the same. In this process, the use of technology at work does not take on the role of a direct control instance but is often used as a support tool in the primary instance.

Menz et al. (2019, p. 183) summarize marketization as an approach to the reorganization of work as a "double movement: on the one hand, the opening of the company to the market [...], and on the other hand, the incorporation of market and competition mechanisms into the company"[36]. It is precisely the latter, namely the *internalization of the market*, that drives workers into what is in part a limitless market and outcome orientation (Menz et al., 2019, p. 183). Marketization refers not only to the opening up of the company but also of the individual employee to the mechanisms of the market with all its risks and uncertainties, which have an unfiltered effect on employees through company management (Peters, 2001, pp. 31–34).

Kratzer and Dunkel (2013, p. 47) describe this conflicting interest of workers in the course of marketization as an "organizational dilemma: the attainability of unattainable goals cannot be controlled"[37] – at least not directly. As an instrument of rationalization, *indirect control mechanisms* (Peters, 2011) aim to internalize economic objectives as one's own individual work goals and attempt to increase the productivity of employees by granting them targeted scope for action in the performance

36 Own translation of "doppelte Bewegung: einerseits die Öffnung des Unternehmens in den Markt [...], andererseits die Hereinnahme von Markt- und Konkurrenzmechanismen in das Unternehmen" (Menz et al., 2019, p. 183).

37 Own translation of "organisatorisches Dilemma: Die Erreichbarkeit unerreichbarer ziele lässt sich eben nicht steuern oder organisieren" (Kratzer and Dunkel, 2013, p. 47).

of work tasks (Menz et al., 2019, p. 183). Concrete examples of indirect control mechanisms can only be sketched since they are interwoven into work organizations and hardly ever occur in physical form (examples in Kratzer & Dunkel, 2013, p. 49). These certainly include performance-related income, comprehensive control and indicator orientation, client orientations, or individual target agreements.

In contrast to direct control logics, which aim at minimizing job autonomy, indirect control mechanisms specifically exploit the granting of job autonomy. In this framework, digital technologies are still considered control instruments that eliminate the decentralization of processes and have a performance-documenting effect on workers. In relation to technology usage, Menz et al. (2019, p. 183) also refer to findings from the 1990s, which describe that information systems are essentially exploited to manage organizational complexities. In this sense, learning ADM is much better suited to dealing with these complexities in a predictive and anticipatory manner.

Indirect control mechanisms massively fall back on the subjective share in the work process in the form of self-control. However, self-control in no way equates to self-determination because job autonomy is transferred in a very targeted fashion and sometimes only partially (Mronga, 2013, p. 102). Marketization implies that the boundaries between organizational and individual work objectives begin to blur, as subjectivity is no longer regarded as a disruptive factor (in the Taylorist sense) but as a driver of labor power. Kleemann (2012, p. 7) describes this process of *subjectification of work* as the "targeted corporate utilization of human subjectivity for the work process, based on new ('post-Tayloristic') corporate strategies for the utilization of living labor"[38].

As many service workers are exposed to growing market pressure (Kratzer & Dunkel, 2013, p. 41), their subjective mechanisms for coping with the demands and needs of service recipients are increasingly under tension (Senghaas-Knobloch, 2011, p. 30). This highlights the contradictory nature of the marketization and subjectification of work in the service sector. The role of ADM systems in this relationship remains unclear at first. However, there is a risk that learning systems, which are already being used by management to cope with organizational complexities, will increasingly reach a level of maturity that allows access to the subjective part of work.

38 Own translation of "gezielte betriebsseitige Vernutzung von menschlicher Subjektivität für den Arbeitsprozess, die auf neuen ('post-tayloristischen') betrieblichen Strategien der Vernutzung lebendiger Arbeit beruht" (Kleemann, 2012, p. 7).

According to Senghaas-Knobloch (2008, p. 79), these subjective efforts are always necessary to cope with work demands. The formalizing and standardizing requirements of using technology contradict subjectifying work actions, which are particularly difficult to plan due to situational, experience-driven, and sense-guided behavior. When considering coping mechanisms for using technology, it is necessary to either identify the technical and organizational conditions that prevent the insertion of subjectivity into work processes (Senghaas-Knobloch, 2008, p. 74) or to recognize the subjective characteristics that protect workers from the intervention of technological control mechanisms. The latter, of course, refers to the aforementioned labor capacity and experiential knowledge of workers (Pfeiffer, 2004), which contrasts with the assumed simplicity of formalization and automation of tasks.

