

Towards A Human-AI Collaboration Maturity Model for Small and Medium-Sized Enterprises

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COLORADO STATE UNIVERSITY



AGENDA

PART 1 CONCEPTS OF A MATURITY MODEL
RESEARCH MOTIVATION

PART 2 IDENTIFIED GAPS & CHALLENGES

PART 3 RESEARCH OBJECTIVES
DEVELOPING THE HAIC MATURITY MODEL

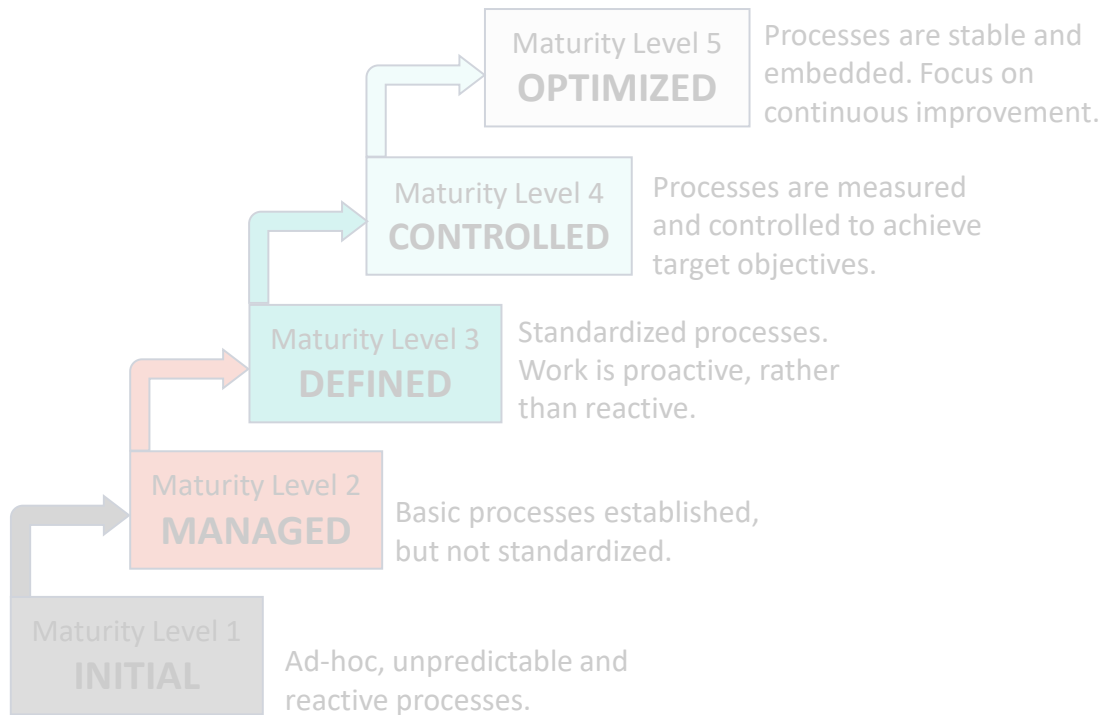
PART 4 STRATEGIES FOR VALIDATING THE MODEL
SURVEY ANALYSIS & RESULTS
RESEARCH CONTRIBUTION

UNDERSTANDING CAPABILITY MATURITY MODELS

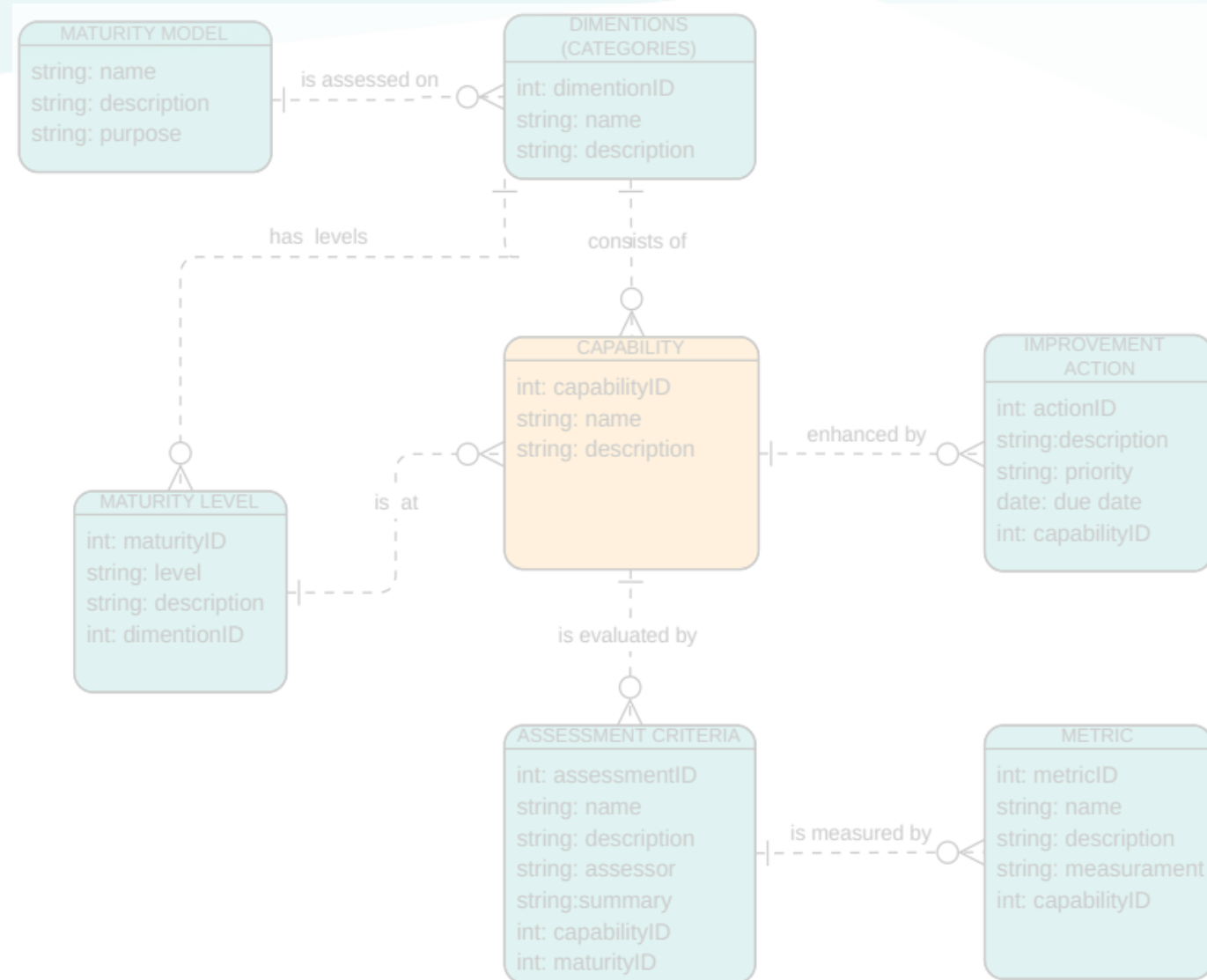
CONCEPTUAL MATURITY FLOW AND BASIC STRUCTURE

Conceptual Maturity Flow

The maturity level indicates how well a functional area, system or process within an organization is doing.



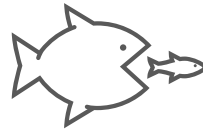
Entity Relationship Diagram (structure)



