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## The Integration of AI in Software Engineering

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### Abstract

Artificial Intelligence (AI) is a paradigm shift in the modern mode of software engineering and has a transformative potential to automate, create efficiency, and improve the quality of the Software Development Lifecycle (SDLC). The given study explores the complex nature of the influence of AI technologies on the process of software engineering and looks at the patterns of their adoption, advantages, difficulties, and ethical issues. With the use of a mixed-methods research design, this study integrates quantitative survey data of 22 software engineering professionals (reflecting a wide range of organizational environments) (54.5 percent academic institutions, 22.7 percent small to medium enterprises, and other industries) with qualitative expert results. The research findings reveal a significant utilization of AI tools in critical SDLC processes, particularly in planning and requirements (45.5%), design and architecture (36.4%), coding (36.4%), and testing (36.4%). Conversely, the application of AI in maintenance is minimal (9.1%). The respondents have indicated that they were seeing a lot of value, such as efficiency (63.6%), better code quality (59.1%), and better decision-making (59.1%). Nevertheless, the research highlights such important implementation issues as the lack of skills (45.5%), ethical issues (45.5%), and complexities of the integration (36.4%). Importantly, 81.8% of respondents highlighted the outstanding role of ethical considerations, with data privacy (31.8) and algorithmic bias (22.7) becoming the most common ones. The study offers strategic recommendations for

successful AI implementation, emphasizing continuous training, robust ethical governance frameworks, gradual implementation strategies, and interdepartmental collaboration. The empirical findings can inform organizations about how to approach AI in software development and help create a platform for the responsible, efficient, and ethically motivated integration of AI technologies into software engineering practice. The proposed research will close the knowledge gap of critical importance in the study of strategies for practical AI implementation and balance technological innovation with moral responsibility in developing the profession of software engineering.

**Keywords:** artificial intelligence, software engineering, software development lifecycle, AI ethics, automation, code quality, algorithmic bias, and data privacy.

## 1. Introduction

### 1.1. Background

Software Engineering (SE) is a field that is experiencing a radical shift regarding the incorporation of the Artificial Intelligence (AI) phenomenon, which is already radically changing the technological environment and the functions of the professionals in the field [1]. The growing use of AI technologies has resulted in a higher level of automation, subsequently improving the quality of the code and making data-driven decision-making processes easier [2, 3]. These encompass improvements in automated code generation, intelligent debugging, and AI-assisted predictive maintenance [4]. Therefore, software engineers are not focused on manual and low-level coding activity anymore but rather on more strategic tasks, which demand a more collaborative effort with AI systems and interdisciplinary competence. Although the advantages of AI in SE are enormous, its adoption has several problems, such as ethical issues and job displacement [5, 6]. This changing environment requires an in-depth study on the role of AI in the future of software engineering and the trends that are emerging to define the profession [2, 7].

### 1.2. Problem Statement and Research Gap

Although the revolutionary power of Artificial Intelligence (AI) on Software Engineering (SE) is not underestimated, there is a considerable gap in scholarly research related to the practical and ethical issues of this implementation. The rapid development of AI technologies presents a complex set of concerns that must be addressed to ensure their responsible and effective use. These consist of finding the right balance between automation and human control, ensuring the efficiency of the development processes, and exploring the ethical aspects of the AI-based systems [6, 8]. The existing literature tends to dwell upon the possible advantages of AI in SE, yet the empirical studies on the means of successfully incorporating AI into the Software Development Lifecycle (SDLC) and reducing the risks are unavailable. The proposed research will focus on filling this gap, offering the detailed overview of the existing state of AI adoption in SE, defining the main issues and opportunities, and providing the framework of the ethical and effective implementation.

Through its practical orientation, the current study aims to offer considerable information to the scholars and professionals engaged in the domain [4, 9].

### 1.3. Purpose and Objectives

The paper will discuss the following questions:

To determine how much AI is currently being applied to automate various phases of the Software Development Lifecycle (SDLC) and the resulting effects on the outcome of the project.

To determine and discuss the core benefits and issues related to the application of AI technologies in software engineering practice.

To estimate the ethical implications and considerations of AI adoption in software projects and suggest strategies that can implement it in a responsible way.

### 1.4. Research Questions

What is the use of AI to improve the process and effectiveness of the different phases of the Software Development Lifecycle (SDLC)?

