

An Artificial Intelligence Cycle Model Against the Shortage of Skilled Professionals - An AI-based Holistic Solution Approach for Human Resources

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Abstract:

In order to counter the impending shortage of skilled professionals in the aging societies of our time in many western countries such as Germany, solutions for business and society are urgently needed. Here, artificial intelligence (AI) can play an important role in mitigating the problem with the help of diverse applications. At the same time, it is important to consider both the needs of the respective employee and the company to ensure that the use of AI has a positive impact on the organization and finds social acceptance.

In this article, we describe the newly developed OSQE model (Optimize, Secure, Qualify, Expand) shown in Figure 1 from Annex, which for the first time outlines an AI cycle against the shortage of skilled professionals in a holistic approach that focuses equally on people and companies. This can serve organizations as a guide for strategy development, decision-making for and implementation of AI-supported measures in an entire cycle of an employee's affiliation with a company.

The model takes three driving forces into account: companies, professionals, and AI applications. In the model, the measures to be implemented are prioritized with ascending numbering based on what would be most urgent for a company to implement. All measures relate to areas of action that place people at the center and can be assigned to the classic cycle of belonging of an employee in the company. In this regard, the opportunities that AI offers to professionals and companies are highlighted.

Keywords: artificial intelligence; human resources management; skills shortage; digital transformation; OSQE model; responsible AI.

JEL Classification: O35; O31; O15.

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Introduction

This article was written to help address an important problem for business and society: For several reasons, many societies around the world are battling a shortage of skilled professionals - in some cases, a shortage of professionals in general. A key role in the fight against the shortage of skilled professionals is played by the enterprises themselves². By taking appropriate action, they can set an important course. Today's skilled professionals themselves are also essential to solving the problem (Schindler, 2022; Goulart, Liboni, and Cezarino, 2022; Case et al., 2023).

Indeed, a major thrust for combating the shortage can be unleashed on the basis of digital transformation - in particular through the well-considered and sensible use of AI. The extensive consulting experience of the authors of this article shows, however, that both many professionals and many companies have difficulties in finding their bearings in the field of AI and in deciding on and implementing targeted measures. There are various reasons for this. Thus, there is often reservations and uncertainty when dealing with the topic of AI. A contributing factor is that AI is considered difficult to understand due to its association with mathematics, statistics and computer science. In addition, studies show a diffuse feeling of fear of AI, especially in Germany. (Kersting, 2021; Sindermann et al., 2022).

In working environments, employees are often concerned about being "rationalized away" as a result of AI projects and consequently losing their jobs. This is often exacerbated by the fact that companies shy away from discussing the opportunities that AI offers all those involved, so as not to arouse fears within the workforce. A proactive approach is therefore often lacking that addresses augmentation of work with the help of AI (Meier, Seufert, and Guggemos, 2019) also because in many cases there is a lack of basic knowledge about the technologies and their possibilities such as Blueprints for implementation in non-IT domains.

Many discussions about AI grapple with fundamental ethical issues (Gatt, 2022) which can turn decisions about the use of AI in a company into fundamental decisions that are assessed in different moral ways. This implicitly raises the inhibition threshold for managers and employees to position themselves in this regard. And furthermore, the use of AI raises not only technological and ethical issues that need to be addressed, but equally legal, social, political, and economic issues that affect society as a whole (M Del Giudice, Scuotto, and Orlando, 2023a; Haefner et al., 2021; Chatterjee et al., 2021).

This makes it all the more important to transparently highlight the opportunities and challenges that AI presents to combat the skills shortage, as well as to outline ways to approach the topic holistically. This article is intended as a starting point to support companies and employees both in the holistically oriented and responsible use of AI to alleviate the shortage of skilled professionals and in a human-centered orientation of the use of AI.

1. Research Background

The shortage of skilled professionals is a major problem for many western countries such as Germany. According to a recent study by the Institute for Employment Research (IAB), there were more than 1.8 million vacancies in Germany in the third quarter of 2022 (Aktuelle Ergebnisse Für Arbeitsmarkt- Und Berufsforschung, 2023). This problem is expected to worsen significantly in the coming years, with companies and public administration alone expected to "require up to 780,000 additional technology specialists in Germany by 2026"(Gross, 2021). It is expected that the "transformation of the economy" towards decarbonization and digitalization will lead to a growing demand especially for STEM³ professionals (Gillmann, 2021; Bakari, 2022; Bakari et al., 2022).

