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Work Package 3
Methodology and tools for Innovation management

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EXECUTIVE SUMMARY

Leveraging diverse sources, including market trends and stakeholder discussions, the report provides a comprehensive understanding of challenges and opportunities related to the Open Call challenges and topics. Task 3.2 - *Preliminary market analysis & opportunities related to open call topic and challenges* is strategically linked with other project tasks, especially business coaching within WP5 - *Towards successful Application experiments*, for a cohesive innovation management strategy.

Addressing Industry 5.0 trends, the report explores challenges such as worker safety and industry attractiveness. It concludes with business case scenarios for each of the 10 challenges, offering hypotheses aligned with project objectives, covering market perspectives, expected value propositions and differentiation and potential business models.

In summary, this report serves as a valuable guide for EARASHI beneficiaries in evolving the dynamic landscape of Industry 5.0 and achieving sustainable, human-centric solutions with the support of the project partners.

TABLE OF CONTENTS

1	INTRODUCTION	5
2	METHODOLOGY	7
3	MARKET TRENDS AND GENERAL FINDINGS REGARDING HUMAN CENTRICITY	9
3.1	Human-centricity to improve the well-being and safety of workers	9
3.2	Human-centricity to address the issue of the attractiveness of industry for talents	10
4	BUSINESS CASES SCENARIOS	11
4.1	Mobile robotic assistance for repetitive tasks	11
4.2	Robotic assistance for heavy-duty	12
4.3	Machine/tools for recycling goods, electronics, batteries	14
4.4	Digitalization procedure for production tools & machines for industry 5.0	15
4.5	Workers’ stress monitoring and assistance to limit work-related stress	17
4.6	Collaboration between AI and Human supervisors to solve complex problems	18
4.7	Human-centric robotic assistance for assembly work cell	20
4.8	Automation for the optimisation of intra-factory logistics	22
4.9	Enhanced digital planning to optimise the execution of the tasks of production operators	23
4.10	Gamification of work tasks via the use of digital technologies (AI, Drone, AR...)	25
5	CONCLUSION	27

1 INTRODUCTION

As part of *Work Package 3 - Methodology and tools for Innovation management, Task 3.2 - Preliminary Market analysis & opportunities related to open call topic and challenges* aims at bringing insights to the application experiments beneficiaries regarding their business exploitation. The ambition of EARASHI is to be able to reach a first level of maturity for the commercial exploitation of the solutions developed and supported by the project to facilitate their pre-industrialization and industrialization as well as the financing necessary for their development. For this, BLUMORPHO will provide its unique expertise in developing attractive activities and business cases, inherited from BLUMORPHO’s team collaboration with leading corporates and investors. The work performed within *Task 1.2 Community Engagement* was also leveraged to engage with the EARASHI ecosystem and collect insights from external stakeholders. Task 3.2 is also strongly linked to *Task 4.1 - Definition of the call topics* as a preliminary analysis was necessary to define the topic and challenges themselves.

Hence, the objective of Task 3.2 is to provide the application experiment beneficiaries with insightful information on market trends and business model scenarios for them to develop their business case in the frame of *Task 5.2 – Business coaching*. They will leverage the content of its deliverable in the definition of their business exploitation, in addition to the coaching programme defined in the *D3.1 Report on Methodology and training tools to optimise market reach and business opportunities*. The links with the other tasks are summarised in Figure 1 below.

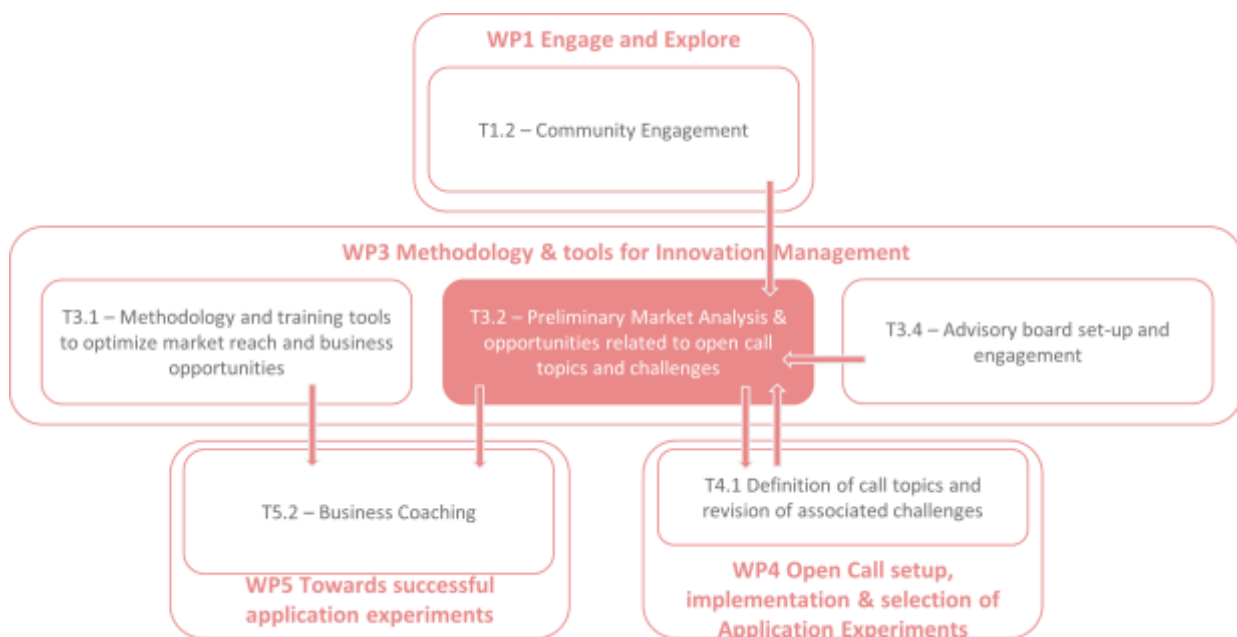


Figure 1 Links existing between task 3.2 and other tasks in the project

This report introduces the methodology and the sources of information that were used to gather the necessary information to provide an overview of each challenge regarding:

- The market perspectives;
- The existing solutions;
- The expected value propositions;

- The differentiation factors;
- The possible value chain positioning;
- Some business model scenarios.
- Applications experiments from Open Call 1 addressing this challenge

2 METHODOLOGY

To gather the information in this report and to complete the work of Task 3.2, BLUMORPHO leveraged different sources of information:

- Market trends and literature analysis from publicly available content;
- Interviews and collective sessions with members of the Advisory Board (as described in *D3.3 Report on the Advisory Board governance and structure*) (Figure 2)



Figure 2 Members of the Advisory Board

- Interview and discussion with external stakeholders: corporates and investors active in the field of manufacturing (Figure 3).