What are the key advantages and pitfalls associated with the introduction of AI to software engineering?

What are the best ideas for incorporating ethical issues into the AI process in software engineering?

## 2. Literature Review

### 2.1. Artificial Intelligence in the Software Development Life Cycle

Artificial Intelligence (AI) is becoming a part of different stages of the Software Development Life Cycle (SDLC), making it more efficient and automated [1, 2].

**Planning and Requirements:** The AI tools will enable collection and analysis of user requirements, which will substantially enhance their accuracy in the developmental phase that is the most important [1, 10]. AI-based methods allow more accurate and effective requirement elicitation because manual activities are automatized, and intelligent analysis is offered [4].

**Design and Architecture:** AI can use historical information and system specifications to suggest the best design patterns and architectures, hence, helping developers to design robust and maintainable systems [2, 11]. Machine learning methods analyze code repositories and architectural models, suggesting ways to enhance their efficiency and scalability [11].

**Coding:** Intelligent software, including GitHub Copilot and OpenAI Codex, are developer productivity tools that generate and refactor code using machine learning algorithms. These assist in providing real-time feedback, making quality code suggestions, and saving on time spent on coding as well as decreasing manual effort [1, 3, 12].

**Testing:** The automated testing tools based on AI can create test cases, detect the vulnerable area, and increase the test coverage with the minimum human intervention [1, 2]. The AI is able to handle large volumes of data to determine edge cases and situations that may not be sufficiently covered during manual testing and, therefore, results in a more comprehensive software validation [2].

**Maintenance:** AI enables the monitoring of the performance, predicts the possible failures, enables predictive maintenance, and decreases the time when the system will be offline [1, 2]. AI models can predict the appearance of system failures ahead, provide proactive maintenance, and enhance the operation of the DevOps pipeline [2].

## 2.2. Benefits of AI in Software Engineering

The AI implementation in software engineering can provide several great benefits [1, 9]:

**Increased Productivity:** By automating repetitive tasks with the aid of AI, developers can concentrate on solving more complicated problems, which will help shorten the process of delivering software overall [1, 2]. AI applications make it simple to automate processes that are time-consuming, like programming, debugging, and deployment [1, 4].

**Higher Quality:** AI-based software can help measure the quality of code and minimize defects with intensive analysis and prompt suggestions [1, 3]. These types of AI check the code against potential defects, security risks, and quality compliance and are thus more effective at improving the accuracy of the later development phases [1, 2].

**Reduced Time-to-Market:** The ability to have shorter development cycles leads to accelerated software product releases, giving organizations an advantage over their competition [1, 2]. The transformative effect of AI has been seen through the reduction of the development process and the provision of novel solutions to the software development process, which are large and complex [1, 2].

## 2.3. Challenges of AI in Software Engineering

Even though AI has many benefits for software engineering, there are also some problems that come with using it [3, 13]: **Skill Gap:** There aren't enough people who are proficient at both software engineering and AI, which makes it challenging to use AI-driven solutions well [3, 13]. The lack of knowledge about AI technologies in software engineering is still a major problem [3, 13]. **Difficulties with integration:** Adding AI to current workflows can be a difficult and expensive process that requires careful planning and execution [10, 11]. Making sure that systems can work together and integrate smoothly is one of the greatest problems [10, 11].

**Ethical Issues:** The use of AI brings up big worries about bias, accountability, and openness in decision-making processes. This means that clear ethical rules and guidelines need to be established [6, 8]. Algorithmic biases can reinforce and exacerbate disparities, necessitating that developers meticulously evaluate datasets and rigorously test AI systems to guarantee equity and just results [6, 8, 14].

Ethical issues cover a wide range of problems, such as algorithmic bias, data security, openness, responsibility, and the possibility of losing jobs [5, 8]. To build trust, fairness, and long-term success in the development process, it is important to manage these ethical risks well [6, 8].

### **3. Methodology**

#### **3.1. Research Framework**

This study utilizes a mixed-methods research design, combining qualitative and quantitative approaches to achieve a thorough understanding of AI integration in software engineering. This framework facilitates data triangulation, thereby augmenting the validity and reliability of the findings [15, 16].

#### **3.2. Data Collection Processes**

**Surveys:** Structured surveys were used to collect quantitative data from 22 software engineering professionals, such as developers and project managers. The survey tool was made to gather information about how they used AI tools, how they adopted them, what they thought were the benefits, and what problems they ran into.

