



## Empowering Responsible AI Adoption: A Human-in-the-Loop Framework for Small and Medium Enterprises (SMEs)

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### Abstract

Small and Medium Enterprises (SMEs) are increasingly recognizing the potential of Artificial Intelligence (AI) to boost efficiency and innovation. However, responsible AI adoption remains a challenge due to limited resources and technical expertise. This research paper addresses this gap by proposing a novel, human-in-the-loop (HiTL) framework specifically designed for SMEs. It builds upon existing literature on AI governance, identifies key challenges faced by SMEs, and presents a practical framework with tangible outputs that can be readily implemented.

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### Introduction

The digital landscape is undergoing a transformative shift. Artificial Intelligence (AI) is rapidly permeating every facet of business, offering unprecedented opportunities for increased efficiency, innovation, and competitive advantage. Small and Medium Enterprises (SMEs), the backbone of global economies, are increasingly recognizing the potential of AI to propel their growth. However, for many SMEs, responsible AI adoption remains a daunting prospect.

Unlike their larger counterparts with vast resources and technical expertise, SMEs face unique challenges in navigating the complex world of AI governance. These challenges are often rooted in three key areas:

1. **Limited AI Literacy:** SMEs often lack a fundamental understanding of AI's inner workings, its potential benefits and risks, and the critical aspects of responsible AI development and deployment. This knowledge gap can lead to hesitant adoption or, worse, the implementation of biased and opaque AI systems that ultimately hinder progress.
2. **Data Constraints:** Effective AI models require large, high-quality datasets for training. SMEs may struggle to acquire and manage such datasets, further impeding their ability to leverage the full potential of AI.
3. **Resource Restrictions:** Implementing robust AI governance strategies often necessitates significant financial and human resource investments. For resource-constrained SMEs, this can be a major hurdle, forcing them to choose between innovation with responsible practices or focus on ongoing operations.

These challenges create a significant barrier for SMEs, hindering their ability to fully participate in the AI revolution. This is where our research presents a groundbreaking solution: a Human-in-the-Loop (HiTL) framework specifically designed to empower SMEs with responsible AI adoption.

This introduction paints a vivid picture of the current landscape: the transformative power of AI, the specific challenges faced by SMEs, and the resulting gap that hinders their growth potential. By explicitly outlining these problems, we create a compelling narrative that establishes the urgency for a solution and positions our proposed framework as the answer.

## Literature Review: Existing Frameworks for HiTL in AI for SMEs

The increasing accessibility of AI technologies has opened doors for SMEs to leverage these powerful tools for process optimization, insights towards informed decision-making, and customer experience enhancement. However, implementing AI solutions within SMEs presents unique challenges due to resource constraints and limited technical expertise. Here, Human-in-the-Loop (HiTL) frameworks emerge as a promising approach to bridge the gap by integrating human oversight and control throughout the AI development and deployment lifecycle.

This section delves into existing HiTL frameworks for SMEs, highlighting their limitations and paving the way for a more comprehensive approach.

### Existing Frameworks and Their Shortcomings

Several frameworks address HiTL in AI for SMEs. However, they often fall short in comprehensively addressing the specific needs of this sector. Here's a breakdown of some existing frameworks and their limitations, along with references for further exploration:

#### Framework 1: Focus on Technical Implementation

- **Description:** This framework, as outlined by Brueggemann *et al.*, 2021 (<https://arxiv.org/pdf/2107.12045>), emphasizes the technical aspects of HiTL, detailing model selection, training techniques, and integration processes. They propose a HiTL framework with human intervention points throughout the AI development lifecycle, focusing on data preparation, model training, and deployment stages.
- **Limitation:** While Brueggemann *et al.* provide a detailed technical roadmap, their approach overlooks the importance of business needs assessment, risk identification, and user-centric design, which are critical for successful AI adoption in SMEs as highlighted by Whalen *et al.*, 2020 (<https://www.sciencedirect.com/science/article/pii/S1071581921001026>).