Figure 3 Investors and Corporates in the field of manufacturing BLUMORPHO interacted with between M1 and M15

Once cross-referenced and analysed, the information was used to highlight market trends and general findings related to the topic of human centrality in the industry (Section 3). It was also used for each challenge to highlight the market perspectives, the existing solutions, the value propositions, the differentiation factors, the value chain positioning and some business model scenarios (Section 4).

The work on the challenges preliminary market analysis started with the first definition of the challenges as described in *D4.1 – Use Case and Challenge Report*. Interactions took place with BLUMORPHO's industrial and investor network, EARASHI partners and the Advisory Board between M1 and M6 and allowed us to detect megatrends we consider as impacting the EARASHI project:

- Difficulties hiring a young and qualified workforce;
- Health and safety of workers
- The need for new and more circular supply chains
- How to achieve European Sovereignty?
- How to decarbonize industry?

These activities also permitted to define the list of the 10 challenges:

- Mobile robotic assistance for repetitive tasks
- Robotic assistance for heavy-duty
- Machine/tools for recycling goods, electronics, batteries
- Digitalization procedure for production tools & machines for industry 5.0
- Workers' stress monitoring and assistance to limit work-related stress
- Collaboration between AI and Human supervisors to solve complex problems
- Human-centric robotic assistance for assembly work cell
- Automation for the optimisation of intra-factory logistics
- Enhanced digital planning to optimise the execution of the tasks of production operators
- Gamification of work tasks via the use of digital technologies (AI, Drone, AR...)

The challenges were then further elaborated with a more detailed description of the issue, the associated sub-challenges and an example of an existing commercial solution (fully described in *D4.1 Use-cases and challenges report*)

3 MARKET TRENDS AND GENERAL FINDINGS REGARDING HUMAN CENTRICITY

Industry, especially in Europe, is facing major challenges that will require transformations towards Smart and Sustainable practices. Indeed, to bring back operations in Europe as encouraged by the European Commission through its European sovereignty strategy, it is needed to implement strategies to ensure industry competitiveness and productivity, sustainability regarding planet boundaries and the people. This is defined as Industry 5.0.

According to the European Commission, Industry 5.0 **“places the well-being of the worker at the centre of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet.”**

According to Nicolas Leterrier, Customers Innovation & ONE labs global VP at Schneider Electric, Industry 5.0, also called Industry 4. is about thinking **“what is currently changing for the people in the production chains, their day-to-day life, the impact on the way to behave, the skills that are needed and that should be developed, the mindset regarding the transformation, and how to produce more with less: less effort, energy efficiency. In the end, it should improve the capacity and the capability of the company to produce sustainably.”**

3.1 Human-centricity to improve the well-being and safety of workers

Eurostat frequently publishes statistics on the accidents related to work in the EU27. As a matter of fact, in 2021, there were 2.88 million non-fatal and 3347 fatal accidents at work, which is an increase compared to the 2020 figures (2.7 million non-fatal, 3335 fatal). Among all the sectors in the study, Manufacturing represents the one with the most non-fatal accidents (~19.5% of all accidents) and the third regarding fatal accidents (~15% of all accidents)¹. The factors explaining the incidence of accidents in the manufacturing industry are:

- The ageing workforce: the mean age of the workforce in industry is increasing
- The increasing stress perceived at work in the manufacturing sectors
- The production machines that are a source of accidents
- The detection of musculoskeletal disorders linked to an activity in manufacturing
- The appearance of cognitive overload, digital fatigue, mental exhaustion and various forms of ‘techno-stress’ linked to automation
- Climate change affecting workers’ safety and health (heat, air pollution, extreme weather events...)

For a significant number of industrial stakeholders BLUMORPHO interacted with over the past months (from the Advisory Board and the network of BLUMORPHO), safety and wellbeing are the topics to be prioritised when we talk about human centricity. The quick development and implementation of mobile and/or

¹https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics#Analysis_by_activity

collaborative robots in industries generate more dangerous situations for operators as well as being a new source of stress.

Certifications will be necessary to check the safety of an automated process, especially in cases where humans are involved. The actual ability (regarding skills, knowledge and certifications) of operators to work in the same environment as these automated systems also needs to be validated. One of the sources of accidents is the lack of knowledge of the actual risks of accidents.

3.2 Human-centricity to address the issue of the attractiveness of industry for talents

According to a study made by Randstad in 2021, unfilled positions are expected to create productivity losses of up to \$2.5 trillion by 2028 at the global scale. Several factors are considered to impact the difficulties in hiring a Young and qualified workforce:

- The image reflected by the manufacturing field towards the Young generation considering it too male-dominated and not attractive
- The fear of workers regarding the takeover of automation and robotisation on their Jobs, requiring as well different skills
- The political and socio-economic changes such as COVID-19, Brexit and global conflicts that generated travel restrictions and changes in the way people work
- The ageing and retiring of the workforce which is not replaced, introduces a talent shortage and a loss of expertise
- The low employee retention, with 25% of workers believing their skill set is or will be redundant.

According to industrial experts, the key to addressing the attractiveness of industry towards talents is the enrichment of work and lighter workloads for operators. The implementation of automation and robotisation solutions induces the development of work-related stress in older generations which need to accept the novelty. It also requires new knowledge and know-how for current and future generations in the factory. Efforts need to be pushed towards:

- The automation of repetitive, low-value-added and dangerous tasks,
- The User Experience (UX) of the new robotic and software solutions, make things easier and more accessible, lighter and less stressful for the users
- The Ergonomics, to reduce physical and mental fatigue
- Gamification, to make jobs more pleasant.

A study led in the US on neurotechnologies at work² showed that Employees in high-trust organizations are more productive, have more energy, better collaborate, and are more loyal; employees in low-trust companies feel disempowered and become disengaged. And disengagement matters: It has been recently estimated that corporations in the United States lose \$450 billion to \$550 billion each year because of it.