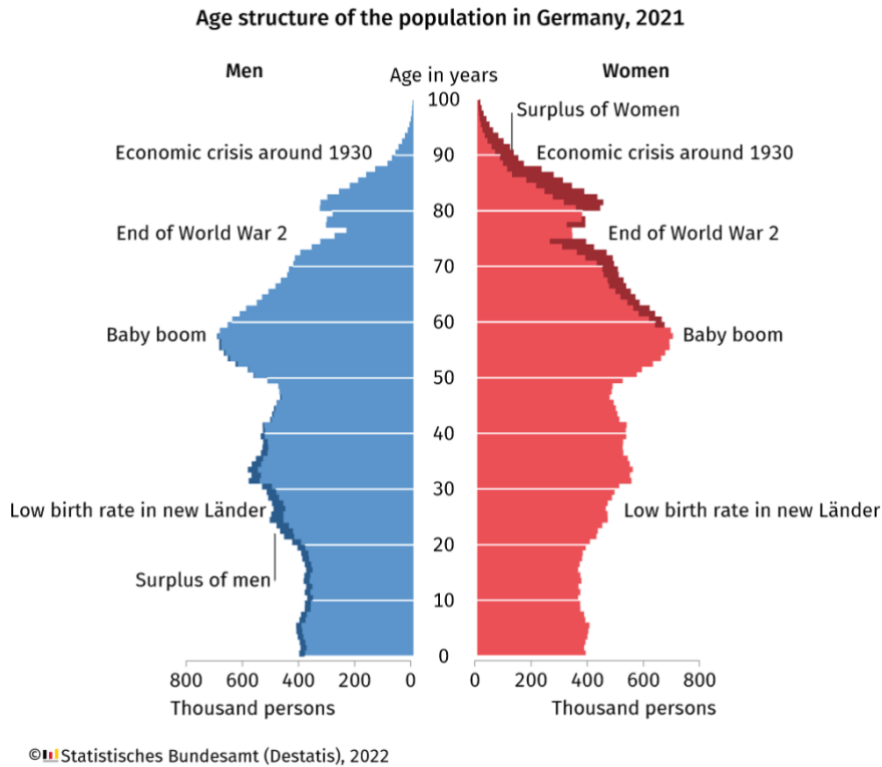
One major reason is that demographic change will have a significant impact within this decade, as shown in Figure 2. Many members of the so-called baby boomer generation will retire, and the following generations will not be able to absorb this quantitative outflow of professionals. (Mitten Im Demografischen Wandel - Statistisches Bundesamt, 2023).

In addition, there is a qualitative shift. In Germany in particular, there is a declining interest and level of training in the area of STEM education, which is of particular vital to companies. For example, the number of first-year students in STEM subjects has declined significantly in recent years, and achievement tests of school students in these subjects also indicate a reduced level of performance (Plünnecke, 2022).

² For reasons of simplification, the term "enterprise" will also be used in the following to refer to public enterprises and public administration.

³ STEM is a common abbreviation for Science, Technology, Engineering, and Math.

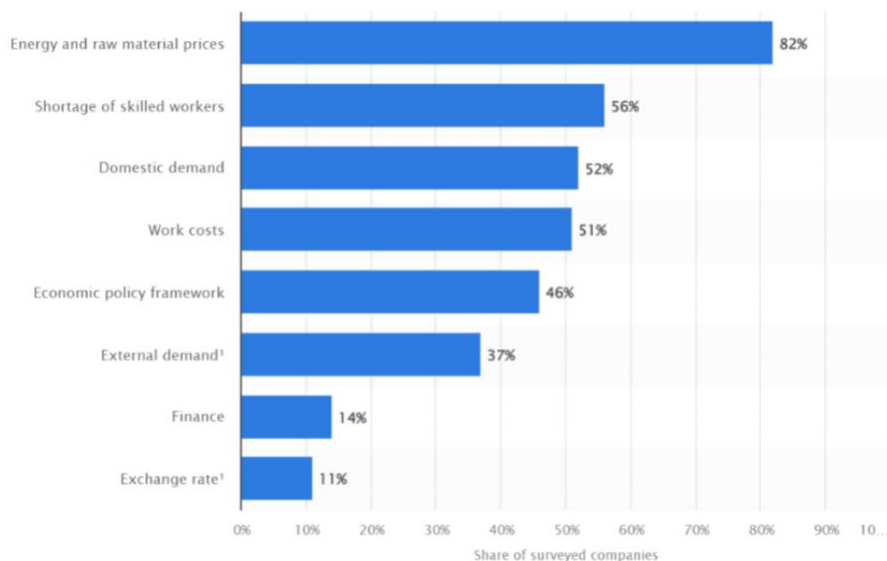
Figure 2. Age structure of the population in Germany, 2021



