care, judgment, dexterity

CRAEFT

Risk Assessment

Project Acronym	Craeft
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http://www.craeft.eu/

Executive summary

This deliverable identifies the risks related to the project's objectives and activities and highlights various challenges and potential obstacles that need to be carefully managed and mitigated. These risks encompass technical complexities, data availability and quality, compatibility and integration issues, pedagogical effectiveness, skill transferability, engagement and motivation, content security, intellectual property infringement, technical challenges, user acceptance, privacy and data protection, quality control, misrepresentation, and market competitiveness.

The deliverable is structured as follows:

Section 1 makes an introduction to the project the purpose and scope of risk assessment and its importance for Craeft.

Section 2 presents the methodology for risk assessment adopted in Craeft.

Section 3 presents a preliminary identification of the risks of Craeft in conjunction with the project objectives.

Section 4 presents an assessment of the likelihood and impact of each risk identified in the previous section to evaluate and justify the likelihood and impact of each of the identified risks. Then a risk evaluation matrix is created to summarise the findings of the risk analysis

Section 5 proposes mitigation strategies for each of the identified risks.

Section 6 presents our strategy towards continuous risk assessment.

Section 7 provides concluding remarks.

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Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
CAP	Craeft Authoring Platform
CIDOC-CRM	CIDOC-Conceptual Reference Model
DMP	Data Management Plan
EDM	European Data Model
FAQ	Frequently Asked Question
GDPR	General Data Protection Regulation
HTTPS	Hypertext Transfer Protocol Secure
IPR	Intellectual Property Rights
MoCap	Motion Capture
UCD	User Centred Design
VR	Virtual Reality
WP	Work Package

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1. Introduction

1.1. Background information on Craeft

Craeft aims to deepen our understanding of various crafting activities that encompass care, judgement, and dexterity. It draws upon disciplines such as Anthropology, Knowledge Representation, Cognitive Science, Art History, Advanced Digitisation, Audio-visual & Haptic Immersivity, and Computational Intelligence. The project seeks to explore crafts as living and developing heritage, sustainable sources of income, and a means of expressing the mind through imagery, technology, and accumulated knowledge.

One of the main challenges addressed by Craeft is the declining number of practitioners and apprentices in crafts. This decline is attributed to factors such as lack of awareness, difficulties in transmitting knowledge, and economic demotivation stemming from the absence of certificates and accredited qualifications, particularly for high-quality training and standards of practice.

To tackle these challenges, Craeft proposes to catalyse craft education and training using intuitive digital aids, telecommunications, craft-specific simulators, immersive visualisation, and high-end digitization. The goal is to broaden access, make learning more economical, enhance practical application, and overcome constraints posed by geographical remoteness. The integration of haptics intelligence in digital design aims to connect tacit knowledge with computer-aided craft-specific design tools. Workflow simulation and experimental archaeology will aid in recovering lost techniques, leading to material savings, reuse, and reduced energy consumption. Digital conservation and reenactable preservation will prevent the neglect of possibilities and the acceptance of inferior forms of craftsmanship.

Despite industrialization, the demand for handmade personal items and design diversity remains constant, as they allow individuals to express their uniqueness. Craeft seeks to enhance the value of crafted products by adding digital dimensions that contextualize and personalize individual artefacts. The project recognizes the importance of human touch and purposeful handiwork, which embed intangible dimensions into the artefacts. By integrating haptics into digital design and providing craft-specific computer-aided design tools, practitioners can adapt efficiently to diverse needs and optimize workflows. Furthermore, Craeft aims to seamlessly integrate with digital fabrication opportunities to automate mundane tasks, reduce energy and material consumption, facilitate reuse and recycling, and offer repair instructions and technical assistance.

Practitioners and makers are part of a widely dispersed social group, and their decisions, practices, and influences are guided by common orienting principles. Craeft plans to implement a Community Portal that supports professional communication, product and skill certification, tutoring, assistance, and self-promotion. The objective is to increase practitioners' income streams by facilitating remote tutoring, certifying authentic skills, and gaining recognition from others. The project also emphasizes the importance of engaging young individuals through the development of games and toys that promote interest and safe practice. Additionally, the social benefits of craft practice are recognized, as it positively influences personal and communal well-being when pursued as a vocational, leisure, and social activity.

The efficacy of the Craeft approach will be piloted in eight representative craft instances, addressing objectives related to Craft Education & Training, Design, Valorisation, and Community services across a range of materials. Given its interdisciplinary nature, Craeft holds the potential for broader impacts in vocational training, digitization technologies, and the understanding of creativity in practical domains.

1.2. Purpose and scope of the risk assessment

In Craeft we define risk assessment as the systematic process of identifying, analysing, and evaluating potential risks associated with the DoW. It involves assessing the likelihood and impact of identified risks to make informed decisions and develop appropriate risk management strategies. Our goal is to identify potential uncertainties that could affect the objectives, assets, or stakeholders involved. These risks can arise from various sources, such as technological factors, environmental conditions, human factors, regulatory requirements, or financial considerations.

Key considerations when conducting the risk assessment plan of Craeft included:

- **Identify Risks:** Identifying potential risks that may impact the project. These risks can include anything that could hinder the successful completion of the project objectives.
- **Assess Probability:** Evaluate the likelihood of each identified risk in a subjective way or based on historical data or expert opinions. Assign a probability value to each risk.
- **Assess Impact:** Determine the potential impact of each risk on Craeft by considering both the magnitude of the impact and the probability of it occurring.
- **Prioritize Risks:** Rank the risks based on their probability and impact to prioritize the risk mitigation efforts and allocate resources accordingly.
- **Develop Mitigation Strategies:** For each identified risk, develop strategies to mitigate or minimize its impact.
- **Monitor and Review:** Regularly monitor the identified risks during the project duration and keep track of any changes in their probability or impact to update your risk assessment accordingly.
- **Communicate and Document:** Communicate the identified risks, their potential impact, and the mitigation strategies to the project stakeholders. Maintain comprehensive documentation of the risk assessment process and its outcomes.

1.3. Importance for Craeft

Risk assessment is crucial for a project like Craeft due to several reasons. It will allow the Craeft consortium to systematically identify and analyse potential risks that could impact the project's success. In Craeft's case, there are multiple interdisciplinary elements involved, including knowledge representation, digitization technologies, cognitive science, and more. Each of these domains carries its own set of risks, such as technical challenges, resource constraints, coordination issues, or unforeseen complexities. By conducting a thorough risk assessment, we can proactively identify these risks and take appropriate measures to mitigate or manage them.

Another important consideration is the identification of risks that could potentially lead to project delays. Craeft aims to address the declining numbers of practitioners and apprentices in crafts by implementing various interventions, such as intuitive digital aids, craft-specific simulators, and high-end digitization. However, the introduction of new technologies, training methodologies, and complex interdisciplinary workflows can introduce risks that may impact project timelines. By assessing these risks, the project team can minimize the chances of delays and keep the project on track.

Resource constraints, such as limited funding, availability of skilled personnel, or technological limitations, can significantly affect project outcomes. Through risk assessment, Craeft can identify potential resource-related risks and devise strategies to optimize resource allocation.

Risk assessment allows for a comprehensive evaluation of risks that could impact stakeholders' interests and expectations. Craeft involves various stakeholders, including practitioners, artisans, and the wider community. By assessing risks related to stakeholder engagement, communication, or satisfaction, the project team can devise strategies to address these risks and ensure that stakeholders' needs are effectively met. This enhances stakeholder satisfaction and increases the likelihood of project success.

Risk assessment also plays a vital role in ensuring the long-term sustainability of the project results. Craeft aims to have a lasting impact on craft education, training, and the preservation of Cultural Heritage (CH). By assessing risks related to economic viability, scalability, or technological obsolescence, the project team can develop strategies to mitigate these risks and ensure that the project's outcomes and benefits are sustainable even after the project's completion.

2. Methodology

In Craeft we have identified a four-step methodology for risk assessment as presented in the following table:

Step No.	What	How
1	**Identify Risks:** Identifying potential risks that could affect the project's objectives.	This can be done through brainstorming sessions, reviewing project documentation, conducting interviews with stakeholders, and leveraging lessons learned from similar projects. Document each identified risk in detail, including its description and potential impact on the project.
2	**Evaluate Risk Severity:** Assess the overall severity of each risk by considering both its likelihood and impact.	Multiplying the assigned probability and impact scores or using a risk matrix that categorizes risks into different severity levels. This step helps in understanding the criticality of each risk and assists in determining which risks require immediate attention.
3	**Develop Risk Response Strategies:** Based on the assessed risk severity, develop appropriate risk response strategies.	Common risk response strategies include risk avoidance (eliminating the risk), risk mitigation (reducing the likelihood or impact of the risk), risk transfer (shifting the risk to a third party), or risk acceptance (acknowledging the risk and preparing contingency plans). Each risk should have a specific response strategy identified, along with clear actions and responsibilities.
4	**Monitor and Review:** Continuously monitor and review the identified risks throughout the project's lifecycle.	Regularly assess the effectiveness of the implemented risk response strategies and make necessary adjustments if new risks emerge or existing risks change. Maintain open communication channels with stakeholders to ensure ongoing risk awareness and timely updates to the risk assessment.

Sections 3-6 provide an overview of how the above-mentioned process has been initiated for the project.

3. Risk Identification

In this section, we conduct a preliminary identification of the risks of Craeft in conjunction with the project objectives.

3.1. O1. Understanding crafting actions and processes, in a Maker-Material-Negotiation model

The following risks have been identified for O1:

O1.R1 - Technical Complexity: The project involves understanding crafting actions and processes through a Maker-Material-Negotiation model. The technical complexity of implementing such a model could pose a risk, including challenges in developing accurate representations, capturing relevant data, and creating effective simulations. Insufficient technical expertise or limitations in available technologies could impact the project's success.

O1.R2 - Data Availability and Quality: The project relies on digitization and analysis of various signals related to crafting activities, including surfaces, motion, sounds, and material properties. Ensuring the availability and quality of diverse and representative data for analysis could be a challenge. Limited access to specific crafting activities or difficulties in obtaining accurate and comprehensive data sets may impact the project's ability to derive meaningful insights.

O1.R3 - Compatibility and Integration: The project aims to develop a unifying model that combines mechanical, perceptual, and intellectual components of crafting activities. Ensuring compatibility and seamless integration between different components, such as the ontology for crafts (CrO), the Craft Authoring Platform (CAP), and data encoding standards like CIDOC-CRM and EDM, could present technical and interoperability challenges. Lack of compatibility could hinder effective collaboration and data sharing.

O1.R4 - Ethnographic Complexity: The project intends to incorporate advanced ethnographic observations to capture the context, evolution, and narratives surrounding crafting techniques and materials. Conducting ethnographic studies across diverse crafts, techniques and materials could be complex and time-consuming. Challenges may arise in coordinating fieldwork, managing different cultural contexts, and ensuring accurate representation and modelling of the observed practices.

O1.R5 - Stakeholder Engagement: The success of the project depends on the active participation and engagement of various stakeholders, including practitioners, craft masters, artisans, and researchers. Risks may arise if there is a lack of stakeholder collaboration, resistance to change, or difficulties in obtaining meaningful contributions from practitioners. Ensuring ongoing stakeholder involvement and effective communication throughout the project is essential for its success.

O1.R6 - Resource Limitations: Adequate resources, including funding, expertise, and technological infrastructure, are crucial for the project's execution. Insufficient resources or budget constraints may impede the implementation of necessary technologies, limit the scope of data collection, or hinder the

development of required software tools. Managing resource limitations effectively is important to mitigate associated risks.

