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Impact of Artificial Intelligence (AI) and Emerging Technologies on Scientific Research

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Abstract: *This study explores the impact of Artificial Intelligence (AI) and emerging technologies on scientific research quality and efficiency, focusing on students at Allama Iqbal Open University, Islamabad (AIOU). The research employs a quantitative design, utilizing a structured questionnaire to collect data from 169 participants. Both independent and dependent variables were operationalized, with AI-related factors considered as independent variables and research quality and efficiency as the dependent variable. Data was analyzed using correlation and regression analysis via SPSS, and the reliability of the scales was confirmed using Cronbach's Alpha, which showed acceptable to excellent reliability (0.736 for AI-related scales and 0.867 for research quality scales). The study found a strong positive correlation between General Perception of AI and Current Use of AI, indicating that better perceptions of AI correlate with higher usage in research. Additionally, concerns about AI's use were positively related to the perceived improvement in scientific research quality, suggesting that despite reservations, the technology is seen as beneficial in enhancing research processes. Regression analysis confirmed that AI has a significant impact on improving research quality and efficiency, with AI usage explaining a substantial portion of the variation in research outcomes. The study concludes with recommendations for increasing training in AI technologies, addressing ethical concerns, and fostering interdisciplinary collaboration to maximize AI's benefits in research.*

Introduction

Artificial Intelligence (AI) has become an accepted technology all over the world that can potentially enhance our living standards and boost the economy. Due to this, AI has been used widely in numerous sectors of the social systems (Heeg & Avraamidou, 2023). The term AI refers to the ability of a machine or a system to replicate the human intelligence. The goal of AI is to create a machine that can think and act like a human being i.e. learns reason, plan, perceive, and anticipate. Intelligence is one of the major characteristics that distinguish human beings among other animals. The inexhaustible industrial revolutions are gradually replacing human labour, regardless of the social status, with a continuously increasing number of types of machines. The second significant challenge will be the fact that machine

intelligence will be taking the place of human resources soon (Xu et al., 2021).

The importance of research efficiency in academic and industry is associated with the fact that the efficiency allows the more efficient use of resources and the production of knowledge with insight. The role of research efficiency in the development of knowledge and the new technologies and methods discovery in the academic circles is significant. Hanks (2002) focuses on the efficiency of research by offering original research data and information that would be valuable to both the industrial and academic researchers and graduates. Torrence et al., (2008) states that appropriate research in such fields as risk assessment and antibiotic resistance must be carried out to reduce the fears of the population and to guarantee the safety of food. Research efficiency is greatly demanded to enhance creativity, ease operations and boost output in industrial sector. As the wireless communication technologies evolved, the research areas are now more attractive, which results in the increase of road safety and efficiency of the traffic (Eze et al., 2014).

Salonitis et al., (2016) also indicates the significance of research efficiency to advance sustainability by giving an idea of the current state of the art concerning industrial practices and research topics that are associated with energy-efficient processes. Liu et al., (2019) summarizes the significance of research efficiency in the emerging areas, including that of edge computing systems. This survey study was used to review existing edge computing programs and systems to explore new research opportunities and assist users in making the right choice of the systems to use in specific applications. Zhen et al., (2019) studies are eager to mention how the exploration of new research issues is urgently needed to reach the maritime shipping networks and green ports with greater effectiveness and efficiency. AI has been of interest to many disciplines when it comes to how it can improve the productivity of research.

Hermens and Clarke (2009) indicated that there could be great innovation in terms of teaching and learning practices when they explained how business simulations that are involving the use of computers were being applied in higher institutions of learning in order to fuel the practical knowledge of students on real business issues. Bhatt and Muduli (2023) performed thematic analysis of the literature on the application of AI in the area of learning and development with a focus on how critical thinking and synthesis of historical research may result in the identification of crucial topics.