Source: Published by Federal Statistical Office, Destatis, (2022)

Therefore, especially in aging societies like Germany, this loss of labor will lead to a burden on the economy and society that is hardly imaginable in its scope today - with all the resulting problems for the national economic performance, competitiveness of companies, as well as public budgets (Geis-Thöne, 2021). The problem is recognized, as can be seen in Figure 3. For example, in the summer of 2022, 56% of German industrial companies identified the shortage of skilled professionals "as a major business risk" (Geschäftsrisiken Für Die Deutsche Industrie 2022 | Statista 2022).

Figure 3. Perceived business risks for companies in Germany, 2022



Source: German Chamber of Commerce and Industry (DIHK) Business Survey (2022)

The use of AI has immense potential to provide great relief and help counteract this labour shortage problem. Especially in the field of economy, there are numerous possibilities for approaches (Mullins, 2022; Zhang, Mishra, and Brynjolfsson, 2021; Kim et al., 2023). In our opinion, it is essential to think holistically about the entire cycle of an employee's affiliation with a company. This is the only way to tap the full potential of AI to tackle the shortage of skilled professionals and to create overarching benefits for companies and employees.

In this holistic approach, it is also crucial to take into account the needs of all stakeholders to ensure that the AI measures are a sustainable success not only technologically, but also organizationally, socially as well as politically in terms of their acceptance. Many employees are skeptical with regard to the use of AI, seeing it less as a relief than as a threat that could lead to the loss of their jobs. Addressing such fears and countering them constructively will be an important task for companies. At the same time, however, studies suggest that not only the willingness, but also the desire of employees to incorporate AI into HR is present among a majority of younger Generation Y employees (Pandey and Eng, 2019). It is indispensable to show all employees, regardless of age, what their working life will be like after the introduction of AI.

2. Challenges

The often-existing reservations about AI has already been described at the beginning, and must be taken seriously and taken into account in all AI projects. Companies and employees must be able to approach the topic with the feeling that they can master the challenge. A holistic approach provides an overview and the certainty that nothing has been overlooked. Information about targeted AI applications and potentials as well as the associated challenges must flow in a correspondingly structured manner. Concerns about the negative impact of AI projects on today's employees must be taken seriously and countered on the basis of effective measures and thus in a well-founded manner. After all, digital transformation is already changing existing job profiles, and the more disruptive the technologies, the greater the impact on job profiles and qualifications. This requires not only a reassessment of traditional qualification paths, but also represents both an opportunity and a challenge to better address the qualification needs of employees and companies and to demonstrate promising prospects for the future.

Particular attention must also be paid to the fact that when selecting AI applications, the principle applies that they must be culturally and legally appropriate to the conditions in the country of application. This fundamentally requires a national review of AI applications (Brewster and Hegewisch 2017), and leads to more difficult conditions for companies that have multiple international locations, but is nevertheless essential to consider.

The use of AI applications in the human resources (HR) field is further complicated by the fact that, depending on the size of the company, small data sets are available (Tambe and Cappelli, 2018). Moreover, the more personal data is digitally available and used by different people, the more a transparent guideline and education on cybersecurity threats and safeguards is needed as an inseparable part of any AI strategy (Garba, Siraj, and Othman, 2022).

Many research questions result from the foregoing. Some of the most pressing are:

- What measures are needed to unleash the potential of using AI to combat the skills shortage?
- Which business areas and application areas should companies focus on first?
- How can the business requirements of companies and the needs of employees be taken into account in the same way as other transformation processes?
- How can we ensure that AI is used successfully in a responsible and sustainable way?

3. Methodology

In order to outline practical approaches and provide orientation for companies and employees, a holistic approach should be chosen. This is necessary to exploit the potential of AI for the benefit of people and companies in overcoming the shortage of skilled professionals. The approach should focus equally on companies and employees along relevant subject areas, such as when an employee joins the company or during his or her qualification. In this way, the resulting requirements can be taken into account in the technological and organizational utilization of AI.