The ideal form of corporate exploitation of subjectivity in the course of marketization is offered by Voß and Pongratz (1998) to the Entreployee: The Entreployee no longer acts as a simple seller of labor, but as a contractor who brings labor power into the company in a self-controlled, self-economized, and operationalized manner. This self-control may refer to various job autonomy dimensions in relation to a concrete work task (method, time, location, etc.). The marketization of labor capacity, exploiting high levels of job autonomy, ultimately accesses all the individual resources of workers. The authors place the Entreployee[39] in close connection with the growing economic importance of the service sector, in which not only new forms of work often take hold but which are based on corporate flexibilization[40] to a considerable extent. The logic

39 Entreployees not only often work as service providers but are more likely to be female, see overview in M. Frey (2004). Voß (2007, p. 107) emphasizes that the Entreployee is a gender-neutral ideal type, but the author has nevertheless had to accept clear criticism of the supposedly male form of the concept (e.g., Jurczyk, 2002, p. 105) which, in particular, does not do justice to the responsibility of reproductive work (Winker and Carstensen, 2007, p. 282). M. Frey (2004, p. 68) further assumes that women are better able to meet the demands of marketization than men because they have experienced the dissolution of boundaries, i.e., balancing different spheres of life.

40 According to Büssing and Glaser (1998, p. 587), flexibilization may take four forms: numerical flexibility (number of employees), functional flexibility (improved and broader qualification of employees), financial flexibility (performance-based remuneration system), and temporal flexibility. The disposition of working time plays a key role as it allows for the demand-oriented use of labor and is thus expressed as a condition of job autonomy (Büssing and Glaser, 1998, p. 586). The impact of flexibilization in the sense of job autonomy depends to a large extent on whether employees are faced with flexibility opportunities or requirements (overview in Wöhrmann et al., 2016, pp. 54–82).

of the Entreployee is essentially explained by access to the subjective momentum that employees use at work. Granting job autonomy takes on the function of an enabler of this access. Finally, the motivation to work is also transformed into an individualized search for meaning, which centrally presupposes a form of self-disciplining (Voß, 1998, p. 480).

In this context, it is important to note that using technology does not necessarily involve intervening in the subjectivation of work. However, subjectifying intervention in the work process is often necessary to ensure the integration of technical tools into the work process. This form of subjectification is described by Voß and Weiß (2005, p. 141) as *compensatory subjectification*, which refers to the compensatory intervention of subjects in the work process as more technology is used.

In the overall picture and as a consequence of increasing marketization, the *delimitation* of boundaries and subjectification must be thought of closely together and even be described as a complementary relationship (Voß & Weiß, 2005, p. 143). The blurring of boundaries and subjectification are no less than symptoms accompanying specific corporate strategies that attempt to access the resource of subjectivity. Compensatory subjectivization therefore assumes that intervention by workers in technical processes is necessary, regardless of whether it is rule-based or learning-based.

Furthermore, M. Frey (2004, p. 63) considers delimitation to be a central consequence of marketization and subjectification, namely with regard to the boundaries between professional and private life, the extreme outcome and performance orientation of work, the spatial dissolution of regular work environments, and the boundaries between management and employees. The latter refers to the internalization of corporate principles and practices on the part of employees. The exploitation of legal gray areas and blurring of boundaries is another area of concern. According to M. Frey (2004, p. 63), the common feature of all these forms is the "partial dissolution of an institutional constitution of work"[41].

Delimitation essentially breaks up existing organizational logics to make them more flexible. As the concept encompasses all social levels, delimitation attacks and deliberately dissolves established social structures (Voß, 1998, p. 474). According to Voß (1998, p. 480), those social structures may include:

41 Own translation of "partielle Auflösung einer institutionellen Verfasstheit von Arbeit" (M. Frey, 2004, p. 63).

- Time: flexibilization of working hours, duration, and distribution
- Space: decoupling of work from the place of work
- Tools/technology: Self-organization in the choice and use of technical aids
- Work content/qualification: Self-organization in the execution of work, self-responsible maintenance of work ability
- Social organization: self-organization of horizontal and vertical co-operation
- Sense/motivation: individual motivation and goal/sense setting.

As a final note, experiencing the dissolution of boundaries is of course not limited to employees who face particularly strong marketization and subjectification trends but also affects those under more restrictive conditions, such as Taylorist work systems. Regarding learning ADM, it appears likely that their use contributes to further delimitation from the workplace institution in terms of time and place, as well as influencing the further internalization of self-control.

5.3. Digital Taylorism: Just old wine in new bottles?

When it comes to the embedding of digital technologies and learning ADM in existing organizational relations, Crawford (2021, p. 58) states that "rather than representing a radical shift from established forms of work, the encroachment of AI into the workplace should properly be understood as a return to older practices of industrial labor exploitation". The reference to the rationalization logic of Taylorism seems reasonable. Many other authors establish this connection to already-known organizational phenomena as well.

What is called Digital Taylorism (e.g., Brown, 2011, p. 65; The Economist, 2015; Kirchner et al., 2020, p. 3; Staab & Nachtwey, 2016, p. 27) today still refers to the separation of tasks, prescribed work steps, their division to the smallest level, and the control of workers – with rule-based and learning means. New to Digital Taylorism in the service sector is the extent of restructuring established business models (e.g., e-commerce division in retail), the extensive possibilities of technical process control, and new forms of peer-to-peer control (Staab & Nachtwey, 2016, pp. 27–29). As a result, work intensification and devaluation tendencies occur, which insist on increased pressure to perform with little job autonomy. Staab and Nachtwey (2016, p. 28) emphasize the networking idea behind digital technologies, which, as the authors describe, are similar to an assembly line and clearly show the contours of the Taylorist idea. According to Brown (2011, p. 72), the special quality of Digital Taylorism also lies in its digital interconnectedness and global nature. Accordingly, monitoring and control options are available regardless of location (Brown, 2011, p. 74).