To understand the ways in which anthropomorphism and archetypes can be modified in the context of marketing AI-based products, Karimova et al., (2021) carried out emotionalist interviews to understand how the participants perceive these products, including Sophia, Alexa, and Articoolo. This study has demonstrated the interdisciplinary nature of AI studies, which represents the possibility of the connection between Jungian archetypes and AI products. Lutfiani et al., (2024) reviewed the input of AI in improving resource efficiency within urban infrastructure to create new methods of optimizing the use of resources, energy management, and better monitoring and control systems. This study demonstrates how AI technology can entirely transform the landscape of sustainability and management of urban infrastructures. Mahmud (2024) examined the applicability of AI in automating the library cataloguing and classification processes by discussing existing applications, challenges, and opportunities. The objective of this study is to investigate the impact of AI and emerging technologies on scientific research by analyzing the ways in which AI technologies enhance various aspects of the research lifecycle. This work offers an exhaustive comprehension of the role of AI in the transformation of research processes.

Research Questions

1. How does AI enhance specific research activities such as literature review, data analysis, and experimentation?
2. What future opportunities exist for leveraging AI to further improve scientific research efficiency?

Literature Review

The possibility of AI-enhancing and mostly automating research has raised heated debates in various fields of science. The past years were characterized by the rising popularity of the application of AI methods and technology in studies of more and more fields. Peyravi et al., (2020) focused on the issue of AI and marketing correlation and potential future uses of AI in marketing campaigns. Fredström et al., (2021) emphasized some of the future research directions in this area by also covering how the spread of inventions can be observed at scale on patent data using AI-based analysis. Sharpless and Kerlavage (2021) explored the future of AI in cancer research and care and introduced major opportunities and breakthroughs that the use of AI promises in that highly valuable sphere in medicine.

Chichekian and Benteux (2022) wrote about the future of AI-assisted classroom learning and the need to quantify the performance of AI-assisted devices and the part of the instructors in the matter. When examining the application of AI to communication, Sundar and Liao (2023) cogitated over the psychological ramifications of AI as a communication tool and provided the research topics to focus on in the future in this field. In discussing the topic of AI-powered decision-making in management, Ramachandran et al., (2023) provided a review of the current state of technologies in the field of AI in decision-making processes and proposed future research topics in the study.

Judit et al., (2023) examine the application of AI tools in education and enlighten on the possibility of improving the educational processes by exploring the views of university instructors on the integration of AI. Dedema and Ma (2024) explored how researchers use and perceive generative AI technologies, thereby offering useful data on how researchers adopt and assess such technologies. Lastly, Thaler et al., (2024) introduced the Institute for AI and Fundamental Interactions (IAIFI) and have indicated the significance of introducing physics intelligence to AI tools to address physics problems that are difficult to solve.

Wagner et al., (2024) expressed concerns regarding AI/ machine learning tools, specifically, by emphasizing on computational checklists and synthetic data, which would encourage repeatability and ethics in AI/ machine learning investigation. To be more influenced, academic work requires efficiency of research. It has been revealed that the effective search methods utilizing the appropriate scholarly databases may significantly improve the quality of systematic reviews and meta-analyses. The search systems applied to synthesize the evidence depend on the quality of the evidence and also affect the recall and precision of relevant literature. Effective business modelling in the corporate world is needed to implement innovation in product development as in the techno-based industries. By investing in business modelling technologies, businesses are able to maintain a strategic competitive advantage and enhance operational efficiency. The application of AI tools like ChatGPT to simplify the process and increase the efficiency of the work of various organizations has also been identified (Pradana et al., 2023).

There are many techniques of evaluating research efficiency which may be classified into parametric and non-parametric techniques. Data Envelopment Analysis (DEA) is a nonparametric analysis method that uses the output of decision-making units relative to the input to determine the efficiency of the decision-making unit. DEA has numerous purposes such as use as agriculture and education. An approach that uses statistical noise in the data in estimating the efficiency frontier and is parametric.

Economics is a field where SFA is often used to measure efficiency and productivity (Olesen & Petersen, 2016).

Different industries have been interested in seeking ways of exploring measures that can establish effectiveness of research. Kaski and Heikkila (2002) were interested in developing one technique to inform the formation of product structures, as well as quantify the disparity among the alternate implementations of the design alternatives in the effort to minimize the operation and asset expenses in demand-supply chains. Martin and Patterson (2009) mentioned the applicability of enterprise effectiveness by linking the supply chain performance to the financial performance of an enterprise.