² <https://hbr.org/2023/03/neurotech-at-work>

4 BUSINESS CASES SCENARIOS

The exploitation of publicly available information, cross-analysed with the inputs of the different industrial stakeholders BLUMORPHO interacted with over the period M1-M15 allowed drafting of business case scenarios for solutions addressing the different challenges of EARASHI. Hence, for each challenge, this section proposes a hypothesis for solutions addressing the challenges, especially regarding:

- The challenge description
- The market perspectives;
- The existing solutions;
- The expected value propositions;
- The differentiation factors;
- The possible value chain positionings;
- Some business model scenarios.
- Applications experiments from Open Call 1 addressing this challenge

4.1 Mobile robotic assistance for repetitive tasks

Challenge description	Repetitive tasks on the production lines face several stakes: time consumption, fatigue, difficult tasks for older people and human error, possibly leading to accidents and absenteeism. Smaller businesses do not invest in a full robotic line and could benefit from a versatile solution which could be implemented anywhere in the factory when and where needed.
Market perspectives	Mobile robotics, and especially Autonomous Mobile Robotics (AMR) is a topic of great interest for industrial companies. The global mobile robotics market is projected to grow significantly in size between 2019 and 2030. While the market was sized at some 10.85 billion U.S. dollars in 2019, it is expected to reach the size of around 72.51 billion U.S. dollars in 2030 ³ . Repetitive tasks very often are low added value, are not attractive to workers, and can lead to mental and physical fatigue causing work-related health issues
Existing solutions	AMR solutions to complete repetitive tasks are implemented throughout the entire production and/or assembly processes, but also for intra-logistics and quality control. Commercial solutions exist to support workers in the process of screwdriving, in the process of quality control and the inspection of manufactured articles post-production. AI is also leveraged to make robots able to gain flexibility in continuously learning new tasks. An example of such a “Large Behaviour Model” is being implemented in a Toyota Factory ⁴ .

³ <https://www.statista.com/statistics/1255116/global-mobile-robotics-market-size-forecast/>

⁴ <https://www.lebigdata.fr/toyota-lbm-ia-diffusion-policy-robots>

Expected value propositions	<p>A holistic approach prioritizing the acceptance, safety, and productivity of the workforce while enhancing the ergonomic experience. With a commitment to seamless integration, solutions should empower organizations to embrace innovation without compromising operational continuity. Invest in a future where the workforce thrives, and businesses achieve new heights of success.</p>
Differentiation factors	<p>The differentiation lies in the absence of the need for the expertise of trained workers for the client, time-efficient set-up, unwavering quality assurance, proactive risk assessment, advanced human-robot collaboration engineering, and the flexibility and autonomy afforded by AI. By embracing these differentiators, a future is paved where robotic assistance seamlessly integrates into shopfloors, unlocking new levels of efficiency and innovation.</p>
Value chain positioning	<p>Possible clients would be industrial companies with a high level of repetitive tasks in their product manufacturing process from intra-logistics to quality control. Depending on the level of personalisation and needed support to implement the solutions in the shopfloor, the solutions could be commercialized through distributors.</p>
Business model scenarios	<p>The possible business models for addressing the challenge of mobile robotic assistance in repetitive tasks are diverse. Robot as a Service (RaaS) introduces a subscription or pay-per-use model, granting access to robotic assistance without the need for upfront ownership. Leasing and Maintenance Contracts offer businesses the option to lease robotic systems along with comprehensive maintenance and support services. Custom Robotic Solutions involve tailoring robotic systems to suit specific heavy-duty applications, ensuring personalized efficiency. Prioritizing seamless integration with existing infrastructure emphasizes compatibility with the client's machinery or workflow. Data Analytics and Insights contribute value by providing data-driven insights for optimizing heavy-duty operations. Training and Consultancy Services are integral, offering guidance for the effective integration of robotic systems. An Outcome-based Pricing approach ties charges to achieved outcomes or performance improvements, aligning incentives. Lastly, engaging in Industry Contracts for large-scale projects provides opportunities for long-term collaboration and innovation.</p>
Application Experiments	<p>MAS-AI led by the company Spin Robotics, aims at developing AMR screwdriving platforms to support workers in the assembly and disassembly of parts</p>

4.2 Robotic assistance for heavy-duty

Challenge description	<p>On the same line as repetitive tasks on the production lines, heavy duty often leads to health & productivity issues. In terms of health, musculoskeletal disorders are long-term consequences on heavy-duty workers, which lead to a decrease in productivity and low attractiveness in hiring. The risk of accidents is also high. Robotic assistance can decrease the risks for the workers and give them more time to focus on more added-value tasks.</p>
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Market perspectives	<p>The global heavy-duty robot platform market size was valued at USD 278.6 million in 2022 and is expected to reach USD 382.7 million by 2028.⁵ The growth of the market is driven by the need for better productivity but also to intake of AI making them more and more able to collaborate safely with humans on diverse operations.</p>
Existing solutions	<p>Two types of collaborative robots for heavy duty can be identified, the ones that are remote-controlled by operators and cobots (collaborative robots) such as exoskeletons as direct support for operators in their need to carry and move heavy loads. They are implemented at different levels in the shop floor and warehouse, from logistics purposes to production operations. Many solutions exist on the market, most of the time adapted to the specific sector it addresses.</p>
Expected value propositions	<p>Regarding this challenge, the expected value relies on achieving tasks more efficiently with reduced time commitments, ensuring the safety of workers by minimizing accidents and lowering absenteeism, cultivating worker acceptance through user-friendly approaches and accessibility, resulting in increased overall productivity, elevating the ergonomic design for an enhanced user experience, and seamlessly integrate innovations without causing substantial production interruptions.</p>
Differentiation factors	<p>Differentiation factors rely here on a good understanding of the limitations and capabilities of exoskeletons and other collaborative robots, robust quality and safety assurance protocols, engineering solutions that facilitate seamless collaboration between humans and robots, optimizing their combined strengths, and artificial intelligence to offer flexibility and autonomy.</p>
Value chain positioning	<p>Potential customers include industrial companies for which operations are required to lift and move heavy loads. Distributors could commercialize the solutions depending on the specificities of the targeted applications and the flexibility of the solutions.</p>

⁵ <https://www.businessresearchinsights.com/market-reports/heavy-duty-robot-platform-market-107709>

