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Regional Competence Centers for Work-Related Research as Drivers of Innovation in the Digital Transformation – An Overview

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Regionale Kompetenzzentren der Arbeitsforschung als Innovationstreiber in der digitalen Transformation – ein Überblick

1 Introduction

The current working society is constantly seeking innovation and improvement, with digitization being a driving force in this pursuit. In particular, there has been a significant focus on the utilization of Artificial Intelligence (AI) technologies, as they are expected to bring about technological advancements and enhanced economic competitiveness. The ultimate goal is to effectively integrate these digital technologies, especially in small and medium-sized enterprises (SMEs), in order to promote sustainable structural changes within the working society. To achieve this objective, eight “Regional Competence Centers for Work-Related Research” have been established, tasked with researching and appropriately introducing the socio-economic opportunities and risks associated with digital technology implementation. This article provides a brief overview of these research and transfer networks, including their objectives, stakeholders, structures, and activities.

2 Artificial intelligence as a subject of work-related research

As a leading industrialized country, Germany is challenged by the effects of technological advancements, socio-demographic shifts, and geopolitical changes. These structural transformations impose an increased burden on commercial enterprises to satisfy diverse customer requirements while

operating in a high-quality and resource-efficient manner, especially under volatile market conditions. In response to these challenges, Work-Related research plays a crucial role in developing a scientific foundation for productive and ergonomic work. In particular, ergonomic considerations for designing socio-technical work systems are gaining importance in strengthening the innovative capabilities, decision-making abilities, and resilience of business companies (Braun 2023).

One key objective of Work-Related research is to further advance concepts of rationalization and humanization in a contemporary manner by examining issues such as functional division, computerization, and automation. The potential performance gains of artificial intelligence make it particularly suitable for automation purposes, with AI systems expected to be utilized across various industries and sectors where high-quality datasets are available. AI software is based on mathematical models and algorithms to capture and imitate human and machine behavior (Landgrebe and Smith 2022), enabling the implementation of flexible automation solutions, predictive maintenance systems, or autonomous service chatbots etc.

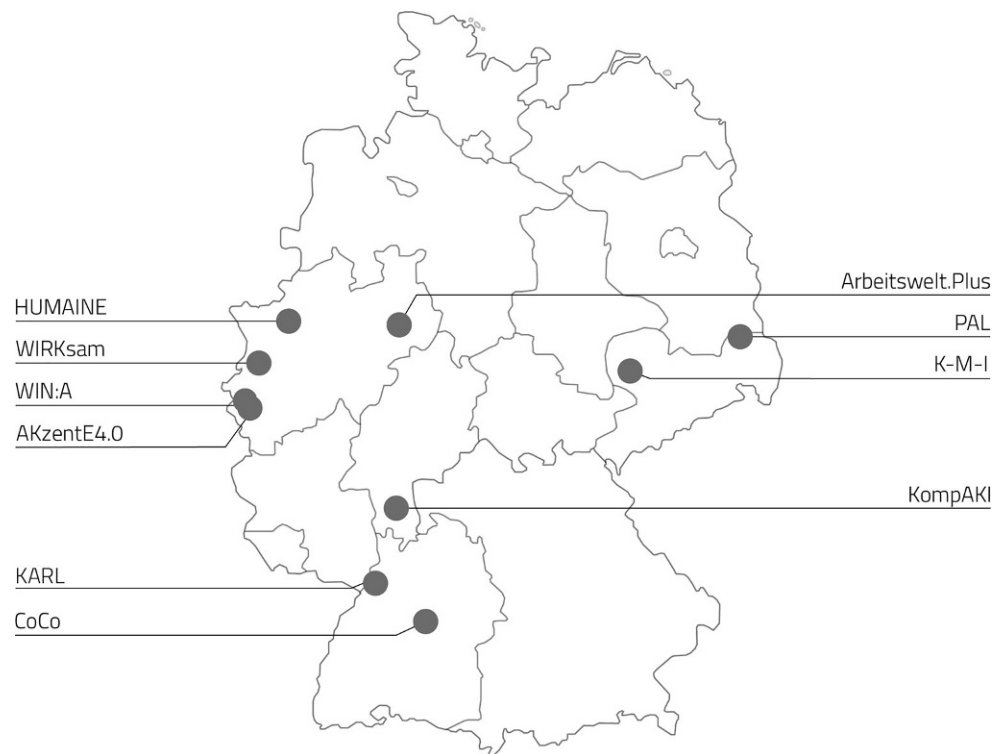
However, the full potential of digital technologies in terms of functional improvements and overall benefits has not yet been fully realized, especially in SMEs. This can be attributed partly to inadequate knowledge transfer between science and industry. Addressing this “transfer problem” is vital in finding solutions to critical challenges facing the working society, such as lack of skilled workers, productivity loss due to health issues, and wasting of resources (Braun 2024). As such, there is a public interest in supporting SMEs as an important sector of the economy in managing socio-economic structural change.