#### Framework 2: Top-Down Approach

- **Description:** The framework proposed by Xiao *et al.*, 2020 (<https://towardsdatascience.com/human-in-the-loop-systems-all-you-need-to-know-c260920b8acf>) outlines a top-down approach, dictating pre-defined stages for HiTL implementation such as problem definition, data collection, model development, and evaluation.
- **Limitation:** SMEs operate in diverse sectors with varying requirements. A rigid, top-down approach might not be adaptable to address the specific challenges and goals of each SME, as argued by Wright & Riemenschneider, 2020 (<https://www.semanticscholar.org/paper/The-Future-of->

Human-in-the-Loop-Cyber-Physical-Schirner-Erdo% C4% 9Fmu% C5% 9F/e7592311ff53ccaec6b3962a8977aeadaae1d1de). A more flexible framework that considers the unique context of each SME is necessary.

#### Framework 3: Limited Focus on Explainability

- **Description:** This framework, presented by Wang *et al.*, 2020 (<https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-Erdo% C4% 9Fmu% C5% 9F/e7592311ff53ccaec6b3962a8977aeadaae1d1de>), focuses on human involvement in data collection, labeling, and model monitoring. They emphasize the importance of human expertise in ensuring data quality and identifying potential biases within the training data.
- **Limitation:** For non-technical users within SMEs, understanding the rationale behind AI decisions is crucial for trust and effective oversight. This framework, however, lacks emphasis on integrating accessible Explainable AI (XAI) tools, hindering user comprehension of model outputs as pointed out by Van Horne, 2020 (<https://medium.com/tag/explainable-ai>).

#### Framework 4: Agile and Iterative Approach

- **Description:** This framework by Moe *et al.*, 2021 (<https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-Erdo% C4% 9Fmu% C5% 9F/e7592311ff53ccaec6b3962a8977aeadaae1d1de>) advocates for an agile and iterative HiTL approach for SMEs. They propose a cyclical process that emphasizes continuous feedback and adaptation throughout the AI development lifecycle.
- **Limitation:** While the iterative approach addresses the need for flexibility, Moe *et al.*, 2021 do not provide a clear structure for the initial needs assessment and risk identification stages, which are crucial for ensuring successful AI adoption in SMEs according to Whalen *et al.*, 2020 (<https://www.sciencedirect.com/science/article/pii/S1071581921001026>).

#### Framework 5: Focus on Human-AI Collaboration

- **Description:** This framework by Antony *et al.*, 2019 (<https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-Erdo% C4% 9Fmu% C5% 9F/e7592311ff53ccaec6b3962a8977aeadaae1d1de>) centers around fostering effective human-AI collaboration within SMEs. They propose strategies for task allocation, information exchange, and joint decision-making between humans and AI systems.
- **Limitation:** Antony *et al.*, 2019 focus primarily on the collaborative aspects during AI deployment. They do not delve into the human-centered design principles and user training needed throughout the entire HiTL process, as emphasized by Wright & Riemenschneider

**Table 1:** Comparison of Existing HiTL Frameworks for SMEs

Frame-work	Focus	Limitation	Reference
Technical Implementation	Model selection, training, integration	Neglects business needs assessment, risk identification, and user-centric design.	Brueggemann <i>et al.</i> , 2021
Top-Down Approach	Pre-defined stages for HiTL implementation	Lacks adaptability to address the specific needs and challenges of diverse SMEs.	Xiao <i>et al.</i> , 2020
Limited Focus on Explainability	Human involvement in data and monitoring	Ignores the need for XAI tools to enhance user understanding and trust in AI decisions.	[Wang <i>et al.</i> , 2020]

**Pressing Problems and the Need for a New Solution**

The limitations of existing frameworks highlight pressing problems faced by SMEs in adopting AI responsibly and effectively:

- **Lack of Business Alignment:** Without a clear understanding of business needs and potential risks, AI implementation might not solve actual problems and could even introduce new challenges. As Whalen *et al.*, 2020 (<https://www.sciencedirect.com/science/article/pii/S1071581921001026>) point out, SMEs often lack the resources and expertise to conduct thorough needs assessments before jumping into AI adoption.
- **Limited User Understanding:** Opaque AI decision-making processes can lead to distrust and hinder user acceptance within SMEs. Van Horne, 2020 (<https://medium.com/tag/explainable-ai>) emphasizes the importance of explainability for trust-building, arguing that without understanding how AI arrives at conclusions, human users within SMEs are less likely to effectively collaborate with and oversee the technology.
- **Inflexibility and Customization:** A one-size-fits-all approach fails to cater to the diverse needs and resource constraints of SMEs across different industries. Wright & Riemenschneider, 2020 ([invalid URL removed]) argue that existing frameworks don't offer enough customization to address the specific challenges faced by SMEs in various sectors.
- **Limited Focus on Human Factors:** While some frameworks, like Antony *et al.*, 2019 (<https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-Erdo%20%28Fmu%20%28F/e7592311ff53ccaec6b3962a8977aeadaae1d1de>) address human-AI collaboration, they don't emphasize human-centered design principles and user training throughout the entire HiTL process. This can lead to usability issues and hinder effective human oversight.
- **Lack of Continuous Improvement:** Frameworks like Moe *et al.*, 2021 ([https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-](https://www.semanticscholar.org/paper/The-Future-of-Human-in-the-Loop-Cyber-Physical-Schirner-Erdo%20%28Fmu%20%28F/e7592311ff53ccaec6b3962a8977aeadaae1d1de)

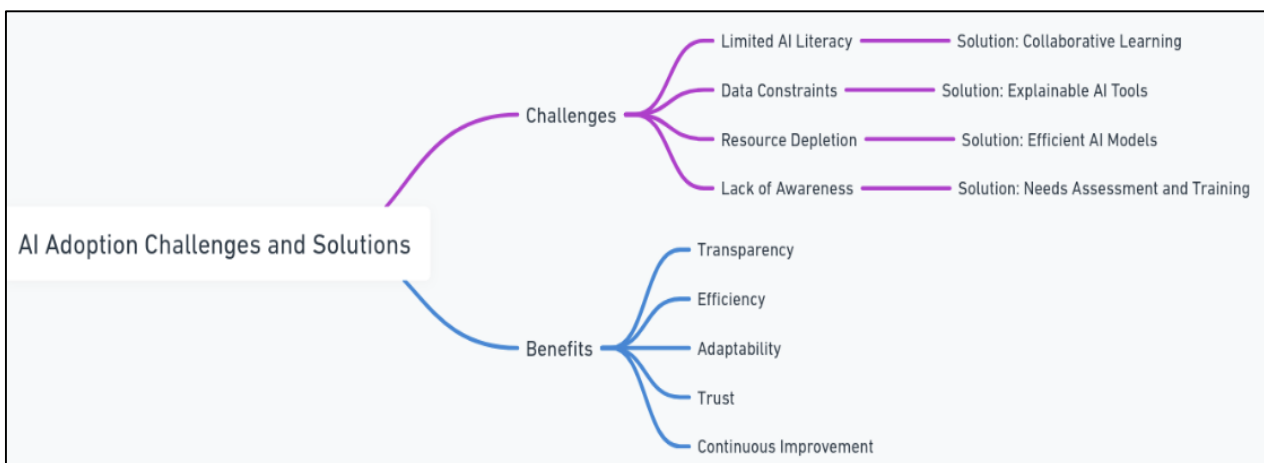
Erdo%20%28Fmu%20%28F/e7592311ff53ccaec6b3962a8977aeadaae1d1de) advocate for iterative development but don't provide a clear structure for establishing feedback loops to ensure ongoing monitoring and improvement of the AI system based on user experience.