Chen and Delmas (2011) offered a new approach to calculating a CSP index with the help of DEA, which opened new horizons to the empirical research on CSP in the coming years. In order to place the energy efficiency on the centre of attention, Bianzino et al., (2010) compressed and contrasted a group of energy metrics that are followed in communications network research. Uddin et al., (2013) emphasized the significance of green data centres and necessity to take measures of Power Usage Effectiveness to analyse the performance and efficiency of data centres in terms of cost and operational efficiency.

Badenhorst et al., (2013) examined the effectiveness of information flow within a supply chain, as well as the formulated conceptual framework of metrics and indicators to assess the effectiveness of information flows. In order to offer a guideline on the design and optimization of data centres, Zhou et al., (2013) offered application-level metrics regarding the use of power efficiency in data centres. Sinsky et al., (2020) introduced the basic measures of Electronic Health Record (EHR) use in the healthcare industry to capture the characteristics of practice efficacy including total EHR time and time on documentation. Such measures are used to show their applications by numerous stakeholders. In their analysis of the relevance of the graph and network theory measures applied to quantify connectivity in geomorphic systems, Wohl et al., (2019) emphasized the fact that the pattern of connectivity is important to be understood to operate rivers.

Corrado et al., (2022) demanded the use of a choral approach, however, through the combination of digital twins and green measurements, the authors argued that smart cities and structures should tackle the issues pertaining to sustainability. Recent studies also suggest AI based literature reviews, a type of reviewing, in which AI applications facilitate various steps, including the analysis of the data, literature search, and problem formulation. In this way, it can save the time and effort that are so in demand when conducting a thorough review. Natural language processing (NLP) algorithms are used to summarize studies before they become large and facilitate academic professionals in determining gaps and putting up new questions based on their research (Butson & Spronken, 2024).

Many studies demonstrate that many research processes, such as data processing and literature reviews, can be accelerated with the help of AI. An in-depth examination of the literature e.g. has shown that 26 articles pointed out time-saving as the most common advantage of AI across the fields. Automating simple tasks, AI helps the researcher to spend more time doing complicated analyses. This may mean the automation of the initial scans of the articles that could filter out the poor-quality submissions before the human review in the peer-review process, for example. As machine learning algorithms are involved in making the complicated content judgments and derive patterns of large data sets, more interest in the research subjects becomes feasible. According to the findings of the new research, despite numerous benefits, there are unsettled questions that require to be addressed, particularly regarding the long-term consequences of AI on the rigor of methodology and academic integrity (Ekundayo et al., 2024).

The vision of multidisciplinary research also opens due to AI capacity to analyse a large variety of data,

which can result in new cross-disciplinary cooperation. Jialiang et al., (2021) have also examined the effects that AI-algorithmic decision-making processes have on procedural fairness perceptions among the workers and determined that AI-based decisions might result in a decrease in perceived fairness compared with those made by a human supervisor. Mazingue (2023) has been trying to shed some light on the benefits and pitfalls of the introduction of AI in CRM systems through exploration of the multi-dimensional effects of AI in CRM. Fu et al., (2025) examined the role of AI in relationship breakdown with specific focus on the breakup processes that have been simplified by the computer-mediated communication. Chang et al., (2024) analyzed the influence of the propensity of employees to use AI on the impact of AI-induced techno stress to determine the potential influence of technostress on the use of AI. Thottoli (2024) focused on the application of AI and ICT to optimize the auditing processes and emphasized the importance of the technologies in the context of optimizing the audit processes. Yahanda et al., (2025) highlighted the uses of AI in the medical sphere by providing the narrative review and commenting on the existing and potential future effects of AI on spine surgery and research.