<p>Business model scenarios</p>	<p>To effectively tackle the challenge of robotic assistance in heavy-duty tasks, businesses can adopt various strategic models. Robot as a Service (RaaS) introduces a subscription or pay-per-use approach, allowing users to access robotic assistance without the burden of ownership. Leasing and Maintenance Contracts offer a comprehensive solution by allowing businesses to lease robotic systems while ensuring maintenance and support services. Custom Robotic Solutions involve the design and customization of robotic systems tailored to specific heavy-duty applications, ensuring optimal performance. Emphasizing seamless Integration with Existing Infrastructure ensures compatibility with a client's current machinery or workflow. Offering valuable insights, Data Analytics and Insights contribute to the optimization of heavy-duty operations. Training and Consultancy Services become essential, guiding the effective integration of robotic systems into existing workflows. With Outcome-based Pricing, charges are tied to achieved outcomes or performance improvements, aligning incentives. Engaging in Industry Contracts for large-scale projects provides opportunities for sustained collaboration and innovation in the heavy-duty tasks domain.</p>
<p>Application Experiments</p>	<p>Auto-ANT, led by the company ANT Maschinen, developing autonomous mobile robots to move truck trailers.</p>

4.3 Machine/tools for recycling goods, electronics, batteries

<p>Challenge description</p>	<p>Recycling practices and recycled materials are more and more implemented in different value chains. Recycled components are often not competitive. Efficient and cost-effective recycling requires solutions to sort and separate wastes as well as recycling processes limiting human intervention and exposition to hazardous compounds.</p>
<p>Market perspectives</p>	<p>Europe's recycling machine market is anticipated to project a valuation of USD 811 million in 2023 and further expand to reach USD 1 355 million by 2033⁶. The progression of the recycling machinery market stems from a growing recognition of the sustainable benefits associated with recycling and reusing waste or scrap materials, including but not limited to plastic, construction materials, metal, paper, and other forms of waste.</p>
<p>Existing solutions</p>	<p>Many solutions exist in the area of recycling, mainly for metal and plastic wastes post-production and post-consumer. The main drawback of these solutions is their lack of versatility, whether it is dedicated to one specific step in the recycling process (detection, sorting, disassembly, recovery...), or specific types of waste.</p>

⁶ <https://www.factmr.com/report/europe-recycling-machine-market>

Expected value propositions	A successful product or solution for automated recycling should offer improvements in productivity, cost-effectiveness, reduced human intervention, versatility across different waste streams, and cost-effective treatment for both high and low-volume materials. This comprehensive approach ensures that the challenges of recycling are effectively addressed, making the process more sustainable and economically viable.
Differentiation factors	Differentiation in automated recycling hinges on intricate algorithms, AI-driven recognition speed, and versatile grippers designed for the efficient handling of mixed materials. These attributes collectively position a product or solution as advanced, adaptable, and at the forefront of addressing the complexities of modern recycling challenges.
Value chain positioning	Automated recycling solutions can be implemented at every step of the value chain, depending on the types and complexity of the wastes it can process. It can then be implemented at different manufacturing sites along the value chain or in some cases (such as in the case of aluminium, steel and some mainstream plastics) after the end of life of the products. The value brought to the customers/partners' needs in this case is to be well identified as it mainly relies on the collection of wastes.
Business model scenarios	Optimal business models for products addressing the challenges of automated recycling involve diverse approaches. Companies can engage in direct product sales, offering automated recycling systems for purchase. Alternatively, a subscription or leasing model allows users to access these systems through periodic payments. Another option is a pay-per-use model, where charges are based on the volume of waste processed. Some businesses may opt for an integrated service model, providing end-to-end solutions that encompass installation, training, and maintenance. Furthermore, monetizing data derived from the recycling process presents an opportunity, for companies to sell valuable insights. Additionally, contributing to sustainability efforts can be financially rewarded through the sale of eco-credits or carbon credits, enhancing the overall attractiveness of these business models.
Application Experiments	None directly. MAS-AI though, by addressing the disassembly of products, could address this challenge.

4.4 Digitalization procedure for production tools & machines for industry 5.0

Challenge description	Industry 5.0 builds on lessons learnt from Industry 4.0, implementing sustainability, human centricism and resilience in supply chains, and focusing less on the financial benefits. To ensure the shift on the shop floor, digitalisation needs to be thought of differently and implemented with care.
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<p>Market perspectives</p>	<p>Industry 5.0 Market size is expected to be worth around USD 658.4 Bn by 2032 from USD 131.13 Bn in 2022, growing at a CAGR of 18%⁷. Businesses adopting these solutions experience heightened efficiency, productivity, and smart manufacturing practices. The demand is particularly high for solutions offering data-driven insights, predictive maintenance capabilities, and integration with Internet of Things (IoT) technologies. Flexibility, adaptability, and end-to-end supply chain integration are key considerations. Cybersecurity and data privacy are critical for market trust. The rise of digital twins, simulation technologies, and a focus on sustainability contribute to the overall market dynamics. Additionally, solutions catering to diverse industries and providing insights into resource consumption find broad market appeal. Continuous adaptation to evolving market needs and technological advancements is crucial for success in this landscape.</p>
<p>Existing solutions</p>	<p>Existing solutions gather a range of technologies and platforms. Manufacturing Execution Systems (MES) manage and monitor processes, while Industrial Internet of Things (IIoT) platforms enable connectivity and predictive maintenance. Digital twins provide virtual replicas for simulation, and Augmented Reality (AR) and Virtual Reality (VR) enhance training and maintenance. Edge computing enables real-time decision-making, and cloud-based manufacturing platforms facilitate data storage and collaboration. Robotics and Collaborative Robots (Cobots) automate tasks, and Enterprise Resource Planning (ERP) systems integrate business processes. AI and ML applications analyze data for insights, while Cyber-Physical Systems (CPS) enable real-time control. These solutions collectively contribute to increased efficiency, flexibility, and collaboration in manufacturing processes.</p>
<p>Expected value propositions</p>	<p>Products and solutions for the digitalization of production tools and machines in Industry 5.0 must prioritize worker well-being, optimize data flow through various systems, and provide standardized interfaces. By addressing these key considerations, these solutions can truly deliver value by fostering a healthier workplace, improving operational efficiency, and contributing to seamless connectivity.</p>
<p>Differentiation factors</p>	<p>Products and solutions addressing the digitalization of production tools and machines for Industry 5.0 must differentiate themselves through several key considerations. Firstly, sustainability should be ingrained in algorithms to optimize resource utilization and promote eco-friendly manufacturing practices. Secondly, the inclusion of the human factor in algorithms is crucial for fostering a harmonious collaboration between humans and machines, prioritizing workforce well-being. Differentiation also lies in the accuracy and quality of digitalization models, requiring high-fidelity representations for precise simulations and optimizations. Lastly, effective risk control mechanisms are essential to mitigate production failures or slowdowns, ensuring operational continuity and resilience in the face of challenges.</p>