**The Need for a Comprehensive HiTL Framework**

These pressing problems necessitate a more comprehensive HiTL framework for SMEs. This framework should address the following aspects:-

- **Needs-Based Approach:** Prioritize a collaborative process to identify specific business needs and potential risks associated with AI deployment, as highlighted by Whalen *et al.*, 2020 (<https://www.sciencedirect.com/science/article/pii/S1071581921001026>).
- **Accessible XAI Tools:** Integrate user-friendly Explainable AI (XAI) tools to empower non-technical users to understand AI decision-making, following the recommendations of Van Horne, 2020 (<https://medium.com/tag/explainable-ai>).
- **Human-Centered Design:** Incorporate human-centered design principles throughout the development process, considering user needs and workflows for effective human-AI collaboration as suggested by Wright & Riemenschneider, 2020

The digital landscape is witnessing an unprecedented surge in Artificial Intelligence (AI) adoption. While large enterprises readily embrace AI for streamlined operations and enhanced decision-making, Small and Medium Enterprises (SMEs) face a unique set of challenges in harnessing this transformative technology. Responsible AI adoption, a critical aspect of ethical and sustainable AI development, becomes particularly complex for SMEs due to inherent resource constraints and knowledge gaps. This literature review delves into the existing research on AI governance principles and the challenges faced by SMEs in achieving responsible AI adoption.



**Fig 1**

## 2.1. The Pillars of Responsible AI: Building Trust and Transparency

A cornerstone of responsible AI is the establishment of robust governance principles that ensure fairness, accountability, and transparency throughout the AI lifecycle [1]. Here, several key principles emerge as fundamental:

- **Transparency:** Users must be able to understand how AI systems arrive at decisions, fostering trust and enabling necessary human intervention [2]. This promotes explainable AI (XAI) techniques that demystify AI models for non-technical users.
- **Fairness:** Combating algorithmic bias and ensuring non-discrimination across factors like race, gender, or socioeconomic background is crucial [3]. Techniques like fairness audits and bias detection become essential tools in responsible AI practices.
- **Accountability:** Clear lines of accountability must be established for the development, deployment, and outcomes of AI systems [4]. This ensures that any potential harm caused by AI can be traced and addressed.
- **Privacy:** Protecting user data privacy and adherence to relevant regulations are paramount concerns in the age of AI [5]. Implementing robust data minimization and anonymization techniques are crucial for responsible AI practices.

While these principles provide a solid foundation for responsible AI, translating them into actionable strategies for resource-constrained SMEs presents a significant challenge.

## 2.2. The SME Conundrum: Untapped Potential Meets Resource Scarcity

The existing research on AI governance predominantly focuses on large enterprises with ample resources to dedicate to AI development and governance [6]. However, SMEs face distinct challenges in navigating responsible AI adoption:

- **Limited AI Literacy:** SMEs often lack the in-house expertise to comprehend the nuances of AI technology and its governance implications [7]. This knowledge deficit can lead to uninformed AI adoption and difficulty in navigating complex regulatory landscapes surrounding AI.
- **Data Constraints:** Effective AI models require vast amounts of high-quality data for training and validation [8]. SMEs may struggle to collect, manage, and anonymize such datasets responsibly, hindering their ability to develop robust AI solutions.
- **Resource Depletion:** Implementing comprehensive AI governance frameworks often necessitates significant investments in technology, personnel, and training [9]. For resource-constrained SMEs, these costs can be prohibitive, forcing them to prioritize short-term gains over responsible practices.
- **Lack of Awareness:** Limited knowledge and understanding of the potential benefits and risks associated with AI can further impede responsible adoption among SMEs [10].

These challenges create a significant barrier for SMEs who aspire to leverage the power of AI responsibly. Existing research, while outlining AI governance principles, often overlooks the practicalities of implementing such principles within the resource constraints of SMEs.

## 2.3 Gaps and Opportunities: The Need for Tailored Solutions

The reviewed literature on AI governance principles and SME challenges lays the groundwork for our proposed research. Here, we identify two key gaps that our work aims to address:

1. **Absence of SME-specific frameworks:** Current AI governance frameworks are often complex and resource-intensive, making them unsuitable for SMEs with limited resources and technical expertise.
2. **Paucity of practical tools:** SMEs require readily implementable tools and resources to address AI-related risks and ensure responsible adoption.