**Expert Interviews:** We got qualitative data by doing in-depth interviews with experts in AI and software engineering. The purpose of these interviews was to obtain more detailed answers, confirm the survey results, and look at new trends and their ethical effects in more depth.

#### **3.3. Data Analysis Methods**

**Statistical Analysis:** Descriptive statistics were used to search for patterns in the quantitative survey data on the use of AI tools, the benefits people thought they would receive, and the problems they thought they would face. We used inferential statistics to test hypotheses and examine variable relationships.

**Content Analysis:** Qualitative data obtained from expert interviews underwent systematic content analysis. This included coding and organizing themes about AI integration, ethical issues, and suggestions for the future, which made it possible to identify patterns that happen again and new ideas [17].

#### **3.4. Ethical Considerations in Research Design**

All research protocols complied with stringent ethical standards. All participants gave their informed consent, which made sure that they were willing to take part and understood the purpose of the study. Anonymity and confidentiality were preserved during the data collection and analysis stages. The research design was examined to mitigate any potential harm to participants and to guarantee the ethical execution of the study.

### **4. Results and Discussion**

## 4.1. Overview of AI Integration in Software Engineering

Artificial Intelligence (AI) is quickly changing the field of software engineering by improving automation, encouraging new ideas, and making things work faster. As businesses and schools use AI technologies more and more in the Software Development Lifecycle (SDLC), it's important to know how to use AI tools, what their pros and cons are, and what ethical issues come into play when they are used [18].

## 4.2. Analysis of AI Incorporation into Software Engineering

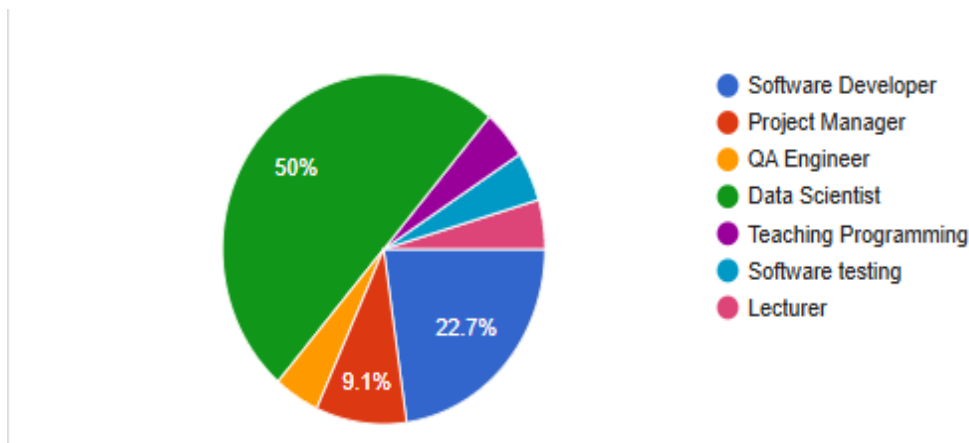
### 4.2.1. Questionnaire Analysis

We got the data for this part by sending a questionnaire to 25 people who work in computer science. We got 22 responses, which we were able to analyze. Below are the demographic and experience profiles of the people who answered.

### Section 1: Demographics

#### 1. Roles in the Software Development Process

The sample showed a wide range of roles in the software development process. The largest group was data scientists (50%, 11 respondents), followed by software developers (22.7%, 5 respondents). A smaller number of people (9.1%, 2 respondents) said they worked as a project manager, QA engineer (4.5%, 1 respondent), teaching programming (4.5%, 1 respondent), software testing (4.5%, 1 respondent), or lecturer (4.5%, 1 respondent). This distribution indicates that the respondents have a lot of knowledge about data-driven and AI-related practices, which is a favorable starting point for learning more about how to use AI.



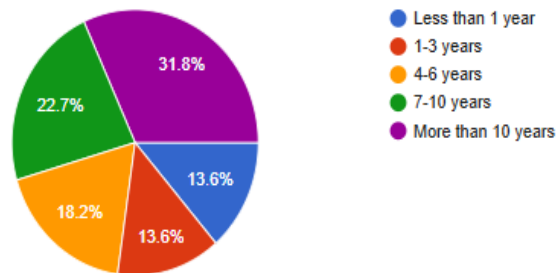
#### 2. Years of Experience in Software Engineering

The experience levels of the respondents were varied:

- Less than 1 year: 13.6% (3 respondents)

- 1-3 years: 13.6% (3 respondents)
- 4-6 years: 18.2% (4 respondents)
- 7-10 years: 22.7% (5 respondents)
- More than 10 years: 31.8% (7 respondents)

This diverse range of experience ensures that the findings reflect perspectives from both emerging professionals and seasoned experts in the field.