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Fig. 1 Map of the geographical location of the competence centers and the meta-projects

Abb. 1 Karte der geografischen Lage der Kompetenzzentren und der Metaprojekte



3 Regionalization of work-related research

Since the 2010s, the German Federal Ministry of Education and Research (BMBF) has provided funding for research and transfer projects focused on implementing digital technologies in the workplace. Notably, funding has been allocated to fields such as “Industry 4.0” and Artificial Intelligence (AI). Through various research and application projects, digital technologies have been successfully integrated into processes, systems, and products in large companies. However, it has become clear that SMEs need additional support in implementing work-related research results (Cernavin and Joerißen 2022).

Strategic collaborations are crucial for successful technology transfer and should not prioritize short-term economic gains or narrow objectives. The quality of this transfer is greatly influenced by trustful networking between cooperation partners. This can be achieved through continuous collaboration with mutual benefits for both researchers and practitioners. Regional clusters, which consist of cooperation partners from science, industry, educational institutions, service providers, social partners, and other institutions can facilitate such collaborations. These clusters allow business enterprises to access knowledge, infrastructure, and a skilled workforce within their region. Furthermore, self-reinforcing specialization within regional clusters fosters innovative power (Porter 2000).

Since the beginning of 2020, the German Federal Ministry of Education and Research (BMBF) has been provid-

ing extensive funding for a series of 13 “Regional Competence Centers for Work-Related Research” (ReKoda) as part of their research program on production, services, and work. Eight of these centers have made Artificial Intelligence a central focus of their research and transfer activities (see Fig. 1). Four of these centers are strategically located in regions affected by the phase-out of coal mining, namely Lusatia and the Rhineland, where they facilitate collaboration between research institutions, businesses, and educational institutions to address socio-economic challenges and develop innovative design concepts (BMBF 2019). Two scientific meta-projects provide support for these competence centers: “Connect & Collect: KI-gestützte Cloud für die interdisziplinäre vernetzte Forschung und Innovation für die Zukunftsarbeit” (CoCo) (*translated as: “AI-supported cloud for interdisciplinary networked research and innovation for future work”*) enables efficient networking among the centers while systematically promoting the transfer of knowledge from research to application through the implementation of a social platform (Braun 2023). The meta-project “Wissens- und Innovations-Netzwerk: Arbeitsforschung” (WIN:A) (*translated as: Knowledge and Innovation Network: Work-Related Research*) primarily serves the competence centers in the regions affected by the coal mining phase-out. It aims to establish participatory transfer structures for practical knowledge modules to sustainably implement advisory services within SME structures (Koonen 2023).

Table 1 Overview of the “Regional Competence Centers for Work-Related Research” (ReKodA) with a focus on artificial intelligence**Tab. 1** Übersicht der „Regionalen Kompetenzzentren der Arbeitsforschung“ mit Themenschwerpunkt Künstliche Intelligenz