However, classical Taylorism had little, if any, access to the service sector. That appears to be changing. In the light of low union and social partnership coverage as well as many precarious employment conditions in services (Haipeter, 2020, p. 48), this development is all the more worrisome. Under the umbrella term of Digital Capitalism, Nachtwey and Staab (2015, p. 76) explain Digital Taylorism as the techno-digitally supported rationalization wave that now also affects the service sector and pushes workers back into the supposedly overcome labor struggles of the 1970s and 1980s. The control imperative and capital valorization again take center stage. In the system of Digital Capitalism, as Nachtwey and Staab (2015, p. 78) continue, the company as an institution and social space is increasingly dissolving – very much in line with the definition of delimitation according to M. Frey (2004, p. 63). The trend toward delimitation extends to dimensions of labor law, for example, in that a small core of fixed employees is confronted with many who are flexibly employed. Digital Taylorism assumes that companies rely on classical control mechanisms to minimize uncertainty and subjectivity (Menz et al., 2019, p. 188). The unsolvable control gap of Taylorism is being reworked by means of digital technologies, especially ML-based systems.

Schaupp (2020, p. 202) summarizes the characteristics of Digital Taylorism as follows: In Digital Taylorism, *digital* systems provide work instructions and lead to familiar simplification and segmentation of work (Nachtwey & Staab, 2015, p. 76), while the work actions of employees are recorded *digitally* and are recorded down to the smallest detail (Brown, 2011, pp. 72–74). In contrast to classic Taylorism, however, this makes the entirety of work processes more opaque in terms of the black box character, not only for workers but *also for management*, whose tasks are also subject to partial automation (Nyckel et al., 2017, p. 238). It is precisely this black box property that is characteristic of learning ADM. Management feedback is replaced by permanent digital feedback from the technical system, which calls for self-optimization and self-monitoring by employees (Nyckel et al., 2017, pp. 230–236). In this process, companies become more self-organized, but workers also disconnect more from the organization, which ultimately goes hand in hand with the dissociation from the formerly stable institution of the company (Nachtwey & Staab, 2015, p. 78).

However, as this summary by Schaupp (2020) indicates, the supporters of Digital Taylorism have already been confronted with critical voices that either do not consider the concept sufficient for describing current developments or even discover inconsistencies with Taylorist ideas: With reference to the industrial sector, Nies (2021, p. 482) describes that highly flexible production systems, lower plannability and quantities, as well as the flexible use of labor, can hardly be reconciled with the requirements of formalization, as some digital tools require. The theory of Digital Taylorism has not yet found an answer to this problem. As with the ironies of automation, Taylorism reaches the limits of controllability.

In addition, there are well-known *limits to the formalizability* of human labor. Butollo, Engel, et al. (2018, p. 144) ask whether Digital Taylorism fails because of the same obstacles as classic Taylorism, and thus focus in particular on the involvement of workers in the work process with all their skills and experience. Butollo, Engel, et al. (2018, p. 146) further pose the question of the validity of Digital Taylorism, namely to what extent digital work processes continue to depend on the subjectivity of workers and how disruptions and impasses can be dealt with. Digital Taylorism, including the possible use of learning ADM systems and thus the minimization of subjectifying work, is in contradiction to compensatory subjectification (Voß & Weiß, 2005, p. 141) and the importance of labor capacity and experiential knowledge (Pfeiffer, 2004).

Menz et al. (2019, p. 197) agree and recognize not the corporate ideal of Taylorism in current developments but, rather, the creation of even more transparency with ongoing marketization. Nor does it focus on curtailing job autonomy. Taylorism, however, pursues different strategies rather than new forms of control. It is the answer to the problem of transforming work by other means. Ideally, Digital Taylorism is accompanied by formalization and standardization to utilize digital technologies and create transparency in work processes: "Digitalization is the dream of controlling the entire value creation process while at the same time being able to respond flexibly to the market"[42] (Menz et al., 2019, p. 196). This means that the visibility of the work process has been massively increased, while the goal of using technology remains the operational exploitation principle (Menz et al., 2019, p. 197). However, these observations seem to relate less to learning systems due to their lack of transparency.

Possibly, the proclamation of Digital Taylorism only refers to the *service factories* (Nachtwey & Staab, 2015, p. 76) of the BigTech and

42 Own translation of "Die Digitalisierung ist der Traum von einer Durchsteuerung des gesamten Wertschöpfungsprozesses, die gleichzeitig flexibel auf den Markt reagieren kann" (Menz et al., 2019, p. 196).

platform companies. Nies (2021, p. 481) confirms that the goals of Digital Taylorism are similar to those of classical Taylorism, and that digital means are used to minimize job autonomy through transparency, real-time control, and quantifiability. However, the most radical forms of this control regime have so far been observed primarily in logistics and the platform economy.