3.2. O2. Digital re-enactment of craft actions and processes

The following risks have been identified for O2:

O2.R1 - Technical Complexity: The digital re-enactment of craft actions and processes involves computational modelling, Artificial Intelligence (AI), Motion Capture (MoCap), and 2D, 2.5D, 3D, and 4D reconstruction. The technical complexity of implementing these technologies and integrating them into a coherent simulation framework could pose risks. Challenges may arise in accurately capturing and representing the nuances of craft actions, handling large datasets, ensuring real-time performance, and maintaining realism in the simulation.

O2.R2 - Data Availability and Accuracy: The success of the re-enactment relies on the availability and accuracy of data used for training the simulators. This includes data related to hand, body, and tool motion, material transformations, gestures, and sensory stimuli. Risks may arise from limited access to diverse and representative datasets, inconsistencies in data quality or labelling, and potential biases or gaps in the training data that could impact the realism and effectiveness of the simulations.

O2.R3 - Interpretation of Craft-specific Actions: Craft actions are initiated through the observation of the material and the preparation through cognitive activities of the interaction of the practitioner with the tools, and the subject matter. Understanding cognitive aspects may be challenging, At the same time capturing and simulating accurately these interactions are also risky. Risks may arise from difficulties in interpreting and representing craft-specific actions, gestures, and material transformations in a way that is faithful to the craft's essence and in a machine-readable format. Misinterpretation of the cognitive aspects or oversimplification of actions could result in simulations that do not accurately reflect the craft's intricacies and may not be useful for training or re-enactment purposes.

O2.R4 - Realism and Immersion: The objective includes the creation of realistic virtual artefacts and the use of immersive interfaces such as augmented reality (AR), virtual reality (VR), and haptics. Ensuring a high level of realism and immersion in the simulations is crucial for their effectiveness and user engagement. Risks may arise from limitations in the available hardware or software technologies, difficulties in achieving realistic haptic feedback through the implemented haptic devices, or challenges in maintaining a smooth and immersive user experience without causing discomfort or simulation sickness.

O2.R5 - Training and Education Applications: The Craft Studio aims to support education and training applications for craft techniques. Risks may arise from the effectiveness of the simulations in conveying knowledge and skill development. Challenges include designing appropriate training exercises, providing clear and comprehensive instructions, ensuring the simulations cater to different learning styles and skill levels, and addressing potential limitations in the transferability of simulated skills to real-world craft practice. These risks are enlarged through the need for a high level of individualisation of the training content and the difficulties in the replication of training activities from the trainees.

O2.R6 - User Feedback and Validation: Gathering user feedback and validating the effectiveness of the simulations pose potential risks. It is important to involve practitioners and students in the evaluation and

improvement of the simulators to ensure that they accurately represent the craft processes and effectively support learning and re-enactment. Challenges may arise in collecting timely and constructive feedback, addressing diverse user perspectives, and incorporating feedback into iterative development cycles.

3.3. O3. Education

O3.R1 - Adaptation to Evolving Technologies: Craft education can benefit from the use of technology and digital tools for remote learning and educational experiences. The project may face challenges in adapting to evolving technologies and ensuring the compatibility and effectiveness of educational materials with different tools and platforms.

O3.R2 - Quality and Relevance of Educational Materials: Streamlining the curation of educational materials per craft is an important aspect of the objective. Risks may arise regarding the quality and relevance of the educational content produced. Ensuring that the vocabulary, principles, techniques, and instructions provided are accurate, comprehensive, and up-to-date is essential. There is a need to validate the materials and ensure they meet the educational objectives and needs of the learners.

O3.R3 - Adoption and Integration Challenges: Implementing new tools and technologies in craft education requires successful adoption and integration into existing educational systems and practices. Risks may arise from resistance to change, difficulties in training craft educators to use the new tools effectively, or challenges in aligning the digital educational experiences with the overall curriculum and teaching methodologies. Furthermore, since education in many cases is informal due to the lack of enough craft schools in Europe this risk becomes greater since there is a plethora of different training methods to apply to. Considering also the fact that many craftspeople do not get paid to train and do not see the need to spend time and energy with youngsters who may not follow up after the training we should take into consideration the provision of incentives for them to keep teaching. Ensuring smooth adoption and integration requires effective change management strategies and continuous support for educators.

O3.R4 - Learning Effectiveness: The objective emphasizes the development of critical thinking, judgement, problem-solving skills, and continuous design principles in craft education. Risks may arise if the implemented digital educational experiences fail to effectively enhance these learning outcomes. It is essential to design interactive simulations, explanatory materials, and learning activities that engage learners, facilitate understanding, and promote active learning. The effectiveness of these approaches should be continuously evaluated and refined.

O3.R5 - Balancing Mistakes and Positive Feedback: The objective recognizes that mistakes and uncertainty are part of skill development. However, striking the right balance between providing constructive feedback on mistakes and maintaining positive reward systems can be challenging. Risks may arise if learners become demotivated or discouraged due to frequent errors or if the positive aspects of skill development are not adequately reinforced. Ensuring a supportive learning environment and implementing appropriate feedback mechanisms are crucial to mitigating these risks.

O3.R6 - Accessibility and Inclusivity: When adopting digital tools and technologies for craft education, it is essential to consider accessibility and inclusivity aspects. Risks may arise if certain learners face barriers in accessing or using digital educational materials due to disabilities, limited internet connectivity, or

technological constraints. Ensuring that the materials are accessible, available in multiple formats, and cater to diverse learning needs and abilities is important to mitigate these risks.

3.4. O4. Training

O4.R1 - Technology Implementation and Usability: The objective involves the creation of craft-specific immersive vocational training systems with haptic interaction for tactile sensing and actuation. Risks may arise from the implementation of complex technologies, such as virtual reality (VR), augmented reality (AR), and haptic feedback systems. Challenges may include ensuring the usability and user-friendliness of the training systems, addressing potential technical issues, and providing adequate training and support for users who may be unfamiliar with these technologies.

O4.R2 - Realism and Immersion: The effectiveness of craft training heavily relies on the realism and immersion provided by the training systems. Risks may arise if the simulations or haptic interactions fail to accurately replicate the tactile sensations and dexterous manipulations required in craftwork. Ensuring high-quality haptic rendering, realistic tool usage, and accurate simulation of material properties are essential to create an immersive and effective training experience.

O4.R3 - Cost and Accessibility: Craft practice often involves a cost in terms of materials and workshop usage. The objective aims to economize the development of monitoring and actuation skills by enabling practice away from the workshop using virtual materials. However, ensuring the availability and accessibility of the necessary hardware and software tools for virtual training may present cost and resource challenges. Risks may arise if the training systems are not accessible to all learners or if the cost of equipment limits their widespread adoption. Finally, we should also consider the risks of people with weak digital skills adopting such material.

O4.R4 - Pedagogical Effectiveness: The objective includes training attention, actuation skills, and social interaction in the workshop. Risks may arise if the training exercises and simulations fail to effectively develop these skills or if the instructional strategies do not align with the needs and learning preferences of the trainees. It is crucial to design training experiences that engage learners, provide clear guidance, offer appropriate feedback, and foster social interaction to facilitate knowledge transmission.

O4.R5 - Skill Transferability: Craft training simulations aim to develop understanding, dexterity, perception, and actuation skills. Risks may arise if the skills acquired through virtual training do not transfer effectively to real-world craft practice. The challenge lies in ensuring that the training systems and exercises closely mimic the complexity and nuances of actual craftwork to facilitate seamless skill transfer. Continuous evaluation and validation of the training effectiveness in real craft contexts are important to mitigate this risk.

O4.R6 - Engagement and Motivation: Sustaining learner engagement and motivation throughout the training process is crucial for effective skill development. Risks may arise if the training simulations or exercises fail to captivate learners or if the training becomes monotonous or repetitive. Furthermore, there is always a risk of learners not seeing the real applicability and conversion of the practice into finished products and real job opportunities. Designing varied and engaging training experiences, incorporating gamification elements, and providing clear learning goals and progression pathways can help mitigate these risks.

3.5. O5. Design

O5.R1 - Technical Complexity and Tool Integration: The objective involves the development of computer-aided digital design and fabrication tools for craft-specific workflows. Risks may arise from the technical complexity of developing and integrating these tools into the Design Studio. Challenges may include ensuring compatibility with existing design software and hardware, managing data exchange between different tools, and maintaining a seamless workflow across the design and fabrication stages. Technical expertise and thorough testing will be crucial to mitigate these risks.

O5.R2 - Realism and Accuracy: The Design Studio aims to provide realistic simulation and preview of designs in virtual and augmented reality environments. Risks may arise if the simulations and visual/haptic rendering fail to accurately represent the physical properties and interactions of craft materials and objects. Challenges include accurately capturing highly reflective or transparent materials, ensuring high-resolution surface scanning, and simulating realistic illumination effects. Striving for realism and accuracy in the virtual environment will be important to provide designers with an authentic and informative design experience.

O5.R3 - Learning Curve and User Experience: Introducing craft-specific 3D editing tools and computer-aided design tools to designers may require them to learn new software interfaces and techniques. Risks may arise if the learning curve is steep or if the user experience of the tools is not intuitive or user-friendly. Designers may face challenges in adapting their existing design processes to the new digital tools. Providing comprehensive documentation, tutorials, and user support will be essential in mitigating these risks and facilitating a smooth transition for designers.

O5.R4 - Material and Resource Optimization: The objective emphasizes the use of digital design and fabrication to conserve resources, such as material, energy, workspace usage, and practitioner time. However, risks may arise if the workflow implementation or the use of design-specific aids does not effectively lead to material savings or streamlined processes. Ensuring efficient workflows, automated menial workflow parts, and accurate simulation of assets will be crucial to achieving the desired resource optimization outcomes. Continuous evaluation and refinement of the workflow implementation will be important in addressing these risks.

O5.R5 - Fabrication Challenges: The integration of the Design Studio with subtractive/additive manufacturing devices introduces risks associated with the fabrication process. Challenges may arise in translating the virtual designs into appropriate formats for fabrication, ensuring the accuracy of the manufacturing process, and coping with the limitations or complexities of specific materials or manufacturing techniques. Collaboration with experts in fabrication technologies and thorough testing of the fabrication workflow will help mitigate these risks.

O5.R6 - Alignment with Craft Interpretation and Workflow: The objective aims to explore the "interpretation of design in a workflow" specific to craft processes. Risks may arise if the digital design tools and simulations fail to align with the craft-specific interpretation and workflow. It is important to involve craft practitioners and experts in the design process, gather their feedback, and validate the effectiveness of the tools in capturing the essence of craft interpretation and enabling seamless workflow design. There is also a risk of confusion between a standardized process (design + manufacturing) described above and a craft production where all pieces are unique because interpretation, conditions

etc. are never the same. Craeft uses fabrication processes for design and not to industrialize craft production.

3.6. O6. Preservation & Revival

O6.R1 - Certification and Skill Recognition: The objective aims to establish certification programs and skill acknowledgement for craft education and training. Risks may arise from the complexity and standardization of certification processes, ensuring the credibility and recognition of certifications across different materials and learning approaches. Challenges may include defining criteria for certification, developing robust evaluation methods, and ensuring that certifications align with industry standards and requirements. Collaboration with craft experts, industry associations, and relevant stakeholders will be important in mitigating these risks and establishing a recognized and respected certification system.

O6.R2 - Income Stream Diversification: The objective seeks to support craft practitioners in diversifying their income streams through tutoring and skill-specific services. Risks may arise from the challenges of implementing effective online tutoring platforms, ensuring high-quality feedback and technical assistance, and reaching new markets with specialized techniques. Additionally, managing intellectual property rights (IPR) and protecting against unauthorized use of craft designs and techniques can pose legal and reputational risks. Thorough planning, user feedback collection, and legal guidance will be essential in addressing these risks and creating sustainable income opportunities for craft practitioners.