Title/Acronym	Region	Key topics	Homepage
Arbeitswelt.Plus	Ostwestfalen-Lippe, Paderborn	Industrial and commercial SMEs	https://arbeitswelt.plus
HUMAINE	Ruhr Metropolis, Bochum	Healthcare, service, manufacturing	https://humaine.info
KARL	Technology Region Karlsruhe	Working and learning, manufacturing, public transport	https://kompetenzzentrum-karlsruhe.de
KompAKI	Rhine-Main, Darmstadt	Manufacturing, software	https://kompaki.de
AKzentE4.0	Rhenish coalfield, Aachen	Sustainability, industrial SMEs	https://www.akzente40.de
K-M-I	West Saxony, Leipzig	Manufacturing, service	https://kmi-leipzig.de
PAL	Lusatia, Mittweida	Industrial SMEs, education	https://pal.webspace.tu-dresden.de
WIRKsam	Rhenish coalfield, Hürth	Textile industry, manufacturing	http://www.wirksam.nrw
CoCo	Nationwide, Stuttgart	Meta-project for the competence centers	http://www.coco-projekt.de
WIN:A	Nationwide, Aachen	Meta-project for the competence centers in the coalfields	http://www.wina-projekt.de

This article is based on insights gained in discussions, workshops and on-site visits to the competence centers over a period of three years. These insights were documented in a structured way in order to obtain an overview of the research and transfer network.

4 Presentation of the competence centers

4.1 Common features

The Regional Competence Centers for Work-Related Research, focused on Artificial Intelligence, aim to support medium-sized enterprises in socio-economic structural change through the implementation of human-centered AI technologies. These centers address various regions, sectors and key topics (see Table 1), including sustainability as an additional topic to create synergies.

The overarching goal of designing AI-assisted work with a human-centered approach is consistent with the ergonomic principles of rationalization and humanization (cf. Schlick et al. 2018). This approach aims to increase users' acceptance of and trust in AI while preserving their autonomy.

The regional competence centers carry out research and transfer activities using established network structures, some of which have been formed in previous campaigns. Their networks consist of up to 40 institutional partners. These institutions are complemented by associated multipliers such as social partners, chambers of industry and commerce, and business development agencies.

Research, application and transfer are the three main areas of competence of the competence centers. The activities are typically organized in projects. The results of research and application are then incorporated into transfer activi-

ties, which are described as a triad of “inform, upskill, and implement”. Transfer projects, which often lasting several months, aim to communicate research results to SMEs in order to demonstrate appropriate ways of implementing human-centered AI applications. This is achieved through the use of methodological toolkits that address issues such as occupational health and safety, human resources, technology design, process optimization, and change management etc.

Administrative and outreach activities within the competence centers are usually centralized and coordinated. These activities include issuing of publications, organizing workshops, participating in conferences and exhibitions, and setting up laboratories and demonstrators. Through face-to-face communication, partners have the opportunity to build personal relationships, gain insight into relevant project activities, and leverage cross-project synergies.

The German Federal Ministry of Education and Research provides funding for these competence centers for a period of five years. To ensure their sustainability beyond this period, viable business models are being developed.

Below we present a brief overview of the eight “Regional Competence Centers for Work-Related Research”, including their regional scope, key stakeholders involved, main industries represented, and key issues addressed.

4.2 Arbeitswelt.Plus

The Arbeitswelt.Plus competence center has a primary focus on the implementation of artificial intelligence in the industrial working environment of small and medium-sized enterprises (SMEs) located in the Ostwestfalen-Lippe (OWL) region. Supported by the Bielefeld University, Paderborn University, OWL University of Applied Sciences, Bielefeld University of Applied Sciences, the

University of Applied Sciences, the Fraunhofer IEM and the Fraunhofer IOSB-INA, as well as nine partner companies and one educational institution, this center aims to further advance research and innovation in this field.

As an outgrowth of the renowned “it’s OWL” excellence cluster which was founded in 2012, the Arbeitswelt.Plus competence center benefits from the support of more than 220 companies and institutions from the mechanical engineering, electrical engineering and automotive sectors. With its involvement in around 90 innovation projects to date, “it’s OWL” continues to drive significant progress and developments.

In close cooperation with the research infrastructures of the Ostwestfalen-Lippe region, the transfer activities and formats of the competence center Arbeitswelt.plus are designed to ensure the effective dissemination of knowledge. The center uses a transfer methodology based on ecosystem models that focuses on three key dimensions: stakeholders, formats, and relevant content (Fechtelpeter 2022). In addition laboratories, demonstrators, and creative spaces facilitate transdisciplinary collaboration between researchers and practitioners and enable prototype development and testing.

