ADVANCE SOCIAL SCIENCE ARCHIVE JOURNAL
Available Online: https://assajournal.com
Vol. 05 No. 01. Jan-March 2026.Page#.4643-4652
Print ISSN: 3006-2497 Online ISSN: 3006-2500
Platform & Workflow by: Open Journal Systems

Motivation to Shape the Future of Early Childhood Care and Education with Artificial Intelligence: An International Comparison of Pakistan with Other Countries

Ghulam Haider
Ph.D Scholar University of Sargodha
Email: haidergazi82@gmail.com
Amt-ur-Rauf
Ph.D Scholar University of Sargodha
Email: amatu.raof@gmail.com
Hafsa Abdul Majid
Ph.D Scholar University of Sargodha
Email: Hafsahamajid@gmail.com
Dr. Dildar Hussnain
School Education Department
Email: dildarshah136@gmail.com

ABSTRAC
The use of Artificial Intelligence (AI) in Early Childhood Care and Education (ECCE) is a revolutionary field in the realm of education policy worldwide. In other countries such as high income countries, AI applications are being trialed for enhancement and personalization, whereas low and middle-income countries (LMICs) like Pakistan may see AI as a means to systemic inequities, gaps, and limitations in access, quality, and equity. This extensive article makes an international comparative analysis and looks at the varying motivations, strategic approaches and moral concerns behind the adoption of AI in ECCE in different national settings including Pakistan, Finland, Singapore and China. Comparing the early intentions for innovation in Pakistan to those of Finland and Singapore, which are driven by innovation, and China which is focused on scale, it presents a comparison in terms of what is happening in Pakistan. This paper critically synthesizes the literature, policy analysis, and comparative evaluation to support this argument that national context, including infrastructure, governance, cultural norms, and economic capacity, significantly influences the course of AI's evolution in the field of ECCE. The results indicate that if not complemented by parallel investments in basic infrastructure, good ethical standards, and teacher capacity, AI can deepen the existing educational and digital inequality. It has been identified that the digital divide in Pakistan is enormous, with only 45% children in the age group 3-5 years enrolled in pre-primary education, and rural children only 32% of the total enrolment, with trained ECCE educators serving an average of 45 children per classroom. The article ends with recommendations for Pakistan and other contexts that are based on evidence, which call for a "glocalized" approach to the use of AI:

adapting the potential of global technologies to local contexts, and ensuring that AI is an equitable tool in child development.

Keywords: Artificial Intelligence, ECE in Pakistan, International comparison, Educational Technology, Policy, Equity, Digital Divide, Glocalization.

1. BACKGROUND

Early Childhood Care and Education (ECCE) is known globally to be a key factor in lifetime learning, health and socio-economic development (UNESCO 2022). Cognitive, social-emotional and physical skills develop during the first eight years of life and serve as the building blocks for future development. Studies show that investing in quality ECCE results in a return of 7-13% annually based on educational attainment, health outcomes and economic productivity (Heckman, 2006). At the same time, Artificial Intelligence (AI) has been on a tear in the 21st century, and its "sub-technologies" (Machine Learning (ML), Natural Language Processing (NLP), and computer vision) have infiltrated across numerous industries. The AI market is set to grow to $1.8 trillion by 2030, accounting for a growing proportion of education technology (PwC, 2024).

These fields converge into great possibilities and great complexities. On the international level, the reasons for the integration of AI in ECCE are diverse, ranging from the goal of individualizing learning processes and automating administrative work, to offering developmental screening, and assisting teachers who are overwhelmed. But the translation into practice is strongly mediated, however, by a country's technological infrastructure, educational policy landscape, socio-cultural values and economic resources. While high-income countries test out AI to supplement already robust systems, LMICs such as Pakistan are driven by the pressing need to overcome systemic challenges, such as limited access, resources, and a shortage of teachers.