O6.R3 - Community Service: Lack of certification and attribution to communal or individual IPR can pose challenges to motivation and quality recognition within the craft community. Risks may arise from the complexity of managing and attributing contributions, ensuring fair and transparent peer review processes, and protecting intellectual property rights. Developing a robust Community Portal that facilitates acknowledgement, registration of contributions, and links to official trademark registrations and certifications will be crucial in mitigating these risks and fostering a supportive and collaborative craft community.

O6.R4 - Sustainable Innovation: The objective aims to promote sustainable growth, innovation, and compliance with sustainable policies and certificates in craft practices. Risks may arise from the challenges of integrating sustainable practices into traditional craft techniques, ensuring compliance with regulations and certifications, and creating awareness and education around sustainable innovation. Collaboration with sustainable design experts, providing educational materials on sustainable practices, and actively engaging with funding agencies and relevant stakeholders will be important in addressing these risks and promoting sustainable and responsible craft practices.

O6.R5 - Awareness and Promotion: Creating awareness and promoting European crafts and identity is crucial to counter the declining demand and decreasing markets for craft products. Risks may arise from the complexities of managing and curating digital content collections, organizing digital exhibitions, and effectively reaching potential customers. Challenges may include coordinating with regional authorities, ensuring an accurate representation of craft traditions and values, and attracting tourism services. Content curation, collaboration with regional authorities and tourism agencies, and targeted marketing strategies will be essential in mitigating these risks and successfully promoting European crafts and identity. It is important to change people's mindset by informing them about crafted products that are of higher quality, offer longevity versus mass consumption reduce waste and are created through green growth practices.

3.7. O7. Product valorisation

O7.R1 - Risk of Digital Content Security: Linking craft products with unique identifiers and digital content opens up the risk of unauthorized access or tampering with the linked content. There is a possibility of hackers or malicious individuals gaining access to the digital information and compromising its integrity.

O7.R2 - Intellectual Property Infringement: As craft products are linked with digital content and certificates, there is a risk of unauthorized reproduction or copying of the digital content, leading to potential intellectual property infringement. It is crucial to establish measures to protect the originality and ownership of the digital assets associated with the products.

O7.R3 - Technical Challenges and Compatibility: Integrating digital dimensions with craft products may involve complex technical requirements, such as embedding visual codes or creating digital platforms for registration and content linkage. There is a risk of encountering technical challenges during the implementation phase, including compatibility issues, system failures, or difficulties in maintaining and updating the digital infrastructure.

O7.R4 - User Acceptance and Adoption: The success of product valorisation through digital dimensions depends on customer acceptance and adoption. There is a risk that customers may not embrace or fully understand the added value of the digital content associated with craft products. Ensuring user-friendly interfaces, clear communication, and effective marketing strategies are important to mitigate this risk.

O7.R5 - Privacy and Data Protection: Collecting and storing personal data related to customers and their interactions with craft products and digital content carries inherent privacy and data protection risks. It is crucial to comply with relevant data protection regulations and implement robust security measures to protect sensitive customer information.

O7.R6 - Quality Control and Misrepresentation: The introduction of digital dimensions and linked content raises concerns about maintaining quality control and ensuring that the associated digital representations accurately reflect the craft products. There is a risk of misrepresentation or discrepancies between the physical product and the digital information, potentially leading to customer dissatisfaction or loss of trust.

O7.R7 - Market Competitiveness: While product valorisation through digital dimensions can provide unique selling points for craft products, there is a risk that competitors may adopt similar strategies or offer alternative digital solutions. Staying competitive in the market and continuously innovating to differentiate craft products from others is essential to mitigate this risk.

4. Risk Analysis

In this section, we assess the likelihood and impact of each risk identified in the previous section to evaluate and justify the likelihood and impact of each of the identified risks. Then a risk evaluation matrix is created to summarise the findings of the risk analysis.

4.1. Assessment of likelihood and impact

4.1.1. O1. Understanding crafting actions and processes, in a Maker-Material-Negotiation model

- **O1-R1 -** Technical Complexity:
  - **Likelihood:** Moderate

    Rationale: The technical complexity of implementing a Maker-Material-Negotiation model for understanding crafting actions and processes can be challenging. It may require expertise in computational modelling, data capture, and simulation. While there may be potential technical hurdles, advancements in technology and available expertise can help mitigate the likelihood to some extent.

  - **Impact:** High

    Rationale: The impact of technical complexity can be significant if the project faces difficulties in accurately representing crafting actions and processes, capturing relevant data, and creating effective simulations. These challenges may affect the project's ability to derive meaningful insights and achieve its objectives. However, with adequate technical expertise and resources, the impact can be mitigated.

- **O1-R2 -** Data Availability and Quality:
  - **Likelihood:** Moderate

    Rationale: Ensuring the availability and quality of diverse and representative data for analysis can be a challenge. The project relies on digitizing and analyzing various signals related to crafting activities. Obtaining comprehensive and accurate data sets may require access to specific crafting activities and collaboration with practitioners. Limited availability or challenges in obtaining high-quality data can increase the likelihood of this risk.

  - **Impact:** Moderate

    Rationale: The impact of data availability and quality issues can affect the project's ability to derive meaningful insights and develop accurate models. Insufficient or poor-quality data may limit the project's effectiveness in capturing the nuances of crafting actions and

processes. However, careful data collection strategies and data validation measures can help mitigate the impact.

- **O1-R3 -** Compatibility and Integration:
  - **Likelihood:** Moderate

    Rationale: Developing a unifying model that integrates different components, such as the ontology for crafts, the Craft Authoring Platform, and data encoding standards, can present technical and interoperability challenges. Achieving seamless compatibility and integration among these components may require careful planning and coordination. The likelihood of this risk can be influenced by the availability of compatible technologies and the expertise to implement them.

  - **Impact:** Moderate

    Rationale: The impact of compatibility and integration issues can hinder effective collaboration, data sharing, and workflow integration. Lack of compatibility may result in data inconsistencies, difficulties in exchanging information, or limitations in the project's ability to leverage existing tools and resources. However, with proper attention to technical standards and interoperability considerations, the impact can be managed.

- **O1-R4 -** Ethnographic Complexity:
  - **Likelihood:** Low to Moderate

    Rationale: Conducting advanced ethnographic observations across diverse crafting techniques and materials can be complex and time-consuming. The likelihood of this risk depends on the project's scope, the number of research sites, and the availability of resources for conducting ethnographic studies. However, careful planning and collaboration with experts in ethnography can help manage this risk.

  - **Impact:** Moderate

    Rationale: The impact of ethnographic complexity lies in the potential challenges related to coordinating fieldwork, managing cultural contexts, and accurately representing and modelling observed practices. Difficulties in collecting comprehensive ethnographic data or capturing the full context of crafting activities may limit the project's ability to develop a holistic understanding. Effective methodologies and close collaboration with practitioners can help mitigate the impact.

- **O1-R5 -** Stakeholder Engagement:
  - **Likelihood:** Moderate

    Rationale: The success of the project depends on the active participation and engagement of various stakeholders, including practitioners, artisans, and researchers. The likelihood of this risk is influenced by factors such as stakeholder receptiveness to new approaches, willingness to contribute, and availability for collaboration. Communication and relationship-building efforts can mitigate this risk.

- **Impact:** Moderate

  Rationale: The impact of stakeholder engagement issues can hinder the project's progress and the depth of insights gained. Lack of stakeholder buy-in, resistance to change, or limited contributions from practitioners may limit the project's effectiveness in capturing and incorporating diverse perspectives. Establishing effective communication channels and fostering a collaborative environment can help mitigate the impact.

- **O1-R6 -** Resource Limitations:
  - **Likelihood:** Moderate

    Rationale: Adequate resources, including funding, expertise, and technological infrastructure, are crucial for the project's execution. The likelihood of resource limitations can depend on factors such as project budget, availability of funding, and access to specialized expertise and equipment. Managing resource allocation effectively can help mitigate this risk.

  - **Impact:** High

    Rationale: The impact of resource limitations can affect various aspects of the project. Insufficient resources or budget constraints may restrict the implementation of necessary technologies, limit data collection efforts, or hinder the development of required software tools. Effective resource management, prioritization, and collaboration with relevant stakeholders can help mitigate the impact.

4.1.2. O2. Digital re-enactment of craft actions and processes

- **O2.R1 -** Technical Complexity:
  - **Likelihood:** Moderate to High

    Rationale: Implementing complex technologies such as computational modelling, artificial intelligence, motion capture, and 3D/4D reconstruction can pose technical challenges and require expertise. The complexity involved in integrating these technologies into a coherent simulation framework increases the likelihood of facing difficulties and potential setbacks.

  - **Impact:** High

    Rationale: The technical complexity of implementing these technologies can impact the overall effectiveness and functionality of the simulation. Challenges in accurately capturing craft actions, handling large datasets, ensuring real-time performance, and maintaining realism may result in simulations that do not meet the desired standards or fail to provide a satisfactory user experience.

- **O2.R2 -** Data Availability and Accuracy:
  - **Likelihood:** Moderate

Rationale: The success of reenactment relies on the availability and accuracy of diverse and representative datasets. Obtaining access to such datasets and ensuring their accuracy and comprehensiveness may pose challenges, increasing the likelihood of potential issues in data availability and quality.

- **Impact:** High

  Rationale: Inaccurate or incomplete datasets can affect the realism and effectiveness of the simulations. Limited access to diverse data, inconsistencies in data quality or labelling, and potential biases or gaps in the training data may impact the fidelity and reliability of the simulations, limiting their value for training and re-enactment purposes.

- **O2.R3 -** Interpretation of Craft-specific Actions:
  - **Likelihood:** Moderate

    Rationale: Craft actions involve nuanced interactions and gestures that may be challenging to capture and simulate accurately. Interpreting and representing these craft-specific actions faithfully requires a deep understanding of the craft's essence, increasing the likelihood of facing difficulties in accurately representing the intricacies of craft actions. Reporting practitioners' "observations" during crafting activities could support understanding.

  - **Impact:** Moderate

    Rationale: Misinterpretation or oversimplification of craft actions in the simulations may result in a lack of accuracy and fidelity. If the simulations fail to accurately reflect the craft's intricacies, they may not be useful for training or re-enactment purposes, limiting their educational value and effectiveness.

- **O2.R4 -** Realism and Immersion:
  - **Likelihood:** Moderate

    Rationale: Achieving a high level of realism and immersion in the simulations requires advanced hardware and software technologies. Challenges may arise in selecting appropriate technologies, achieving realistic haptic feedback, and maintaining a smooth and immersive user experience without causing discomfort or simulation sickness.

  - **Impact:** Moderate

    Rationale: Inadequate realism or immersion in the simulations may diminish the user experience and reduce the effectiveness of the educational and training applications. If the simulations fail to provide a realistic and engaging environment, learners may not fully benefit from the immersive nature of the experience, limiting the educational impact.

- **O2.R5 -** Training and Education Applications:
  - **Likelihood:** Moderate

Rationale: Designing effective training exercises, providing clear instructions, and ensuring the simulations cater to different learning styles and skill levels can be challenging. There is a likelihood of facing difficulties in creating simulations that effectively convey knowledge and skill development.

- **Impact:** Moderate

Rationale: The effectiveness of the simulations in supporting education and training depends on their ability to meet the learning objectives and engage learners. Challenges in designing appropriate exercises, providing comprehensive instructions, and addressing limitations in skill transferability may impact the overall educational value and effectiveness of the simulations.

- **O2.R6 -** User Feedback and Validation:
  - **Likelihood:** Moderate

Rationale: Gathering students' and practitioners' feedback and validating the simulations require their active involvement. The process of collecting timely and constructive feedback, addressing diverse user perspectives, and incorporating feedback into iterative development cycles may pose challenges.

  - **Impact:** Moderate

Rationale: User feedback and validation are crucial for ensuring the simulations accurately represent the craft processes and effectively support learning and re-enactment. Challenges in collecting feedback and addressing user perspectives may impact the refinement and improvement of the simulators, potentially reducing their educational value and effectiveness.