THREE KEY MOTIVATIONS



Humans & AI
working together



Small & Medium-
Sized Enterprises



SERC's SE
ROADMAPS

MOTIVATION AND RESEARCH BACKGROUND

HUMANS & AI WORKING TOGETHER: THE MISSING MIDDLE



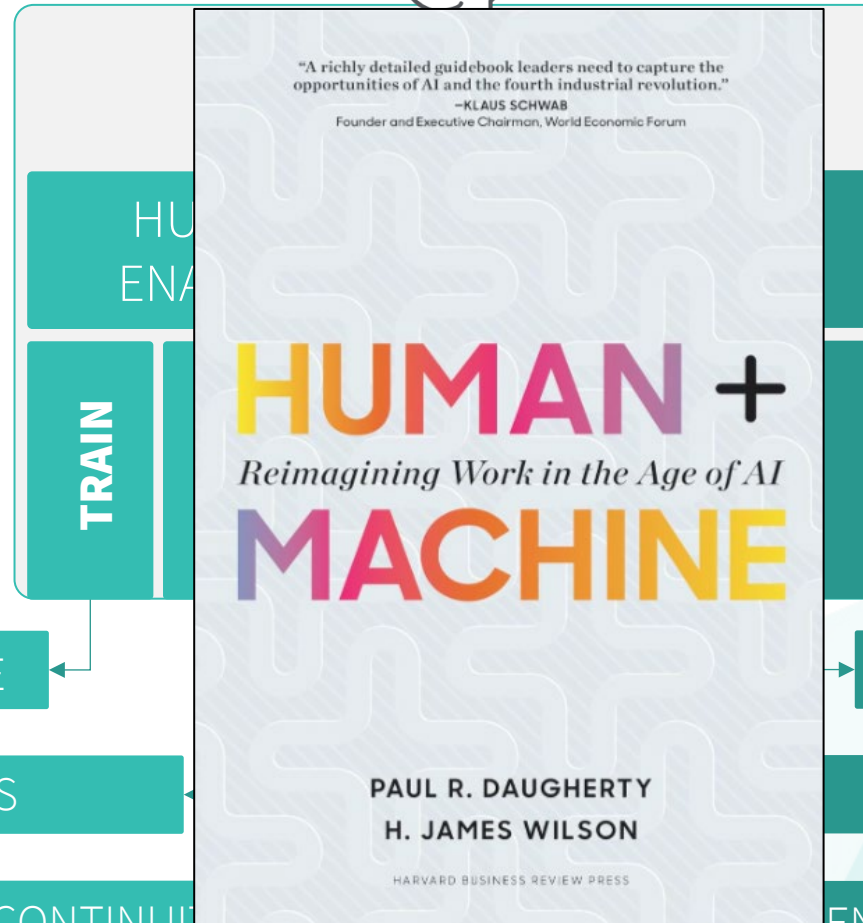
HUMAN-ONLY ACTIVITY

LEAD

IMPROVISE

CREATE

JUDGE



MACHINE-ONLY ACTIVITY

TRANSACTION

DETECT

PREDICT

OPTIMIZE

HUMANS TRAIN AI FOR PERFORMANCE

HUMANS CLARIFY AI'S DECISIONS

HUMANS ENSURE AI'S CONTINUITY

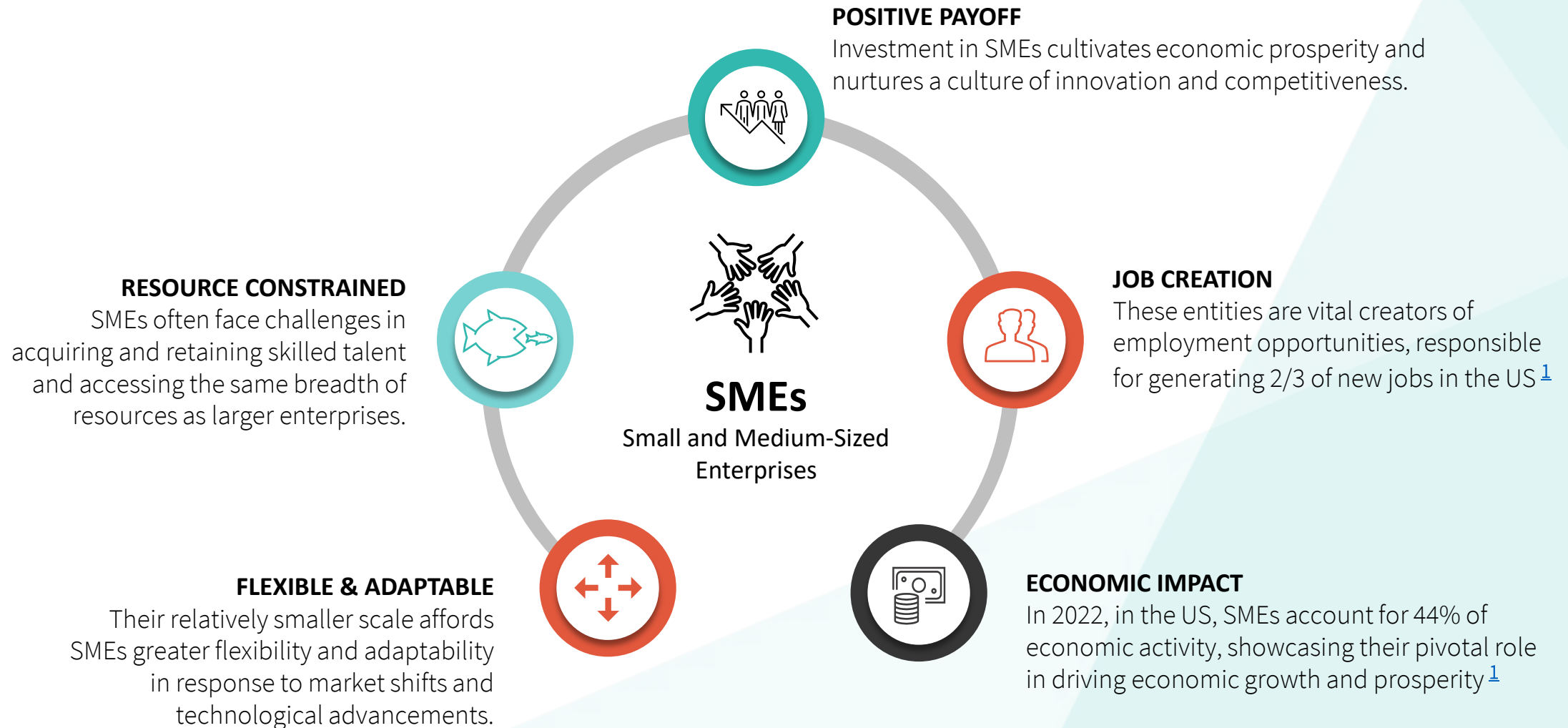
AI PERFORMS PHYSICAL TASKS

AI GIVES UI PERSONALITY

AI AUGMENTS WITH POWERFUL INSIGHTS

MOTIVATION AND RESEARCH BACKGROUND

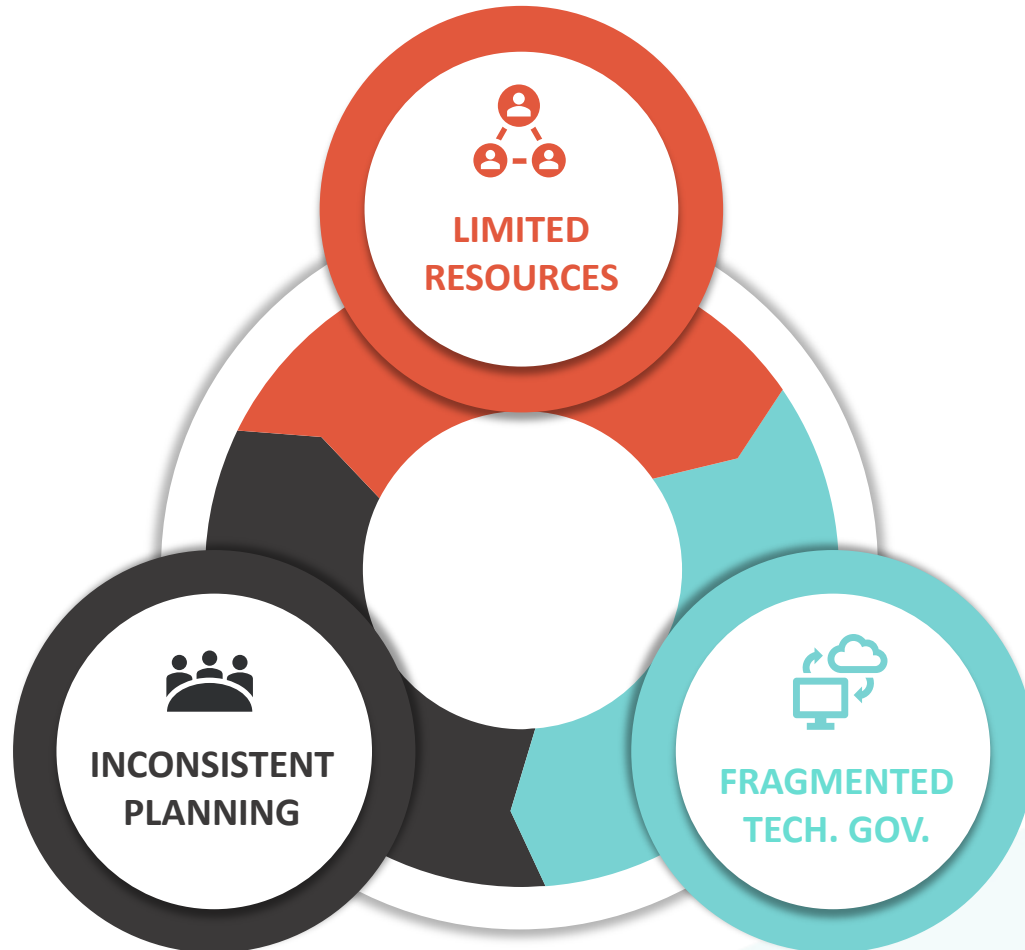
WHY FOCUS ON SMALL AND MEDIUM-SIZED ENTERPRISES (SMEs)



MOTIVATION AND RESEARCH BACKGROUND

LEADERSHIP CHALLENGES: WHY MATURITY MODELS MATTER TO SMEs

THE SME CHALLENGE TRIFECTA



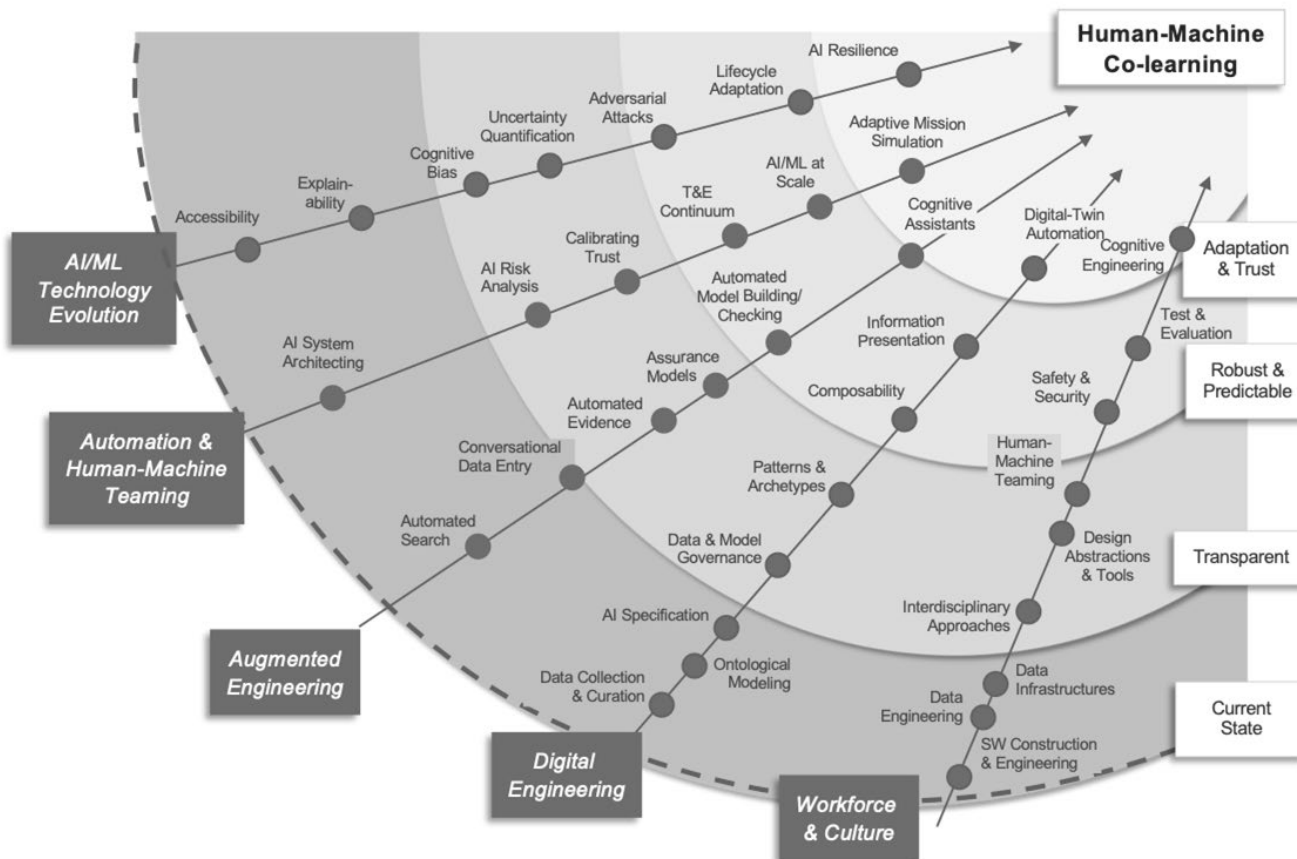
MATURITY MODELS ADDRESSING THIS CHALLENGE:

- **Resource Management**
 - Evaluates and maximizes technology investments & needs
 - Improves the dynamics between technology & workforce
 - Optimizes operational processes for higher productivity
 - Uncover skill gaps and professional development needs
- **Planning**
 - Provides structured guidance for measuring improvement
 - Pinpoints key areas and functions for strategic investment
 - Aligns daily operations with long-term objectives
 - Improves talent acquisition & retention rates
- **Technology Governance**
 - Enhances decision-making for adopting new technology
 - Provides a framework to help manage IT resources
 - Helps manage risk during tech deployment and operations

MOTIVATION AND RESEARCH BACKGROUND

THINKING IN TERMS OF SKILLS AND COMPETENCIES OVER JOB TITLES

ALIGNMENT WITH SERC'S ROADMAPS



SERC RESEARCH ROADMAP – AI & AUTONOMY (sercuarc.org)

Rethinking systems engineering talent requires grasping how AI will transform the stages within the execution path

RE-EVALUATING THE EXECUTION PATH:

- 1. Impact on Product Development:** Gen AI significantly accelerates design, coding, documentation, testing, and more complex tasks
- 2. New Skills Required:** Engineers need skills in code review, integration of AI models, and design thinking.
- 3. Evolving Roles:** Roles may merge or require new responsibilities, emphasizing flexibility in talent management

GAPS FOUND IN THE LITERATURE REVIEW

MISSING PIECES AND IDENTIFIED OPPORTUNITIES

01

MINIMAL FOCUS ON HUMAN-AI COLLABORATION DYNAMICS

The literature review revealed a gap in exploring the effective collaboration between humans and AI systems at the workplace.

03

MINIMAL FOCUS ON TRAINING STAFF FOR AI-READINESS

There was limited discussion on the importance of preparing staff for AI adoption and usage, including reskilling and upskilling.

05

LIMITED ASSESSMENT OF ETHICAL IMPLICATIONS OF AI

Transparency and fairness in AI decision-making were inconsistently addressed. Principles of trust not consistent.

02

LIMITED COVERAGE ON DIGITAL CAPABILITIES IN SMEs

Research lacked depth on enhancing SMEs' digital and technical capabilities for AI adoption / integration.

04

LEADERSHIP'S LIMITED ROLE IN DRIVING AI INITIATIVES

Leadership's impact on the success of AI initiatives in organizations was inadequately addressed.

06

INSUFFICIENT GUIDANCE ON DATA PRIVACY BEST-PRACTICES

Some direction was found in many but not all models regarding maintaining data security, privacy and data protection standards.

RESEARCH OBJECTIVES

CHARTING THE COURSE FOR A HUMAN-AI COLLABORATION MATURITY MODEL



OBJECTIVE

RESEARCH OBJECTIVES:

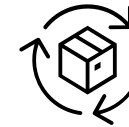
1. Develop a comprehensive Human-AI Collaboration Maturity Model that provides step-by-step guidance for SMEs
2. Address literature gaps by focusing on SME-specific challenges in leadership, Resources constraints and IT governance and mgmt.