The ECCE scenario in Pakistan is challenging. The Pakistan Education Statistics Report (2023) revealed that only 45% of children in the age group 3-5 years are enrolled in pre-primary education, and there is a significant gap between rural areas (32%) and urban areas (68%). In public ECCE centres, the teacher-student ratio is on average 1:45, which is higher than the recommended ratio of 1:15 (UNESCO, 2022). Additionally, 67% of the rural ECCE centres do not have reliable electricity and only 28% of the rural ECCE centres have internet access (Hassan & Rizvi, 2023). The constraints impose urgency and challenge to the integration of AI, a technology that may have the potential to fill gaps but could also exacerbate existing inequities.

2. INTRODUCTION

2.1 Theoretical Framework

This analysis is based on an integrated theoretical framework, based on two complementary approaches. The lens through which to examine the influence of perceived usefulness and perceived ease of use on adoption decisions for educators and policymakers is the Technology Acceptance Model (TAM) (Davis, 1989). Second, the Ecological Systems Theory of Bronfenbrenner (1979) provides a model through which all of the various nested environmental systems (microsystem to macrosystem) are seen as interacting to influence child development and school practices. These frameworks allow a sophisticated understanding of how individual perceptions, institutional contexts, and wider socio-cultural and political-economic factors (Holmes et al., 2019) all help to shape the nature of AI's adoption in ECCE.

2.2 The Global Landscape of AI in ECCE

UNESCO (2021) and the OECD (2023) have started to introduce guidelines, highlighting the potential of AI to facilitate play-based learning and complement rather than supplant human interaction. The literature lists some important applications:

Personalized and Adaptive Learning: AI-driven systems can adjust the content and pacing to meet the needs of each child (Luckin, 2022; Holmes et al., 2019).

Intelligent Tutoring Systems (ITS): These systems offer individualized tutoring in areas of literacy and numeracy (Woolf et al., 2023), but there are concerns about their ability to cater to very young children (Akgun & Greenhow, 2022).

Automated Assessment and Developmental Screening: NLP can test children's speech for milestones in language acquisition and computer vision can identify possible developmental delays (Smith & Ali, 2023).

AI's Administrative and Pedagogical Support for Educators: AI can alleviate educators' workload by sending automated progress reports to parents. (Bevan et al., 2022).

This is not a matter of taking the technology for granted, however, because of worries about the displacement of play-based learning, the removal of teacher professional judgment, and the saturation of surveillance, there is an increasing body of scholarship that warns of the dangers of uncritical adoption (Selwyn, 2021; Williamson, 2021).

2.3 Divergent Motivations: A Typology from Literature

Based on scholarly research, there are several models which can explain the national motivations for AI in ECCE:

Enhancement Model (e.g., Finland, Sweden): Motivation is driven by the desire to be continually innovative in a robust and fair public ECCE system. The emphasis is on "slow AI", ethical issues, child agency, and enhancing pedagogical practice (Dignum et al., 2023).

Competitive Advantage Model (e.g., Singapore, South Korea): AI integration is part of national economic and technological strategy to stay competitive in the world (Tan & Siti, 2023).

The Scale and Efficiency Model (e.g., China, India): With a large population base, the key is to standardize quality and organize classroom management with AI at an unprecedented scale (Zhang & Huang, 2023).

The Gap-Filling Model (e.g., Pakistan, Nigeria, Bangladesh): Motivation is connected to solving short-term problems which include lack of skilled teachers, inadequate and inaccessible learning materials, and inaccessible rural communities (Chaudhry & Mahmood, 2024). The risks covered are a “digital dump” of inappropriate technologies and the need to locate (UNICEF, 2022).

2.4 Pakistan context in literature

The following are identified as meaningful themes in the research specific to Pakistan:

Motivational Drivers: There is motivation to use AI in local language learning apps, remote teacher training and to close the rural-urban ECCE gap (Khan & Ahmed, 2023). 39% of Grade 3 children can read a story in their local language (ASER Pakistan, 2023).

The critical barriers are Internet access is 36% of the population nationally (PTA, 2024), mobile broadband coverage in rural areas is only 24%, the average teacher to student ratio is 1:45 (Hassan & Rizvi, 2023) and less than 5% of public ECCE centers have any digital device.