4.1.3. O3. Education

- **O3.R1 -** Adaptation to Evolving Technologies:
  - **Likelihood:** Moderate to High

Rationale: Technology is constantly evolving, and the project's success relies on adopting and leveraging the most up-to-date tools and platforms. The availability and compatibility of these technologies may change over time, increasing the likelihood of facing challenges in adapting to new technologies.

  - **Impact:** High

Rationale: Inadequate adaptation to evolving technologies can hinder the effectiveness and compatibility of educational materials. It may result in outdated or incompatible content, reducing the overall quality of craft education experiences and limiting the project's potential impact.

- **O3.R2 -**Quality and Relevance of Educational Materials:

- **Likelihood:** Moderate

  Rationale: Developing high-quality and relevant educational materials requires careful planning and expertise. While efforts can be made to ensure accuracy and comprehensiveness, challenges may arise in meeting the diverse needs and expectations of learners, increasing the likelihood of some gaps or limitations in the materials.

- **Impact:** High

  Rationale: The quality and relevance of educational materials directly impact the effectiveness of craft education. If the materials are inaccurate, incomplete, or not aligned with learners' needs, it can hinder their learning outcomes and diminish the value of the educational experience.

- **O3.R3 -**Adoption and Integration Challenges:
  - **Likelihood:** Moderate

    Rationale: Adopting new tools and technologies in education often requires significant changes in existing systems and practices. Resistance to change, lack of familiarity with the new tools, and difficulties in integrating them into established workflows can increase the likelihood of facing challenges during the adoption and integration processes.

  - **Impact:** High

    Rationale: Smooth adoption and integration are crucial for the success of the project. If educators and stakeholders struggle to embrace and effectively use the new tools, it can hinder the seamless implementation of craft education practices, limiting the project's overall impact.

- **O3.R4 -**Learning Effectiveness:
  - **Likelihood:** Moderate

    Rationale: Ensuring that digital educational experiences effectively enhance learning outcomes can be a complex task. Designing interactive simulations, explanatory materials, and learning activities that engage learners and promote critical thinking and problem-solving skills requires careful planning and continuous evaluation.

  - **Impact:** High

    Rationale: The effectiveness of digital educational experiences directly affects the learning outcomes of craft education. If the materials and activities fail to engage learners or do not effectively enhance critical thinking and problem-solving skills, it can limit the educational impact of the project.

- **O3.R5 -**Balancing Mistakes and Positive Feedback:
  - **Likelihood:** Moderate

Rationale: Striking the right balance between providing constructive feedback on mistakes and maintaining positive reinforcement is a delicate challenge in skill development. Balancing these aspects effectively requires careful instructional design and implementation strategies.

- **Impact:** Moderate

  Rationale: If the feedback mechanisms are not properly designed or if learners feel overwhelmed or discouraged by frequent errors, it can negatively impact their motivation and hinder their skill development. However, with appropriate feedback mechanisms and a supportive learning environment, this risk can be mitigated.

- **O3.R6 -**Accessibility and Inclusivity:
  - **Likelihood:** Moderate

    Rationale: When adopting digital tools and technologies, it's important to consider accessibility and inclusivity aspects. However, challenges can arise due to limitations in internet connectivity, technological constraints, or the need to cater to diverse learning needs and abilities.

  - **Impact:** Moderate

    Rationale: Inadequate consideration of accessibility and inclusivity can create barriers for certain learners, limiting their access to educational materials and hindering their participation in craft education. Addressing these challenges is crucial to ensure equal opportunities and maximize the project's impact.

4.1.4. O4. Training

- **O4.R1 -** Technology Implementation and Usability:
  - **Likelihood:** Moderate

    Rationale: Implementing complex technologies such as VR, AR, and haptic feedback systems may present challenges in terms of technical implementation and ensuring usability. Users who are unfamiliar with these technologies may require training and support to effectively utilize the training systems.

  - **Impact:** Moderate

    Rationale: Difficulties in technology implementation or usability issues may hinder the effectiveness of the training systems. If users struggle to interact with or navigate the systems, it may impact their ability to learn and develop craft-specific skills effectively.

- **O4.R2 -** Realism and Immersion:
  - **Likelihood:** Moderate

Rationale: Achieving a high level of realism and immersion in the training systems requires accurate haptic rendering, realistic tool usage, and simulation of material properties. Challenges may arise in replicating the tactile sensations and dexterous manipulations required in craftwork.

- **Impact:** High

  Rationale: Insufficient realism and immersion in the training systems may limit the effectiveness of skill development. If the simulations fail to accurately replicate the craft-specific experiences and sensations, learners may not acquire the necessary skills or may struggle to transfer them to real-world craft practice.

- **O4.R3 -** Cost and Accessibility:
  - **Likelihood:** Moderate

    Rationale: Ensuring the availability and accessibility of the necessary hardware and software tools for virtual training may present cost and resource challenges. Limited access to equipment or high costs may restrict the widespread adoption and accessibility of the training systems.

  - **Impact:** Moderate

    Rationale: Limited accessibility to the training systems may hinder learners' opportunities for practice and skill development. Additionally, if the cost of equipment is prohibitive, it may limit the participation of certain individuals or communities, reducing the inclusivity and impact of the vocational training systems.

- **O4.R4 -** Pedagogical Effectiveness:
  - **Likelihood:** Moderate

    Rationale: Designing effective training exercises and instructional strategies that align with the needs and learning preferences of the trainees can be challenging. Ensuring that the simulations and exercises effectively develop attention, and actuation skills, and facilitate social interaction requires careful pedagogical considerations.

  - **Impact:** High

    Rationale: Ineffective training exercises or instructional strategies may limit the development of key skills and hinder knowledge transmission. If the training fails to engage learners, provide clear guidance, or offer appropriate feedback, it may negatively impact the effectiveness of the vocational training systems.

- **O4.R5 -** Skill Transferability:
  - **Likelihood:** Moderate

Rationale: The challenge lies in ensuring that the skills acquired through virtual training transfer effectively to real-world craft practice. Skill transferability depends on the fidelity of the training systems in replicating the complexity and nuances of craftwork.

- **Impact:** Moderate

  Rationale: If the virtual training does not adequately prepare learners for real craft practice, it may limit their ability to apply the acquired skills effectively. Continuous evaluation and validation of skill transferability in real craft contexts, with the participation of practitioners, is important to mitigate this risk.

- **O4.R6 -** Engagement and Motivation:
  - **Likelihood:** Moderate

    Rationale: Sustaining learner engagement and motivation throughout the training process can be challenging. Monotonous or repetitive training experiences may lead to decreased engagement and reduced motivation to continue skill development.

  - **Impact:** Moderate

    Rationale: Low engagement and motivation may hinder skill development and limit the effectiveness of the vocational training systems. Designing varied and engaging training experiences, incorporating gamification elements, and providing clear learning goals can help mitigate these risks.

4.1.5. O5. Design

- **O5.R1 -** Technical Complexity and Tool Integration:
  - **Likelihood:** Moderate

    Rationale: Developing and integrating computer-aided digital design and fabrication tools for craft-specific workflows can be technically complex. Challenges may arise in ensuring compatibility, managing data exchange, and maintaining a seamless workflow across different tools.

  - **Impact:** High

    Rationale: Difficulties in tool integration and technical complexity may hinder the effectiveness of the Design Studio. Incompatibility or inefficient data exchange between tools may disrupt the design and fabrication workflow, impacting productivity and hindering the realization of material and time savings.

- **O5.R2 -** Realism and Accuracy:
  - **Likelihood:** Moderate

Rationale: Providing realistic simulation and accurate representation of craft materials and objects in the virtual environment requires overcoming challenges related to material properties, surface scanning, and illumination effects.

- **Impact:** High

  Rationale: Inaccurate simulations or visual/haptic rendering may limit the designers' ability to make informed design decisions. If the virtual environment does not faithfully represent the physical properties and interactions of craft materials, it may lead to suboptimal designs or unrealistic expectations.

- **O5.R3 -** Learning Curve and User Experience:
  - **Likelihood:** Moderate

    Rationale: Introducing new software interfaces and techniques to designers may present a learning curve and challenges in adapting existing design processes to digital tools.

  - **Impact:** Moderate

    Rationale: Steep learning curves or poor user experience of the tools may slow down the design process and hinder designers' productivity. Providing comprehensive documentation, tutorials, and user support can mitigate these risks and facilitate a smooth transition for designers.

- **O5.R4 -** Material and Resource Optimization:
  - **Likelihood:** Moderate

    Rationale: Ensuring effective material savings and streamlined processes through digital design and fabrication workflows requires careful implementation and optimization.

  - **Impact:** Moderate

    Rationale: Inefficient workflows or ineffective use of design-specific aids may limit the achievement of material savings and resource optimization goals. Continuous evaluation and refinement of the workflow implementation will be important to address these risks and maximize resource conservation.

- **O5.R5 -** Fabrication Challenges:
  - **Likelihood:** Moderate

    Rationale: Integrating the Design Studio with subtractive/additive manufacturing devices introduces risks associated with the fabrication process and specific materials or techniques.

  - **Impact:** Moderate

Rationale: Challenges in translating virtual designs into appropriate formats, ensuring accuracy in the manufacturing process, or coping with material or technique limitations may impact the quality and feasibility of the fabricated products. Collaboration with people employing such technologies in their daily practice and thorough testing will help mitigate these risks.

- **O5.R6 -** Alignment with Craft Interpretation and Workflow:
  - **Likelihood:** Moderate

    Rationale: Ensuring that the digital design tools and simulations align with the craft-specific interpretation and workflow requires the active involvement of craft practitioners and experts.

  - **Impact:** Moderate

    Rationale: Misalignment between the digital tools and the craft-specific interpretation and workflow may limit the effectiveness and usability of the Design Studio. Gathering feedback from craft practitioners and validating the tools' effectiveness in capturing the essence of craft interpretation will help mitigate these risks.

4.1.6. O6. Preservation & Revival

- **O6.R1 -** Certification and Skill Recognition:
  - **Likelihood:** Moderate

    Rationale: Establishing certification programs and skill recognition processes can be complex and require collaboration with craft experts and industry associations.

  - **Impact:** Moderate to High

    Rationale: Risks may arise from the challenges of standardizing certification processes, defining criteria, and ensuring the credibility and recognition of certifications. Inadequate certification processes or lack of industry acceptance may undermine the value of certifications and hinder skill recognition within the craft community. Probably certifying knowledge digitally and completing skills certification with hands-on certification would be a solution. Digital certification would also act as a filter to keep only motivated learners.

- **O6.R2 -** Income Stream Diversification:
  - **Likelihood:** Moderate

    Rationale: Implementing effective online tutoring platforms and diversifying income streams for craft practitioners can present technical and market challenges.

  - **Impact:** Moderate to High

Rationale: Risks may arise from challenges in providing high-quality feedback, technical assistance, and reaching new markets. Additionally, managing intellectual property rights (IPR) and protecting against unauthorized use of craft designs and techniques can have legal and reputational implications. Addressing these risks requires careful planning, user feedback collection, and legal guidance.

- **O6.R3 -** Community Service:
  - **Likelihood:** Moderate

    Rationale: Managing contributions, peer review processes, and intellectual property rights within the craft community can be complex.

  - **Impact:** Moderate to High

    Rationale: Risks may arise from challenges in attributing contributions, ensuring fair peer review processes, and protecting intellectual property rights. Developing a robust Community Portal that facilitates acknowledgement, registration of contributions, and links to official registrations and certifications can mitigate these risks and foster a supportive craft community.

- **O6.R4 -** Sustainable Innovation:
  - **Likelihood:** Moderate

    Rationale: Integrating sustainable practices into traditional craft techniques and ensuring compliance with regulations and certifications require careful planning and education.