ACTION PLAN

RESEARCH STRATEGY:

1. Design the HAIC Model following proven methodologies
2. Validate the model through surveys and focus groups of SME stakeholders
3. Pilot-test the new model in real-world SME settings for further feedback and refinement



OUTCOME

RESULTS AND DELIVERABLES:

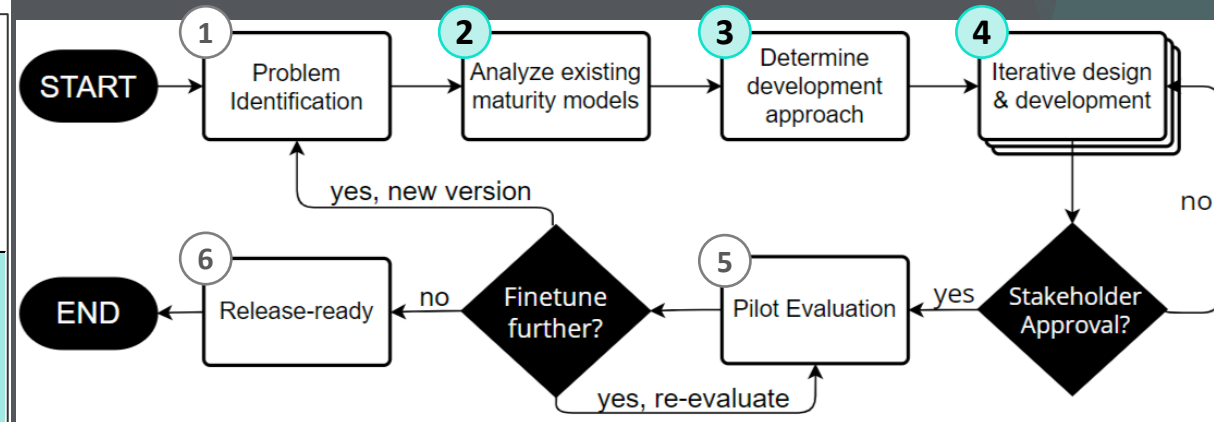
1. Gain academic insights on human-AI collaboration, the role of leadership in driving AI initiatives, AI ethics and trust within the SME landscape.
2. An Excel Worksheet tool designed to streamline the application and evaluation of the HAIC Model within SME operations

MATURITY MODEL DEVELOPMENT

DEVELOPMENT FRAMEWORKS EVALUATED

Framework	Phases	Validation Rigor	Multidisciplinary Participation	Adaptability	Practical Approach	Balanced Perspectives	Technical Focus	Notes
Becker et al.	1. Problem definition, 2. Analyze models, 3. Dev. Strategy. 4. Iterative design and development. 5. Pilot evaluation, iterative improvement, 6. Release-ready	High	Moderate	Moderate	Moderate	Moderate	Low	Selected Framework: Balances rigorous validation with accessibility, suited for iterative, feedback-driven development.
De Bruin et al.	1. Scope, design components. 2. Populate measures. 3. Model testing and deployment. 4. Maintenance	High	Low	Low	Moderate	Moderate	Low	Similar validation as Becker, but less focus on iterative feedback.
Salviano et al.	1. Initial decisions, design architecture. 2. Model development. 3. Validation. 4. Consolidation	Moderate	High	Moderate	Low	Low	Low	Strong in multidisciplinary participation, less in adaptability and accessibility.
Mettler & Rohner	1. Identify problems, define goals. 2. Design and evaluate. 3. Pilot testing	Low	Low	High	High	Low	Low	High adaptability and accessibility, less rigorous in validation.
Von Wangenheim et al.	1. Knowledge identification. 2. Specification, validation. 3. Use, support. 4. Evolution	Moderate	Low	Moderate	Moderate	Low	High	High technical focus, moderate in other areas.

Becker et al.'s Procedure Model:



2

ANALYSE SELECTED MATURITY MODELS

- Artificial Intelligence (AI) Maturity models
- Digital Transformation (DT) Maturity Models
- Human-Machine Teaming (HMT) Frameworks

3

DETERMINE DEVELOPMENT APPROACH

- Extension: Expanding an existing model's constructs
- Synthesis: Combining elements from multiple models
- Creation: Developing a new model from the ground up

4

ITERATIVE DESIGN & DEVELOPMENT

- Develop Metamodels, Pivot Models and Concept Matrices
- Proposal of the new model's core constructs
- Validation of the core constructs

COMPARATIVE ANALYSIS AND DEVELOPMENT APPROACH

ARTIFICIAL INTELLIGENCE (AI), DIGITAL TRANSFORMATION (DT) & HUMAN-MACHINE TEAMING (HMT) MATURITY MODELS

- **Model Selection and Analysis:** Selected for comparative analysis 10 DT models, 10 AI models, and 10 HMT frameworks
- **Criteria for Comparison:** The models were evaluated based on their constructs, support, maintainability and implementation
- **Comprehensive Review Approach:** The analysis aimed to uncover the strengths, limitations, and unique insights each model offers for fostering effective human-AI collaboration within SMEs

10 AI

1. IBM AI Maturity Model
2. Yams et al., AI Innovation Maturity Index
3. Microsoft AI Maturity Model
4. ElementAI AI Maturity Model
5. StatWorx AI Assessment
6. Gartner AI Maturity Model
7. OVUM AI Maturity Assessment Model
8. Alsheibani, et al., AIMM
9. AppliedAI AI Maturity Model
10. Accenture AI Maturity Assessment Model

10 DT

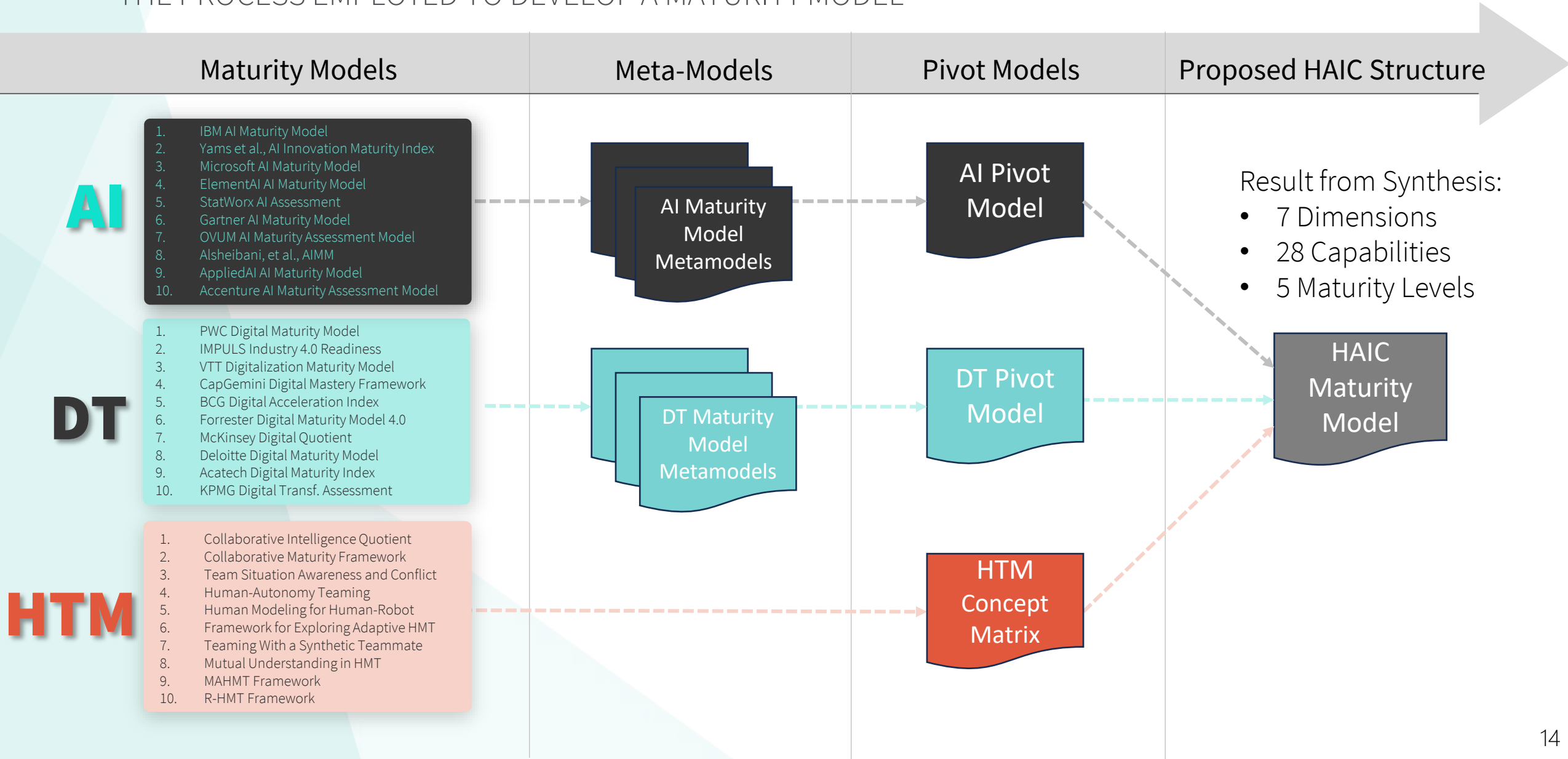
1. PWC Digital Maturity Model
2. IMPULS Industry 4.0 Readiness
3. VTT Digitalization Maturity Model
4. CapGemini Digital Mastery Framework
5. BCG Digital Acceleration Index
6. Forrester Digital Maturity Model 4.0
7. McKinsey Digital Quotient
8. Deloitte Digital Maturity Model
9. Acatech Digital Maturity Index
10. KPMG Digital Transf. Assessment

10 HTM

1. Collaborative Intelligence Quotient
2. Collaborative Maturity Framework
3. Team Situation Awareness and Conflict
4. Human-Autonomy Teaming
5. Human Modeling for Human-Robot
6. Framework for Exploring Adaptive HMT
7. Teaming With a Synthetic Teammate
8. Mutual Understanding in HMT
9. MAHMT Framework
10. R-HMT Framework