⁷ <https://www.linkedin.com/pulse/industry-50-market-projected-grow-18-rate-through-period-pasalkar/>

Value chain positioning	Customers for solutions addressing the digitalization of production tools and machines in Industry 5.0 include manufacturing enterprises, technology providers, industrial automation companies, OEMs, supply chain and logistics firms. These customers seek enhanced operational efficiency, innovation, compliance with standards, and sustainable practices through the integration of digitalization solutions into their manufacturing processes.
Business model scenarios	The best business models, for digitalization solutions in the context of production tools and machines for Industry 5.0, include licensing and subscription models for software, consulting and integration services, outcome-based pricing tied to measurable results, Robot as a Service (RaaS) for pay-per-use access, Platform as a Service (PaaS) for a centralized solution, data analytics and insights services, freemium models with premium features, leasing and maintenance contracts, custom solution development for unique needs. The choice of the most suitable model depends on factors such as market dynamics, target customers, and the company's capabilities, with the potential for hybrid models to offer a comprehensive approach.
Application Experiments	None

4.5 Workers' stress monitoring and assistance to limit work-related stress

Challenge description	Modern manufacturing processes are stressful and require maximum concentration. The employee attention who is working with the complex equipment should be focused on what is happening, and the multi-functionality of the control panels is increasing every year.
Market perspectives	With 55.80% of manufacturing employees reporting workplace stress, the manufacturing industry ranks in third place in terms of the industries with the highest stress rates ⁸ . Solutions addressing the challenge of workers' stress monitoring and assistance benefit from a significant market potential. Solutions addressing stress management demonstrate a market potential, addressing a critical need for organizations seeking to create supportive, healthy work environments and boost employee well-being.
Existing solutions	Key trends include the adoption of wearables and biometric monitoring, integration of AI and machine learning for personalized insights, enhancement of employee assistance programs, a heightened focus on mental health and well-being, and the development of remote work stress solutions.
Expected value propositions	Solutions addressing worker stress monitoring and assistance must deliver a value proposition that revolves around precise information delivery, high worker acceptance, guidance through intuitive HMIs, and a direct impact on safety enhancement and accident reduction.

⁸ <https://www.logisticsit.com/articles/2022/09/12/manufacturing-landed-in-the-top-3-most-stressed-industries>

Differentiation factors	Differentiation in solutions for worker stress monitoring and assistance lies in the incorporation of adaptive user interfaces, mixed reality experiences, automated fatigue and stress assessments, advanced biometric monitoring, predictive analytics, real-time feedback, and cognitive/emotional assessments.
Value chain positioning	Customers in the manufacturing sector for solutions addressing worker stress monitoring and assistance include manufacturing enterprises, HR departments, occupational health and safety teams, production managers, safety equipment suppliers, government occupational health agencies, industrial psychologists, technology providers, trade unions, and workers' representatives.
Business model scenarios	Possible business models for solutions addressing worker stress monitoring and assistance in the manufacturing sector include subscription-based models for recurring revenue, enterprise licensing for one-time payments, freemium models with premium features, performance-based models tied to outcomes, data licensing and analytics, hardware-software bundling, risk management services, employee wellness platform integration, and pay-per-use models for flexibility.
Application Experiments	HANDFUL hardware solutions monitor operator stress and working conditions as well as allow predictive maintenance.

4.6 Collaboration between AI and Human supervisors to solve complex problems

Challenge description	Today, using AI is a commonplace. It allows companies to use their existing software to analyze the vast amount of data they routinely collect. However, it is today solely focused on machines and tools. There is now a need to implement an AI supervision process applied to the whole process to bring data to all machines and conclusions to the entire product.
Market perspectives	<p>The global artificial intelligence in manufacturing market size is estimated to be valued at USD 3.2 billion in 2023 and is anticipated to reach USD 20.8 billion by 2028, at a CAGR of 45.6%.⁹</p> <p>The market perspectives for solutions addressing the collaboration between AI and human supervisors in manufacturing are optimistic and marked by several key trends. This collaboration is expected to enhance efficiency and productivity, facilitate complex problem-solving, enable predictive maintenance, improve quality control, enhance safety protocols, augment the skills of the human workforce, support adaptive learning, contribute to market competitiveness and innovation, empower the workforce, ensure regulatory compliance and ethical AI practices, and optimize global supply chains. While these trends indicate positive outcomes, challenges such as workforce adaptation and ongoing skill development need consideration.</p>

⁹https://www.marketsandmarkets.com/Market-Reports/artificial-intelligence-manufacturing-market-72679105.html?gad_source=1&gclid=Cj0KCQiA4Y-sBhC6ARIsAGXF1g4ss__rjdTVxVMoHfllpxpFNOq1t5IzJ8iy-xFOPw_Okk2UhM7JdLQaAvUZEALw_wcB

<p>Existing solutions</p>	<p>Existing commercialized solutions, addressing the collaboration between AI and human supervisors in manufacturing, include predictive maintenance platforms, quality control and visual inspection systems, collaborative robots (cobots), AI-enhanced process optimization software, supply chain management systems, digital twins for manufacturing, AI-integrated human-machine interfaces (HMIs), AI-powered maintenance assistance, collaborative AI-driven decision support systems, employee training platforms with AI, AI-based inventory management systems, energy management solutions with AI, human-centric AI assistants, and AI-enhanced workplace safety solutions. These solutions cover a wide range of applications, from optimizing operations and improving quality control to enhancing workplace safety and employee training.</p>
<p>Expected value propositions</p>	<p>Solutions addressing the collaboration between AI and human supervisors in manufacturing offer a compelling value proposition by ensuring precise information delivery, positioning AI and robots as assistants to human operators, enabling the automatic generation of alternative solutions, increasing Overall Equipment Effectiveness (OEE), tracking problem issues comprehensively, and making AI calculation outcomes accessible and readable to operators. The value extends to proactive issue resolution, enhanced decision support, fostering a culture of continuous improvement, and promoting operational flexibility and adaptability.</p>
<p>Differentiation factors</p>	<p>Solutions addressing collaboration between AI and human supervisors in manufacturing, differentiate by emphasizing the accuracy and learning speed of models and algorithms, prioritizing data quality with automatic recognition of flawed data, adopting adaptive learning for continuous improvement, excelling in real-time problem resolution, offering a user-friendly interface for easy data interpretation, taking a holistic approach to data security and privacy, and providing scalability with integration capabilities.</p>
<p>Value chain positioning</p>	<p>Customers in the manufacturing field include manufacturing enterprises, production and plant managers, operations managers, quality control teams, maintenance teams, supply chain managers, technology and IT departments, safety and compliance officers, human resources departments, data analysts and scientists, logistics and warehouse managers, engineering teams, regulatory compliance officers, and continuous improvement teams. These diverse customers represent various roles and departments within manufacturing organizations, highlighting the broad applicability and impact of solutions facilitating collaboration between AI and human supervisors.</p>