This necessity entails a degree of complexity that must not be underestimated. What is needed are assessments of technology and possible technological applications, their impact both in organizational (Entwicklung Einer Wertorientierten IT-Strategie 2008; Chowdhury et al., 2023) and economic aspects, including the question of their half-life until technological obsolescence. In addition, various questions also arise from an ethical point of view (Vrontis et al., 2021) and, of course, the corporate culture, organizational aspects, social factors and general acceptance must be taken into account. Here, the details of an implementation are important: Experiences with Human-Computer-Interaction (HCI) show that different users with their different motivations and needs should be addressed in order to act successfully (Dvir, 2017; M Del Giudice, Scuotto, and Orlando, 2023b).

For example, the views and needs of employees, managers and entrepreneurs have both overlaps and differences, and the company must also be seen as an actor with its own requirements and interests.

This article therefore addresses the four research questions mentioned under Challenges above. To answer them, a novel, holistically oriented model was developed, which is presented below.

4. Results and Findings

Decision-makers and employees can apply the "AI cycle against the shortage of skilled professionals" as a guide on the way to a holistic approach. Since the associated model is based on the four categories of Optimize, Secure, Qualify and Expand, it is called the "OSQE model" for short. This model was developed by the authors and represents the appropriate application possibilities of AI along a cycle. The OSQE model is based on the phases of an employee's affiliation with a company and begins, also in the sense of a maturity model of a company, where measures are easiest to implement for each company: with the so-called "low hanging fruits". The resulting measures were color-coded according to this logic - as in a traffic light system.

The philosophy regarding the way AI should be used and according to which the cycle was developed is reflected in the chosen holistic approach of the developed OSQE model: Both the needs of the company and the employee are equally in the center of interest and are brought into harmony with each other. This is in line with the "Responsible AI" fundamental principle of finding responsible, human-centered solutions in AI developments. A related branch is the field of "Ethical AI", which places AI development under the judgment aspects of ethical standards (Ng et al., 2022).

It should be noted that in practice there is often a large gap between the basic principles of a responsible AI solution that have been developed and what is being practiced in companies (Schiff et al., 2020). Therefore, it is useful to follow a clear methodology (Benjamins, Barbado, and Sierra, 2019) to follow in order to consistently ensure Responsible AI principles in AI implementations.

A responsible approach to AI relates not only to the application purpose, the methods and principles used for the introduction and ongoing operation of AI, but also to the concrete application. Especially in AI, there are many new developments within very short time intervals, as for example in all technologies dealing with large language models (Wilson and Daugherty 2020) like ChatGPT (Wiggers 2022; Korzynski et al. 2023; Budhwar et al. 2023), image generation technologies like DALL-E 2 or Midjourney, general applications around Generative AI, Diffusion Models (Yang et al. 2022) etc. As with most fast-moving technological developments, many questions of a technological, social, cultural, ethical, and legal nature remain unanswered.

However, it is foreseeable that these new technologies will probably not only have a major impact on our working world but will also significantly influence it very quickly. It is therefore all the more important, both as a company and as an employee, to deal intensively with the topic of AI at an early stage (Berente et al., 2019) and to gain experience at least with AI applications that are now established. This helps considerably, both as a decision-maker and as an employee, to be able to assess the new technological developments and their significance for one's own business and work area in a self-responsible and competent manner. This is even more important as many tech companies in the past have been better at seizing business opportunities than adequately considering ethical implications of the algorithms used (Heikkilä, 2022) Therefore, not only but also especially HR managers have to deal intensively with the possibilities of AI in order to be able to comply with the standards valid to date, e.g., with regard to ethics and fairness (Charlwood and Guenole, 2022).

In addition, it is important to adhere to the basic principles of the EU Artificial Intelligence Act, a new EU regulation on the responsible use of artificial intelligence, which is currently already in the legislative process (Tchametsky and Gehrke 2022).

The four categories: Optimize, Secure, Qualify and Expand considered in the holistic OSQE model will be explained in the following and outlined with some exemplarily selected applications.

In principle, a holistic approach is necessary in order to do justice to the topic. However, even a holistic approach begins with individual implementation steps. For example, a company can make a very good start with individual measures in selected areas, familiarize itself and its employees with the use of AI, and then close existing gaps step by step on the basis of the experience gained. In this regard, activities in the area of optimizing current activities - highlighted in red in the OSQE model according to a traffic light system to document prioritization - are a good idea. It is precisely in these areas that there is already at least a basic understanding of the potential of AI. Studies show that many companies see automation solutions in particular as a measure against the shortage of skilled professionals (DATEV Magazin, 2022; Kökütü, 2023) Thus, these could be a sensible start to orienting themselves more and more in the direction of holism.