Current efforts: +1.5 Million learners reached with AI-powered personalized learning in Urdu through Taleemabad app. The Tele-Taleem programme in KP aims to reach remote communities through the provision of AI-enhanced content delivery (Khan & Ahmed, 2023).
Governance Fragmentation: ECCE governance is distributed over several provinces, ministries, which make it difficult to develop a national AI strategy.
Research Gaps: Limited number of studies is available on impact of AI tools in ECCE settings in Pakistan, and none of them are longitudinal in nature.

2.5 Research Objectives and Questions

1. Discuss about the main motives behind the adoption of AI in ECCE in Pakistan, Finland, Singapore and China.
2. Examine the relationship between motivation and strategy and practice in the national context.
3. Compare the opportunities and threats of using AI in the ECCE sector in Pakistan.
4. Create a policy framework that considers context-based ethical, equitable and effective integration of AI in Pakistan.

2.6 Research Questions

1. What are the motivations for adopting AI in the field of ECCE in Pakistan, Finland, Singapore and China?
2. What impacts do national context factors (policy, infrastructure, culture, economy) have on integration strategies for AI?
3. What are the takeaways from other countries for Pakistan in exploiting the opportunities and risks of AI?
4. What are the policy recommendations to promote ethical and effective integration of AI in Pakistan's ECCE?

3. Methodology

The method used in this study is qualitative comparative case study approach as described by Yin (2014), which is employed via document analysis and literature synthesis to understand the integration of AI in ECCE in four national contexts. Based on the “most different systems” design (Przeworski & Teune, 1970), four countries were identified: Pakistan (central case; LMIC gap-filling model), Finland (enhancement model), Singapore (competitive model) and China (scale model). The data were obtained from various secondary sources such as peer-reviewed journal articles (2019-2024), policy documents, international reports (UNESCO, OECD, UNICEF), and national statistics (Pakistan Education Statistics, PTA, ASER Pakistan). AI, ECCE, and the four countries' keywords were used to systematically search the literature in Scopus, Web of Science, Google Scholar, ERIC, and JSTOR. An integrated theoretical framework of the Technology Acceptance Model (Davis, 1989) and Bronfenbrenner's Ecological Systems Theory (1979) guided the analysis, which was carried out using a four-step structured thematic analysis (Braun & Clarke, 2006): contextual mapping, policy and strategy analysis, comparative cross-analysis, and thematic synthesis. Triangulation of multiple data sources, an audit trail of analytical decisions and explicit acknowledgment of limitations provided additional trustworthiness. The limitation is that this study is based on secondary data only, as it is a policy-driven exploratory study, which was suitable for this comparative study.

4. COMPARATIVE ANALYSIS: PAKISTAN VIS-À-VIS NTERNATIONAL BENCHMARKS

4.1 Finland: Ethics and Augmentation

The Finnish ECCE system is one of the most respected in the world and it is universal, with highly qualified teachers (those with a master's degree), a strong emphasis on play-based pedagogical approach and a high level of trust in teachers within society. AI is seen as an instrument to support creativity and exploratory learning instead of teaching (Dignum et al., 2023). The policy framework is robust, based on the national AI strategy, the EU AI Act and GDPR compliance. AI-based toys for group play and analytics for teachers are among the key initiatives. While there are of course some important lessons Finland can offer Pakistan in the policy process, it is not possible to transfer its “slow AI” philosophy (deliberation and testing) directly due to resource limitations.

4.2 Singapore: The International Development of Language Skills

The "Smart Nation" initiative in Singapore offers a holistic framework for the inclusion of technology. Motivation is to maintain an international quality education and develop future ready skills (Tan & Siti, 2023). Policy is bottom-up, systematic, is rigorously piloted, and is central purchased. The most important projects are the country-wide adaptive learning platforms and the sensor-based "smart kindergartens". Singapore illustrates how policy and infrastructure can come together to create and achieve impact that is aligned with Pakistan's need for coordinated governance.