Henceforth, for Schaupp (2020), the theoretical approach of Digital Taylorism does not go far enough to explain current technological developments at the workplace and therefore brings *Cybernetic Control Theory* (Beer, 1963; Wiener, 1948, as cited in Schaupp, 2020) into play as a further explanation. Nyckel et al. (2017, p. 229) also interpret the new popularity of algorithmic control systems as returning to established ideas of cybernetic control, which combines the principle of self-control with feedback mechanisms. Schaupp (2020, p. 204) explains that, following Beer (1963, p. 61), management cybernetics describes systems of controlled self-organization that are characterized by complex demands on control abilities. These dynamic organizations are hardly transparent, which is why Beer (1963, p. 22) points to the black box character of these systems.

This also shows why management functions are becoming obsolete in management cybernetics (also Nyckel et al., 2017). The organization is supposed to regulate itself at the lowest possible hierarchical level (Schaupp, 2020, pp. 205–206). What Beer (1963, p. 146, as cited in Schaupp, 2020) lacked at that time for success in his conception of controlled self-organization was the *central nervous system*, which directs the desired feedback mechanisms. At this point, at the latest, the parallels to modern ML-based management systems become clear. The presence of cybernetic control elements is supported in particular by the intransparency of algorithmic process control for both employees and management (Nyckel et al., 2017, p. 238).

The peculiarities of cybernetic control clearly suggest that the control gap of Taylorism at work is further closed. Cybernetic process control mechanisms no longer only aim to directly control employees – as assumed in the sense of traditional LPT – but are also intended to minimize the planning leeway of middle management (Nyckel et al., 2017, p. 230). Learning feedback systems, which are supposed to coordinate specific actions via a direct coupling to control goals, play a supporting role in these control systems (Nyckel et al., 2017, p. 232). This means that these algorithmic control systems intervene in the execution of individual process steps, adjust them to the control goals in real time if necessary, and give feedback directly to employees. This questions the necessity of the planning and coordinating tasks of middle management (Nyckel et al., 2017, p. 233).

Overall, the cybernetic control system is more dynamic than Digital Taylorism, especially regarding time regimes. Permanent and holistic monitoring and transparency of work are linked to automated management and feedback mechanisms that leave workers to take responsibility for their own work. In this sense, only a few employees overall have the impression that digital technology is forcing predetermined work behavior to a greater extent than was previously the case (Schaupp, 2020, p. 206). In comparison to Taylorism, technical (learning algorithms) and organizational (feedback instead of management) innovations are more strongly intertwined (Schaupp, 2020, p. 207).

5.4. Corporate strategies as drivers between technology and job autonomy

Criticism of the restriction to Digital Taylorism as an explanatory model for the technical and organizational change currently being observed points not only to conceptual weaknesses but also to the fact that the principles apply only selectively to specific branches. Several authors, meanwhile, question the narrow corporate target corridor associated with the use of technology from the company's point of view: overcoming the transformation problem of labor through rationalization. Gautié et al. (2020, p. 777) write in this regard that the use of digital technologies is not the cause of a possible revitalization of Taylorism but enables it. The cause is a change in corporate strategies. The goal behind using a particular technology, it is argued, follows a particular corporate strategy, which can be understood in diverse ways in relation to job autonomy.

As described earlier, control mechanisms have distinct influences on job autonomy (Nies, 2021, p. 479). Nies (2021, p. 480) names three fundamental functions of control mechanisms: first, to deal with the transformation problem of labor. Second, management control must always be considered an instrument of power that is intended to keep opportune employees in check. Third, control (whether directly or indirectly) aims at orienting performance to market requirements.

In particular, this strengthens the argument that no technology by design is intended solely for rationalization in the sense of labor power (including minimization of job autonomy), but rather that the actual effect of using technology is determined by its organizational embedding in the company, which in turn follows a specific corporate strategy. Menz et al. (2019, p. 190) aptly point out that, in the context of the current digitalization movement, the use of technology as a control instrument is no longer primarily designed for rationalization (as in classic Taylorism) but for process optimization. Menz et al. (2019, p. 191) suggest that if workers do not perceive this digital transparency as an increase in supervision and a restriction of job autonomy, it is because the goal of technology use is not rationalization but the optimized attempt to meet performance targets.

Nies (2021, p. 478) likewise criticizes the one-sided reference in the discussion of Digital Taylorism to control in the execution of work and the minimization of subjective influence by employees and expands the perspective to include the systematic corporate utilization of job autonomy. However, Nies does not limit herself to rationalization as the sole objective of technology deployment. Accordingly, the implementation of technology is not necessarily aimed directly at the control interests of companies and, in this sense, does not have a distinct impact on job autonomy. Rather, the focus shifts to the entirety of possible corporate strategies for dealing with digitalization.