<p>Business model scenarios</p>	<p>Possible business models for solutions addressing the collaboration between AI and human supervisors in manufacturing include subscription-based models for recurring revenue, licensing models for one-time or periodic fees, consulting and integration services, performance-based models tied to outcomes, pay-per-use models offering flexibility, freemium models with basic features for free and premium features for a subscription fee, partnerships and collaborations with other industry players, hardware-software bundling for comprehensive solutions, data licensing and analytics for insights, custom development services, training and certification programs, risk-sharing models based on performance improvements, outsourced AI services, and open-source models with revenue generated through support and customization services.</p>
<p>Application Experiments</p>	<p>MANIAC developing an analysis co-pilot to pilot operations at the plant level. AI-WELD, AI-supported quality inspection of welds by X-ray radiography</p>

4.7 Human-centric robotic assistance for assembly work cell

<p>Challenge description</p>	<p>The assembly of small systems causes posture problems leading to mental and physical fatigue as well as musculoskeletal pain in the long term. Complexity and dexterity make humans essential assets for these manufacturing processes. Collaborative solutions are needed to improve working conditions and efficiency.</p>
<p>Market perspectives</p>	<p>The assembly robot market is estimated to reach a valuation of USD 14,8 billion in 2023 and will top USD 44,4 billion by 2033, growing with a CAGR of 11,6%¹⁰. With the increasing focus on Industry 4.0, there is a growing demand for innovative technologies that enhance efficiency and collaboration in manufacturing processes. Human-centric robotic assistance offers increased efficiency, improved worker safety, flexibility, and adaptability to changing production needs. The collaborative robotics trend, rising labour costs, and workforce challenges further contribute to the market growth. Technological advancements in robotics, AI, and sensors enhance the capabilities of these systems, and the establishment of industry standards supports their safe integration. The market expansion is observed globally across sectors like automotive, electronics, and aerospace, showcasing a positive trajectory for the adoption of human-centric robotic assistance in manufacturing.</p>

¹⁰<https://www.factmr.com/report/assembly-robot-market#:~:text=The%20assembly%20robot%20market%20is,11.6%25%20from%202023%2D2033.>

<p>Existing solutions</p>	<p>Existing solutions for human-centric robotic assistance in assembly work cells encompass a variety of technologies. Collaborative robots (cobots) are designed to work alongside humans safely, incorporating sensors for adaptability. Sensory feedback systems use force and torque sensors, vision systems, and proximity sensors for enhanced human-robot interaction. Advanced grippers and end-effector systems offer precision in delicate assembly tasks. Safety-rated software and control systems ensure compliance with safety standards. Adaptive and learning systems enable robots to adapt behaviour based on the environment and human interactions. Human-robot interface (HRI) technologies facilitate seamless communication, while user-friendly programming interfaces simplify task-level programming. Simulation and digital twin technologies allow for virtual optimization of human-robot interactions. Industry-specific solutions tailor offerings to unique challenges in different sectors, contributing to safer and more efficient collaborative manufacturing environments.</p>
<p>Expected value propositions</p>	<p>Solutions addressing the challenge of human-centric robotic assistance in assembly work cells must bring distinct value propositions to enhance the efficiency and safety of manufacturing processes. The capability to detect when and where an operator is facing challenges ensures proactive intervention, improving overall workflow resilience. Prioritizing the safety of workers is crucial, with an emphasis on accident reduction and decreased absenteeism, creating a secure work environment. Ensuring the acceptance of workers is crucial for successful integration, emphasizing the collaborative nature of human-robot interactions. Additionally, the reduction of human tasks through robotic assistance not only optimizes efficiency but also allows human workers to focus on more complex and cognitive aspects of assembly work. Ultimately, the value proposition is strengthened by the ability of solutions to precisely bring the right item to the right place at the right time, streamlining assembly processes and minimizing errors.</p>
<p>Differentiation factors</p>	<p>Differentiation in solutions addressing the challenge of human-centric robotic assistance in assembly work cells is achieved through advanced Human-Robot Collaboration (HRC) engineering and the sensibility of algorithms in robots. The key distinguishing factor is the emphasis on creating a seamless and user-friendly collaboration interface that facilitates intuitive interactions between humans and robots. Additionally, the sensibility of algorithms plays a crucial role, ensuring responsiveness to the nuances of assembly tasks, adaptability to changing conditions, and a high level of safety in dynamic environments. A differentiated solution excels not only in technical sophistication but also in its ability to effectively and sensitively navigate the intricacies of human-robot collaboration within assembly work cells.</p>
<p>Value chain positioning</p>	<p>Customers for solutions addressing human-centric robotic assistance in assembly work cells span a diverse range of industries, including manufacturing enterprises from diverse fields (automotive, consumer, aerospace, medical device....), industrial equipment manufacturers, logistics and warehousing companies, technology integrators, and research institutions. These customers seek solutions to enhance efficiency, collaboration, and flexibility in their assembly processes.</p>

<p>Business model scenarios</p>	<p>Potential business models include Robot as a Service (RaaS) with subscription or usage-based fees, Licensing for ownership through one-time or periodic payments, Custom Integration Services for tailoring and integration, Maintenance Contracts for ongoing support, Outcome-based Pricing tied to achieved results, Hardware Leasing for access without upfront investment, Data Analytics and Insights Subscription for valuable information, Volume-based Pricing aligned with task volume, and Industry-specific Solutions tailored to sector-specific needs.</p>
<p>Application Experiments</p>	<p>MAS-AI depending on the size of the screw the robots can address at the end of the project.</p>