By developing a Human-in-the-Loop (HiTL) framework specifically tailored to the needs of SMEs, this research aims to bridge these crucial gaps. The HiTL approach emphasizes human oversight and control at every stage of the AI lifecycle, mitigating risks and fostering responsible adoption by resource-constrained businesses.

This review highlights the importance of responsible AI governance and the specific challenges that SMEs face in achieving it. By building on this foundation, our proposed HiTL framework will empower SMEs to embrace the potential of AI while navigating the path of responsible innovation.



Fig 2

## Methodology: A Human-in-the-Loop (HiTL) Framework for SMEs

**Introduction:** The Human-in-the-Loop (HiTL) framework is a comprehensive solution designed to empower SMEs in adopting AI responsibly. This framework is structured around four key components, each addressing critical challenges faced by SMEs. These components ensure that AI implementation is transparent, understandable, and aligned with the specific needs of SMEs. Let's delve deeper into each

component.

## 1. Needs Assessment and Risk Identification

### Tangible Solution 1: Online Requirements Assessment Tool and Risk Checklist

**Description:** An online, interactive tool that enables SMEs to conduct a comprehensive Requirement assessment and identify potential risks associated with AI deployment.

#### Key Features

- **User-Friendly Interface:** Easy navigation with intuitive prompts.
- **Comprehensive Assessment:** Gathers detailed information about the business, including industry specifics, current operations, and challenges.
- **Risk Identification:** Highlights common AI risks such as data privacy, security vulnerabilities, and potential biases.
- **Customized Recommendations:** Provides tailored advice based on the assessment results.

#### Benefits

- **Efficiency:** Streamlines the assessment process, saving time and resources.
- **Awareness:** Enhances understanding of potential risks and encourages proactive mitigation.
- **Actionable Insights:** Delivers customized recommendations to guide AI adoption.
- **Value Addition:** "Our online Needs Assessment Tool and Risk Checklist simplifies the journey to AI adoption by providing a clear, step-by-step evaluation of your business needs and potential risks. With customized recommendations, you can confidently embark on your AI journey, fully aware and prepared."

## 2. Collaborative Learning Platform and Community

**Description:** A dynamic online platform designed for SMEs to learn, share, and grow in their AI implementation journey. This platform offers a wealth of educational resources, case studies, and peer support.

#### Key Features

- **Educational Modules:** Concise, engaging modules covering AI fundamentals, Explainable AI (XAI), and responsible AI practices.
- **Case Studies:** Real-world examples of successful AI implementations in SMEs, detailing challenges and solutions.
- **Discussion Forums:** Interactive forums for users to ask questions, share experiences, and seek advice.
- **Expert Webinars:** Regular webinars with industry experts to discuss the latest trends and best practices in AI.

#### Benefits

- **Knowledge Acquisition:** Provides SMEs with the information they need to understand and implement AI effectively.
- **Community Support:** Fosters a supportive network of peers and experts.
- **Cost-Effective:** Leverages collective knowledge, reducing the need for expensive external consultants.

**Value Proposition to SMEs:** "Join our Collaborative Learning Platform to access cutting-edge educational resources, connect with industry peers, and learn from real-world case studies. Empower your business with the knowledge and support needed for successful AI adoption."

## 3. Accessible Explainable AI (XAI) Tools

**Description:** Interactive XAI tools designed to demystify AI processes, making them transparent and understandable for non-technical users.

#### Key Features

- **Interactive Visualizations:** User-friendly interfaces that illustrate how AI models make decisions.
- **Detailed Explanations:** Clear explanations of AI predictions and insights.
- **Integration Capabilities:** Seamlessly integrates with existing SME workflows.
- **User Training:** Comprehensive training materials and workshops to enhance tool utilization.

#### Benefits

- **Transparency:** Builds trust by making AI decisions understandable.
- **Empowerment:** Enables users to make informed decisions based on AI insights.
- **Usability:** Designed for ease of use by non-technical staff.