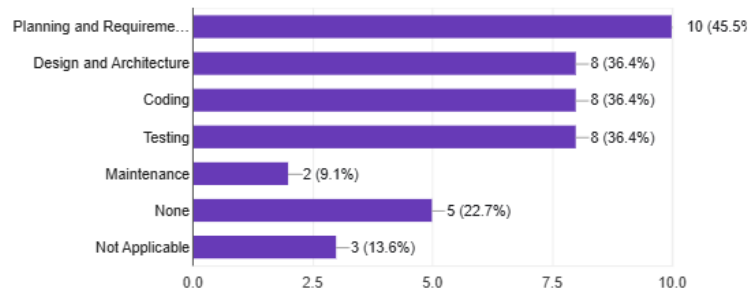
## Section 2: AI Tool Adoption in SDLC Phases

### 1. AI Tool Adoption Across SDLC Phases

The study investigated the adoption of AI tools across different phases of the SDLC. The findings indicate varying levels of integration:

- Planning and Requirements: 45.5% (10 respondents)
- Design and Architecture: 36.4% (8 respondents)
- Coding: 36.4% (8 respondents)
- Testing: 36.4% (8 respondents)
- Deployment: 27.3% (6 respondents)
- Maintenance: 9.1% (2 respondents)

These results highlight a stronger adoption of AI in the earlier and mid-stages of the SDLC, with maintenance being the least utilized area. This suggests potential for further AI integration in post-deployment phases.



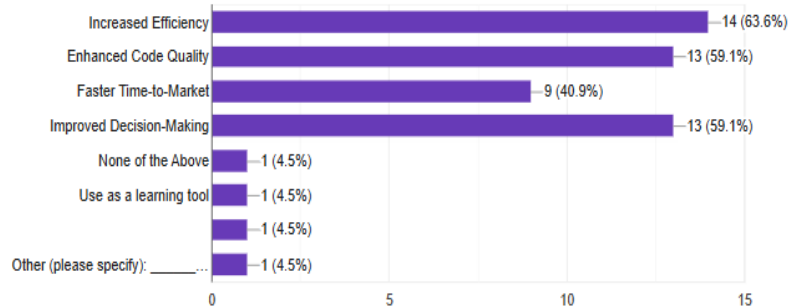
## 2. Perceived Benefits of AI in Software Engineering

Respondents identified several key benefits of integrating AI into software engineering practices:

- Increased Efficiency: 63.6% (14 respondents)
- Enhanced Code Quality: 59.1% (13 respondents)
- Improved Decision-Making: 59.1% (13 respondents)
- Faster Time-to-Market: 40.9% (9 respondents)
- Cost Reduction: 31.8% (7 respondents)

The most prominent benefits are perceived to be increased efficiency, enhanced code quality, and improved decision-making, aligning with the theoretical advantages discussed in the literature review.

## Section 3: Challenges and Ethical Considerations

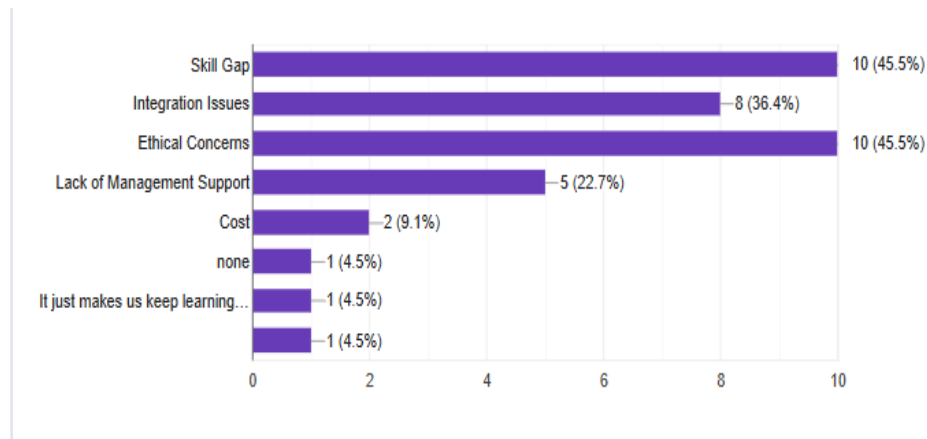


### 1. Challenges in AI Implementation

The study identified several critical challenges hindering the effective implementation of AI in software engineering:

- Skill Gaps: 45.5% (10 respondents)
- Ethical Concerns: 45.5% (10 respondents)
- Integration Complexities: 36.4% (8 respondents)
- High Initial Investment: 22.7% (5 respondents)
- Lack of Trust in AI: 18.2% (4 respondents)

Skill gaps and ethical concerns emerged as the most significant challenges, indicating the importance of targeted training and robust ethical frameworks.



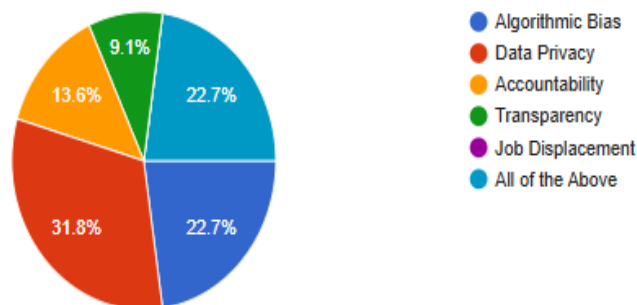
## 2. Importance of Ethical Considerations

A significant majority of respondents (81.8%, 18 respondents) emphasized the paramount importance of ethical considerations in AI integration. Specific ethical concerns highlighted include:

- Data Privacy: 31.8% (7 respondents)
- Algorithmic Bias: 22.7% (5 respondents)
- Accountability: 18.2% (4 respondents)
- Transparency: 13.6% (3 respondents)
- Job Displacement: 9.1% (2 respondents)

These findings reinforce the critical need for addressing ethical dimensions, particularly data privacy and algorithmic bias, to ensure responsible AI adoption.

## 4.3. Discussion



These findings indicate that software development with AI is becoming ever more common, though far from universal. There exist significant sectoral disparities, including between university and industry settings. Notable benefits found are clear efficiency and quality gains, largely in duly

qualified teams practicing ethics. The greatest issues found to have emerged due to the deployment of AI are those of skill, ethics, and integration mismatches, rather than cost or job losses. Findings concur with recent scholarly discourses emphasizing the dual nature of AI's influence: enormous promise and considerable deployment woes [19, 20].

Additionally, 81.8% of respondents emphasized ethical matters, suggesting that software engineering circles are becoming more aware of the societal consequences of AI. The issues of data protection and algorithmic bias align with the broader debate in the AI ethics community, which advocates for inclusive ethical guidelines and frameworks [21, 14]. This identified lack of recognized competency highlights the urgency to have in place recurrent education and training schemes to ensure that professionals acquire the appropriate knowledge to carry out effective and safe deployment of AI in a competent and viable form [13].

## **5. Ethical Framework for AI in Software Engineering**

It is also necessary to ensure the responsible growth and use of artificial intelligence in order to establish an effective system of ethical principles. Such a system will be grounded in shared principles about the ethics of AI and will deal with fairness, accountability, privacy, and transparency issues [14, 21].

### **5.1. Fundamental Moral Values**

Artificially intelligent software development tools also must be transparent about the procedures behind the decisions. This means that there has to be complete documentation behind the data upon which they were trained, the algorithms employed, and the reason behind the outputs delivered by the AI, particularly during critical phases such as design and testing [22].

**Lack of Discrimination and Fairness:** Serious steps should be taken to control algorithmic bias because the output is either discriminatory or unfair. This calls for a deep examination of artificial intelligence models on different datasets, continued verification to stop the emergence of biases, and the establishment of procedures to rectify them once they are detected [14].

**Responsibility and Governance:** Well-delineated obligations should be established to manage the growth, operations, and upkeep of artificial intelligence systems. Organizations should develop governance policies that combine ethical control, allow mechanisms to redress wrongs, and ensure ethical considerations and controls remain the overriding concern at all times [21, 23].