4.8 Automation for the optimisation of intra-factory logistics

<p>Challenge description</p>	<p>Improvements and automation in intralogistics would allow the optimization of the incoming flow for machines and work cells, and more globally optimize operations at the shopfloor level, including stocks and ERP management. Such solutions would support operators in supplying the machines or accessing the right tools to achieve their tasks.</p>
<p>Market perspectives</p>	<p>The global intralogistics market is predicted to expand at a high-value CAGR of 14,8% and go from USD 18,9 billion in 2022 to USD 75,3 billion by 2032. The key drivers include the potential for increased efficiency and productivity, cost reduction through resource optimization, real-time visibility and control of logistics operations, flexibility to adapt to changing manufacturing needs, integration with Industry 5.0 technologies, enhanced safety, and risk mitigation. The rise of Autonomous Mobile Robots (AMRs) and the growing trend of warehouse automation contribute to the positive outlook. Factors such as global supply chain disruptions, the need for market competitiveness, and a focus on environmental sustainability further bolster the demand for automation solutions. Overall, the adoption of automation in intra-factory logistics is expected to play a crucial role in creating more resilient, efficient, and innovative manufacturing processes.</p>
<p>Existing solutions</p>	<p>Existing solutions addressing the automation of intra-factory logistics in the manufacturing industry gather a range of technologies. These include Autonomous Mobile Robots (AMRs) and Automated Guided Vehicles (AGVs) for autonomous material transport, Conveyor Systems for streamlined movement of goods, Automated Storage and Retrieval Systems (AS/RS) for optimized storage, Robotics for picking and packing tasks, Warehouse Management Systems (WMS) for holistic logistics management, Automated Forklifts for pallet and goods transport, Automated Sorting Systems for item categorization, Collaborative Robots (Cobots) for flexible collaboration with human workers, Automated Drones for inventory management, Predictive Analytics and Machine Learning for process optimization, and Smart Conveyor Systems for adaptive material transport.</p>

<p>Expected value propositions</p>	<p>The value propositions of intra-factory logistics automation solutions lie in optimizing items and goods flow, efficient fleet management, substantial reduction of operator movements, and the optimization of handling systems. A holistic approach that embraces connectivity, data analytics, and adaptability is essential to meet the evolving demands of modern manufacturing environments.</p>
<p>Differentiation factors</p>	<p>Differentiation circles around advanced algorithms for flow optimization and Simultaneous Localization and Mapping (SLAM). The effectiveness of these algorithms is crucial for ensuring efficient and responsive item and goods movement within manufacturing facilities. A differentiated solution should not only optimize logistics flow but also demonstrate adaptability and scalability, integrating seamlessly with existing systems and accommodating changes in production requirements. Robust cybersecurity measures further distinguish a solution, addressing the increasing importance of securing interconnected and data-sharing automated logistics systems.</p>
<p>Value chain positioning</p>	<p>Potential customers in the manufacturing industry for intra-factory logistics automation solutions include large enterprises across diverse sectors like automotive, electronics, aerospace, consumer goods, pharmaceutical, food, textile, energy, and chemicals... Automotive manufacturers, electronics producers, and aerospace companies especially seek enhanced logistics efficiency. Industrial equipment makers also represent potential customers. Contract manufacturers providing services to various industries, technology integrators, and research institutions focused on manufacturing are additional potential customers.</p>
<p>Business model scenarios</p>	<p>Possible business models for providing intra-factory logistics automation solutions in the manufacturing industry include traditional Product Sales and Subscription/Service-based models. Leasing allows companies to access technology without a large upfront investment, while the Pay-per-Use model aligns costs with actual usage. Integrated Solution Services offer a comprehensive package, including installation and maintenance. Data Monetization involves collecting and analyzing data for valuable insights. Outcome-based Pricing charges based on achieved outcomes. Customization and Upgrades and Industry-specific Solutions, address specific needs. Eco-credits or Carbon Credits incentivize sustainability.</p>
<p>Application Experiments</p>	<p>Auto-ANT, led by the company ANT Maschinen, developing autonomous mobile robots to move truck trailers.</p>

4.9 Enhanced digital planning to optimise the execution of the tasks of production operators

<p>Challenge description</p>	<p>With the increase of robotic assistance on the shop floors and digitization of production lines, factory workers are often confronted with working several machines. Enhanced digital planning needs to provide real-time data to factory workers and directly update the machines' tasks to increase productivity.</p>
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<p>Market perspectives</p>	<p>The market perspectives for solutions addressing enhanced digital planning in production operations are positive, driven by the potential for efficiency gains, real-time monitoring, resource optimization, data-driven decision-making, and the overall pursuit of Industry 4.0 principles. Manufacturers seeking to remain competitive are likely to invest in such solutions to enhance their operational agility and productivity.</p>
<p>Existing solutions</p>	<p>Existing solutions for enhanced digital planning to optimize the execution of tasks for production operators include a range of technologies and software tools. Manufacturing Execution Systems (MES), Enterprise Resource Planning (ERP) Systems, and Advanced Planning and Scheduling (APS) Software offer real-time tracking, resource management, and dynamic scheduling. Digital Twins provides virtual replicas for simulation and optimization. Collaborative planning tools and IoT-enabled Production Monitoring facilitate communication and real-time data insights. Predictive Analytics Platforms utilize machine learning for task optimization, while Robotics Process Automation (RPA) automates repetitive tasks. Workflow Management Systems, Cloud-based Planning Platforms, and Augmented Reality (AR) for Work Instructions contribute to streamlined workflows. Blockchain enhances supply chain visibility for better planning.</p>
<p>Expected value propositions</p>	<p>Solutions addressing enhanced digital planning for production operators bring significant value propositions, encompassing adaptability to customer requests, high worker acceptance through user-friendly interfaces, optimization tailored to diverse company divisions, seamless connections between MES and ERPs, improvements in Overall Equipment Effectiveness (OEE), and enhanced overall productivity. These solutions provide real-time visibility, decision support tools, and the ability to adapt to changes in demand and market conditions. They contribute to cost reduction, efficiency gains, compliance with regulations and quality standards, and facilitate quick adjustments to production plans.</p>
<p>Differentiation factors</p>	<p>Differentiated solutions addressing enhanced digital planning distinguish themselves by prioritizing a worker-centric approach. They actively collect and implement worker feedback in algorithms, fostering a continuous improvement loop. These solutions feature adaptive algorithms, user-friendly interfaces, and customization options to align with individual operator preferences. Offering anonymous feedback channels ensures open communication, while real-time integration of insights and feedback analytics contributes to a responsive and informed planning process. Differentiation also lies in providing training and support mechanisms based on feedback, creating a culture of collaboration between operators and management. Overall, these solutions prioritize the human element, ensuring a more intuitive, adaptive, and worker-friendly digital planning environment.</p>
<p>Value chain positioning</p>	<p>Potential customers in the manufacturing field for solutions addressing enhanced digital planning include large manufacturing enterprises, and small and medium-sized enterprises (SMEs). Custom manufacturing and contract manufacturers catering to various industries are also potential customers.</p>
<p>Business model scenarios</p>	<p>Possible business models include subscription-based, pay-per-use, license fee, freemium, customization, outcome-based pricing, data monetization, industry contracts, and open-source.</p>