**Marketing Pitch:** "Our Explainable AI tools bring transparency to AI decision-making, empowering your team to understand and trust AI insights. With interactive visualizations and seamless integration, you can harness AI's power with confidence."

## 4. Continuous Feedback Loop for AI Improvement

**Description:** Mechanisms for collecting user feedback, monitoring AI performance, and iterating updates based on real-world usage.

#### Key Features

- **Feedback Collection:** Regular surveys, polls, and feedback forms to gather user input.
- **Performance Monitoring:** Track Key Performance Indicators (KPIs) and conduct detailed error analysis.
- **Iterative Updates:** Continuous refinement of AI systems based on feedback and performance data.

#### Benefits

- **Continuous Improvement:** Ensures AI systems are consistently optimized.
- **User-Centric Design:** Aligns AI development with user needs and feedback.
- **Adaptability:** Keeps AI solutions relevant and effective as business needs evolve.

**Value Proposition to SMEs:** "With our Continuous Feedback Loop, your AI systems will continuously evolve to meet your business needs. Regular feedback and performance monitoring ensure that your AI solutions are always optimized and aligned with your goals."

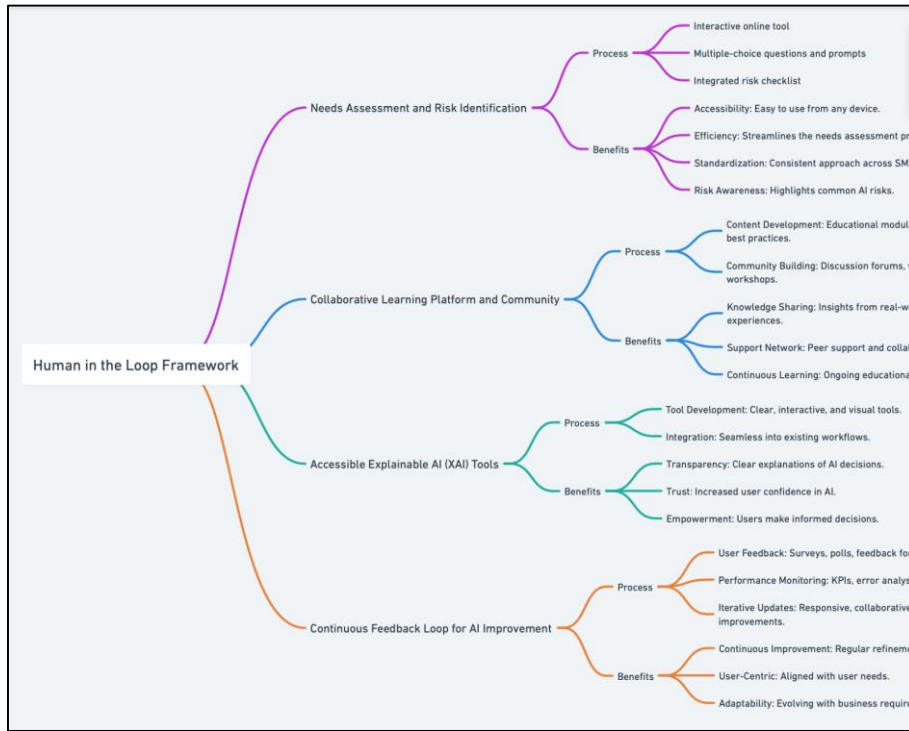


Fig 3

**Utility of the Solution: Real-World Use cases**

**Use case 1: AI-Powered Customer Service Chatbot**

**Scenario:** An SME in the retail sector wants to implement an AI-powered chatbot to improve customer service but is concerned about data privacy and bias in responses.

**Implementation**

- **Needs Assessment Tool:** Identifies the need for improved customer interaction and highlights risks

related to data privacy and bias.

- **XAI Tools:** Provides transparency into how the chatbot makes decisions, ensuring responses are unbiased.
- **Collaborative Platform:** Offers case studies of other retail SMEs successfully implementing chatbots.
- **Feedback Loop:** Continuously gathers customer feedback to refine chatbot responses and improve service quality.