Based on the so-called *Corporate Approach* (Betriebsansatz, Altmann, 1978, pp. 153–167), Nies (2021, p. 486) describes four corporate strategies, referring to Altmann et al. (1982, p. 19), each of which describes different ways for companies to realize capital utilization. With this idea, "not the manifestation of digital technology, but the identification of the corporate interests of utilization behind it"[43] (Nies, 2021, p. 487) moves into the focus of analysis:

- The *labor power-related strategy* (Nies, 2021, pp. 489–490), also known as *labor power rationalization*, is most compatible with the principles of Digital Taylorism in that it attempts to deal with the transformation problem of labor while maximizing control logics and minimizing job autonomy. Under this strategy, however, there may equally be an expansion of job autonomy under the marketization mechanisms. The focus lies on utilizing labor power.
- The *strategies of process rationalization* or *systemic rationalization strategies* (Nies, 2021, p. 490) describe logics in which technical systems are not designed for control but for the optimization of processes, which has a concrete effect on the organization of work and thus on job autonomy. However, their direction of effect is not predefined and must be determined based on specific examples. While this strategy follows rationalization principles, the various mechanisms for utilizing labor power are secondary.

43 Own translation of "nicht die Erscheinungsform digitaler Technik, sondern die Identifizierung der dahinterstehenden betrieblichen Nutzungsinteressen" (Nies, 2021, p. 487).

- With *market and business strategies*, Nies (2021, p. 491) refers to purposeful technology use for improving market positions. This strategy relates, for example, to the tracking of products for end customers and, in this sense, has less to do with the control ideas of companies.
- The fourth strategy is more of a non-strategy because technology use follows *innovation and discourse-driven digitalization* (Nies, 2021, p. 492). This involves reacting to competitors and external effects, not necessarily a specific objective associated with the technology.

These corporate strategies may refer to both rule-based and learning ADM. Nies (2021, p. 492) concludes that the influence of technology on job autonomy does not necessarily result from the prevailing control mechanisms. If, as in most cases, there is a connection between job autonomy and control, then the specific direction of the impact on job autonomy and the interest in exploiting this changed autonomy depends on the specific corporate strategy behind using a technology.

While Nies (2021) and Menz et al. (2019) deal with the use of digital tools, which can include both rule-based and learning ADM in this general sense, Huchler (2023, p. 366), as one of the few authors who does not limit himself to the monitoring and control properties of technical systems, adds another perspective on the functions of technology in the work process. In particular, Huchler emphasizes the assisting character of subsymbolic, i.e., learning, systems. The author adds to the direct or indirect control properties of these systems and introduces the controlling effect of the technical systems as *control by design* as a kind of latent control instrument. Huchler (2023, p. 367) refers to control by means of work equipment, which in turn has an indirect influence on work, for example, on job autonomy. This idea might correspond to the strategies of process rationalization.

Huchler (2023, p. 368) specifically points out the similarity between subsymbolic systems and indirect control. Accordingly, technical systems with learning elements enable the complexity of work to be kept open for a long time, in contrast to purely rule-based systems. The need to master work processes is thus suspended since only functions and goals are given to the system and not precise calculation steps (Huchler, 2023, p. 369). This is where the black box properties of learning systems come into play, which are comparable to indirect control in that they aim at a specific controllable result and not the path to it. The linearity of these systems can be suspended thereby.

However, according to Huchler (2023, p. 369), the logic of indirect control, especially the focus on flexibility and adaptability, is transferred to technical systems rather than to employees. Accordingly, learning systems trigger a "new phase of technology-centered handling of complexity and uncertainty in work processes"[44] (Huchler, 2023, p. 369), which not only represents a further step in the direction of automation. It also demands higher levels of compensation and supplementation (Huchler, 2022, p. 164) from employees in order to integrate the systems into the socio-technical system. According to Huchler's assumptions, some parallels to cybernetic control theory may be drawn.

In summary, as valuable as these approaches to determining the specific corporate strategy for assessing the impact of technology use on job autonomy are, the extent to which these considerations can also be applied to the service sector remains an open question. For a long time, the paradigm of Baumol's cost disease (Baumol, 1967) predominantly excluded the rationalization possibilities of service work. Accordingly, service work can hardly be rationalized without lowering the quality of the service because wages always rise, and thus total costs also rise. For this reason, it is particularly desirable from a corporate perspective to increasingly anchor rationalization principles, to the disadvantage of service quality, in the service sector: personnel costs are high and capital intensity is too low (Ahlers et al., 2018, p. 10).

However, it is fairly obvious that the ideas of Baumol's cost disease, which attributed special resilience to rationalization in the service sector, have long since lost their validity. On the one hand, the technicization of service tasks has long since taken over those branches, whose contents are particularly susceptible to automation efforts. After all, what is being witnessed is a sometimes disruptive change in the organization of work on the basis of technical innovations – for example, in retail and logistics, whose online segment is keeping the entire industry under constant pressure to change (Staab & Nachtwey, 2016, p. 25).