**Data Protection and Privacy:** With data-hungry AI needing to consume so much data, there is the necessity to ensure the data has stringent measures on how to secure and maintain its confidentiality. This requires compliance with regulations such as GDPR, adoption of complex data anonymization procedures, and the availability of safe data handling at all the phases of the SDLC [14].

**Human Oversight and Supervision:** Although artificial intelligence can execute various tasks, human oversight remains essential. AI systems should enhance human capabilities rather than completely supplant them, incorporating mechanisms to permit human intervention and final decision-making, particularly in contexts that are high-risk or sensitive [6].

## **5.2. Practicing with Ethical AI**

For them to implement these principles effectively, organizations should:

**Establish Ethical AI Standards:** Develop design principles and best practices aligned with the nuances of software engineering to deploy artificial intelligence.

**Train and educate continually:** Offer developers and engineers on an ongoing basis the ethical implications of artificial intelligence, responsible development of artificial intelligence, and techniques by which to discern bias.

**Establish ethical review committees:** Prior to initiating AI projects, an individual should enlist multidisciplinary review committees to examine ethical considerations generated by the projects.

**Foster an accountability culture:** Promote transparent communication and a future-thinking mindset to identify and resolve ethical challenges within development teams.

## **6. Constraints and Future Research**

### **6.1. Constraints**

The study contributes to the worthwhile knowledge on the addition of AI to software programming but has several limitations:

**Sample Size and Generalizability:** The quantitative survey component adopted a proportionally minimal sample size (22 professionals), and the results therefore may not generalize to the wider software engineering population. Future studies ought to ensure more participants and more participants.

**Self-Reported Data:** Using self-report data via interviews and questionnaires can lead to biases like social desirability bias. Follow-up studies can blend the observational techniques or objective performance measures with the self-report data.

**Geographical Scope:** Respondents to this research were sampled from limited organizational settings, and hence the results may not be equally applicable to various geographical locations and different cultural domains.

The field of artificial intelligence and software engineering is in constant flux. Observations and written records capture the present, yet they are subject to swift changes. Longitudinal studies would be advantageous to follow new currents and determine challenges along the way.

## 6.2. Future Research Directions

The finding and the limitation of our study imply many avenues for future research:

**AI Tool Impacts:** Carry out detailed case researches or empirical studies on the way the impacts of particular AI tools (like AI code generation or AI testing frameworks) on productivity, high quality, and ethical outcomes differ over the different cycles of the SDLC.

**Development of ethical AI indicators:** Discussing the creation of standard metrics and procedures to quantify the ethical output of the AI systems during software development, specifically based on bias, fairness, and transparency.

**Cross-Cultural Comparative Studies:** Discuss the variations among patterns of AI adoption, challenges, and ethical points of view among various nations and various cultural settings.

**Longitudinal studies on the learning of skills** will examine the effectiveness, over time, of different training programs and educational projects to help software professionals overcome the artificial intelligence capability gap.

**AI in Software Maintenance:** Since the application of AI is not immense during the maintenance stage, the future research work may be directed towards the generation and validation of AI solutions specifically geared towards the software maintenance activities, i.e., automatically resolving program bugs, system monitoring, and predicting system failures.

## 7. Conclusion

The survey data confirm that artificial intelligence is increasingly common but not universal within the field of software engineering. Also witnessed are large variations between various domains, i.e., between the academic and the industry domains. Overriding advantages include dramatic improvement in quality and efficiency, provided the teams are skilled and ethical. Most critical among the worries are the absence of skills, ethical challenges, and integration difficulties, and not cost and labor replacement considerations. This analysis gives organizations the foundation to manage the difficult application of artificial intelligence to the field of software development efficiently, effectively, and ethically.

## 8. Recommendations

**Investment in Continuing Education:** Continuing education programs are imperative to fill the shortage of skills and to manage the surge in artificial intelligence technology.

**Creating an Ethical System:** Institutions need to implement and abide by positive norms regarding protecting information, preventing algorithmic prejudice, and putting individuals in the driver's seat.

**Begin with a small pilot and expand gradually:** Pilot projects will demonstrate the advantage and determine the optimum AI solutions prior to large-scale application.

Encourage teamwork by ensuring that every department supports the AI implementation and considers all relevant factors.

The sector can learn from the education sector's use of AI to make learning better and boost productivity.

Foster the Sharing of Knowledge: Set up internal forums or "Centers of Excellence" to share effective practices and to benefit from each other's experience.

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