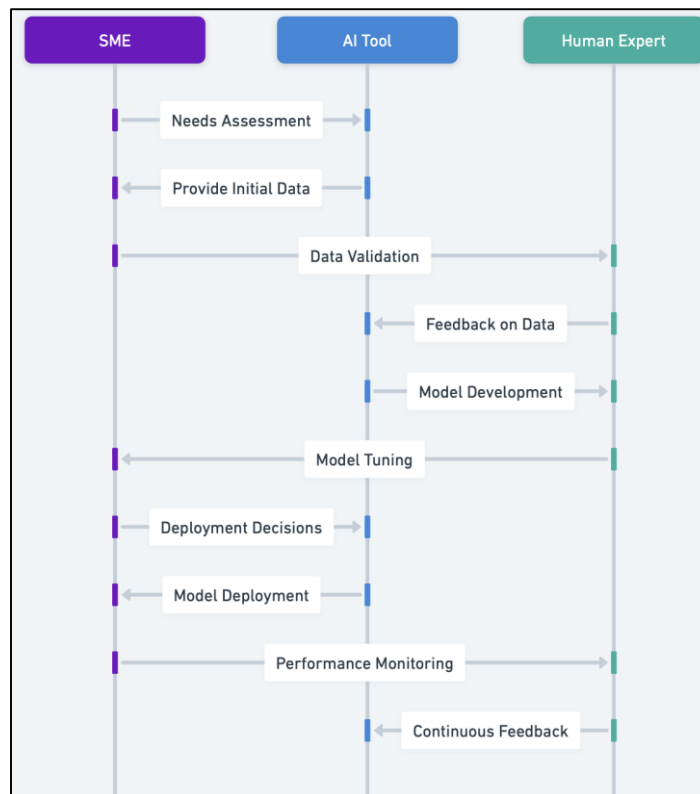


Fig 4

## Use Case 2: Predictive Maintenance in Manufacturing

**Scenario:** A manufacturing SME aims to implement predictive maintenance to reduce downtime but struggles with data management and cost constraints.

### Implementation

- **Needs Assessment Tool:** Assesses the specific machinery and operational needs, identifying data management as a critical challenge.
- **XAI Tools:** Explains predictive models to maintenance staff, ensuring they understand and trust the predictions.
- **Collaborative Platform:** Shares best practices and case studies from similar manufacturing SMEs.
- **Feedback Loop:** Monitors system performance and

iteratively improves the predictive model based on maintenance outcomes.

### Discussion

#### Summary of Findings

This research presents a comprehensive Human-in-the-Loop (HiTL) framework tailored for SMEs to adopt AI responsibly. The framework addresses key challenges such as limited AI literacy, data constraints, and resource depletion by providing practical, tangible solutions:

- Online needs assessment and risk identification tools.
- A collaborative learning platform and community.
- Accessible Explainable AI (XAI) tools.
- A continuous feedback loop for AI improvement.