Application Experiments	None directly. MANIAC developing an analytics copilot could address this challenge indirectly.
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4.10 Gamification of work tasks via the use of digital technologies (AI, Drone, AR...)

Challenge description	In times when recruiting is becoming challenging, manufacturers have to adapt their workplaces, make them more attractive, the work more engaging, and the time spent on the shop floor more impactful. Studies have shown a positive effect of gamification (smartphone-based) on factory workers' motivation and willingness to embrace their tasks. Companies with highly engaged employees tend to outperform those without engagement by 20%.
Market perspectives	The gamification market size is projected to grow from USD 9,1 billion in 2020 to USD 30,7 billion by 2025 at a CAGR of 27,4% ¹¹ . Gamification enhances employee engagement, productivity, and skills development, making work more enjoyable and rewarding. It contributes to motivation, performance improvement, and talent retention. Gamified solutions support data-driven decision-making, stimulate innovation, and are well-suited for remote work and collaboration. The adoption of digital technologies, customization options, and a focus on employee wellness further contribute to the positive outlook. Successful implementation requires careful design, alignment with organizational goals, and ongoing assessment of impact. As the workplace continues to evolve, gamification is likely to play a significant role in shaping a dynamic and engaging work environment.
Existing solutions	Existing solutions incorporate various digital technologies to enhance training, improve performance, and foster a culture of continuous improvement. These solutions include training simulators, performance dashboards, leaderboards, interactive workstations, reward systems, Augmented Reality (AR) applications, gamified maintenance tasks, and safety training games. Additionally, collaborative gamified tasks and real-time feedback systems promote teamwork and provide instant performance evaluation.
Expected value propositions	Prioritizing worker acceptance through intuitive interfaces and user-friendly design is essential. The value proposition should emphasize a significant reduction in training time, coupled with a tangible increase in Overall Equipment Effectiveness (OEE) and overall productivity. Stimulating workers' motivation with elements like rewards and recognition is crucial, to fostering a positive work environment. Customization, real-time feedback, and progress tracking enhance adaptability and empower operators. Safety awareness, continuous learning, and seamless integration with existing systems contribute to a comprehensive value proposition, ensuring a holistic approach to enhancing worker engagement and operational efficiency.

¹¹ <https://www.marketsandmarkets.com/Market-Reports/gamification-market-991.html>

<p>Differentiation factors</p>	<p>Differentiated solutions for gamification in production machines must showcase innovation in non-fully digitized environments, acting as a catalyst for digitization. The ability to drive the transition from traditional to more digital workflows sets these solutions apart. Another key differentiator is the personalization of gamification experiences for operators, tailoring challenges and rewards based on individual work tasks. This personalized approach enhances engagement and addresses the diverse needs of operators, highlighting the solution's adaptability and effectiveness in the production environment.</p>
<p>Value chain positionings</p>	<p>Potential clients for solutions applied to production machines, especially those incorporating gamification, include a wide array of industries. These clients seek solutions to optimize production processes, train operators effectively, and improve overall efficiency. The versatility of gamification makes it applicable to diverse manufacturing settings, with the key being customization to address the specific needs and challenges of each client.</p>
<p>Business model scenarios</p>	<p>Potential business models for gamification solutions in the realm of production machines include subscription-based models, license fee structures, pay-per-use models, and customization fees. Providers can offer outcome-based pricing tied to operational improvements, training and support packages, or even explore partnerships with revenue-sharing arrangements. The freemium model, where basic features are free with premium options available for purchase, is another option. Additionally, there is potential for data monetization, hardware and software bundles, continuous improvement packages, and sustainability-focused models such as earning eco-credits.</p>
<p>Application Experiments</p>	<p>None. Gamification will be explored in every application experiment during business coaching (task 5.2)</p>

5 CONCLUSION

To sum up, this report marks the end of *3.2 Preliminary Market analysis & opportunities related to open call topic and challenges* within *Work Package 3 - Methodology and tools for Innovation management, specifically task*. Its main aim is to offer practical insights to the application experiments benefiting from the project on how to make their solutions commercially viable. EARASHI wants to achieve an initial level of maturity for these solutions and secure funding for further development. BLUMORPHO's extensive experience in creating engaging activities and business cases through collaborations with major corporations and investors is expected to significantly contribute to this task and the overall project goals.

The report employs a systematic methodology, drawing from various sources like market trends, literature analysis, discussions with the Advisory Board, and consultations with external stakeholders. This approach provides a solid foundation for understanding challenges and opportunities, essential for application experiments developing their business cases as part of Task 5.2 – *Business coaching*.

Additionally, the report establishes connections between tasks, emphasizing the relationship between market analysis and subsequent business coaching. Insights from the preliminary market analysis of challenges provide a valuable framework for developing business cases.

In subsequent sections, the report delves into market trends and general findings related to human centricity in the industry. This provides context for exploring challenges such as safety concerns, workforce attraction, and retention. The challenges are completed by potential business case scenarios, offering a strategic roadmap for EARASHI stakeholders navigating the dynamic landscape of Industry 5.0.

As EARASHI progresses, the information in this report stands as a basis for further research and analysis, serving as a valuable resource for the business coaching of application experiments within *WP5 Towards successful application experiments*. The established linkages between market insights, challenges, and business case scenarios provide a robust basis for a thoughtful approach to innovation management within the project's scope.