4.3 China: Scale, Surveillance and Speed

China has a population of over 1.4 billion which poses special challenges. The aim of motivation is the quality control and management of the largest ECCE system in the world (Zhang & Huang, 2023). Facial recognition for attendance, smart classroom management systems, and AI-powered “nanny” robots are some of the major initiatives. China's efforts seem to be very scalable, but it also provides a warning about ethics. Lacking robust data protection legislation (as Pakistan does not have), similar tools could result in privacy breach. China's model emphasizes the role of state capacity and coordination.

4.4 Pakistan: Motivation in the context of constraints

The education system is fragmented and has a high degree of regional variation, serving a population of more than 240 millions in Pakistan. The contribution of the education budget to ECCE is less than 1% (UNESCO, 2022). The major motivation is gap-filling, in the context of teacher shortage and provision of personalized learning in overcrowded classrooms (Chaudhry & Mahmood, 2024). There is no separate AI in ECCE policy in place. Isolated projects are Urdu language Mobile Learning Apps and Tele- Mentoring. The problem is that the motivation to use AI for equity is undermined by the very inequity it would be fighting against – the digital divide. The danger is that this might leave a dual system as AI enhanced private urban centers and under-resourced public/rural centers.

4.5 Table 1: Synthesis of Comparative Analysis

Aspect	Pakistan (Gap-Filling)	Finland (Enhancement)	Singapore (Competitive)	China (Scale)
Primary Motivation	Address access, quality, resource gaps	Enhance play-based pedagogy, ethical innovation	Maintain global competitiveness, systemic excellence	Manage scale, ensure uniformity, tech leadership
Policy Driver	Absent; ad-hoc, donor-driven	Strong, ethics-first, educator-centric	Strong, centralized, national tech strategy	Strong, state-led, social governance
Infrastructure Status	Major constraint; 36% internet, 28% rural ECCE connected	Ubiquitous, reliable, universal connectivity	World-class, universally accessible	Advanced with urban-rural variations
Key AI Focus	Localized content, teacher support, remote learning	Playful learning analytics, educator tools	Adaptive learning, smart environments	Classroom management, facial recognition
Teacher Role	AI as potential support for overburdened teachers	AI as augmentation of professional judgment	AI as tool for professional development	AI as monitoring and quality control
Data Governance	No specific framework; weak protection	Strong GDPR compliance; children's rights priority	PDPA regulation; state-managed	State-controlled; limited transparency
Major Risk	Exacerbating digital divide, unfit solutions	Over-caution slowing innovation	Over-reliance on data, high-stakes implementation	Mass surveillance, privacy loss, reduced human interaction

5. FINDINGS

1. Motivation is Context-Defined: A country's initial socio-economic and educational conditions determine the country's initial motivation. AI for Pakistan is just a means to access and improve basic education quality; for Finland, to refine pedagogy; for Singapore, to provide a competitive edge; and for China, to scale and manage.

2. The other Non-Negotiable Precursor is Infrastructure: Advanced AI applications rely on strong digital infrastructure. Concurrently investing in electricity, connectivity and affordable devices is essential for Pakistan's motivation to be realized. The single most important barrier is the digital divide, defined as the gap between rural ECCE centres, where 67% do not have electricity, and 28% do not have internet access, and urban areas.

3. Policy Vacuum is critical: Pakistan lacks a guiding policy framework as compared to other comparator countries which leave a void in the ethics, standards and direction. This creates a sense of vulnerability for Pakistan, and opens doorways to commercial interests and donor motivated agendas.

4. The Teacher is Central: All good models expect AI to augment the teacher's process of professional judgment and not supplant it. Teacher education, teacher professional development and participation in the design of AI are crucial.

5. Localization is Not Optional: AI tools created for the Western or East Asian contexts will not work in this context because of linguistic, cultural and pedagogical differences. Development of solutions in local languages, which are consistent with cultural norms is essential to success.

6. Economic and Commercial Pressures Drive the Course of AI: Foreign platforms dominate the EdTech market. Mechanisms need to be established in Pakistan for the development of AI such that it does not yield profits to foreign companies but to local communities.

6. DISCUSSION

Equity vs. Expediency: Is there a possibility to use AI to first impact the most marginalized? This needs to be done in a pro-poor manner by the government. The risk is to add to the already existing two tiered ECCE system – with the private urban centers having sophisticated tools and the public rural centers being under-resourced.