  - **Impact:** Moderate

    Rationale: Risks may arise from challenges in integrating sustainability practices, ensuring compliance, and promoting sustainable innovation. Collaboration with sustainable design experts, providing educational materials, and engaging with funding agencies and stakeholders can help address these risks and promote sustainable craft practices.

- **O6.R5 -** Awareness and Promotion:
  - **Likelihood:** Moderate

    Rationale: Managing digital content collections, organizing exhibitions, and effectively reaching customers can present challenges.

  - **Impact:** Moderate

    Rationale: Risks may arise from the complexity of managing digital content, representing craft traditions and values accurately, and attracting tourism services. Content curation, collaboration with regional authorities and tourism agencies, and targeted marketing strategies are essential to mitigate these risks and successfully promote European crafts and identity.

4.1.7. O7. Product Valorisation

- O7.R1 - Risk of Digital Content Security:
  - **Likelihood:** Moderate

    Rationale: The risk of unauthorized access or tampering with digital content is a concern in today's digital landscape, but the specific likelihood depends on the implemented security measures and the attractiveness of the craft products to potential attackers.

  - **Impact:** Moderate to High

    Rationale: If unauthorized access or tampering occurs, it can compromise the integrity and trustworthiness of the linked digital content. This can have reputational and legal implications for craft products and the associated digital assets.

- O7.R2 - Intellectual Property Infringement:
  - **Likelihood:** Moderate

    Rationale: The risk of intellectual property infringement exists when digital content is linked to craft products, especially if the content is valuable or easily reproducible.

  - **Impact:** Moderate

    Rationale: Unauthorized reproduction or copying of digital content associated with craft products can lead to financial losses, dilution of brand value, and disputes over intellectual property rights. Implementing effective measures to protect digital assets and enforcing legal protections can help mitigate this risk.

- O7.R3 - Technical Challenges and Compatibility:
  - **Likelihood:** Moderate

    Rationale: Implementing and maintaining the technical infrastructure required for linking craft products with digital dimensions can present technical challenges and compatibility issues.

  - **Impact:** Moderate

    Rationale: Technical challenges and compatibility issues can impact the functionality, usability, and reliability of the digital dimensions. This can affect the overall customer experience and the perceived value of the linked digital content.

- O7.R4 - User Acceptance and Adoption:
  - **Likelihood:** Moderate

    Rationale: The acceptance and adoption of digital content linked to craft products depend on various factors, including customer awareness, understanding of the added value, and ease of use.

- **Impact:** Moderate

  Rationale: If customers do not embrace or understand the value of digital content, it may not contribute significantly to the perceived value or attractiveness of craft products. Effective communication, user-friendly interfaces, and compelling marketing strategies based on the human aspect of crafts.

- O7.R5 - Privacy and Data Protection:
  - **Likelihood:** Moderate

    Rationale: Collecting and storing personal data related to customers and their interactions with craft products and digital content requires compliance with data protection regulations and robust security measures.

  - **Impact:** Moderate

    Rationale: Privacy breaches or data protection failures can lead to reputational damage, legal consequences, and loss of customer trust. Implementing strong data protection measures and ensuring compliance with relevant regulations are essential in mitigating this risk.

- O7.R6 - Quality Control and Misrepresentation:
  - **Likelihood:** Moderate

    Rationale: Maintaining quality control and accurately representing craft products through digital dimensions require attention to detail and effective processes.

  - **Impact:** Moderate

    Rationale: If the digital representations do not accurately reflect the physical products and the maker's know-how or if there are misrepresentations, it can lead to customer dissatisfaction, negative reviews, and loss of trust. Implementing rigorous quality control measures and ensuring consistency between physical and digital representations can help mitigate this risk. At the same time educating customers is crucial since two handmade vases will always be different, the customers must understand that imperfection and differences are part of the craft-made product's value versus industrially made ones.

- **O7.R7 -** Market Competitiveness:
  - **Likelihood:** Moderate

    Rationale: The risk of market competitiveness arises from the potential for competitors to adopt similar strategies or offer alternative digital solutions.

  - **Impact:** High

    Rationale: Staying competitive in the market requires continuous innovation, differentiation, and effective marketing strategies. Failure to differentiate craft products

or keep up with evolving digital trends can result in a loss of market share or reduced demand. Constant monitoring of the market, understanding customer preferences, and adapting the digital dimensions accordingly can help mitigate this risk. At the same time, we understand that adapting the product to customers' preferences is also risky because crafts cannot compete with big brands in price and cannot be reactive enough. Also when crafts follow trends, they uniformize the product with the risk of losing their identity and value. Trends can inspire but the focus must be on unicity and particularities, like local culture, and roots, that give crafts-made products an added value.

4.2. Risk Evaluation

Risk	Risk-type	Priority	likelihood	Impact
O1.R1 - Technical Complexity:	Technical	High	Moderate	High
O1.R2 - Data Availability and Quality:	Data availability	Moderate	Moderate	Moderate
O1.R3 - Compatibility and Integration:	Technical	Moderate	Moderate	Moderate
O1.R4 - Ethnographic Complexity:	Data collection	Moderate	Low to Moderate	Moderate
O1.R5 - Stakeholder Engagement:	User participation	Moderate	Moderate	Moderate
O1.R6 - Resource Limitations:		High	Moderate	High
O2.R1 - Technical Complexity:	Technical	High	Moderate to High	High
O2.R2 - Data Availability and Accuracy:	Data availability	High	Moderate	High
O2.R3 - Interpretation of Craft-specific Actions:		Moderate	Moderate	Moderate
O2.R4 - Realism and Immersion	Technical	Moderate	Moderate	Moderate
O2.R5 - Training and Education Applications:	Technical	Moderate	Moderate	Moderate
O2.R6 - User Feedback and Validation	User participation	Moderate	Moderate	Moderate
O3.R1 - Adaptation to Evolving Technologies	Technical	High	Moderate to High	High
O3.R2 -Quality and Relevance of Educational Materials	Technical	High	Moderate	High
O3.R3 -Adoption and Integration Challenges	Technical	High	Moderate	High
O3.R4 -Learning Effectiveness	Project Quality	High	Moderate	High
O3.R5 -Balancing Mistakes and Positive Feedback	Project Quality	Moderate	Moderate	Moderate
O3.R6 -Accessibility and Inclusivity	Project Quality	Moderate	Moderate	Moderate
O4.R1 - Technology Implementation and Usability	Technical	Moderate	Moderate	Moderate
O4.R2 - Realism and Immersion	Technical	High	Moderate	High

O4.R3 - Cost and Accessibility	Technical	Moderate	Moderate	Moderate
O4.R4 - Pedagogical Effectiveness	Project Quality	High	Moderate	High
O4.R5 - Skill Transferability	Project Quality	Moderate	Moderate	Moderate
O4.R6 - Engagement and Motivation	User participation	Moderate	Moderate	Moderate
O5.R1 - Technical Complexity and Tool Integration	Technical	High	Moderate	High
O5.R2 - Realism and Accuracy	Technical	High	Moderate	High
O5.R3 - Learning Curve and User Experience	Project Quality	Moderate	Moderate	Moderate
O5.R4 - Material and Resource Optimization		Moderate	Moderate	Moderate
O5.R5 - Fabrication Challenges	Technical	Moderate	Moderate	Moderate
O5.R6 - Alignment with Craft Interpretation and Workflow	Technical	Moderate	Moderate	Moderate
O6.R1 - Certification and Skill Recognition	Project Quality	Moderate to High	Moderate	Moderate to High
O6.R2 - Income Stream Diversification	Project Quality	Moderate to High	Moderate	Moderate to High
O6.R3 - Community Service	Technical	Moderate to High	Moderate	Moderate to High
O6.R4 - Sustainable Innovation	Project Quality	Moderate	Moderate	Moderate
O6.R5 - Awareness and Promotion		Moderate	Moderate	Moderate
O7.R1 - Risk of Digital Content Security	Security-Privacy	Moderate to High	Moderate	Moderate to High
O7.R2 - Intellectual Property Infringement	Security-Privacy	Moderate	Moderate	Moderate
O7.R3 - Technical Challenges and Compatibility	Technical	Moderate	Moderate	Moderate
O7.R4 - User Acceptance and Adoption	Project Quality	Moderate	Moderate	Moderate
O7.R5 - Privacy and Data Protection	Security-Privacy	Moderate	Moderate	Moderate
O7.R6 - Quality Control and Misrepresentation		Moderate	Moderate	Moderate
O7.R7 - Market Competitiveness	Project Quality	Moderate	Moderate	Moderate

5. Risk Mitigation Strategies

Based on the risk analysis of the previous section in this section we propose mitigation strategies for each of the identified risks.

- **O1.R1 - Technical Complexity:**
  - **Create a Multidisciplinary team:** Craeft has ensured and will monitor throughout the project that the project team involved in O1 consists of experts with diverse technical backgrounds, including crafting, data analysis, simulation, and software development. Involved partners are experts in their field and the above-mentioned strategy will help address the technical complexities through continuous collaboration and knowledge sharing.
  - **Perform Feasibility studies:** Before implementing the model, Craeft will conduct thorough feasibility studies to assess the technical requirements, potential challenges, and available technologies. This has been initiated from the first running month of the Project to identify any gaps or limitations and develop mitigation plans accordingly.
  - **Invest in technical training:** When possible, all technical partners will provide training and upskilling opportunities to team members to enhance their technical expertise.
- **O1.R2 - Data Availability and Quality:**
  - **Develop data collection protocols:** Craeft will define standardized protocols for collecting data related to crafting activities to ensure consistency and accuracy. This includes specifying the types of data to be collected, methods of collection, and quality control measures. These will be recorded in the DMP.
  - **Collaborate with craft communities:** Craeft will engage closely with craft communities and practitioners to gain access to diverse and representative datasets. Foster relationships and partnerships to encourage data sharing and participation in the project.
  - **Invest in data generation techniques:** If specific data sets are limited, Craeft will consider employing data generation techniques data to enhance the diversity and size of the available data. This can involve generating synthetic data or adapting existing data to resemble different scenarios or variations.
- **O1.R3 - Compatibility and Integration:**
  - **Use standardized data formats:** Craeft will adopt widely accepted knowledge representation standards such as CIDOC-CRM and EDM to ensure knowledge compatibility and interoperability. This will facilitate seamless integration and data sharing.
  - **Implement an effective data management system:** Craeft will develop a robust data management system (The Craeft Authoring Platform – CAP) that will allow for easy integration, retrieval, and sharing of data across different platforms and tools. Ensure data compatibility and consistency throughout the project lifecycle.
  - **Set up regular communication and collaboration:** Craeft will foster open communication channels between the project stakeholders, including the ontology developers, the Craeft Authoring Platform (CAP) team, and other relevant parties. Encourage frequent collaboration and coordination to address any compatibility issues or integration challenges promptly.