Through eight designated “lighthouse projects,” partner companies have been selected to implement and test challenging AI applications such as laundry sorting using AI-based image recognition, production planning for workload reduction, workforce scheduling for assembly shops, AI-based training through learning journeys, adaptive work assistance for maintenance tasks, and integrated business planning (Papenkordt et al. 2022). These projects demonstrate the potential of AI implementation in various industrial settings and contribute to ongoing innovation in the field.

4.3 HUMAINE

The “Kompetenzzentrum HUMAINE—Transfer-Hub der Metropole Ruhr für die humanzentrierte Arbeit mit KI” (HUMAINE) (*translated as: Competence Center HUMAINE—Transfer-Hub of the Ruhr Metropolis for the human-centered Work with AI*) is a collaborative project based in Bochum, Germany, with a focus on AI applications in healthcare, manufacturing and the service sector. The center is coordinated by the Ruhr University of Bochum, with additional involvement from the University of Duisburg-Essen and the Bochum University of Applied Sciences for Health as academic partners. Twelve funded partners from companies and regional transfer initiatives, as well as other associated partners, extend the HUMAINE consortium (Humaine 2024).

A primary goal of HUMAINE is to develop methods for integrating AI into business processes in order to improve working and living conditions. This includes both technical

and organizational development, creating a link between research and implementation of AI systems. These methods will be tested through pilot applications in different sectors and companies.

A key aspect of HUMAINE’s work is the development of a transdisciplinary model to support the integration of AI into work processes. This model takes into account strategic planning, integrative work system design, and human, technical, and organizational factors. It is based on the expertise and methodological approaches of all partners involved and is continuously evaluated and improved through feedback from application partners (Wilkens et al. 2023).

Knowledge transfer within HUMAINE is facilitated by several event formats, including research fairs where project partners present their findings on the development of human-centered AI applications in collaboration with transfer partners. Career fairs also provide an opportunity for regional companies and institutions to recruit qualified personnel.

The HUMAINE competence center promotes long-term cooperation between research and application in order to advance developments in the field. This is facilitated by a membership system, in which representatives from science, industry, and transfer founded the association “HUMAINE Network e.V.” in April 2024. This provides a low-threshold opportunity for (supra)regional companies, institutions, and individuals to benefit from relevant consulting and development services.

4.4 KARL

The “Künstliche Intelligenz für Arbeit und Lernen” (KARL) (*translated as: AI for Work and Learning*) competence center aims to promote the development of AI-based work and learning systems in the technology region of Karlsruhe. As a leading IT cluster in Europe and the location of the “national digital hub for applied AI”, Karlsruhe offers an ideal environment for collaboration and networking. The KARL network consists of more than 40 institutional partners, coordinated by the Karlsruhe University of Applied Sciences with scientific support from the Karlsruhe Institute of Technology, the Fraunhofer Institutes IOSB and ISI, and the Research Center for Information Technology. Community management and public relations are handled by CyberForum. In addition, eleven regional companies contribute their expertise in areas such as industrial production, automation technology, public transport, tourism and education.

Through scientific pilot projects, KARL aims to actively shape and demonstrate the impact of digital transformation on work and education. These projects focus on the development and testing of methods and prototypes that prioritize human factors in AI-based systems. An AI benchmark,

based on the insights of 215 experts, highlights the operational relevance and availability of AI skills. With a systematic inventory approach, individual skill requirements can be identified for each company, leading to customized training tools (Karl 2024).

Regular professional events allow KARL partners to share their project results with other consortium members and experts. Demonstration centers provide hands-on experience for customers, while project results are integrated into university lectures and companies' in-house training. These transfer activities also aim to stimulate a broader societal discourse on the impact of AI on work and learning.

4.5 KompAKI

The “Kompetenzzentrum für Arbeit und Künstliche Intelligenz” (KompAKI) (*translated as: Competence Center for Work and Artificial Intelligence*) is a collaboration of eleven research partners, including Darmstadt Technical University and Darmstadt University of Applied Sciences, eight manufacturing and software companies, the Rhine-Main Chamber of Industry and Commerce, and other associated partners. Located in the Rhine-Main region, the interdisciplinary project aims to advance the research and implementation of artificial intelligence in the workplace.