Category 1: Optimize

In the first category, "Optimize", the company's measures focus on reducing the workload of employees who are already part of the company and making better use of them.

The relief of the professionals (IT-ZOOM, 2021) (package of measures 1, highlighted in red) can take place intellectually, mentally, physically, or in terms of time. Intellectual relief can be achieved by having AI take over repetitive routine tasks, such as creating reports, entering and processing data, or performing routine analyses. The mental relief can take place, for example, through chatbots taking over at least part of the customer communication, for example, in complaint hotlines (IT-ZOOM, 2021). Another example is AI-assisted anomaly detection, for example, on X-ray images in the field of early cancer detection. The knowledge that a safeguarding cross-check is performed by AI can have a very relieving effect on medical professionals. The physical relief is especially due to the use of robots, e.g., in the health care industry (Agyeman-Manu et al., 2023), agriculture (Dhanush et al., 2023; Sharma, Verma, and Hardaha, 2023; Pickering, Duke, and Au, 2023), industry, or disaster control (Biundo et al., 2016) given. And the temporal relief occurs, for example, through the time saved by the processing of large amounts of data by AI (Engelen, 2022).

The package of measures 2 (highlighted in red) shows that with the help of AI, humans can be better deployed by sharing the work in a strength-specific manner: By having AI take over routine tasks that would require care and concentration from humans over a longer period of time, the error rate decreases (IT-ZOOM, 2021). At the same time, AI-side adoption of hazardous activities decreases the risk of human harm. Humans, on the other hand, can focus on complex (special) cases, such as checking AI-supported identified potential problem cases, so-called "red flags" in the area of IT security, process control, or customer support. The freed-up working time can be used for strategically important topics such as personnel development, creation of new business ideas and products, or personal customer contact. Also, in view of the immense shortage of skilled professionals in the field of information technology, very easy-to-use, so-called no code/low code solutions can enable employees without programming experience to implement their own ideas in the adaptation of the software used.

Category 2: Secure

The second category, "Secure", is measure package 3 (highlighted in orange) with a focus on wanting to retain professionals. According to a survey (Oracle 2021) by Workplace Intelligence and Oracle (2021) in 13 countries, 55% of the more than 14,000 employees and decision-makers surveyed said they would be more likely to stay with a company that uses AI to support their career development. As many as 85% want technology to help them with their career development, especially when it comes to identifying specific training needs and suggesting training opportunities. To this end, AI-powered solutions offer interesting approaches to provide a more individualized approach to employees, thereby increasing employee satisfaction, while also easing the burden on HR departments (Andrea, Judith, and Alexander, 2022; Prikshat, Malik, and Budhwar, 2023; Malik et al., 2023). In this regard, about four-fifths of the issues commonly encountered in HR departments could be handled by AI ("Ai-Works4u.Com: HR-Effizienz Dank Künstlicher Intelligenz" n.d.; Manlio Del Giudice et al., 2023; Cho, Choi, and Choi, 2023).

For example, AI-powered chatbots could be used for surveys to reduce employee turnover. Employees would be able to be proactively surveyed at important milestones in their employment with the company and would have the opportunity to express ideas, wishes or suggestions for improvement in individualized interactions. (Korolov, 2022) In this way, employee participation is actively promoted and supported (Kwon and Park, 2019). On this basis, the company would be able to respond better and more appropriately to the answers than to the results of classic, standardized surveys.

AI-supported individualization in training not only supports learning success, but also shows employees that companies are actively investing in them and their development with the help of new technological support options. Furthermore, according to the aforementioned study, most respondents prefer to work for a company with AI support because it keeps them technologically up-to-date as employees. AI can also provide ongoing support in everyday work with the optimization measures mentioned under the first point and relieve employees of less satisfying tasks, thus increasing job satisfaction and making day-to-day business easier.

With the package of measures 4 (highlighted in orange), AI supports in securing the knowledge of the specialists for the company. This is because AI develops its strength in the use of unstructured data: the major problem of non-AI-supported classic knowledge databases of companies, which always first have to be filled with processed data at great expense. AI algorithms, on the other hand, can learn from historical data, supporting humans as their digital assistant systems (Engelen, 2022). Experienced employees can then use their expertise to evaluate the results, thus actively improving the algorithms used and thus preserving the know-how for the

company. This could avoid a lot of work with written documentation and minimize the risk of something being forgotten or overlooked.