- **O1.R4 - Ethnographic Complexity:**
  - **Engage ethnographic experts:** Craeft has in its core team ethnographic researchers and anthropologists who have experience in studying diverse cultural practices and techniques. Their insights and guidance can help navigate the complexities of ethnographic studies and ensure accurate representation and modelling of observed practices.
  - **Plan and coordinate fieldwork effectively:** Craeft will develop a well-defined plan for conducting ethnographic studies, considering factors such as fieldwork locations, timeframes, and cultural sensitivities. Establish clear protocols for data collection, analysis, and interpretation to ensure consistency and accuracy.
  - **Establish relationships with local communities:** With the collaboration of Craeft dissemination and Communication Leader Craeft will build strong relationships and trust with the communities participating in the ethnographic studies and will respect their cultural traditions and practices, involve them in decision-making processes, and communicate the project's goals and benefits.
- **O1.R5 - Stakeholder Engagement:**
  - **Identify key stakeholders:** Craeft has Identified the key stakeholders relevant to the project, including practitioners, researchers, and community representatives. Furthermore, it plans in WP1 to organise targeted activities to understand their needs, perspectives, and potential concerns to tailor engagement strategies accordingly.
  - **Communication and involvement:** Craeft will establish regular channels of communication with stakeholders, such as workshops, meetings, and online platforms, to keep them informed and engaged throughout the project. Encourage active participation, seek their input, and address their concerns promptly.
  - **Value proposition:** Craeft will communicate the value and benefits of the project to stakeholders, highlighting how their involvement and contributions will positively impact the craft community and their interests. Foster a sense of ownership and shared vision among stakeholders.
- **O1.R6 - Resource Limitations:**
  - **Prioritize resource allocation**: Craeft will identify resource requirements and prioritize their allocation based on their impact on project success. Furthermore, it will allocate resources strategically to focus on high-priority areas and manage constraints effectively.
  - **Seek funding opportunities:** Craeft will seek funding opportunities that align with the project's goals, it will develop proposals and engage in networking to secure additional resources to support the project's execution.
  - **Optimize resource utilization:** Craeft will adopt resource management strategies to maximize the utilization of available resources.
- **O2.R1 - Technical Complexity:**
  - **Establish a skilled and diverse team:** Craeft has formulated a team with expertise in computational modelling, artificial intelligence, motion capture, and 3D/4D reconstruction and has ensured that the team members have a solid understanding of craft processes to address the technical complexities effectively.
  - **Conduct feasibility studies:** Before implementing the simulation framework, Craeft will conduct comprehensive feasibility studies to identify potential technical challenges and limitations. This will help in developing appropriate mitigation plans and allocating resources effectively.
  - **Continuous testing and refinement:** Craeft has adopted an iterative development approach with regular testing and feedback cycles. This will allow for the identification

and resolution of technical issues and ensure that the simulations accurately capture the nuances of craft actions.

- **O2.R2 - Data Availability and Accuracy:**
  - **Establish data acquisition protocols:** Following O1.R2 Craeft will define standardized protocols for data acquisition, ensuring consistency and accuracy. Develop guidelines for capturing hand, body, and tool motion, material transformations, gestures, and sensory stimuli. Regularly validate and update the data to maintain its quality.
  - **Collaborate with craft communities and experts:** Craeft will foster partnerships with craft communities and experts, in the consortium, and outside through collaborations in the context of the communication activities of the project, to gain access to diverse and representative datasets. Engage in ongoing collaborations to ensure the availability of accurate and comprehensive data sets for training the simulators.
  - **Data validation and cleansing:** Craeft will implement rigorous data validation processes to identify and rectify inconsistencies, biases, or gaps in the training data. Utilize data cleansing techniques to enhance the accuracy and reliability of the data used in the simulations.
- **O2.R3 - Interpretation of Craft-specific Actions:**
  - **Involve craft practitioners and experts:** Craeft will collaborate closely with craft practitioners and experts throughout the development process. Furthermore, it will seek their guidance and insights to ensure the faithful representation of craft-specific actions, gestures, and material transformations in the simulations.
  - **Conduct user testing and feedback:** Craeft will regularly gather feedback from craft practitioners and users to evaluate the accuracy and effectiveness of the simulations in reflecting the craft's essence. Furthermore, it will incorporate user feedback into iterative development cycles to refine the simulations accordingly.
  - **Iterate and improve:** Continuously refine the simulation models based on user feedback and insights from craft practitioners. Strive for an iterative improvement process to enhance the fidelity and accuracy of the simulated craft actions.
- **O2.R4 - Realism and Immersion:**
  - **Research and adopt advanced technologies:** Craeft will stay updated with the latest advancements in hardware and software technologies that enhance realism and immersion. To this end, it will continuously evaluate and adopt appropriate technologies that can improve haptic feedback, visual rendering, and user experience.
  - **User-centred design approach:** Craeft will take into consideration and when possible, prioritize the needs and preferences of users when designing immersive interfaces. Furthermore, it will conduct user testing in the context of the pilots to ensure that the simulations provide a smooth and immersive experience without causing discomfort or simulation sickness.
  - **Optimize system performance:** Craeft will continuously optimize the performance of the simulation system to ensure real-time responsiveness and maintain a high level of realism. Furthermore, it will implement efficient algorithms, optimize hardware configurations, and leverage software optimization techniques to achieve a smooth user experience by maximizing the offline calculation of complex problems to ensure smooth real-time operation.
- **O2.R5 - Training and Education Applications:**
  - **Needs assessment and customization:** Craeft will conduct a thorough needs assessment in the targeted crafts and curricula, together with domain experts from participating training organisations to understand the requirements and learning objectives of

different user groups. Furthermore, it will target the customization of the training exercises, instructions, and simulations to cater to different learning styles, knowledge, and skill levels.

- **Comprehensive instructions and feedback:** Craeft will provide clear and comprehensive instructions within the simulations. At the same time, it will offer real-time feedback and guidance to learners to facilitate skill development and address any potential limitations in the transferability of simulated skills.
- **Continuous evaluation and improvement:** This is crucial to regularly evaluate the effectiveness of the training simulations in achieving the desired learning outcomes. Furthermore, it will help gather feedback from practitioners and students and incorporate their suggestions into the iterative development cycles to enhance the training experience.

- **O2.R6 - User Feedback and Validation:**
  - **Establish user feedback mechanisms:** Craeft will implement user feedback mechanisms, such as user testing sessions, to gather timely and constructive feedback from practitioners and students. Furthermore, through the community portal, it will create a supportive environment that encourages open communication and active participation.
  - **Regular evaluation and improvement cycles:** The purpose of user feedback will be to provide data into the iterative development cycles to continuously improve the simulators' accuracy and effectiveness. Craeft will prioritize and address user concerns and suggestions to enhance the user experience and ensure that the simulations align with the craft processes.
  - **Collaboration with practitioners and students:** Craeft will foster collaboration with craft practitioners and students throughout the project. Additionally, it will Involve them in the evaluation and validation processes to ensure that the simulators accurately represent the craft processes and effectively support learning and re-enactment.
- **O3.R1 - Adaptation to Evolving Technologies:**
  - **Monitor new technology:** Craeft will, through its technical partners, monitor the latest developments and trends in technology relevant to craft education to assess emerging tools and platforms, for their compatibility and effectiveness in meeting the project's objectives.
  - **Adopt a Flexible and modular approach:** Craft will do so in the context of the design and development of educational materials. This will allow for easier adaptation and integration with evolving technologies, ensuring that the materials remain compatible and effective.
  - **Collaborate with technology experts:** Craeft will foster collaboration with technology experts and researchers who specialize in the evolving tools and platforms and when possible, engage them in the project to provide insights, guidance, and technical support in adapting educational materials to new technologies.
- **O3.R2 - Quality and Relevance of Educational Materials:**
  - **Content validation and review:** Craeft will perform a content validation and review process involving craft practitioners, and educators. Furthermore, it will ensure in collaboration with them that the vocabulary, principles, techniques, and instructions provided in the educational materials are accurate, comprehensive, and up-to-date.
  - **User feedback and needs assessment:** Craeft will, during the evaluation, gather feedback from learners, educators, and craft practitioners to assess the quality and relevance of the educational materials. Furthermore, it will conduct regular needs assessments to

identify any gaps or areas for improvement and incorporate the feedback into the iterative development process.

- **Collaboration with craft communities:** Craeft will collaborate with craft communities to ensure that the educational materials meet their needs and align with industry standards. At the same time, it will request their input and insights to enhance the quality and relevance of educational material.

- **O3.R3 - Adoption and Integration Challenges:**
  - **Change management and training:** To cope with this issue, Craeft will adopt a change management strategy to address resistance to change and facilitate the adoption of new tools and technologies. This will be done both by involving experts in working with people and new technologies and by training and supporting educators to effectively use these new tools and integrate them into existing educational systems and practices.
  - **Alignment with curriculum and teaching methodologies:** Craeft will ensure that new educational tools align with the overall curriculum and teaching methodologies by collaborating with educators during the design and integration of new tools in existing teaching practices.
  - **Continuous support and professional development:** Craeft will offer ongoing support and professional development opportunities for educators to build their confidence and competence in using the new tools and technologies. To do so it will provide resources, training material and online workshops.
- **O3.R4 - Learning Effectiveness:**
  - **Learning objectives alignment:** In Craeft we should ensure that the digital educational experiences are aligned with the desired learning outcomes and objectives and design interactive simulations, explanatory materials, and learning activities that engage learners, and promote critical thinking, problem-solving, and continuous design principles.
  - **Formative and summative evaluation:** Craeft has defined a robust evaluation process to continuously assess the effectiveness of digital education and collect feedback from learners, educators, and craft practitioners to identify strengths, weaknesses, and areas for improvement. Such feedback will be employed to refine the educational materials and activities.
  - **Iterative improvement:** As part of the adopted UCD an iterative development process will allow Craeft to perform ongoing evaluation and refinement of the digital educational experiences to continuously monitor and analyse learning outcomes, make adjustments based on feedback, and implement improvements to enhance the learning effectiveness.
- **O3.R5 - Balancing Mistakes and Positive Feedback:**
  - **Constructive feedback mechanisms:** Craeft will integrate into the training tools feedback mechanisms that provide constructive guidance and support to trainees emphasizing the importance of learning from mistakes and providing actionable feedback that helps learners improve their skills and maintain motivation.
  - **Recognition and positive reinforcement:** Craeft systems will recognize and reinforce positive aspects of skill development providing opportunities for learners to celebrate their achievements, receive recognition for their progress, and showcase their work via the community portal.
  - **Peer collaboration and support:** Through the community portal Craeft will foster peer collaboration and support within the learning community encouraging learners to share their experiences, provide peer feedback, and learn from one another.
- **O3.R6 - Accessibility and Inclusivity:**

- **Universal design principles:** Craeft will apply universal design principles to ensure that digital educational materials are accessible and inclusive. Furthermore, it will consider diverse learning needs and abilities, including disabilities, limited internet connectivity, and technological constraints, during the design and development process.
- **Multiple formats and accessibility features:** Craeft will provide educational materials in multiple formats to accommodate different learning preferences and abilities. Incorporate accessibility features such as screen reader compatibility, text alternatives for visuals, and adjustable font sizes to enhance accessibility for learners with disabilities.
- **User testing and feedback:** Conduct user testing with a diverse group of learners to identify any accessibility barriers or usability issues. Gather feedback and insights from learners with different needs and abilities to inform iterative improvements that enhance the accessibility and inclusivity of digital educational materials.

- **O4.R1 - Technology Implementation and Usability:**
  - **User-centred design:** Craeft, when possible, will prioritize user-centred design principles to ensure the usability and user-friendliness of the training systems. Furthermore, during the pilots, it will conduct user testing and gather feedback from potential users, including craft practitioners and trainees, to identify and address any usability issues.
  - **Comprehensive training and support:** Provide comprehensive training and support for users who may be unfamiliar with the technologies involved, such as Virtual Reality (VR), Augmented Reality (AR), and haptic feedback systems. Offer tutorials, workshops, and user manuals to guide users through the training process and help them make the most of the technology.
  - **Technical issue resolution:** Craeft will establish a process for addressing potential technical issues promptly. This will involve having a dedicated technical support team to assist users during the pilots in troubleshooting problems and resolving technical issues.
- **O4.R2 - Realism and Immersion:**
  - **Haptic technology optimization:** Ensure high-quality haptic rendering that accurately replicates the tactile sensations required in craftwork. Craeft has experts in haptic technology to optimize haptic feedback systems, including realistic tool usage and simulation of material properties, to enhance the immersive training experience.
  - **Real-world relevance:** Design training simulations and exercises that closely mimic the complexity and nuances of actual craftwork. To this end, Craeft will incorporate real-world scenarios and challenges to facilitate skill development that translates effectively to real-world craft practice. Furthermore, it will continuously evaluate and refine the simulations based on feedback and observations in real craft contexts.
- **O4.R3 - Cost and Accessibility:**
  - **Cost-effective solutions:** Explore cost-effective options for the necessary hardware and software tools used in virtual training. This may involve leveraging open-source technologies, affordable equipment alternatives, or cloud-based platforms that reduce the need for extensive local hardware resources.
  - **Accessibility considerations:** Ensure that the training systems are accessible to all learners. Consider factors such as device compatibility, internet connectivity requirements, and any specific accessibility needs of the user base. Craeft will provide when possible, alternative access options, such as offline materials or compatibility with assistive technologies, to ensure inclusivity and reach a wider audience.
- **O4.R4 - Pedagogical Effectiveness:**
  - **Needs assessment and learner-centred design:** Craeft will conduct a needs assessment to understand the specific needs and learning preferences of the trainees in coordination

with the training organization that participates in the project. At the same time, Craeft will consider these needs while designing training experiences that align with these needs, incorporate engaging instructional strategies, and provide clear guidance. Foster social interaction among trainees to facilitate knowledge transmission and create a supportive learning environment.