Research Gap

The current trends of Artificial Intelligence (AI) and new developments in the realms of science have chased the direction of global scientific research greatly, so the new tools and techniques to discover and innovate are provided fast. Nevertheless, even though, the advances have been made, an evident gap in expertise concerning the ways of successful integration of the technologies into a variety of scientific fields remains (Butson & Spronken, 2024). In particular, little research is done on the issues that are associated with the adoption and implementation of AI in the traditional scientific workflows such as data handling, ethical issues, and the necessity of interdisciplinary partnership. Also, the implications of AI on the reproducibility and transparency of scientific research are insufficiently studied, and the risk of algorithmic biases and the necessity of standardization in methodologies based on AI is raised. These gaps are important issues, which need to be eliminated to ensure that the full potential of AI and other emerging technologies are used to the best of their abilities to create scientific discovery.

Methodology

The study followed a quantitative approach to study how AI and new technologies affect scientific studies. The analysis was carried out through a survey method, which enabled the researcher to gather numerical data on a big sample of respondents. To determine the relationship between variables of AI and its perceived influence on scientific research outputs, the research was designed in such a way. The independent variables were the level of AI and emerging technologies perception, Current Use, Concerns about Use of AI and Future Perception and the dependent variable was the perceived improvement in research quality and efficiency. This study involved a population of 300 students in Allama Iqbal Open University, Islamabad (AIOU) and this comprised of a diverse student population who are both male and female and belong to different academic backgrounds. To provide equal representation of both male and female participants, stratified sampling technique has been used. Using the specified value of the confidence level at 95 per cent, the margin of error at 5 per cent, and the population proportion of 50 per cent; the sample size was calculated to be 169 participants. To collect data about the awareness, attitudes and experiences of the participants towards AI and new technologies, the research tool of this research was a structured questionnaire, which was based on Vera (2023) and 20 items questionnaire of artificial intelligence and self-structured one with 6 items were adopted based on the quality and efficiency of research. The data were collected within the two weeks where the questionnaires were personally distributed to the participants. All the participants

received a copy of the informed consent form with the description of the aim of the study, voluntary character of the participation, and anonymity of the responses. After data collection, it was put into SPSS to be analyzed. The initial calculations were done through the use of descriptive statistics which gave the general impression of the respondent demographics and general trends in the data. Cronbach's alpha was used to determine how reliable the measurement scale was and a score of over 0.7 ensured internal consistency of the scale. Table 1 shows the reliability scores of the scales to be used in the study in terms of Alpha of Cronbach. The AI and Emerging Technologies scale is highly reliable with 20 items and the Cronbach's Alpha is 0.736 that represents a satisfactory level of internal consistency. When the value exceeds 0.7, one can assume that the scale is reliable, that is, it offers stable results. The perfect reliability of a scale is 0.867, whereas the scale of Scientific Research Quality and Efficiency (6 items) has it and is regarded as great. It implies that the measures applied in quantifying the scientific research quality and the efficiency of such research has high consistency.

Table 1: Reliability Scale

Scale	Items	Cronbach's Alpha
AI and Emerging Technologies	20	0.736
Scientific Research Quality and Efficiency	6	0.867

To test the relationships between the independent and dependent variables, correlation and regression analyses were performed. The regression test was used to determine the strength and direction of the relationship between AI integration and perceived research improvement, while correlation analysis helped to identify any significant associations between variables.

Results

Table 2 gives the overview of the demographic data of the 169 individuals who took part in the study. 32% of the respondents were male (54 participants) and 68% were female (115 participants). On age, most of them (51.5%) fell within the age group of 20-22 years with the rest (48.5%) falling within the age group of 23-25 years. The departmental affiliation of the participants is also displayed in the table 24.3% were in the field of Statistics, 25.4% were in the field of Mathematics, 23.7% were in the field of Economics, and 8.9% were in the field of Business Administration, Data Sciences, and the other departments.