This contrasts with service tasks that are supposedly still difficult to automate, i.e., especially person-related services. However, rationalization mechanisms are clearly visible in these branches as well, even if they are less technology-supported in some areas. In this context, Baumol's cost disease must be eliminated by visible cuts in service quality (Table 1). Although the diffusion of recent technologies in the service sector varies considerably, it is reasonable to assume that the rationalization principles and strong marketization tendencies that have been proven for the industrial sector also apply to the service sector. The best example of

44 Own translation of "neue Phase des technikzentrierten Umgangs mit Komplexität und Ungewissheit in Arbeitsprozessen" (Huchler, 2023, p. 369).

this is the healthcare sector, whose supposedly high social importance as a public good has been eroded to the core by excessive economization (overall in Dowling, 2021).

5.5. Expectations of ADM in service work and missing pieces

The initial challenge for Chap. 5 was to identify interpretative guidelines for the occurrence of various forms of job autonomy, relate these to technology use, in particular the features of rule-based and learning ADM, and apply existing theoretical approaches to the empirical analyses envisioned. For this purpose, a central distinction is drawn between less autonomous services (LAS) and highly autonomous services (HAS) as ideal types. Both expressions of job autonomy are assumed to employ different control logics and utilizations of technology, which will be illustrated in the following (Table 4). They are united in the achievement of corporate objectives of profit maximization, capital utilization, resource efficiency, and market orientation. Job autonomy fulfills different organizational roles to achieve these objectives.

Ideal-typical LAS describe branches in which rationalization efforts are expressed in a low degree of job autonomy. Prime examples are trade, logistics, accommodation and food services, or healthcare and social services. These services tend to perform person- and object-related tasks and account for the largest share of employment in the service sector. At the same time, these branches are particularly relevant to society, as they are often involved in the day-to-day care of people – be it the provision of goods or the care of people. Accordingly, many workers in LAS perform interaction work to a high degree and intensity.

The theoretical links originate in classic Taylorism, the wave of criticism in the context of LPT, and the development of Digital Taylorism. Behind these approaches lies a direct control logic, which is aimed at controlling the execution of work. Not only is job autonomy to be minimized to ensure process control and prevent opportune worker behavior. The disruptive factor of subjective involvement in work is also targeted. Control gaps are to be closed as far as possible, thus minimizing uncertainties. What, in its original form, was assigned to industry is in many areas also leading to the industrialization of services – which carries a certain terminological inconsistency.

Table 4: Overview on theoretical embedding of job autonomy and ADM systems

Less autonomous services	Highly autonomous services
Prime examples	
Trade, logistics, accommodation, food services, healthcare, social services	Information, communication, finance, insurance, scientific and technical services
Person and object-related tasks	Data and knowledge-related tasks
Theoretical link	
Classic Taylorism, LPT, Digital Taylorism	Marketization, Subjectification, Cybernetic Control
Control logics	
Direct control / execution control	Indirect control / outcome control
→ Minimizing job autonomy → Minimizing subjectivity → Minimizing uncertainty/risks	→ Utilization of selectively granted job autonomy → Utilization of subjectivity → Individualization of uncertainty/risk
↓	↓
Industrialization of services (dequalification, devaluation, alienation)	**Internalization of market** (self-control, self-optimization, self-responsibility)
Presumed job autonomy characteristics	
– Task Autonomy (–) – Method Autonomy (–) – Criteria Autonomy (–) – Scheduling Autonomy (–) – Working Time Autonomy (–) – Locational Autonomy (–) – Interactional Autonomy (?)	– Task Autonomy (+) – Method Autonomy (+) – Criteria Autonomy (–) – Scheduling Autonomy (+) – Working Time Autonomy (+) – Locational Autonomy (+) – Interactional Autonomy (?)
Corporate strategies	
1) Labor power rationalization 2) Process rationalization and optimization	
Role of digital technology and ADM	
1) Intensification, automation, control 2) Effective processes, reorganization 1 & 2) Creating transparency in work processes (content, time, location)	
↕	
Conflict with non-transparency of learning ADM systems (black box)	
Direct algorithm-driven work	Indirect algorithm-driven work
→ Pacesetter → Real time control → Quantifiability	→ ADM as central nervous system → Control by design → Automated feedback/management

Condition: formalization, standardization	
↕	
Limits of formalization, standardization	
– Conflict with flexibility demands of the market – Necessity of compensatory subjectification	– Conflict with utilization of job autonomy/subjectivity – Necessity of compensatory subjectification
↓	↓
Effects on job autonomy	
1) Job autonomy losses (–) 2) unclear (?)	1) Job autonomy gains (+) 2) unclear (?)
Relation to concepts of action in service work	
– Automation of objectifying actions – Minimization of subjectifying action	– Intensification/support of objectifying actions – Erosion of subjectifying action
Experiences of delimitation	
– Limitation within the company – Delimitation from the company	– Delimitation of organizational/individual objectives – Delimitation of working time/location

The fact that LAS cannot exert much influence on the working time and location-related aspects of their work (Working Time, Locational Autonomy) appears obvious in view of their personal and object-related nature. Given the characteristics of Taylorism, the existence of direct control also suggests that job autonomy is kept as low as possible regarding the selection, execution, and scheduling of tasks (Task, Method, Scheduling Autonomy). This principle also leaves little scope for influencing work objectives and their evaluation (Criteria Autonomy).