MODEL SYNTHETIZATION & SUPER-SETTING PROCESS

THE PROCESS EMPLOYED TO DEVELOP A MATURITY MODEL



CAPABILITY MAPPING AND MATURITY LEVEL DEFINITION

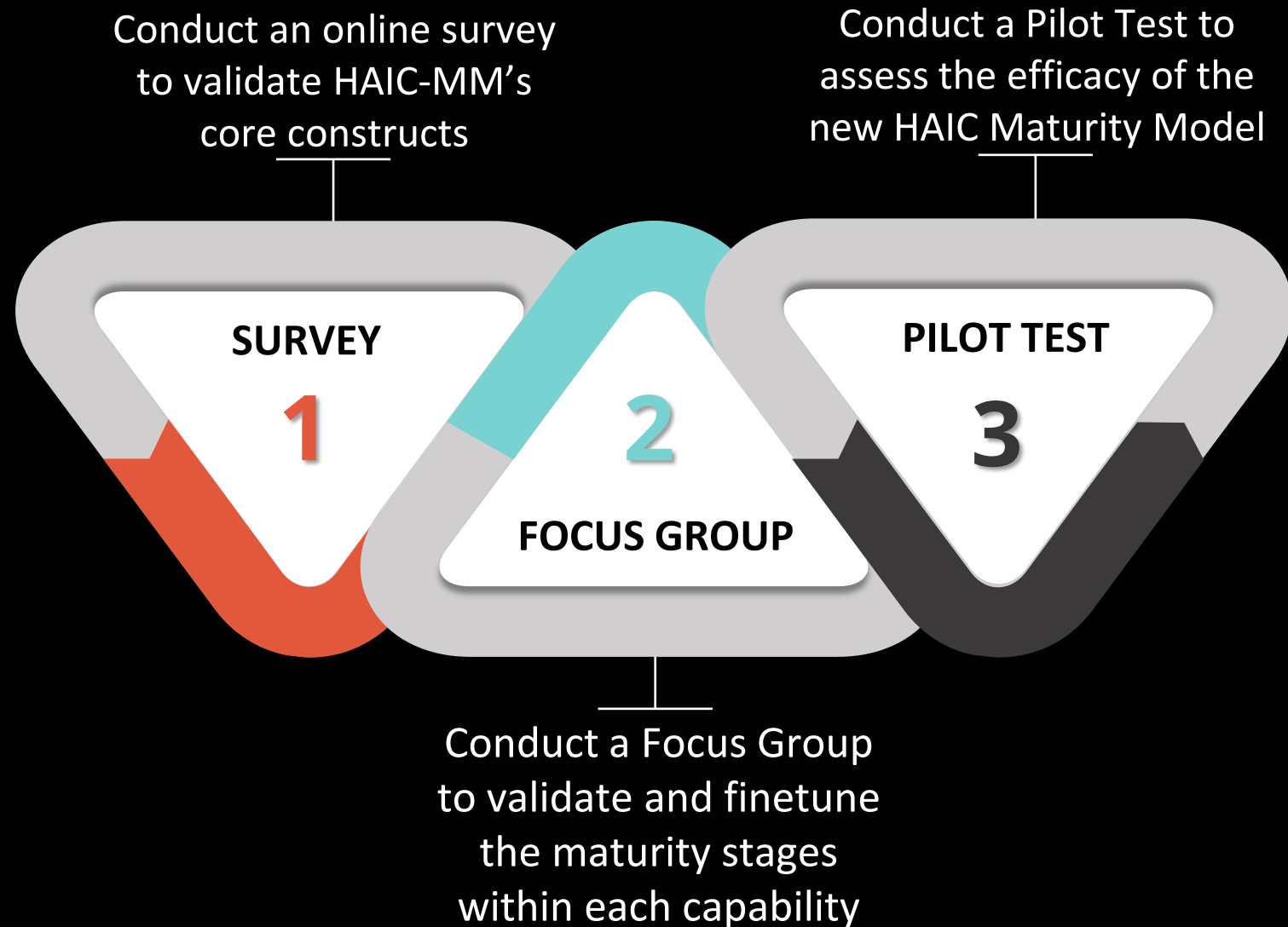
HAIC-MM: STRUCTURE AND MATURITY LEVEL DESCRIPTIONS

HAIC-MM Dimensions	Capabilities
Collaborative Strategy and Leadership	AI-Enhanced Decision Making
	Leadership AI Literacy
	Collaborative Vision Communication
	AI Integration in Business Plans
Empowerment and Adaptive Culture	AI Collaboration Training
	Employee Empowerment Index
	Adaptive Workforce Dynamics
	Adaptive Workforce Development
Integrated Technology and User Experience	User-Centric AI Design
	Technology Integration Level
	Employee Technology Satisfaction
	Human-AI Interaction Quality
Process Harmonization	AI-Enabled Process Efficiency
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Human-Centric Customer Engagement	AI Augmented Customer Interactions
	Customer Feedback on AI Interactions
	Human-AI Response Coordination
	Human-AI Customer Resolution Success
Data Ethics and Human Oversight	Ethical AI Usage Monitoring
	Data Management Compliance
	Oversight Effectiveness
	Transparent AI Operations
Inclusive Governance and Continuous Learning	Diversity in AI Training Data
	AI Impact on Job Roles
	Continual Learning Opportunities
	Inclusive Decision-Making Processes

Maturity Levels & Definitions
<p>Maturity Level Definitions:</p> <p>1- Exploratory</p> <ul style="list-style-type: none"> • Basic awareness and exploration of HAIC concepts • Limited or ad-hoc implementation of AI technologies <p>2 - Developing</p> <ul style="list-style-type: none"> • Active engagement in HAIC initiatives • Development of foundational strategies, processes, and governance <p>3 - Integrated</p> <ul style="list-style-type: none"> • Established and documented practices for HAIC • Cooperative work environments with clear roles and responsibilities <p>4 - Strategic</p> <ul style="list-style-type: none"> • Integrated HAIC across the organization • Managed and optimized processes, and continuous improvement <p>5 - Symbiotic</p> <ul style="list-style-type: none"> • Symbiotic HAIC operating seamless throughout the organization • Continuously evolving HAIC practices driven by data and feedback

VALIDATION STRATEGY

ENSURING EFFICACY THROUGH EMPIRICAL EVIDENCE



SURVEY PARTICIPANTS

DEMOGRAPHIC CRITERIA

- N = 100 participants
- 6-point Linkert scale
- Inclusion Criteria:
 - ≥ 18 years old
 - At least a bachelor's degree
 - Live in US
 - Employed at a company with 100-500 employees
 - Currently serving in a leadership capacity
 - Pass screening question about AI involvement
 - Industries:
 - Manufacturing, Computer and Electronics,
 - Wholesale, Finance and Insurance,
 - Health Care and Social Assistance
 - Information Services and Data
 - Marketing/Sales
 - Hotel & Travel and Leisure Services
 - Telecommunications
 - Scientific or Technical Services
 - Transportation and Warehousing

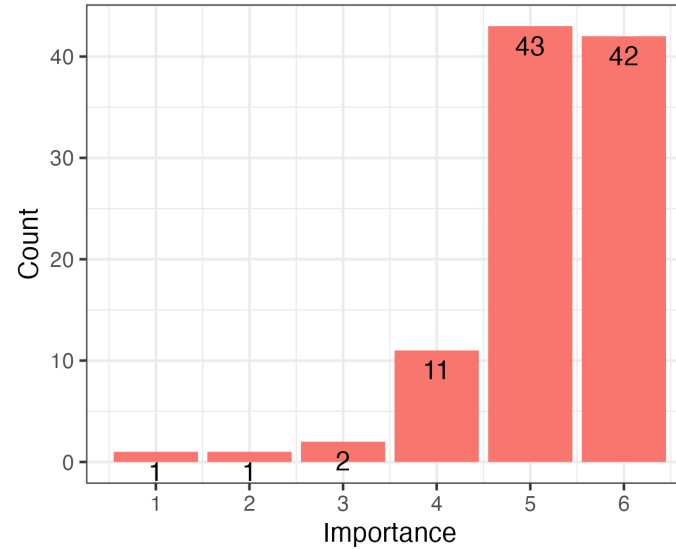
Variable	Count
<i>Gender</i>	
Male	50
Female	50
<hr/>	
<i>Age Group</i>	
25 – 34 y.o.	22
35 – 44 y.o.	43
45 – 54 y.o.	21
55 + y.o.	14
<hr/>	
<i>Race / Ethnicity</i>	
Asian	13
Black	4
Hispanic	6
Latino	21
Multiracial	2
White	54
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<i>Organization Role</i>	
Middle Management	29
Senior Management	9
Director	51
C Level Executive	11
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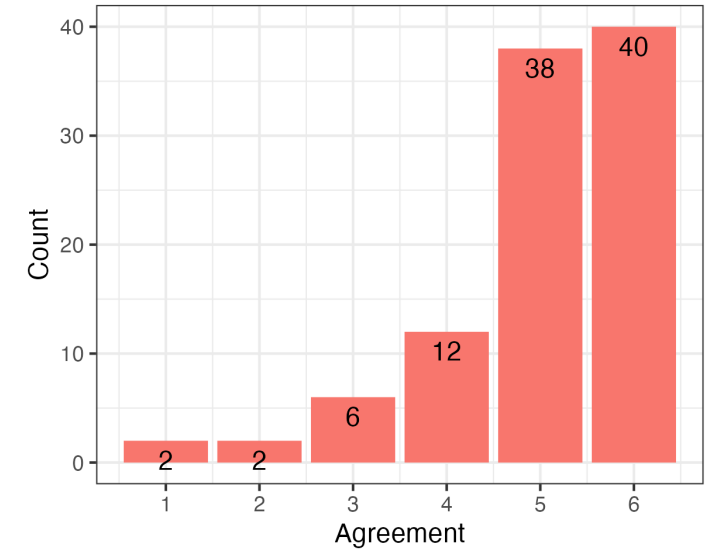
SURVEY RESULTS FOR VALIDATING THE HAIC-MM DIMENSIONS

HAIC-MM Dimensions	
1	Collaborative Strategy and Leadership
2	Empowerment and Adaptive Culture
3	Integrated Technology and User Experience
4	Process Harmonization
5	Human-Centric Customer Engagement
6	Data Ethics and Human Oversight
7	Inclusive Governance and Continuous Learning

How important is integrating AI into strategic planning for competitive advantage?

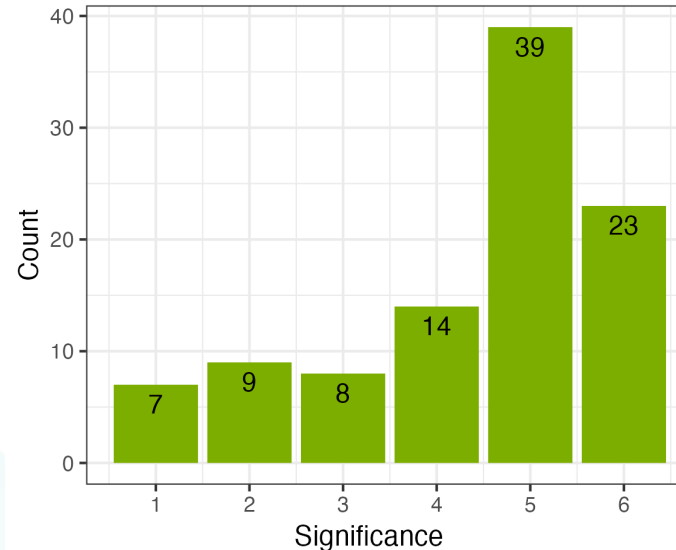


Do you agree company leaders need a deep understanding of AI tools to improve team performance and roles?

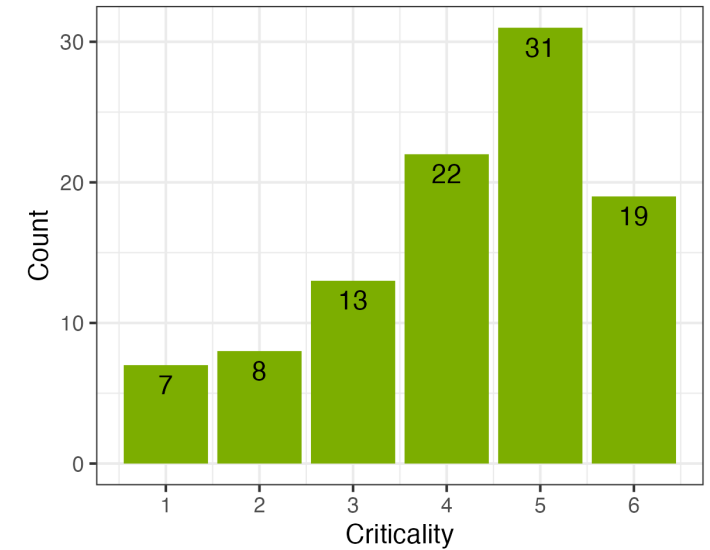


HAIC-MM Dimension	
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How significant is it to empower employees to use AI in their daily roles?

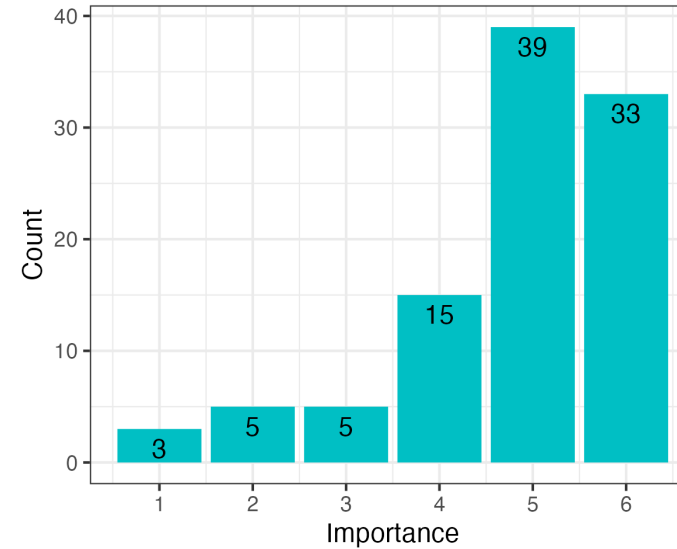


How critical are upskilling programs in equipping staff for effective collaboration with AI?

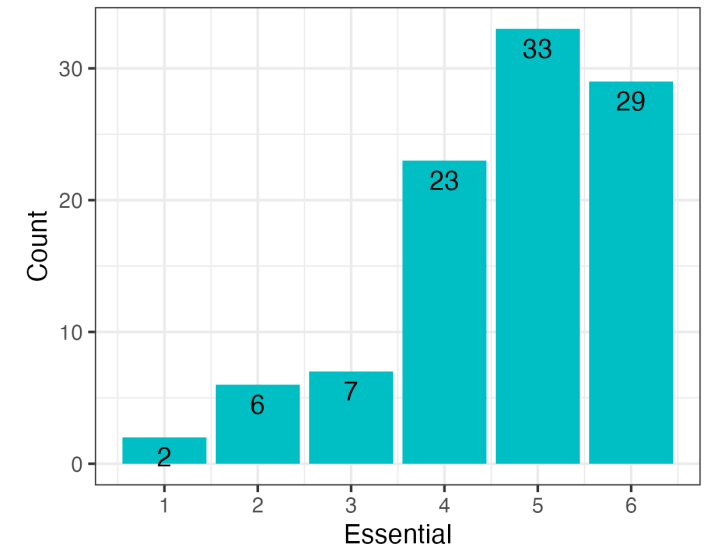


HAIC-MM Dimensions	
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How important is designing user-friendly AI tools for collaboration?