Table 2: Demographic Information (N=169)

Variable		Frequency	Percentage
Gender	Male	54	32.0%
	Female	115	68.0%
Age	20-22 Year	87	51.5%
	23-25 Year	82	48.5%
Department	Statistics	41	24.3%
	Mathematics	43	25.4%
	Economics	40	23.7%
	Business Administration	15	8.9%
	Data Sciences	15	8.9%

	Other	15	8.9%

Table 3 presents the descriptive statistics of the different variables that were measured in the research such as the mean and SD = each measure. The average of the General Perception of AI (GPI) is 3.157 and the SD = 0.711 which means that the respondents have a neutral to slightly positive perception towards AI. The mean of the "Current Use of AI" (UAI) is equal to 3.289 with a lower SD = 0.609, which indicates that the respondents are slightly more experienced at using AI. The mean of the concerns about the use of AI is 3.178 with a SD = 0.514, which is indicative of moderate concerns in the participants. The average of Future Expectations of AI (EAI) was 3.207 and the SD = 0.597, which indicates that the participants hold moderate expectations about the future of AI. Finally, the average of the Scientific Research Quality and Efficiency (SRQE) is 3.029 with a SD = 0.538 that implies that the participants experience moderate research quality and efficiency improvement because of AI.

Table 3: Descriptive Statistics

	Mean	**Std. Deviation**
General Perception of AI (GPI)	3.157	0.711
Current Use of AI (UAI)	3.289	0.609
Concerns About the Use of AI (CAU)	3.178	0.514
Future Expectations of AI (EAI)	3.207	0.597
Scientific Research Quality and Efficiency (SRQE)	3.029	0.538

Table 4 shows correlation among various variables of the study. The correlation between the General Perception of AI and Current Use of AI (GPI and UAI respectively both) shows a strong positive correlation with a correlation coefficient of 0.831 (Significant with 0.01 level). This shows that the better the perception of AI that the respondents have, the more they will use AI. The moderate positive relationship between "Concerns about the Use of AI" (CAU) and "Scientific Research Quality and Efficiency" (SRQE) is (0.724) with the higher the concerns about the use of AI, the higher the perception of the role of AI in enhancing research. Also, the Future Expectations of AI (EAI) are moderately correlated with Scientific Research Quality and Efficiency (SRQE) (0.814) indicating that the fact that people have more positive expectations about the future of AI is associated with the perception that the outcomes of scientific research will improve.

Table 4: Correlation

	GPI	**UAI**	**CAU**	**EAI**	**SRQE**
General Perception of AI (GPI)	1				
Current Use of AI (UAI)	.831**	1			
Concerns About the Use of AI (CAU)	.521**	.429**	1		
Future Expectations of AI (EAI)	.238**	.115	.870**	1	
Scientific Research Quality and Efficiency (SRQE)	.262**	.160*	.724**	.814**	1

* & **. Correlation is significant at the 0.05 & 0.01 level (2-tailed).

Table 5 shows the regression coefficients of the independent variable, which is AI, on a dependent variable of Scientific Research Quality and Efficiency (SRQE). The unstandardized coefficient of AI is 0.667, which implies that as AI increases by one unit, there is increase in the SRQE of 0.667. The standardized coefficient (0.595) indicates a rather good and positive impact of AI on research quality

and efficiency. The t-value of 9.567 and the significance value of 0.000 indicate that this relationship is statistically significant, which confirms that AI has a great influence on the perceived quality and efficiency of scientific research.

Table 5: Regression Coefficient

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	β		
(Constant)	.888	.226		3.924	.000
AI	.667	.070	.595	9.567	.000

a. Dependent Variable: SRQE

The results of the ANOVA of the regression model are provided in Table 6. The regression sum of squares is 17.277, and the residual of sum of squares is 31.520. F-value of 91.536 with a significance of 0.000 implies that there is a high level of significance in the regression model and thus the independent variable (AI) is significant in the variation of the dependent variable (SRQE). The value of the sum of squares and high F-value indicate that the model is able to fit the data and that AI is highly relevant in enhancing the quality and efficiency of research.