Category 3: Qualify

The third category "Qualify" relates to package of measures 5 (highlighted in green), in which the company's employees receive further training with the help of AI or as a result of AI. This is because successful use of AI often requires further training on the part of the company to raise the level of qualification of its employees. In addition, AI can help, for example, in the identification of communication/social training needs, or assist in the targeted selection and offering of training measures (Gisler, Schildknecht, and Wehrmüller, 2020) In this respect, AI can play an important role here in implementing the active competence development of employees that is also required on the part of the company (Hartmann, 2020). And there are AI-supported (Katona, 2021) individualized training programs that convey appropriate content in appropriate language.

In addition, of course, the aforementioned is fundamentally true in the Optimize and Secure categories: The selection, introduction, and handling of AI-based applications keeps decision-makers and employees technologically up-to-date, which is the only way to leverage the potential of new AI applications (IT-ZOOM, 2021) What will be particularly important in the future is not only to develop an understanding of the potential of AI applications, but also how this can be used with regard to the changing shape of today's job profiles (Davenport and Mittal, 2022) This is where developing meaningful augmentation strategies is critical (Hartmann, 2020) In this respect in particular, cooperation between companies and employees that is geared toward creativity is necessary to enable the use of AI that has a positive impact.

Category 4: Expand

The fourth and last category comprises the "expanding" of the company: In measure package 6 (highlighted in blue), AI helps the company to find new skilled professionals: internally as well as externally (Johansson and Herranen, 2019). AI-supported screening of applicant and personnel data for skills and abilities can take place, as can the assessment and outlining of development opportunities and paths with regard to desired positions. This also includes AI-supported matching of data regarding specific position requirements. The application process can also be AI-supported (Rauch, 2022).

Finally, the (last) set of measures 7 (highlighted in blue) relates to the onboarding of new professionals. AI accelerates the onboarding of new employees and improves it through personalized sequencing and alignment. In addition, AI-supported experience mapping can take place at defined points. Faster and more targeted onboarding of new employees is also possible with AI support, for example by using individualized training programs as well as learning simulations and the like.

Discussion

The model is an important initial guide for implementation in companies. However, it is crucial to pay active attention to balancing the needs of those involved during implementation, and thus to ensure that AI can unfold its potential in terms of supporting the company as well as the skilled workforce. Only in this way is a sustainably successful implementation of the new technical possibilities conceivable, which in turn can lead to a positive response in the company. This is the best basis for ensuring open-mindedness and committed participation of all stakeholders in the underlying change process in the company, which should be an actively managed part of any AI introduction.

When introducing AI, concrete positive effects of the AI on the employees must be demonstrated, as well as the perspectives that open up: This includes the relief of employees who can take on other tasks in the time freed up. This can result in positive effects with regard to job enrichment and job improvement. The introduction of AI will also have to be combined with concrete and further training measures, which both companies and employees will have to design and implement proactively and constructively.

There are currently many discussions about whether the rapid development, particularly in the area of generative AI, will not ultimately lead to the creation of unemployment, so that a shortage of skilled workers in some professions is offset by waves of redundancies in other professions. In any case, it is likely that there will be significant changes in the labor market that will have a major impact on the effective skills sets development and changing machine assisted work environments for everyone. The World Economic Forum's Future of Jobs Report 2023 (Di Battista et al., 2023) therefore states that 60% of surveyed companies consider a skills gap of the personal in the local labor market to be the main obstacle to successful business transformation.

The fundamental rule for all topics dealing with technological change in close interaction with HR development is that change can only be managed as a team. Technological competencies must be brought together with the knowledge of the specialist departments, and the entire change process must be supported by management as

well as coordinated with employee stakeholders. Both data protection requirements and ethical guidelines must be adhered to (Andrea, Judith, and Alexander, 2022; Pan and Froese, 2023; Basu et al., 2023; Rodgers et al., 2023a). The development and application of clear ethical standards in the use of AI will be a success factor for social acceptance in this context (Rodgers et al., 2023b).

At the same time, regulators also have their eyes on the opportunities and challenges posed by the introduction of AI. That is why legislative proposals such as the EU Artificial Intelligence Act (Veale, 2021) provide for regulation of AI to unleash the opportunities in a regulatory safe environment (Kop, 2021).