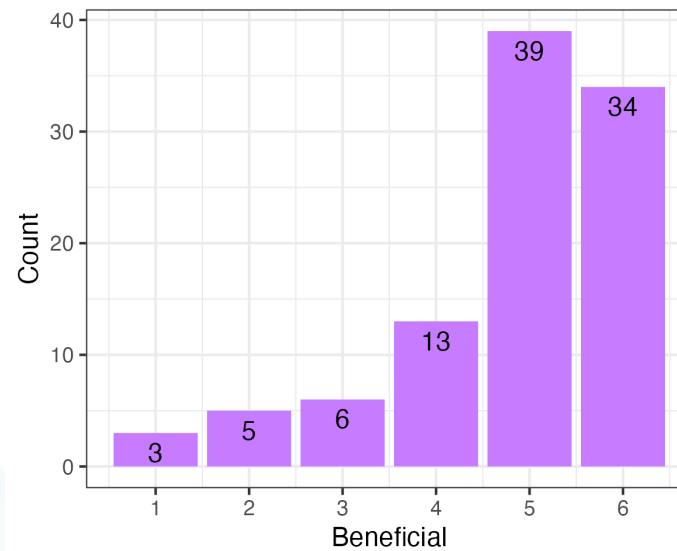


How essential is a positive interaction experience with AI systems for employees?

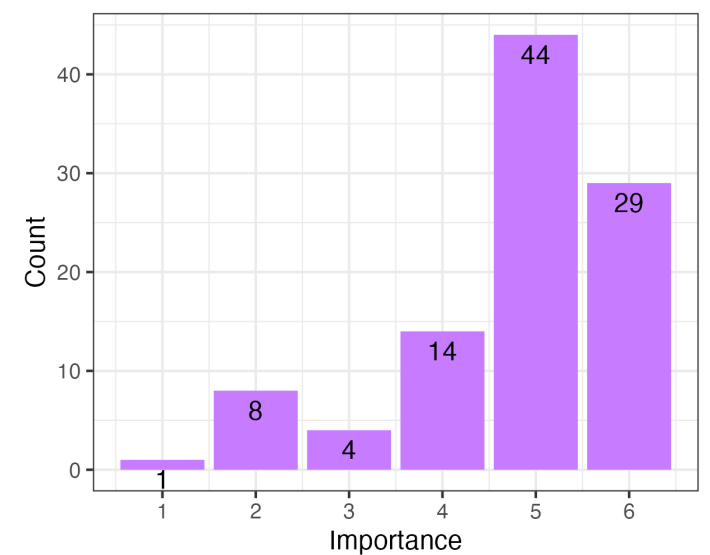


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How beneficial is AI for improving process efficiency in an organization?

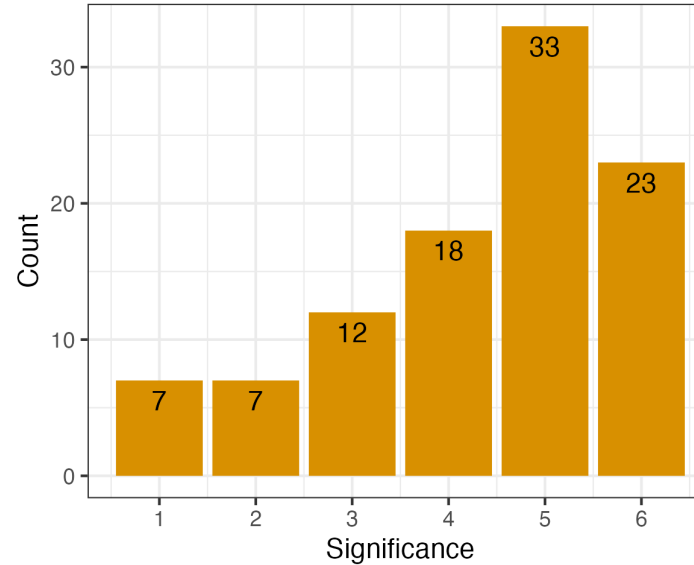


How important is a smooth transition of tasks between AI systems and human employees?

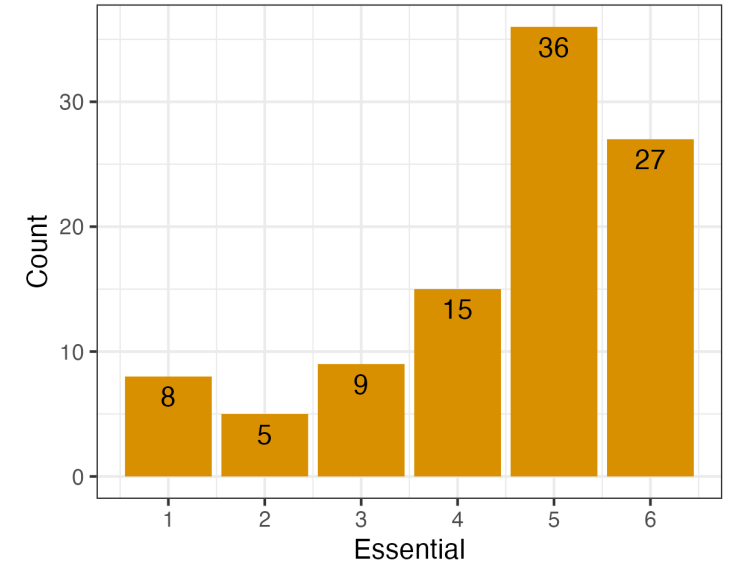


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How significant is AI in supporting customer interactions?

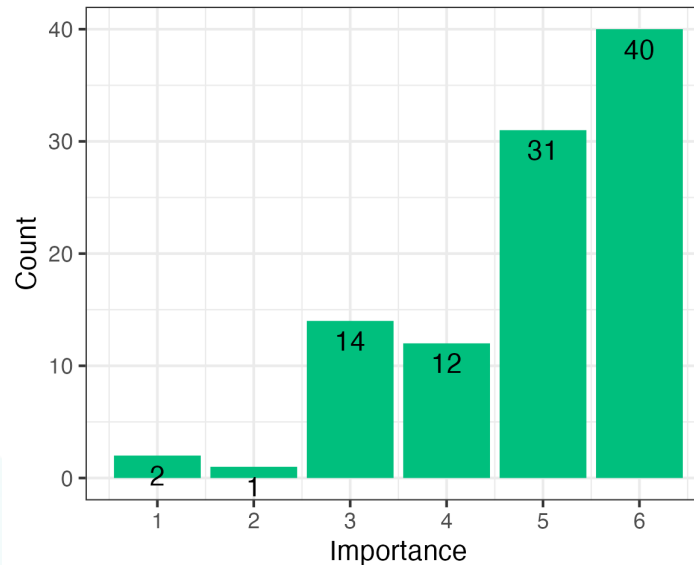


How essential is customer feedback for improving AI interactions and services?

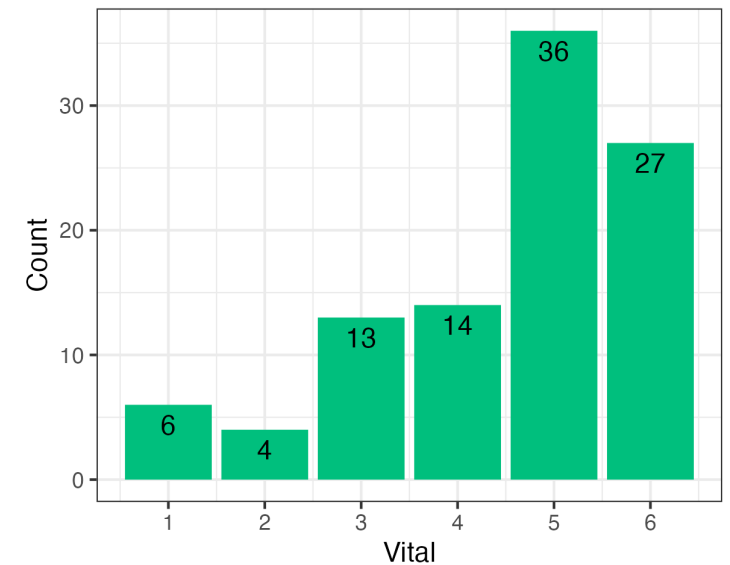


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How important are ethical guidelines when implementing AI solutions?

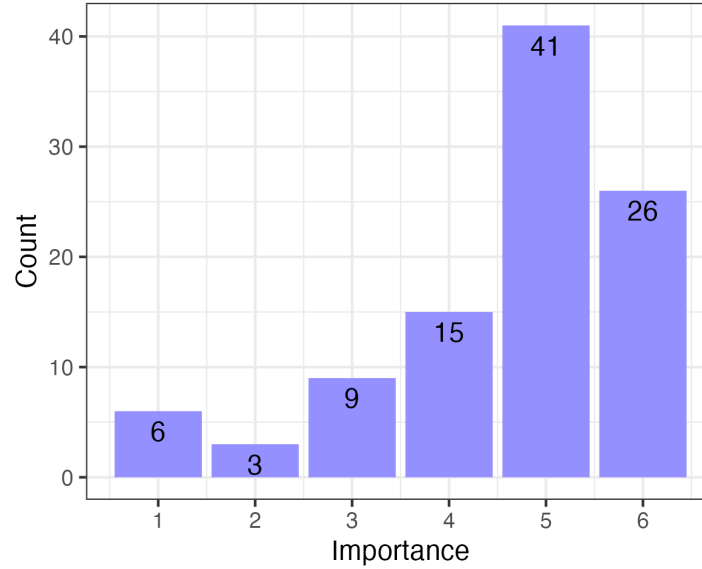


How vital is the transparency and understandability of AI system operations?

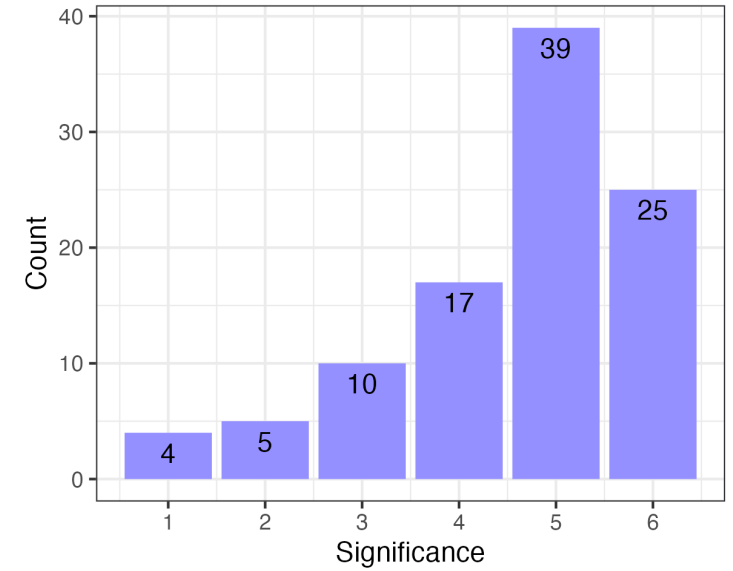


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How important are continuous learning opportunities for improving human-AI collaboration?



How significant are inclusive decision-making processes for AI implementation?



VALIDATING THE MODEL

STRATEGY 2: MATURITY STAGES



Validating the Maturity Stages for the HAIC Model

1. Engage a Variety of SME Stakeholders

- **Objective:** Gain an understanding and detailed description of the maturity level for each HAIC capability across different areas within a SME
- **Method:** Invite stakeholders from multiple levels, including management and executives, to ensure a broad perspective on how AI capabilities are perceived and utilized across different parts of the business.

2. Utilize Existing Survey Data to Guide Discussions

- Start discussions by referencing the existing survey results to pinpoint how AI capabilities are currently perceived and implemented

3. Incorporate Real-World Examples

- Encourage participants to share specific examples of AI usage in their operations to identify areas for improvement and effective integration.