Table 6: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.277	1	17.277	91.536	.000[b]
Residual	31.520	167	.189		
Total	48.797	168			

a. Dependent Variable: SRQE, b. Predictors: (Constant), AI

Discussion

The results of the present study correspond to the existing literature, which makes it possible to believe that AI and new technologies have a great influence on the quality and efficiency of scientific research. The fact that both the positive correlation between the variables is already established between General Perception of AI (GPI) and Current Use of AI (UAI) (r = 0.831) agrees with previous research that demonstrated that, the better the perception of AI among the researchers is, the more willing they are to use it in their work (Brynjolfsson & McAfee, 2017). In this study, the moderate positive correlation was established between "Concerns About the Use of AI" (CAU) and the relative to the concerns, "Scientific Research Quality and Efficiency" (SRQE) (r = 0.724), which indicates that there is a concern about AI but perhaps it is offset by its perceived positive effect on research. This follows the observation of Binns (2018) who noted that even after raising their concerns; researchers are still likely to be thankful of the efficiency and accuracy that AI can provide in their research operations. Also, the regression model (B = 0.667) revealed that there was a statistically significant effect of AI on the perceived increase in the quality and efficiency of scientific research. This observation is in tandem with previous studies by Jha and Topol (2016), who described the use of AI in improving the quality of research, especially in data-intensive research such as bioinformatics and medical research. The above connection between AI and research efficiency is similar to other research works, which indicated that the application of AI could enhance the ability to analyse data, shorten the discovery process, and obtain more precise results (Panch et al., 2018). To the study, it was also established that Future

Expectations of AI (EAI) were positively correlated with Scientific Research Quality and Efficiency (r = 0.814). This is a continuation of previously conducted research by Schwab (2016), who said that the further development of AI has the possibility of transforming not only the speed of the scientific discoveries but also the quality of the research results as well. In the same manner, the moderate association between AI concerns and research quality (r = 0.521) aligns with the research conducted by Siau and Wang (2018), who found out that although there is a valid concern about AI, including the fact that it can replace human researchers, the concern is not too strong to mask the advantage AI offers as a tool of enhancing and increasing the efficiency of the research process. Moreover, the high scores of ANOVA test indicate model strength (F = 91.536, p = 0.000) and are strong indicators of the effects of AI on the quality of the research and are consistent with the recent studies of AI adoption (Shin, 2019). The regression analysis statistical significance supports the research of earlier studies that AI is not only influencing the quality of research but also creating innovations in other fields of science. Compared to the previous works, the given research contributes to a new aspect of the study as it specifically concentrates on the Pakistani student population, which offers a specific view on the perception and usage of the emerging technologies in academic institutions. Although the efficiency of research with the help of AI has been continuously demonstrated to be high in the context of global research (Brynjolfsson & McAfee, 2017; Jha & Topol, 2016), the current research confirms that such attitudes and worries are more common among students in Pakistan, which allows concluding that AI technologies have a global presence and applicability to the scientific research. On the whole, the findings of this research can be added to an ever-expanding amount of literature indicating the transformative potential of AI and new technologies in research. Nevertheless, according to the findings presented in the past literature, the effective introduction of AI in research processes demands managing the issues associated with the ethical considerations, data privacy, and transparency of the algorithms (Binns, 2018; Siau & Wang, 2018). The use of AI in non-Western societies needs to be studied more in the future, and it is hoped that its potential of improvement should be achieved worldwide.

Conclusion

This study has shown that AI and new technologies affect the quality and efficiency of scientific research positively, and strong correlations exist between the perceptions of AI that the participants have and the use of AI in the research process. The results substantiate the trend of literature that AI can make the research process more effective, interfere in data analysis, and optimize research results. Although there are fears about the role of AI in research, the participants had more positive expectations regarding the future role of AI. The paper demonstrates a necessity of further investigation of the implementation of AI into research processes since the technology has immense potential to transform the way science is conducted. Nevertheless, the ethical implications and data privacy can be discussed as one of the areas that should be given attention.

Recommendation

1. To maximize the potential of AI in scientific research, institutions must engage in extensive training of their researchers on AI and new technologies so as to increase their ability and confidence in applying them to scientific research.
2. Research organizations and policymakers are to cooperate in order to establish clear standards and rules of how AI can be used in research, with transparency, fairness and data privacy being among the most important aspects reducing the risks of bias.
3. Interdisciplinary collaboration between computer scientists, researchers, and technologists is also something that should be promoted and encouraged to ensure that

AI can be integrated into other scientific disciplines to create more innovative and efficient research results.

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