A questionable aspect is the degree of Interactional Autonomy, i.e., the dependence on third parties and freedom in shaping cooperation. This form of job autonomy has received little attention since considerations about the organization of work and the utilization of labor have traditionally emerged from the industrial sector. The question arises as to what extent LAS can escape, at least in part, from the prevailing logics of control in the context of interactive work.

The ideal-typical HAS, in contrast, describe branches in which the principles of rationalization and process optimization are expressed in the granting of job autonomy. Prime examples include, in particular, information and communications, finance and insurance, and scientific and technical services. These service branches tend to engage in data- and knowledge-related tasks. The above-mentioned branches are characterized by a relatively high proportion of well-paid jobs and highly qualified employees. At the intersections with customers, clients, and patients, there may still be large interaction shares.

The theoretical explanations for the characteristics of HAS are essentially rooted in discussions of marketization and the associated subjectification of work (and the ideal form of the Entreployee). In the interplay with learning ADM, cybernetic control in particular provides a contrast to Digital Taylorism. Behind these theoretical links lies an indirect control logic that aims to control results rather than execution. The control gap of Taylorism should be closed by means of the targeted granting of job autonomy and the exploitation of subjectivity, which is no longer regarded as a disruptive factor but as an enabler. Thus, in the course of marketization processes, workers in HAS find themselves exposed to the opening of their own work to the market. The direct controlling authority of the company recedes into the background. Thus, market requirements directly affect service workers, who react to this internalization of the market with self-control and self-optimization while investing a large part of their subjectivity.

These developments are particularly ensured by granting job autonomy in the selection and way of performing tasks (Task, Method Autonomy). Working Time and Locational Autonomy complement the flexible and situational adaptation to market requirements. Nevertheless, the possibilities for action in HAS are still framed by limits. Similar to LAS, it remains to be discussed to what extent the group can determine its own work objectives and their evaluation (Criteria Autonomy). Likewise, the degree of freedom in the area of Scheduling Autonomy is at least questionable, but from a different perspective than with LAS. It is logical that workers in HAS can plan and prioritize their tasks independently, but it is evident that the time intensity of work is high and that interruptions in work processes occur frequently. In any case, the time-intensifying factor in the context of marketization should not be underestimated. Finally, the degree of Interactional Autonomy must also be considered in this context. It is possible that this is also not highly pronounced, especially because of the specific organizational forms of HAS (e.g., project work, decentralization), which lead to a dependence on third parties. It is the task of Part II, i.e., the attempt to quantify job autonomy dimensions, to systematically record the characteristics by branch.

Digital technologies and ADM serve a variety of organizational functions for both groups: as a control device, as a process-optimizing element, as a support tool, or as a combination of these. It depends on the operational goals of technology use. If these operational objectives essentially lie on a continuum between reducing human labor, gaining control over it, and improving effectiveness (Pfeiffer, 2018, p. 321), then ADM systems cannot be excluded from this logic.

Nies's (2021, pp. 489–491) emphasis on the corporate strategy behind technology use is taken up in relation to different rationalization principles: labor power rationalization and process rationalization which, as described above, might have different effects on job autonomy. They may therefore be related to both LAS and HAS. Within the framework of the corporate strategy of labor power rationalization, the objective is to intensify labor power utilization through technology or to automate it completely. Control mechanisms play a key role under this target dictate. The strategy of process rationalization, by contrast, strives for more effective processes and value flows through the utilization of technology. Operational reorganization, rather than control, plays a role under this approach. Again, it can be assumed that in practice there is no clear distinction between the two concepts in companies, but that the nuances of both approaches are discernible.

With reference to the classification of ADM systems (Chap. 3.3), it is assumed that automating-substituting ADM systems are more likely to fall under the principle of labor power rationalization, while assisting-informing and augmenting-complementing functions are closer to process rationalization since they may involve a higher degree of organizational change. In this sense, the distinction between corporate strategies should be regarded as ideal-typical because Friedman (1977a) already described that corporate control strategies move between the extremes of direct control and responsible autonomy (overview in Marrs, 2018). However, this view assists in the systematic consideration and interpretation of different logics for exploiting job autonomy.

What is novel about digital and rule-based ADM systems (in relation to both operational strategies) is that their utilization creates a new level of transparency in work processes in terms of content, location, or time. This transparency of detailed work steps has the potential to cause a massive increase in inequality towards management, to the disadvantage of workers. However, this assumption contradicts the opacity of (especially learning) ADM systems for management and workers. This lack of transparency argues for an overall evolution toward less execution control and more result control, regardless of the corporate strategy or utilization of job autonomy.