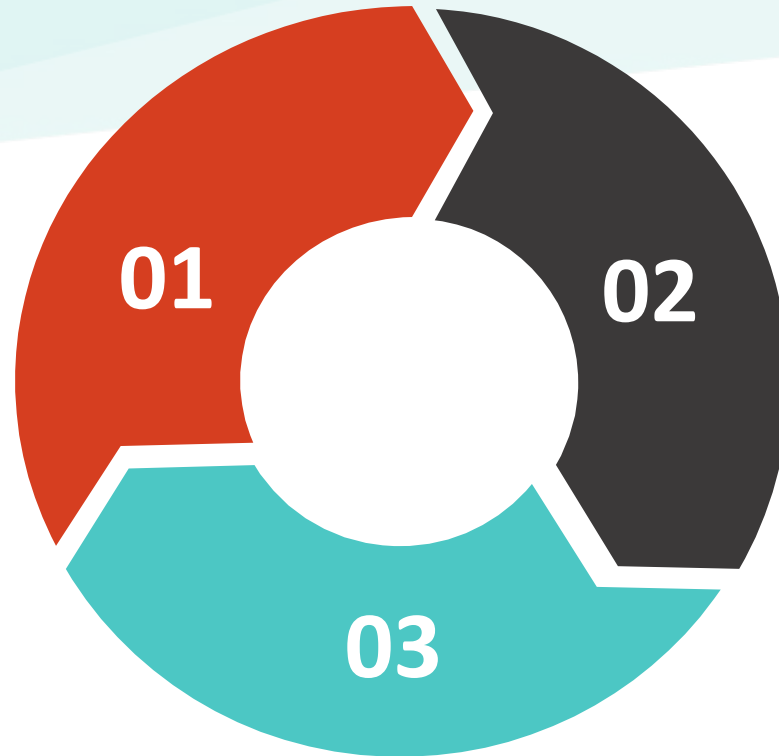
Original Dimension	Revised Dimension	Revised Capability
Collaborative Strategy and Leadership	AI-Enhanced Leadership and Strategy	<ul style="list-style-type: none"> Augmented Decision Making Leadership AI Literacy Inclusive AI Vision Communication AI Strategy Alignment AI Adoption Readiness Assessment
Empowerment and Adaptive Culture	Adaptive AI Culture and Empowerment	<ul style="list-style-type: none"> Targeted AI Collaboration Training AI Partnership Index Workforce AI Adaptability Continuous AI Workforce Development Psychological Safety in AI Collaboration
Integrated Technology and User Experience	Human-Centric AI Integration and Experience	<ul style="list-style-type: none"> Human-Centered AI Design AI Integration Effectiveness Employee Experience with AI Tools Human-AI Collaboration Quality Human Trust in AI Assessment
Process Harmonization	Harmonizing AI and Human Processes	<ul style="list-style-type: none"> AI-Driven Process Optimization Human-AI Collaboration Index Human-AI Task Flow Adaptive Task Allocation
Human-Centric Customer Engagement	Human-Centered AI Customer Engagement	<ul style="list-style-type: none"> AI-Enhanced Customer Engagement Customer Insights on AI Experiences Human-AI Response Integration Human-AI Collaborative Resolution Rate
Data Ethics and Human Oversight	AI Ethics and Human Oversight	<ul style="list-style-type: none"> AI Ethical Oversight AI Data Compliance AI Governance Effectiveness AI Operational Transparency Data Quality Assurance for AI
Inclusive Governance and Continuous Learning	Inclusive AI Governance and Learning	<ul style="list-style-type: none"> Achieving Diversity in AI Training Data Assessing AI Impact on Workforce Roles Continuous AI Learning Opportunities Implementing Inclusive AI Decision-Making Targeted AI Upskilling Programs

KEY CONTRIBUTIONS TO HAIC IN SMEs

CONTRIBUTIONS TO THEORY AND PRACTICE

● **SERC's ROADMAP**

- Supports digital engineering
- Aligns with workforce evolution goals
- Supports system velocity
- Reinforces security and trust
- Promotes continuous improvement and collaboration



● **LEADERSHIP**

- Provides actionable insights for SME leaders to effectively harness AI while balancing investments in human talent
- Enhances the decision-making processes related to AI adoption, aligning investments with organizational goals

● **PRACTICAL**

- Provides a framework for SMEs to navigate AI adoption challenges
- Provides direction for navigating ongoing the “SME Challenge Trifecta”

QUESTIONS & COMMENTS

APPENDIX

- **FURTHER SURVEY RESULTS**

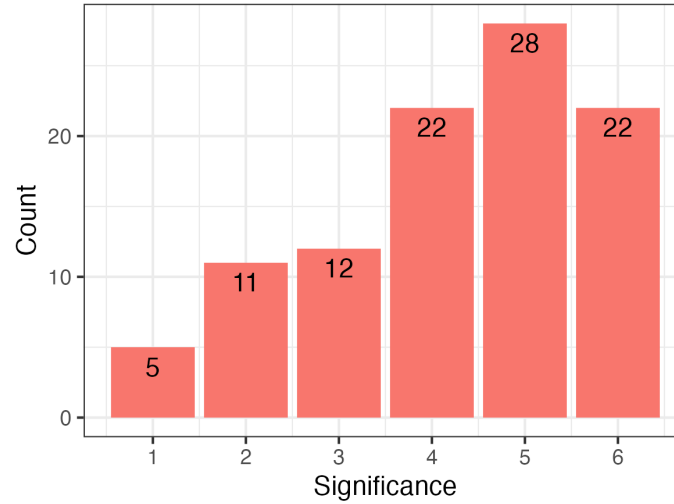
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SURVEY RESULTS FOR VALIDATING THE HAIC-MM CAPABILITIES

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	AI Impact on Job Roles
	Continual Learning Opportunities
	Inclusive Decision-Making Processes

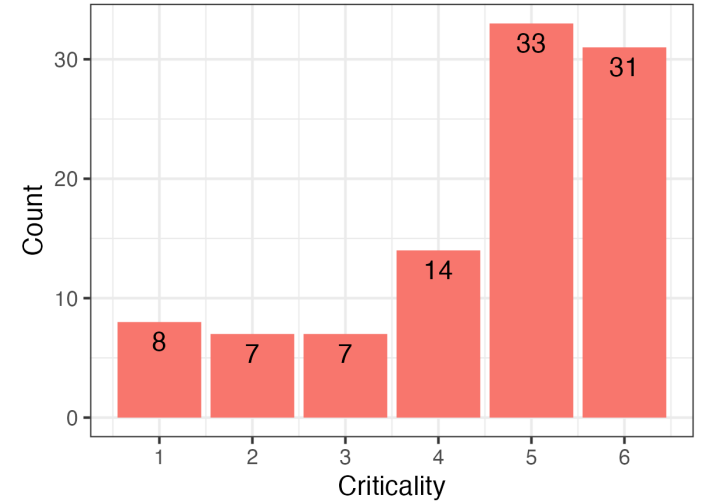
How significant is AI's contribution to strategic decision-making in your organization?

AI-Enhanced Decision Making



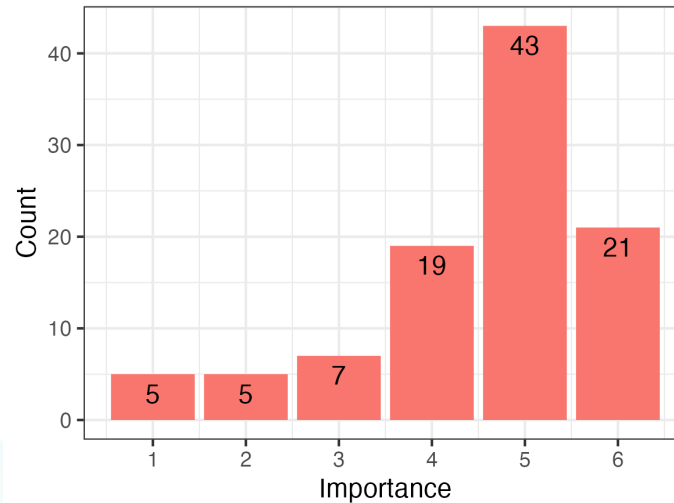
How critical is leadership's understanding of AI for successful integration?

Leadership AI Literacy



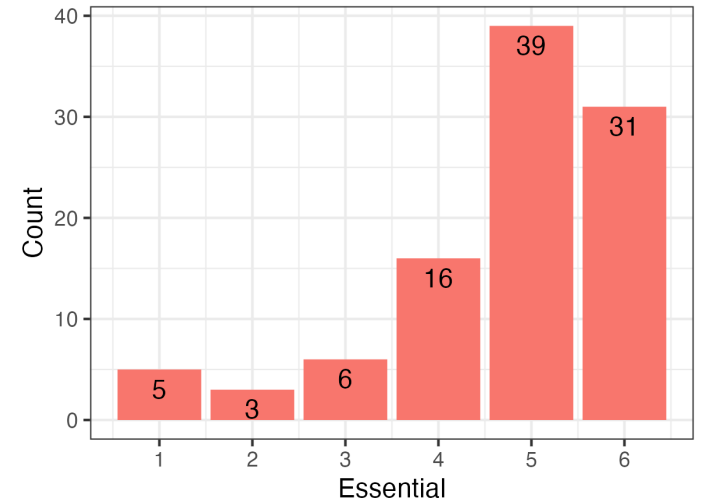
How important is clear communication of AI collaboration vision across the organization?

Collaborative Vision Communication



How essential is AI integration into business planning for competitive advantage?

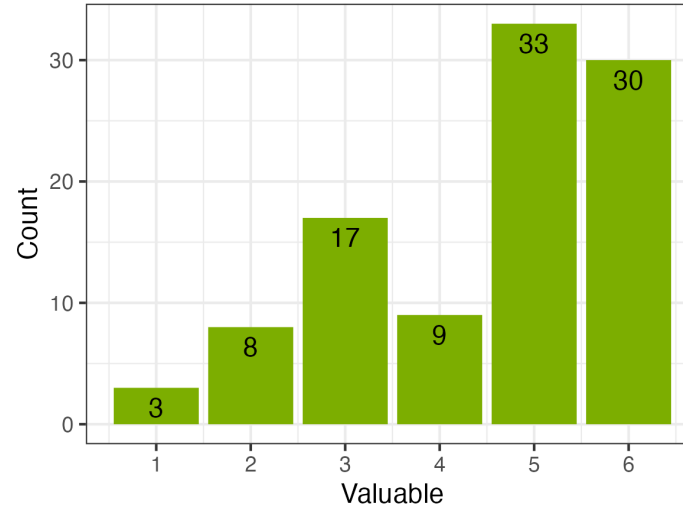
AI Integration in Business Plans



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	Continual Learning Opportunities
	Inclusive Decision-Making Processes

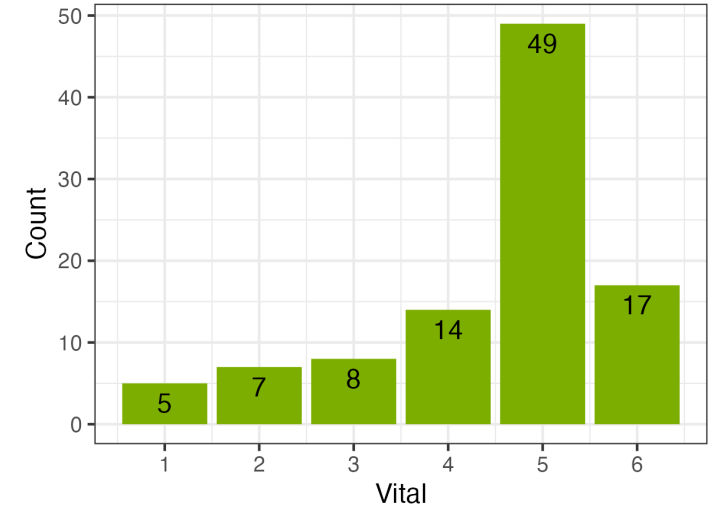
How valuable are training programs for effective human-AI collaboration?

AI Collaboration Training



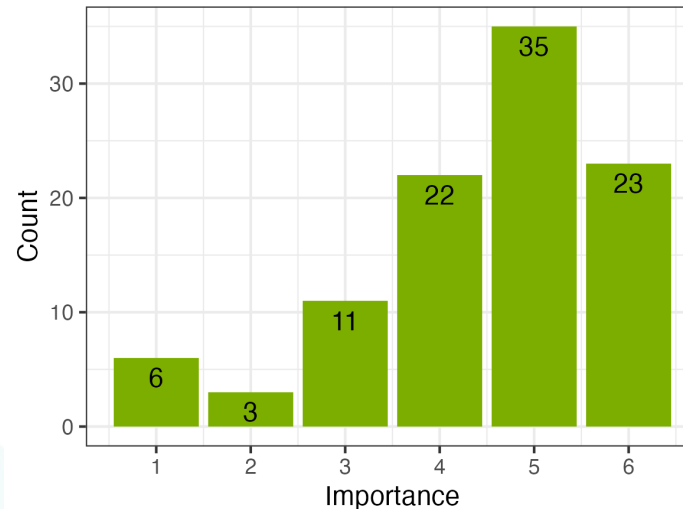
How vital is empowering employees to effectively use AI?