The main focus of KompAKI is application-oriented research on the use of AI in society. This includes the development of scientific foundations for trustworthy AI and AI-based decision-making systems through six research projects. In addition, five application projects will be conducted in collaboration with business partners to implement case studies and demonstrators. Examples include AI-based value stream analysis, data-driven quality management, and interactive “smart use services” for machine operation. The social implications and potential benefits of these AI applications will also be evaluated through case studies.

KompAKI serves as a networking platform for partners from science and industry to explore issues related to the use of AI in the workplace and to translate their findings into practical business solutions. This is achieved through transfer projects where case studies and demonstrators show the potential applications and benefits of AI and meet the information needs of interested companies. The “KompAKI Knowledge Hub” also facilitates connections between specific service offers and demands. Thanks to its semantic data structure, this hub enables comprehensive and transparent search processes (Kompaki 2024). In addition, relevant lectures, workshops and lab tours will be organized to further promote knowledge transfer within the KompAKI network.

4.6 AKzentE4.0

The “Arbeitswissenschaftliches Kompetenzzentrum für Erwerbsarbeit in der Industrie 4.0” (AKzentE4.0) (*translated as: Human Factors Competence Centre for Employment in Industry 4.0*) focuses on the human-centered integration and implementation of digitization concepts and advanced technology in the Rhenish coalfield region.

The primary goals of this project are to increase the competitiveness of SMEs by increasing employer attractiveness through human-friendly digitalization and AI-based automation.

The competence center AKzentE4.0 is a cooperation between RWTH Aachen University, Aachen University of Applied Sciences, Düsseldorf University of Applied Sciences and the FIR research network (“Research—Innovation—Realization”). Together with five operational partners, 14 application partners, and nine associated value partners, these institutions are working to establish an infrastructure, foster collaboration among local stakeholders, experts, and organizations, and further develop human factors methodologies. Partnerships between research institutes and high-tech companies will develop practical solutions for implementing AI technologies in the workplace. In addition, qualification concepts and training will be created based on these solutions (AKzentE4.0 2024).

In addition to the use of digital technologies in the workplace, the AKzentE4.0 competence center also takes into account the United Nations' Sustainable Development Goals (SDGs) in its research and transfer activities. This includes identifying areas where technological advances can contribute to achieving the SDG goals, particularly in promoting dignified and healthy lifestyles through a human-centered approach to technology integration. By engaging in scientific discussions on health-promoting work design, AKzentE4.0 aims to create technical and organizational opportunities to improve workers' well-being at work and promote sustainable work practices. As part of this effort, partner companies will be supported to develop and test AI-based design approaches that have a positive impact on the physical and mental health of workers (Rick et al. 2024).

4.7 K-M-I

The “Künstlich und Menschlich Intelligent” (K-M-I) competence center, also known as the Center for Artificial and Human Intelligence, aims to support companies in the region of Western Saxony in using digital technologies to create social, ecological and economic benefits. Led by the Institute of Applied Computer Science in cooperation with the University of Leipzig, the Chemnitz University of Technology, and the Westsächsische Hochschule Zwickau,

the center brings together a network of twenty application and transfer partners, primarily from the manufacturing industry. With a focus on applied research, these partners combine interdisciplinary expertise to transform innovative ideas into practical solutions. Examples of use cases include production planning, personnel scheduling, quality assurance, machine maintenance, and the administrative preparation of quotations.

In addition, the K-M-I partners are investigating how the use of digital technologies, in particular AI methods, affects the transformation processes within companies. A key aspect of this research is to examine how social and environmental considerations can be integrated into the design of digitized business processes. In line with their goal to promote employee participation in value-based transformation processes, the partners are developing a platform for knowledge exchange (KMI 2024).

The results of this research will contribute to the development of a holistic framework for the human-centered use of AI-based systems. This framework supports companies in navigating socio-economic structural change and establishing AI-driven business models. As part of this effort, consulting services are offered to support companies in their digital transformation process. In addition, training is being developed to equip individuals with both the technical and interpersonal skills necessary to advance the vision of AI-enabled work with and for humans.