  - **Formative evaluation and feedback:** Through the pilots, Craeft has implemented a feedback mechanism to gather input from trainees throughout the training process. Collect feedback on the effectiveness of the training exercises and simulations in developing attention, actuation skills, and social interaction. Use the feedback to make iterative improvements and optimize the pedagogical approach.

- **O4.R5 - Skill Transferability:**
  - **Realism and complexity of simulations:** Craeft will ensure that the training systems and exercises accurately replicate the complexity and nuances of real-world craftwork. Continuously evaluate and validate the training effectiveness in real craft contexts to verify knowledge and skill transferability. Adjust and refine the simulations as necessary to enhance their fidelity and effectiveness in facilitating seamless skill transfer.
- **O4.R6 - Engagement and Motivation:**
  - **Varied and interactive training experiences:** Craeft will design training experiences that are varied and interactive, offering different challenges and activities to maintain learner engagement. Incorporate gamification elements, such as rewards, achievements, and progression systems, to motivate learners and make the training process more enjoyable.
  - **Clear learning goals and progression pathways:** Craeft will provide learners with clear learning goals and a well-defined progression pathway. Furthermore, it will communicate the benefits and relevance of the training, and establish milestones or certifications to track progress. Regularly assess and provide feedback on trainees' performance to foster motivation and a sense of accomplishment.
- **O5.R1 - Technical Complexity and Tool Integration:**
  - **Technical expertise and collaboration:** Ensure that the project team possesses the necessary technical expertise to develop and integrate computer-aided digital design and fabrication tools. Collaborate with experts in the field to address technical challenges, ensure compatibility with existing design software and hardware, and manage data exchange between different tools effectively.
  - **Thorough testing and validation:** Conduct rigorous testing and validation of the developed tools to ensure their functionality, reliability, and compatibility with the Design Studio. Identify and address any technical issues or compatibility issues during the testing phase to minimize risks associated with tool integration.
  - **Seamless workflow design:** Design the workflow of the Design Studio to ensure a seamless transition between the design and fabrication stages. Streamline the data exchange process, automate repetitive tasks, and implement efficient communication protocols to maintain a smooth workflow throughout the entire process.
- **O5.R2 - Realism and Accuracy:**
  - **High-fidelity simulation:** Invest in technologies and techniques that enable the accurate representation and simulation of craft materials, tools, and objects. This may involve using high-resolution scanning methods, advanced visual/haptic rendering algorithms, and realistic illumination models. Strive for realism and accuracy in the virtual environment to provide designers with an authentic and informative design experience.
  - **User feedback and iteration:** Gather feedback from designers and craft practitioners on the realism and accuracy of the simulations and preview experiences. Incorporate their

input into iterative development cycles to improve the fidelity of the virtual representations. Continuously evaluate and refine the simulation techniques to align them with the desired level of realism and accuracy.

- **O5.R3 - Learning Curve and User Experience:**
  - **User-centred design:** Craeft will prioritize user-centred design principles when developing craft-specific 3D editing tools and computer-aided design tools. It is crucial to ensure that the software interfaces and workflows are intuitive, user-friendly, and aligned with designers' existing design processes. Conduct user testing and gather feedback to identify areas for improvement and make the necessary adjustments.
  - **Comprehensive documentation and support:** Craeft will develop and provide comprehensive documentation, tutorials, and user support to help designers navigate the learning curve associated with the new digital tools. Offer resources such as video tutorials, user manuals, and FAQs to assist designers in understanding and using the tools effectively. Offer responsive user support to address any questions or issues that arise during the transition.
- **O5.R4 - Material and Resource Optimization:**
  - **Workflow evaluation and optimization:** Continuously evaluate and refine the workflow implementation to ensure that using Craeft tools effective material and resource optimization can be achieved. Furthermore, Craeft needs to identify for each craft instance areas where the workflow can be streamlined, automate menial workflow parts, and integrate design-specific aids that contribute to material savings and streamlined processes.
  - **Accurate simulation of assets:** Craeft will develop accurate simulation models that enable realistic assessment and prediction of material usage, energy consumption, and workspace requirements. Ensure that the simulations accurately represent the physical properties and behaviours of materials used in craft processes. Validate the simulation models against real-world data to ensure their reliability and accuracy.
- **O5.R5 - Fabrication Challenges:**
  - **Collaboration with crafters that already employ digital fabrication technologies:** Craeft will collaborate with experts in fabrication technologies to address the challenges associated with translating virtual designs into appropriate formats for fabrication. Seek their guidance and expertise in ensuring the accuracy of the manufacturing process and overcoming limitations or complexities associated with specific materials or manufacturing techniques.
  - **Thorough testing and validation of the fabrication workflow:** Test and validate the making workflow to ensure its effectiveness and accuracy. Conduct extensive testing of the virtual-to-physical translation process and assess the quality and accuracy of the fabricated products. Make iterative improvements based on the testing results to minimize risks and enhance the reliability of the fabrication process.
- **O5.R6 - Alignment with Craft Interpretation and Workflow:**
  - **Involvement of craft practitioners and experts:** Involve craft practitioners and experts throughout the design process to gather their feedback and insights. Ensure that the digital design tools and simulations align with the craft-specific interpretation and workflow. Regularly validate the effectiveness of the tools through collaboration, feedback collection, and evaluation in real craft contexts. Incorporate the input and expertise of craft practitioners to refine and optimize the tools for capturing the essence of craft interpretation and enabling seamless workflow design.
- **O6.R1 - Certification and Skill Recognition:**

- **Collaboration with craft experts and industry associations:** Craeft will involve craft experts, industry associations, and relevant stakeholders in the development of certification programs on knowledge as a filter to further develop skills by practical earning. Their expertise and input will help define certification criteria, establish evaluation methods, and ensure alignment with sectorial standards and requirements.
- **Standardization and credibility:** Contribute towards the implementation of a certification process that ensures consistency, credibility, and recognition across different materials and learning approaches. Furthermore, Craeft will develop clear and transparent evaluation criteria to enhance the credibility of the certifications.
- **Continuous improvement and feedback:** Regularly review and update the certification programs based on feedback from craft practitioners, industry professionals, and other stakeholders. Continuously improve the evaluation methods and criteria to adapt to evolving craft practices and industry needs.

- **O6.R2 - Income Stream Diversification:**
  - **Effective online tutoring platforms:** Craeft will develop user-friendly and reliable online tutoring platforms and will prioritize features such as interactive learning tools to facilitate effective tutoring and skill-specific services.
  - **Quality assurance and technical assistance:** Craeft will ensure that craft practitioners receive high-quality feedback and technical assistance to enhance their tutoring services. Provide training tutorials to support tutors in delivering effective and engaging online sessions.
  - **Intellectual property rights protection:** Craeft will provide best practices to craft practitioners about intellectual property rights and guidelines on protecting their designs and techniques.
- **O6.R3 - Community Service:**
  - **Community Portal:** Craeft will develop a comprehensive and user-friendly Community Portal that facilitates the acknowledgement and registration of contributions within the craft community.
  - **Fair and transparent processes:** The project will ensure that peer review processes are fair, transparent, and inclusive.
  - **Intellectual property rights protection:** Craeft will establish mechanisms to protect the intellectual property rights of contributors within the community. Provide information and resources on copyright, trademarks, and licensing options. Raise awareness about the importance of intellectual property rights among community members.
- **O6.R4 - Sustainable Innovation:**
  - **Collaboration with sustainable design experts:** Collaborate with experts in sustainable design and environmental sustainability to integrate sustainable practices into traditional craft techniques. Leverage their knowledge and guidance to develop educational materials, workshops, and resources that promote sustainable innovation in craft practices.
  - **Compliance with regulations and certifications:** Stay updated on relevant regulations and certifications related to sustainable practices in the craft. Ensure compliance with environmental standards and promote the adoption of recognized sustainable certificates. Provide training and resources to help craft practitioners understand and implement sustainable practices effectively.
  - **Stakeholder engagement and partnerships:** Engage with funding agencies, government bodies, and relevant stakeholders to support sustainable craft innovation initiatives. Seek

partnerships with organizations that focus on sustainable development to access additional resources, expertise, and funding opportunities.

- **O6.R5 - Awareness and Promotion:**
  - **Content curation and management:** Develop effective strategies for managing and curating digital content collections related to European crafts. Ensure that the content is diverse, accurate, and representative of craft traditions and values. Regularly update and maintain the content to keep it relevant and engaging.
  - **Collaboration with regional authorities and tourism agencies:** Coordinate with regional authorities and tourism agencies to align promotional efforts and leverage existing platforms and networks. Collaborate on organizing digital exhibitions, craft events, and cultural showcases to reach a wider audience and attract tourism services.
  - **Targeted marketing strategies:** Develop targeted marketing campaigns to promote European crafts and identity. Utilize digital marketing channels, social media platforms, and partnerships with influencers or craft enthusiasts to increase awareness and reach potential customers. Tailor the marketing messages to highlight the unique qualities and cultural significance of European crafts.
- **O7.R1 - Risk of Digital Content Security:**
  - **Robust security measures:** Implement strong security protocols and encryption methods to protect the digital content associated with craft products. Use secure authentication mechanisms and access controls to prevent unauthorized access. Regularly update and patch software and systems to address security vulnerabilities.
  - **Data backups and redundancy:** Maintain regular backups of the digital content to ensure data resilience and recovery in case of security breaches or data loss. Implement redundant systems or distributed storage to minimize the impact of potential breaches.
  - **Monitoring and response:** Employ monitoring tools and techniques to detect and respond to potential security incidents promptly. Implement intrusion detection systems, monitor access logs, and conduct regular security audits to identify and address any security vulnerabilities or breaches.
- **O7.R2 - Intellectual Property Infringement:**
  - **Intellectual property protection mechanisms:** Establish mechanisms to protect the originality and ownership of the digital assets associated with craft products. This may include copyright registration, trademark protection, and licensing agreements. Educate craft practitioners on intellectual property rights and guide them on protecting their designs and digital content.
  - **Watermarking and digital rights management:** Implement techniques such as watermarking or digital rights management to deter unauthorized reproduction or copying of digital content. These measures can help identify the original content creator and track unauthorized usage.
  - **Legal enforcement:** Develop strategies to monitor and enforce intellectual property rights, including the use of legal measures when necessary. Regularly monitor online platforms, marketplaces, and social media channels for potential intellectual property infringements and take appropriate actions to protect the rights of content creators.
- **O7.R3 - Technical Challenges and Compatibility:**
  - **Thorough planning and testing:** Conduct thorough planning and testing to identify potential technical challenges and compatibility issues. Test the integration of digital dimensions with craft products in various scenarios to uncover and address any technical hurdles. Engage technical experts and consultants to ensure the successful integration and ongoing maintenance of the digital infrastructure.