Employee Empowerment Index



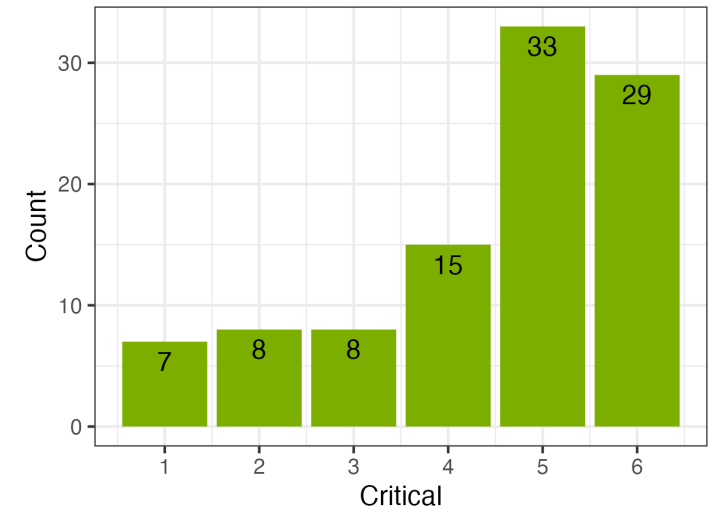
How important is adaptive reallocation of human and AI resources to changing needs?

Adaptive Workforce Dynamics



How critical are upskilling programs for employees' ability to work with AI?

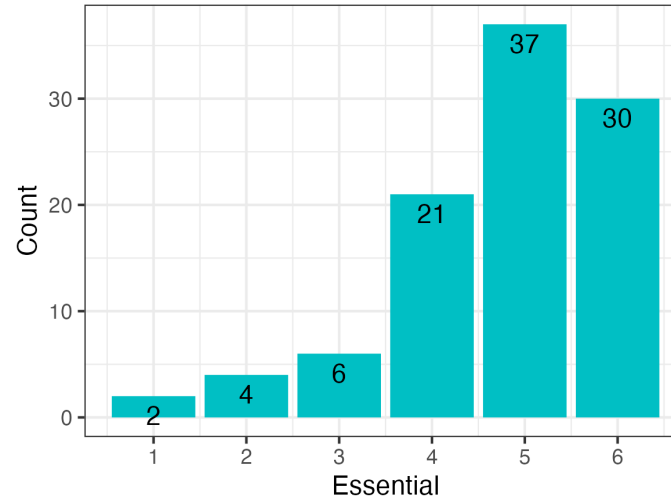
Adaptive Workforce Development



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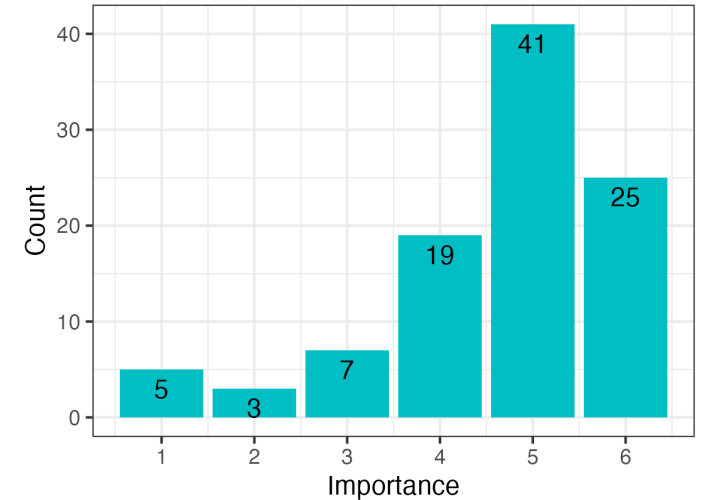
How essential is user-friendly AI design for collaboration and user satisfaction?

User-Centric AI Design



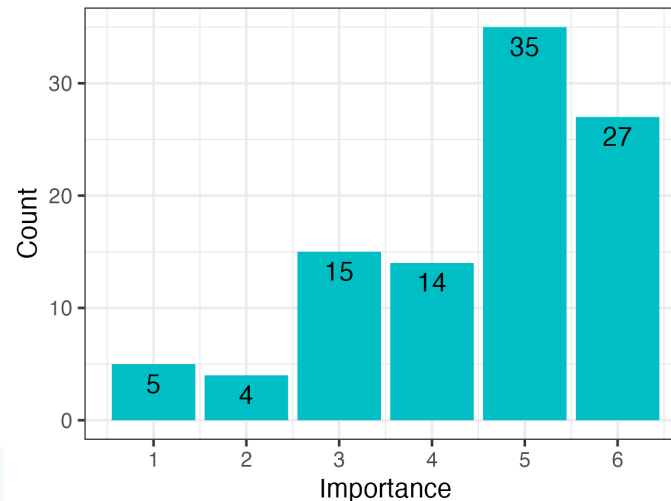
How important is seamless integration of AI into daily workflows?

Technology Integration Level



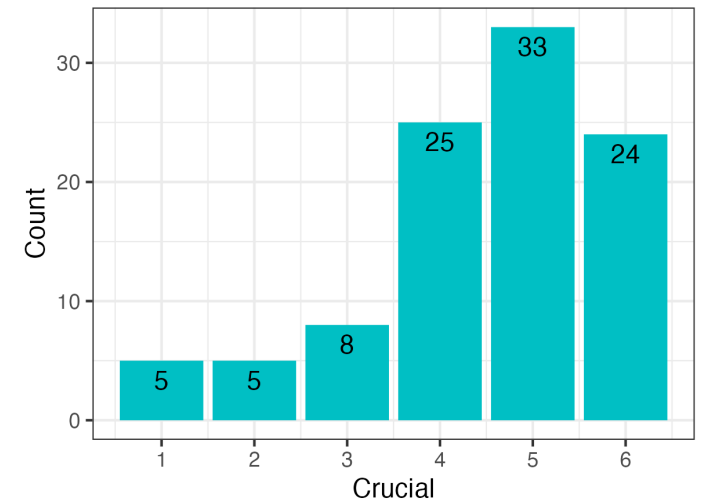
How important is employee satisfaction with AI system interactions?

Employee Technology Satisfaction



How crucial is the quality of interaction between employees and AI systems for effectiveness?

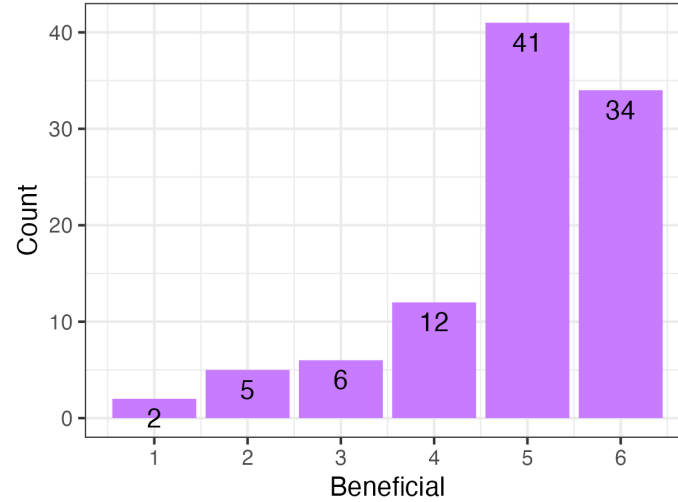
Human-AI Interaction Quality



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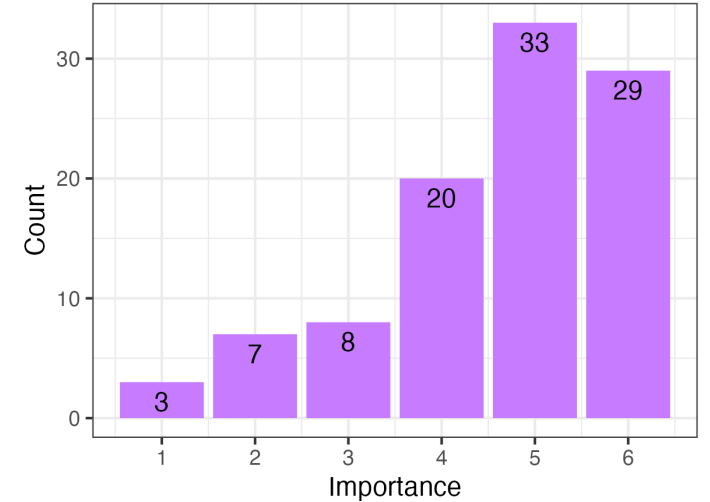
How beneficial is AI in improving efficiency and productivity?

AI-Enabled Process Efficiency



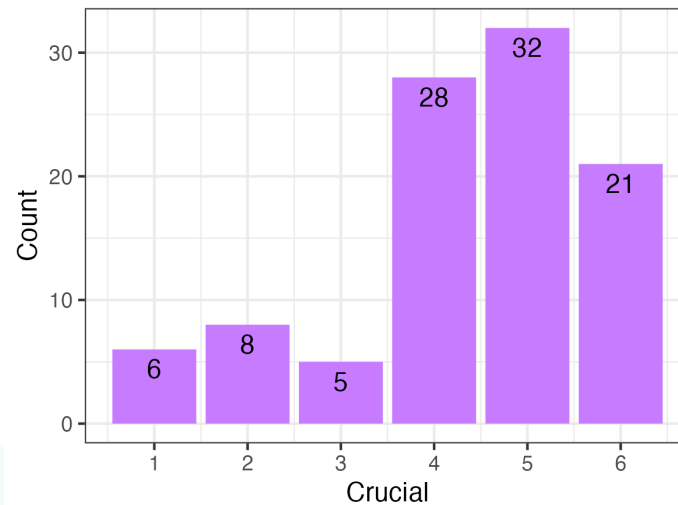
How important is human intervention in overseeing and enhancing AI processes?

Human-Intervention Index



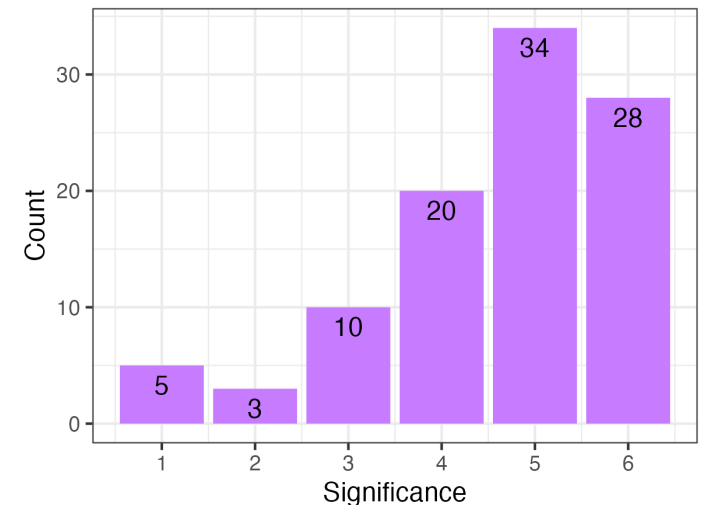
How crucial is the smooth and effective transition of tasks between AI and humans?

Seamless Task Transition



How significant is clear task allocation between humans and AI for productivity?