4.8 WIRKsam

The WIRKsam competence center, located in the Rhenish coalfield, consists of a consortium of five research institutes (Institut für Angewandte Arbeitswissenschaft, RWTH Aachen University, Aachen University of Applied Sciences, Fraunhofer FIT), thirteen application companies, and eleven value partners. The region is facing a structural change with the decline of coal mining and requires attractive future prospects to ensure continued productivity, employment, and prosperity. As such, the WIRKsam competence center aims to support this socio-economic change.

The Rhenish Coalfield also includes the Rhenish Textile Region, which has a rich history spanning 900 years. In addition to technical expertise, the region's textile industry has accumulated experience in adapting to structural change, moving from clothing production to technical textiles since the 1970s. SMEs dominate the region's business landscape.

In order to manage structural change effectively, knowledge transfer is crucial. The WIRKsam competence center not only analyzes the potential socio-economic benefits of AI implementation within business processes, but also considers their generalizability. To increase competitiveness and attractiveness as an employer, a holistic understanding

of innovation that includes social aspects is necessary. By integrating technology, organization, skills and work design, the potential benefits of AI can be harnessed for different stakeholder groups. This requires a deep understanding of human-centered work design principles.

The research approach of the competence center WIRKsam considers the interactions between humans, technology and organization within socio-technical work systems (cf. Ulich 2013). Through “in the loop” design, human and machine characteristics are developed in a complementary way. Through participatory processes, employees have a say in designing their working conditions.

The WIRKsam laboratory was established at the Hürth site to test the participatory design of AI-based work systems. Virtual demonstrators visualize the principles of AI in human-machine systems (WirkSam 2024). The lab also facilitates face-to-face communication between science and industry, promoting collaboration and joint projects. It thus plays a key role in strengthening the competence center.

4.9 PAL

In order to ensure competitiveness in the face of technological and socio-demographic changes, limited mobility, and cultural peculiarities, innovative solutions are needed in the Lusatia region. In order to meet these requirements, the “Perspektive Arbeit Lausitz—Kompetenzzentrum für die Arbeit der Zukunft in Sachsen und Brandenburg” (PAL) (*translated as: Perspective Work Lusatia—Competence Center for Future-oriented Work in Saxony and Brandenburg*) was founded. This initiative brings together four universities and 14 professorships to jointly develop AI-supported solutions for sustainable forms of work and employment that meet the needs of the 23 participating companies.

At the core of the PAL competence center's research and transfer efforts is a data-driven work system design process that includes implementations and evaluations that take into account ergonomic, technical, and economic criteria. Through applications, industrial operators can conduct screenings that can initiate innovation projects. A toolbox is available to process these projects, while analysis results are visualized on a “dashboard of work-related action needs” (Merkel et al. 2023), allowing identification and comparison of operational needs with the support provided by PAL.

A key objective of PAL is to establish and operate local demonstration centers where digital technologies and human-centered design approaches can be experienced in realistic settings. These centers include “innovation labs” and “mobile labs” available to interested companies. Knowledge transfer also takes place through “living labs” and “learning labs” embedded in university courses.

In addition, e-learning modules on topics such as work design, occupational health and safety, and health management will be developed and made available on a learning platform for students and academic staff (Goldhahn et al. 2022). At the end of the project, these modules will be made commercially available in the knowledge base of the “Work-Related Research Academy in Saxony and Brandenburg”. They will be integrated into the training programs of some regional educational institutions, thus consolidating the structures and services offered by PAL beyond the project funding period.

4.10 CoCo

Two scientific meta-projects support the “Regional Competence Centers for Work-Related Research”.

The metaproject “Connect & Collect (CoCo): KI-gestützte Cloud für die interdisziplinäre vernetzte Forschung und Innovation für die Zukunftsarbeit” (*translated as: “AI-supported Cloud for interdisciplinary networked Research and Innovation for the Future of Work”*) explores and supports the networking of stakeholders in Work-Related research, which have come together in the regional competence centers. The project is supported by a network of institutes of the Fraunhofer-Gesellschaft (IAO, ISI, IFF) and the Leibniz Gemeinschaft (Information Center for Economics ZBW, German Institute for Adult Education DIE). The CoCo project partners face the challenge of systematically developing the transfer between science and industry. By networking of the competence centers and their stakeholders, ideas are to be bundled and perspectives for innovative work design are to be expanded.