This forms an important basis for successfully implementing the necessary change measures in companies in particular, but also in society in general, and for harmonizing technology and society.

In the context of the model, however, there are a number of further questions that need to be clarified in the course of the transformation of the companies: These primarily concern questions about the detailed design of the model in practice within the holistic cycle. How does the new distribution of work made possible by the measures described in the "Optimization" category change the job profile and task description of employees? How does this affect the qualification category? For example, it is necessary to consider which areas need to be qualified. With what lead time must qualification measures be started. And how often is qualification carried out? Comparably detailed questions also arise in connection with the other packages of measures when it comes to the concrete implementation of the model in the company. Nevertheless, the following applies: The most important step is the formulation of a red thread that helps to steer the individual measures in a holistically oriented model in a targeted and prioritized manner. The OSQE model provides this common thread.

Conclusion

This article describes the problem of the shortage of skilled professionals using Germany as a case study and discusses the challenges for companies to meet this shortage. In a practical approach, a methodology is developed here to master the challenges with methods of AI. A new circular model was developed for orientation, planning and implementation of measures.

The individual elements of the OSQE model described interlock and result in a continuous cycle consisting of four categories and seven packages of measures. Within this cycle, a company and its professionals can form a meaningful interaction between people and machines. The important thing here is that the measures are thought through, planned and implemented responsibly and sustainably. In this way, the respective strengths of people and machines can be used positively and further developed with the help of suitable qualification measures, among other things.

Human work is not devalued by this, but can, on the contrary, be made significantly easier and (re)designed in a more interesting way by the measures described, if they are implemented responsibly and flanked by qualifications. The company can thus counteract the shortage of skilled professionals in an innovative and people-centric way and increase its competitiveness.

Credit Authorship Contribution Statement:

Marina Tcharnety was responsible for the conceptualization, methodology and writing of the original draft, while Florian Vogt was responsible for data curation, project management, writing review and editing. The research and visualization aspects were carried out collaboratively, with both Marina and Florian contributing equally.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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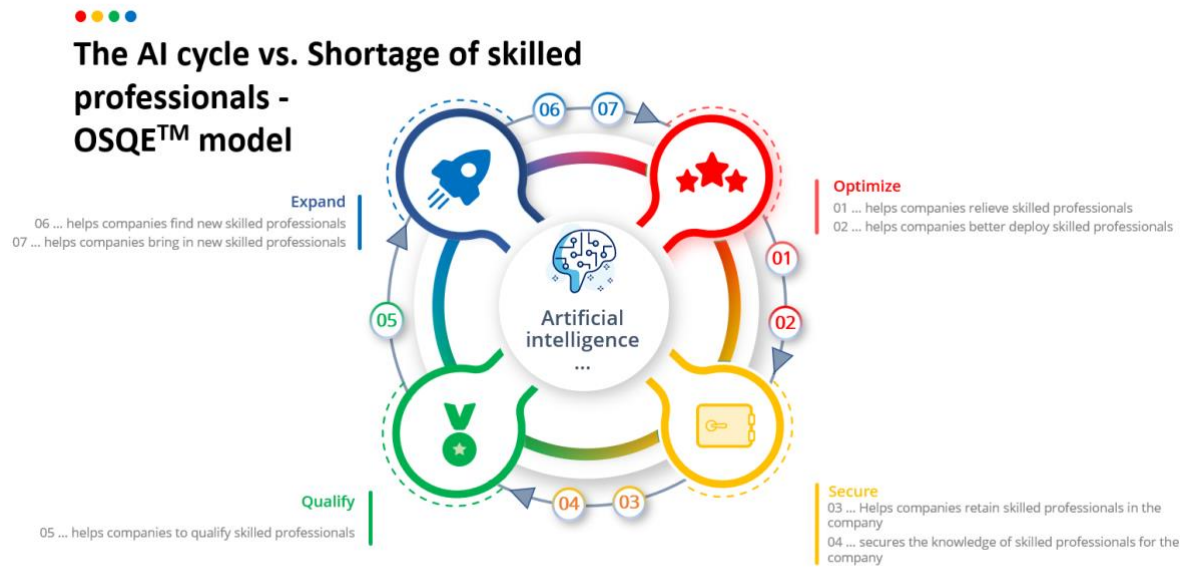
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Annex

Figure 1. OSQE model (abbreviated from Optimize, Secure, Qualify, Expand)



Source: own figure.