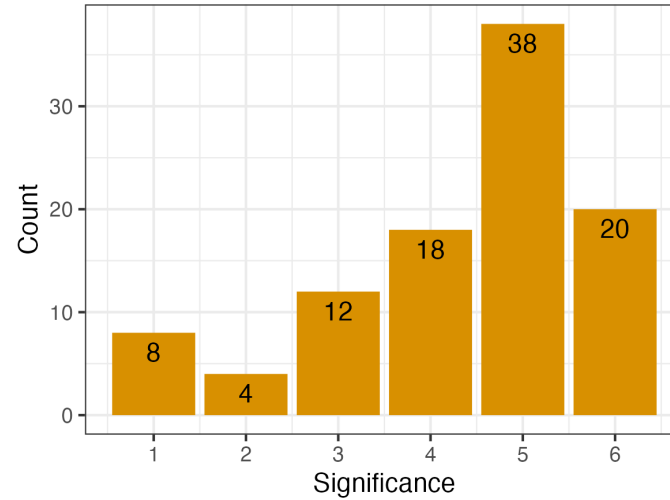
Human-AI Task Allocation



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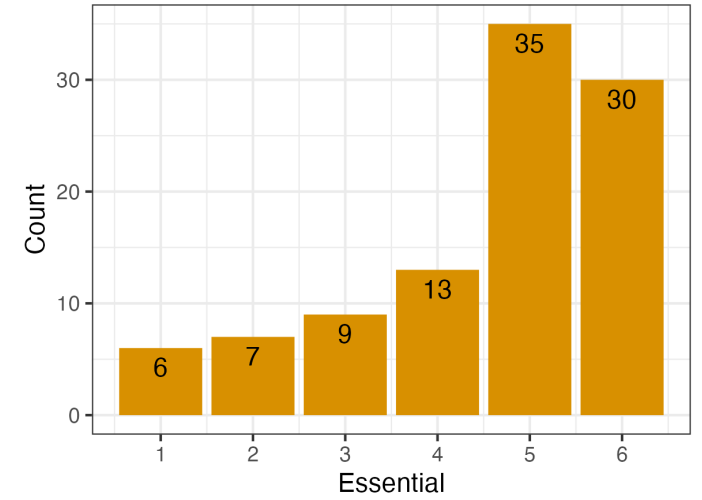
How significant is AI in enhancing customer interactions and satisfaction?

AI Augmented Customer Interactions



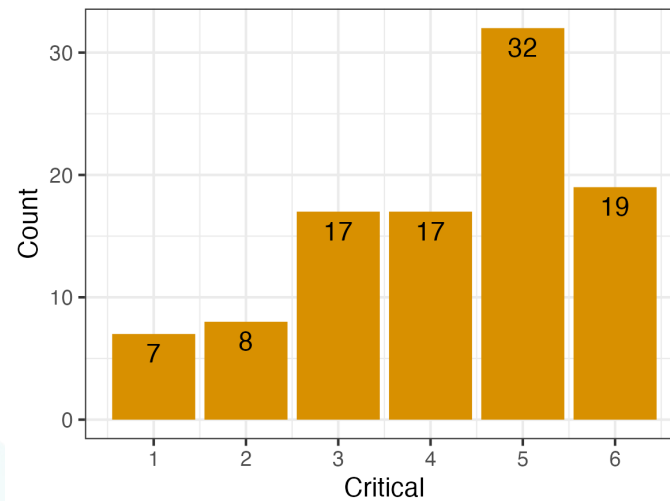
How essential is customer feedback for improving AI-enhanced services?

Customer Feedback on AI Interactions



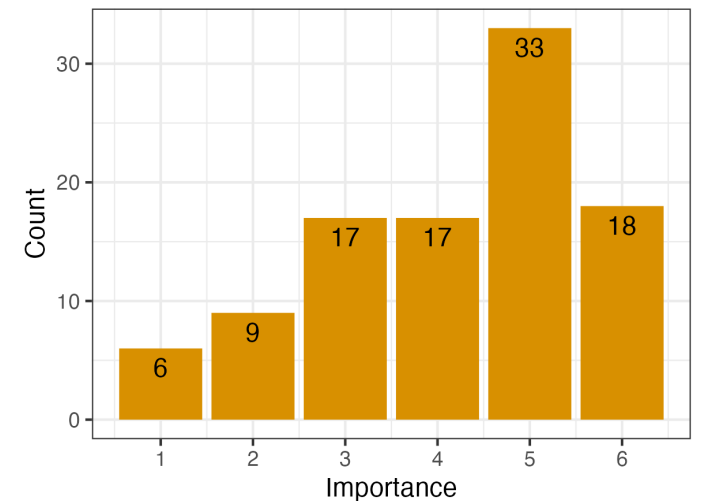
How critical is efficient coordination between human and AI responses in customer service?

Human-AI Response Coordination



How important is AI in achieving successful resolutions in customer service?

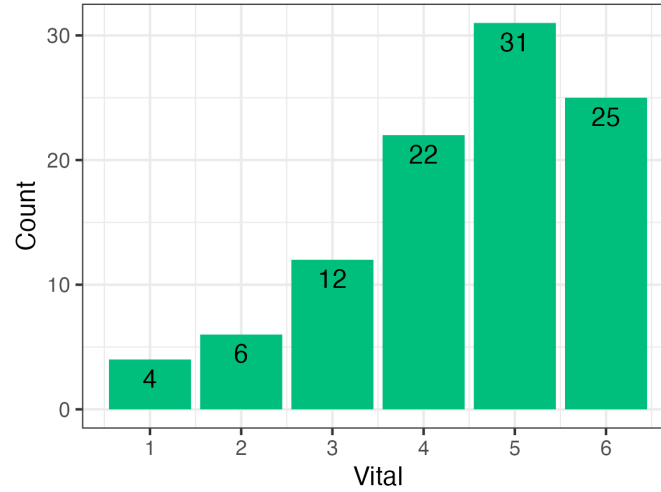
Human-AI Customer Resolution Success



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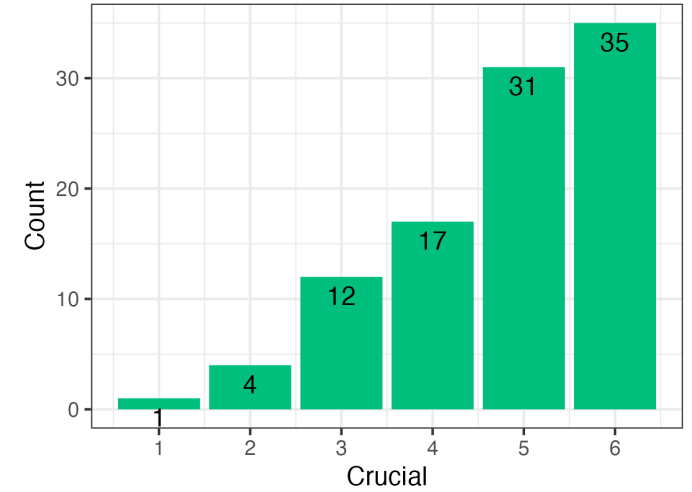
How vital is regular assessment of AI usage against ethical guidelines?

Ethical AI Usage Monitoring



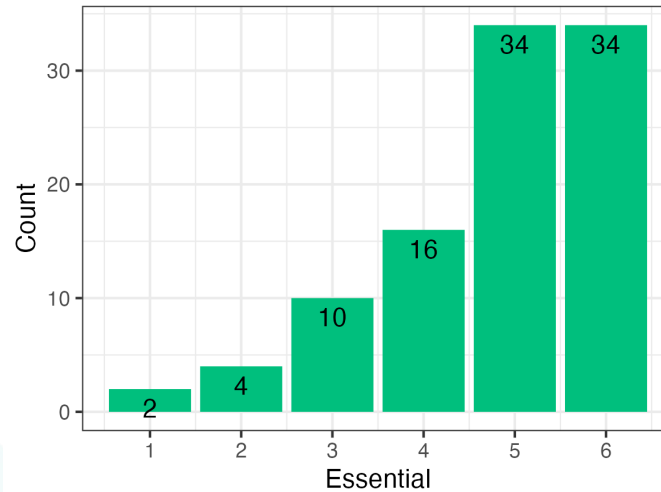
How crucial is adherence to data governance and privacy standards in AI?

Data Management Compliance



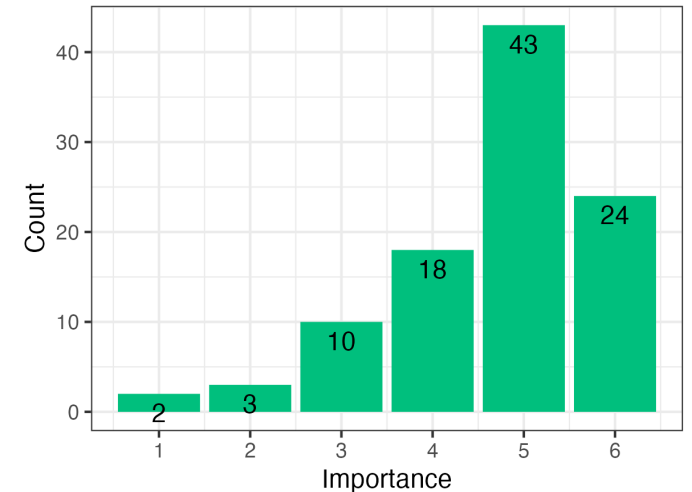
How essential is human oversight in managing and correcting AI outputs?

Oversight Effectiveness



How important is the transparency of AI operations and decision-making processes?

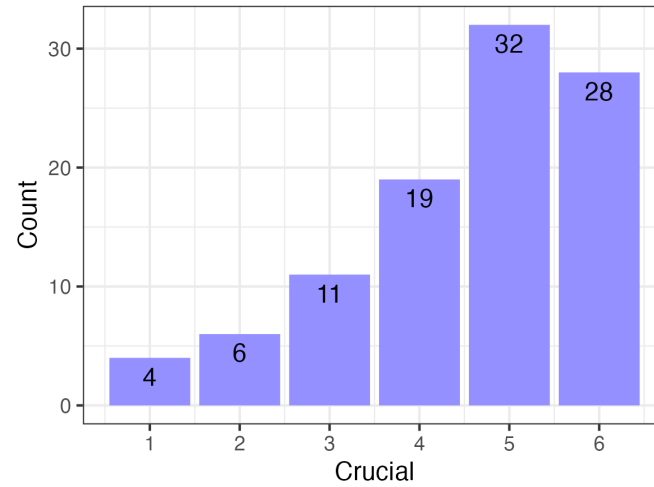
Transparent AI Operations



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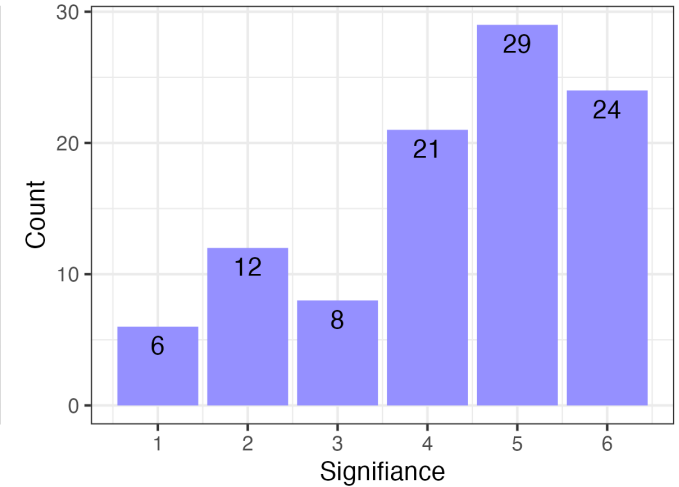
How crucial is diverse data representation in AI training to avoid biases?

Diversity in AI Training Data



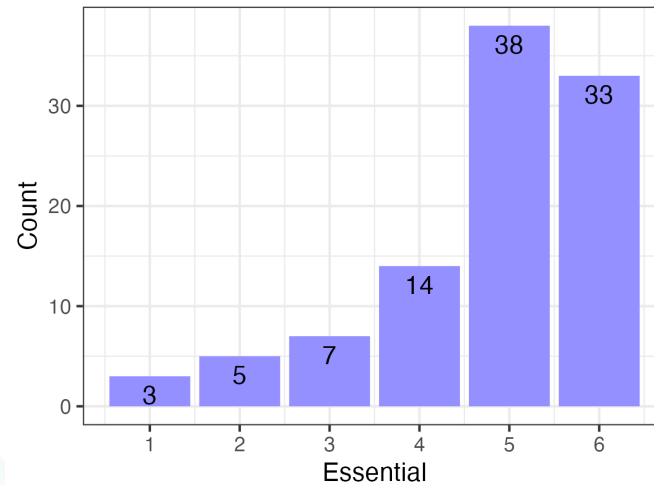
How significant has AI's impact been on job roles and tasks in your organization?

AI Impact on Job Roles



How essential are continuous learning opportunities for human-AI collaboration?

Continual Learning Opportunities



How important are inclusive decision-making processes in AI applications?

Inclusive Decision-Making Processes