The vision is an “ecosystem of work-related research” for beneficial knowledge transfer. This ecosystem should provide innovative impulses for the generation of knowledge, the sustainable improvement of products and services and the development of agile working practices. It is based on complex work contexts with low reliability of action and heterogeneous interests of the stakeholders. Since these contexts allow only limited planning of actions, AI-based decision and assistance systems as well as experience-based skills are expected to gain in importance.

The CoCo project develops a digital platform as a place for dialogue and knowledge transfer. It is being designed, piloted and implemented in close cooperation with the regional competence centers. By creating synergies, the platform increases the visibility, accessibility and practical use of the research results it produces. The platform is based on open-source network software that supports interoperability with other IT systems and tools. It is extensible to allow the network to grow by integrating decentralized offerings. User access takes place via an Internet interface (Braun 2023).

The CoCo project organizes internal and public networking formats, such as virtual “coffee lectures”, workshops and conferences, to bring the stakeholders together and share knowledge.

4.11 WIN:A

The meta-project “Wissens- und Innovations-Netzwerk: Arbeitsforschung” (WIN:A) (*translated as: Knowledge and Innovation Network: Work-Related Research*) primarily serves the competence centers in the regions affected by the phase-out of coal mining. Participatory transfer structures and knowledge bases will provide professional support mainly for SMEs (Koonen 2023). Partners in the WIN:A project are the RWTH Aachen University, the Deutsche Handwerksinstitut (itb), the Bildungswerk der Vereinten Dienstleistungsgewerkschaft im Land Hessen (BTQ) and the “Mittelstand—Gesellschaft—Verantwortung” (OM) foundation.

Currently, innovative Work-Related research results are insufficiently implemented in SMEs. This is due to lack of information and problems translating it into the workplace application context. This deficit requires pragmatic and tailor-made forms of knowledge transfer. Intermediary organizations, such as professional associations or trade unions, can support this transfer process. These intermediaries reach a large number of enterprises, but often do not have sufficient access to the results of Work-Related research themselves.

WIN:A defines knowledge transfer as a multidimensional process that requires the participatory involvement of consultants and managers. In developing transfer structures, WIN:A focuses on the stakeholders in intermediary organizations. SME consultants and council members are seen as trusted partners with reliable networks (Hohlbaum et al. 2023). A participatory transfer culture will provide companies with sustainable and comprehensive access to Work-Related research. This knowledge should be part of the stakeholder mindset. The resulting impulses should strengthen the competitiveness and innovative capacity of companies.

The results of the WIN:A project are documented in a set of action guidelines available on the project website (WIN:A 2024). The “WIN:A Theme Graph” helps experts to understand how their community works and helps them to connect with other experts. The “WIN:A Network Graph” maps relevant institutional nodes in the research community. In addition to a series of workshops, the WIN:A project organizes an annual transfer forum for those involved in work-related research.

5 Conclusion

The “Regional Competence Centers of Work-related Research” aim at strategic partnerships between researchers, practitioners and transfer partners in order to create a positive dynamic for work-related research and to stimulate innovations in the context of socio-economic structural change. Based on relevant experiences, it appears that the pursued innovation strategies, which are primarily technically oriented, need to be expanded with regard to social and communicative aspects. Transfer activities are more effective when stakeholders share common goals and clarify their roles and expectations. To this end, fundamental conflicts of interest between research (i.e., the comprehensive pursuit of knowledge) and operations (i.e., reliable economic solutions) must be recognized and resolved (Braun 2024). The perceptions and interpretations of researchers do not always match the ideas and expectations of operational stakeholders.

It is recommended to create temporal and physical-virtual touchpoints for knowledge transfer, for example through fixed communication formats in networks, through practices or participative decision-making processes where knowledge sharing and learning are part of the daily work and are financially recognized. This requires an awareness that shared knowledge can have a greater impact. Sharing knowledge creates opportunities to gain new insights. There must be incentives for experts to actively network and share their knowledge, which can be incorporated into innovation processes. Finally, the value proposition of regional competence centers will be the effectiveness of networking and transfer activities.

Further recommendations for action are the subject of future research.

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