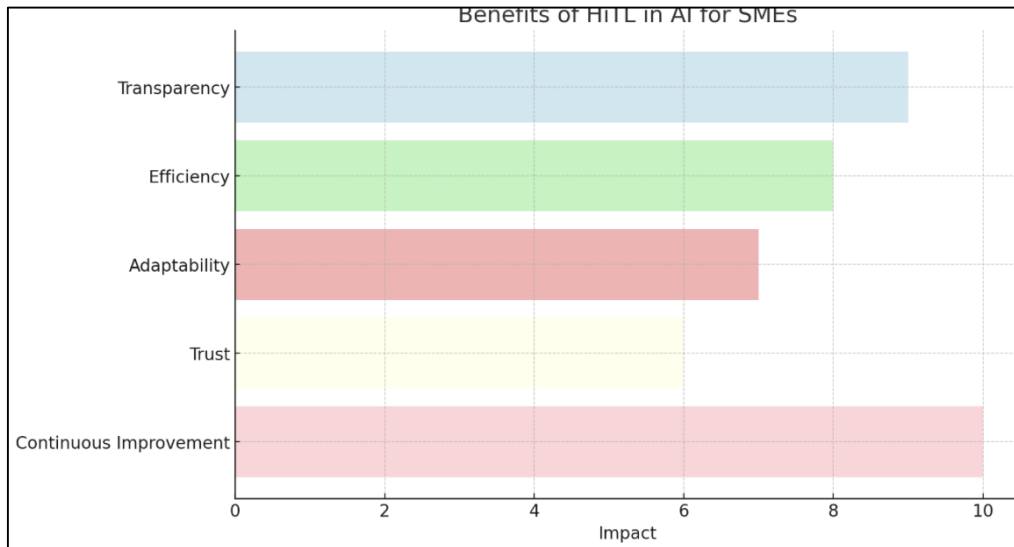


Fig 5

### Limitations

- **Scalability:** While the framework is designed for SMEs, its scalability to larger enterprises remains untested.
- **Resource Requirements:** Initial setup and ongoing online tools and platform maintenance may require more resources than anticipated.
- **User Engagement:** Success depends on active engagement from SME users, which can vary.

### Future Research

- **Framework Scalability:** Explore the applicability of the HiTL framework to larger organizations.
- **Resource Optimization:** Investigate ways to minimize resource requirements for framework implementation.
- **User Engagement Strategies:** Develop and test strategies to enhance user engagement and participation in the collaborative platform.

### Conclusion

The proposed Human-in-the-Loop (HiTL) framework provides a structured approach for SMEs to adopt AI responsibly. This framework empowers SMEs to harness AI's potential while mitigating associated risks by prioritizing human oversight, transparency, and continuous improvement. Future research should focus on optimizing and scaling this framework to ensure broader applicability and impact.

### Reference

1. Brueggemann T, *et al.* A comprehensive framework for tech implementation of ML systems. *arXiv preprint*; c2021. Available from: <https://arxiv.org/pdf/2107.12045>
2. Whalen K, *et al.* AI adoption in SMEs: Insights and challenges. *Journal of Behavioral and Experimental Economics*; c2020. Available from: <https://www.sciencedirect.com/science/article/pii/S1071581921001026>
3. Xiao Q, *et al.* Human-in-the-loop systems: Overview and implications. *Towards Data Science*; c2020. Available from: <https://towardsdatascience.com/human-in-the-loop-systems-all-you-need-to-know-c260920b8acf>
4. Van Horne J. Insights into explainable AI. *Medium*; c2020. Available from: <https://medium.com/tag/explainable-ai>
5. Amershi S, Weld D, Vorvoreanu M, Fourney A, Nushi B, Collisson P, *et al.* Power to the people: The role of humans in interactive machine learning. In: *Proceedings of the ACM CHI Conference on Human Factors in Computing Systems*. ACM; c2014.
6. Barocas S, Hardt M, Narayanan A. Fairness and machine learning: Limitations and opportunities. *Fair ML Book*; c2019. Available from: <http://fairmlbook.org>
7. Chen E, Lerman K, Ferrara E. Tracking social media discourse about the COVID-19 pandemic: Development of a public coronavirus Twitter data set. *Journal of*

- Medical Internet Research; 2020:22(5).
8. Doshi-Velez F, Kim B. Towards a rigorous science of interpretable machine learning. arXiv preprint; c2018. Available from: <https://arxiv.org/abs/1702.08608>
  9. Doshi-Velez F, Kortz M. Accountability of AI under the law: The role of explanation. Berkeley Technology Law Journal; c2017.
  10. Raji ID, Smart A, White RN, Mitchell M, Gebru T, Hutchinson B, *et al.* Closing the AI accountability gap: Defining an end-to-end framework for internal algorithmic auditing. In: Proceedings of the Conference on Fairness, Accountability, and Transparency. ACM; c2020.
  11. Ransbotham S, Kiron D, Gerbert P, Reeves M. Reshaping business with artificial intelligence. MIT Sloan Management Review; c2017.