Within this frame of conflict, the control principle of *direct algorithm-controlled* work is visible for the group of LAS, in that learning ADM systems are still used as pacesetters for individual work steps but also monitor them in real time and enable quantification. A new wealth of monitoring data is thus generated, which in turn is used to precisely control work. For HAS, meanwhile, there are trends toward *indirectly algorithm-driven* work, where middle management in particular is eliminated and control mechanisms are built into the learning systems. Employees are encouraged to exercise self-control via automated feedback mechanisms.

As advanced as some sophisticated ADM systems may be, their deployment is usually conditional on the formalization of work steps and the standardization of work environments. Standardization must not be read exclusively as alienating and monotonous for employees. In terms of occupational safety, standardization, such as the automated specification of precise work steps, can also be regarded as desirable. However, ADM systems still have their limits in terms of formalization and standardization. Regarding the service sector, these technical necessities contrast in particular with the subjective parts of the work, which do not take place in a standardized way but are carried out to a large extent by subjective work actions, i.e., reacting according to the situation and experience.

Since subjectivity should be kept to a minimum in LAS, standardization tends to conflict with a flexible response to market requirements. However, it is also well known that employees in these branches always find ways to bring subjectivity into their work, meaning that compensatory subjectivation must at least be assumed. For HAS, formalization and standardization are in clear conflict with the utilization of job autonomy and subjectivity, which are at the core of the control model. It is also assumed that for both groups, limits to automation remain, perhaps not even due to a lack of technical capability but rather because employees manage to close off some tasks (e.g., interaction work) from access by technology.

Overall, the effects of using rule-based and learning ADM systems on job autonomy assumed on the basis of previous theoretical approaches must always be viewed in light of the underlying corporate strategy. In the isolated view of labor power rationalization, a polarization is likely, which will manifest in LAS as decreases in job autonomy because the strong control mechanisms increasingly make it difficult to identify new scope for action and possibilities for appropriation. It may be that employees are left with only compensatory tasks to empower the technical systems, rather than the other way around. HAS, by contrast, could expect further gains in job autonomy under the dictates of labor power rationalization. These gains could be leveraged for further self-optimization and the identification of subjective opportunities to contribute to the work.

Regarding the strategy of process rationalization and optimization, however, the effect on job autonomy for both groups remains largely open and dependent on the specific technology and its controlling, optimizing, or supporting potential. The necessary reorganization of processes may have unexpected consequences for employees. The possible influence on the interaction part of work is considered to be particularly relevant.

Considering the extended influence of using ADM systems, it may be assumed that effects on both objectifying and subjectifying work actions can be observed. Previous findings indicate that, in the case of LAS, objectifying actions are further automated. Due to the new level of control mechanisms and learning capacities of these systems, the erosion of the remaining possibilities for subjectifying work actions is to be discussed. Little job autonomy and the attempt to eliminate subjectivity from work processes are likely to solidify as a field of conflict with service activities. For the group of HAS, further intensification tendencies are possible, but they also support potentials regarding objectifying work actions. It remains apparent from the previous logic that subjectifying work actions must be further exploited to trigger self-optimization processes among employees.

The experience of delimitation that workers have in the process of using ADM systems is already partially visible. For LAS, it is likely that the minimization of job autonomy will continue to lead to limitations within companies. In addition, delimitations from the institutional unit of the company continue to be realistic. For HAS, delimitations have so far been found to exist in terms of the fulfillment of both personal and corporate objectives, as well as in terms of working time and place of work. Although not desirable, a further intensification of these delimitations is quite conceivable.

Many of these expectations regarding the interplay between job autonomy and ADM need to be examined in the empirical parts that follow. However, it remains to be noted that previous theoretical approaches to achieving transparency in the current utilization of technology in companies reveal two gaps: First, the effects of learning ADM systems and their partial lack of transparency must be embedded in the various control logics because they contradict known attempts to close control gaps in the work process. Is a new phase of technological determinism imminent, as Huchler (2023, p. 369) assumes, and if so, what are the consequences for service workers?

Secondly, the specific characteristics of service work, especially interaction work, and its demands for employees remain, as already mentioned several times, hardly illuminated regarding the use of ADM systems. Subjectifying action as part of interaction work might be the decisive driver of change regarding the use of learning ADM systems. Up until now, it has always been the objectifying work action that was subject to the influence of technology and automation. Does the use of learning

ADM systems result in a change in the subjective share of work? If so, the consequences could be serious, because for many service employees, interaction work is the last instance of creating meaning and motivation at work.

The theory development on both issues is not yet complete. The empirical examination of the interplay between job autonomy and ADM systems also attempts to contribute to this. In this context, the analysis of the empirical data must consider which previous theoretical insights can actually be recognized and which contradictions may arise. The final question is to what extent the utilization of ADM systems contributes to the reinforcement of existing polarizations and inequality developments, i.e., rationalization-led operational structures and market orientation. These questions will have to be returned to at a later point.