- **Regular updates and maintenance:** Stay up to date with technological advancements and industry standards to ensure compatibility and address evolving technical challenges. Regularly update and maintain the digital platforms, software, and hardware to prevent system failures and address compatibility issues proactively.
- **Collaboration and partnerships:** Collaborate with technology providers, digital platform developers, and experts in the field to leverage their expertise and address technical challenges. Establish partnerships to share knowledge, resources, and best practices to ensure a robust and compatible digital infrastructure.

- **O7.R4 - User Acceptance and Adoption:**
  - **User-centred design:** Adopt a user-centred design approach to ensure that the digital content and interfaces associated with craft products are user-friendly, intuitive, and engaging. Conduct user research, usability testing, and feedback collection to understand user needs and preferences and incorporate their feedback into the design and development process.
  - **Clear communication of value:** Communicate the value and benefits of the digital content to customers. Highlight how it enhances their craft experience, provides additional information or customization options, or adds value to the overall product. Develop effective marketing strategies to educate and inform customers about the advantages of the digital dimensions.
  - **Training and support:** Provide adequate training and support to users to familiarize them with the digital dimensions and ensure a smooth adoption process. Offer tutorials, user guides, and online resources to help users understand and utilize the digital content effectively. Provide responsive customer support channels to address any user queries or concerns.
- **O7.R5 - Privacy and Data Protection:**
  - **Compliance with data protection regulations:** Ensure compliance with relevant data protection regulations, such as GDPR, when collecting, storing, and processing customer data. Obtain proper consent, implement privacy policies, and securely handle and protect personal information.
  - **Secure data storage and transmission:** Implement robust security measures to protect customer data, including secure data storage and transmission protocols. Use encryption techniques, secure servers, and secure connections (HTTPS) to safeguard customer information. Regularly update and patch systems to address security vulnerabilities.
  - **Transparent data practices:** Be transparent with customers about the collection, use, and protection of their data. Provide clear privacy policies and inform customers about how their data is handled. Allow customers to exercise their rights regarding their data, such as the right to access, correct, or delete their information.
- **O7.R6 - Quality Control and Misrepresentation:**
  - **Strict quality control processes:** Implement rigorous quality control processes to ensure that the digital representations accurately reflect the craft products. Conduct thorough testing and verification to identify and address any discrepancies between the physical product and its digital representation. Regularly update and refine the digital content to maintain its accuracy and quality.
  - **Feedback and user validation:** Gather feedback from customers and users to validate the accuracy and authenticity of the digital representations. Incorporate user feedback into the refinement process to address any misrepresentations or quality issues. Engage craft practitioners and experts to provide input and guidance on maintaining high-quality digital representations.

- **Clear product information:** Provide clear and accurate product information, including digital content, to set realistic expectations for customers. Communicate any limitations or variations between the physical product and its digital representation. Set clear guidelines and standards for craft practitioners to ensure the quality and consistency of the digital content associated with their products.

- **O7.R7 - Market Competitiveness:**
  - **Continuous innovation:** Foster a culture of continuous innovation within the craft industry. Encourage craft practitioners and designers to explore new digital dimensions and unique selling points to differentiate their craft products. Stay updated with market trends, customer preferences, and emerging technologies to identify opportunities for innovation. This should be carefully pursued by valorising differences and territoriality and educating consumers towards the value of craft products.
  - **Differentiation strategies:** Develop strategies to differentiate craft products with digital dimensions from competitors. Crafts that represent territoriality can benefit from digital innovation to modernise design (not changing and following trends) reinforce their visibility and optimise production costs. This may include offering unique customization options, integrating additional value-added services, or leveraging emerging technologies in creative ways. Continuously assess the market landscape and adapt strategies to maintain a competitive edge.
  - **Collaborations and partnerships:** Collaborate with complementary businesses or industries to expand market reach and create synergistic offerings. Form partnerships with technology providers, designers, or marketplaces to access new customer segments, tap into existing distribution channels, or leverage their expertise and resources to enhance competitiveness in the market.

6. Risk Monitoring and Review

In Craeft risk monitoring and review will be a continuous process. In this deliverable, the preliminary plan is presented which will be re-evaluated throughout the project. To this end during the project, we will make sure that the following activities will take place:

1. Monitoring and Review Schedule: Continuously and reported once per year.
2. Regular Risk Assessments to review the risks and validate their ongoing relevance and accuracy. When necessary, update risk assessments to reflect changes in the project context, stakeholder inputs, or emerging risks.
3. Maintain a Risk Register to document and track all identified risks, their assessments, and mitigation actions and regularly update the register with new risks, changes in risk assessments, and progress in mitigation actions.
4. Identify specific triggers or early warning signs associated with each risk that indicate its potential occurrence or escalation and establish mechanisms to monitor these triggers and promptly raise awareness when they are observed.
5. Review Risk Mitigation Measures to assess the effectiveness of the mitigation actions implemented for each risk. Identify any gaps or areas for improvement in the mitigation strategies and update them accordingly.
6. Review Risk Management Strategies, and determine if any adjustments or enhancements are necessary to improve the identification, assessment, and mitigation of risks. To this end, feedback from project team members, stakeholders, and external experts will be considered to enhance the risk management approach.
7. Engage with project stakeholders, including project team members, external experts, and relevant authorities, to gather insights and perspectives on risk management effectiveness.
8. Document the findings of risk monitoring and review activities, including any updates to risk assessments, mitigation actions, or risk management strategies and communicate them to the project team.
9. Continuously seek opportunities for improvement based on the outcomes of risk monitoring and review activities.

7. First Year Report

During the first year, we encountered the following difficulties.

7.1. Simulation resources

Within the framework of WP2, our consortium encountered challenges pertaining to computational resource limitations during the utilization of the Simulia Abaqus multi-physics simulator for simulating mechanical effects. Specifically, while the mechanical simulation of crafting actions was successfully executed, two primary issues were identified:

1. The computational speed for simulations on conventional computing systems is inadequate, rendering the direct application of these simulations impractical for real-time, interactive contexts.
2. The simulations generate outputs with substantial data volume, necessitating several gigabytes of storage even for depicting minor-scale phenomena.

It is essential to recognize that the simulations employed in our project are considerably more complex and comprehensive than the standard physics simulators integrated into game engines, which primarily focus on kinematic, inertial simulations, and collision detection. In contrast, our simulations incorporate a broader spectrum of variables, including material properties, temperature variations, deformations, and fluid dynamics, among others, thereby demanding greater computational resources.

In response to these challenges, our team has explored and is currently evaluating three potential solutions.

7.1.1. Precomputation

This approach involves the pre-calculation of all conceivable outcomes of a crafting action, which are subsequently stored. A Look-Up Table (LUT) is constructed to associate the parameters of user actions with the corresponding simulation outcomes. Based on the user action parameters, the LUT facilitates the rapid retrieval of the pertinent simulation result. Given the substantial size of the files containing the simulation results, high-speed storage solutions are employed to ensure timely access to precomputed data.

7.1.2. Machine learning

A neural network is trained using the precomputed simulation outcomes. This method eliminates the necessity for direct storage of results, as the neural network assimilates the data and correlates it with input action parameters. While this solution offers temporal efficiency and reduces storage requirements, it yields results that are approximate representations of the simulated outputs rather than precise analytical outcomes.

7.1.3. Use of GPU and simplification

Our team has employed an alternative physics simulator, specifically NVIDIA's PhysX, which significantly enhances computational parallelization. This enhancement is achievable through GPU-based simulation, as opposed to CPU reliance. Although PhysX does not match the versatility of Simulia Abaqus, it adequately supports the simulation of relevant phenomena and material properties. The limitation of this approach lies in its inability to simultaneously simulate intricate mechanical phenomena. However, a focus on fundamental, archetypal actions has facilitated the isolation and simplification of necessary simulation parameters for specific actions.

7.1.4. Conclusion

The selection of a suitable solution is contingent upon the specific requirements of each technical task. In scenarios with less stringent real-time demands, such as those encountered in Craeft Studio and craft education simulations, the strategy outlined in Section 7.1.3 is currently being implemented. Conversely, in the Apprentice Studio, the machine learning approach described in Section 7.1.2 is in use, with ongoing experiments exploring the efficacy of the solution detailed in Section 7.1.3.

7.2. Zenodo upgrade

As delineated in Document D2.2, the project is leveraging the European Commission-funded Zenodo platform for the storage of digital assets designated for Open Access. In particular, the project employs the Zenodo Application Programming Interface (API) to facilitate the integration of Zenodo as a linked repository. This strategic approach contributes to a reduction in storage costs, enhances the security of these assets, and promotes energy efficiency, concurrently enabling the ingestion of these data into Europeana via Zenodo, as elaborated in Document D2.2.

On the 13th of October, 2023, Zenodo underwent a significant upgrade of its core technical infrastructure to the InvenioRDM framework. This transition precipitated a modification in the conventions employed for file naming, which in turn are instrumental in generating Uniform Resource Locators (URLs) for the online access of digital assets. This modification rendered the pre-existing links within the Craeft Authoring Platform (CAP) obsolete, thereby disrupting their functionality. Furthermore, this issue extended to the associated links within Europeana, rendering them inoperative as well.

This challenge was non-trivial, as the adaptation to the new file naming convention could not be accomplished through a straightforward Find/Replace operation, owing to the increased complexity of the new convention.

To address this predicament, the team developed software capable of transforming the links stored within the CAP into the new format, adhering to the updated file naming convention. This solution was pivotal in restoring the functionality of the links and ensuring continued access to the digital assets.

7.3. ETH difficulty in hiring two disparate skills into one position

The consortium partner, ETH, encountered challenges in the recruitment of personnel for the Craeft project. The work specified for development by ETH comprises engineering contributions in hardware

technology, involving actuation, control, and mechanical assembly, as well as software contributions involving interactive systems, front-end applications, and 3D simulators. Since Craeft supports a single person for ETH's contributions, a single suitable candidate had to be identified who strikes a considerably rare balance across both deep hardware skills and software system engineering skills.

To mitigate this issue, ETH leveraged the expertise of multiple existing staff, which helped to offset the initial slow progress to a point that is ahead of schedule at this point. Subsequently, the recruitment process culminated successfully with the appointment of a staff member in February 2024. This addition is anticipated to further enhance the project's execution and contribute to the attainment of its objectives.

8. Conclusion

In conclusion, the risks identified in the deliverable related to the project's objectives and activities highlight various challenges and potential obstacles that need to be carefully managed and mitigated. These risks encompass technical complexities, data availability and quality, compatibility and integration issues, pedagogical effectiveness, skill transferability, engagement and motivation, content security, intellectual property infringement, technical challenges, user acceptance, privacy and data protection, quality control, misrepresentation, and market competitiveness.

To effectively address these risks, a comprehensive risk management plan is implemented. This plan includes proactive measures for risk identification, thorough risk assessment to understand the potential impact and likelihood of occurrence, and the development of appropriate risk mitigation strategies. Monitoring and review mechanisms are established to regularly assess the status of risks, track mitigation actions, and make necessary adjustments based on the evolving project landscape.

The risk management plan also emphasizes stakeholder engagement and collaboration, ensuring that all relevant parties are involved in the risk management process. This involvement can provide valuable insights, feedback, and support in addressing the identified risks.

Furthermore, continuous improvement is crucial for our risk management process in Craeft. Lessons learned from ongoing monitoring and review activities will and incorporated into future iterations of the risk management plan. This iterative approach will help refine risk management strategies and enhance the overall effectiveness of risk mitigation efforts.

We foresee that by effectively addressing and managing these risks, the project can mitigate potential negative impacts, enhance the likelihood of achieving its objectives, and ensure the successful delivery of the desired outcomes.