A reliable internet access and a laptop or tablet: The values of Pakistan regarding childhood, play and family need to be incorporated into the design of AI. This requires not only the participation of engineers, but the participation of anthropologists, child development experts, local communities and religious scholars. Screen time concerns need to be dealt with in a culturally relevant manner.

Human-Centric and Techno-Centric Futures: Part of the essence of ECCE is to build safe, caring relationships. The talk should be focused on the opportunities of AI to promote a better human to human interaction by freeing up time for teachers to be able to be more present with students. The cautionary tale from China's surveillance ridden model is very apt.

The concept of Data Sovereignty and Post-Colonial dynamics: Data sovereignty calls for legal frameworks to ensure that data that is created in Pakistan is for the benefit of the children and communities of Pakistan. This involves data localization, standards for AI systems in Pakistan, and community benefits.

The Political Economy of AI in ECCE: By 2030, the global Ed. Tech market is expected to grow to $400 billion (PwC, 2024). Pakistan needs to build its own AI skills, support local entrepreneurs in Ed. Tech and foster an environment for local solutions.

The role of civil society and community engagement is highlighted. The role of civil society organizations and community based NGOs should be key to integrating AI. To gain trust and acceptance, parental involvement, engagement of religious and community leaders and participatory design are important.

Children's agency and participation: Children's views, opinions and rights need to be taken into account. This can be achieved through participatory design methods which engage children in appropriate ways to produce tools which better address their needs.

Intersectional Equity: Equity needs to be considered not just on a geographic basis but also in relation to gender, disability and socio-economic status. AI integration needs to be created with intersectional equity in mind, not perpetuating inequities.

7. Conclusion

While the need to impact the future of ECCE with AI is a global phenomenon, its manifestation is irreducibly local. It would be a mistake to emulate the way of Finland, Singapore or China on the road towards Pakistan. It has very particular problems—such as disintegration, lack of infrastructure and lack of policy—and a unique approach is required.

The use of AI as a bridge to fill in the gap is a valid and pressing demand in Pakistan. But AI is not the solution in and of itself. It needs to be embedded in a comprehensive, more resourceful and equity-based national ECCE strategy covering the fundamentals: scaling up investment, improving teacher recruitment and training, boosting access, and improving governance.

By comparing, major insights are gained. First, there is the infrastructure, which is the foundation and cannot be negotiated. Second, policy frameworks need to be developed in a proactive manner. Third, empowerment of teachers is crucial. Fourth, localization is not an option.

The implementation of this vision will follow a multi-phase process: Phase 1: Development of policy and engagement with stakeholders, 0-2 years; Phase 2: Investment in infrastructure in under-served districts and targeted teacher training, 2-4 years; Phase 3: Scaled implementation with ongoing monitoring, 4-6 years.

The target should be to create a "glocalized" approach – maximizing on global technological opportunities and building local human connections to enable every Pakistani child to thrive.

8. RECOMMENDATIONS

1. To create a National Policy Framework: Develop a National Policy on AI in ECCE in 12 months with provincial education department, teachers' unions, child development experts, technology experts, and civil society. The aspects of addressing equity in access, data privacy and security, pedagogical appropriateness, teacher empowerment and monitoring and evaluation are addressed.

2. Create Equitable Basic Infrastructure: Invest in digital public infrastructure in ECCE (first in focus areas that are not served). Ensure that they have community digital hubs (CHH) with solar-powered charging stations and offline content libraries, along with offline-enabled AI tools.

3. Invest in Human Capital: The third focus is on investing in human capital.Start a national professional development (PD) initiative for "AI in ECCE. Adjust the curricula of the programs of Bachelor of Education to have a unit on Ethics in Educational Technology. Develop leadership development of school administrators.

4. Promote Contextual Innovation & Research

Establish sandboxes and government incentives for local R&D of AI products for Urdu and regional languages. Ensure independent, longitudinal impact studies of piloted AI tools. Strengthen international cooperation, particularly south-south cooperation.

5. Create Effective Governance and Ethics

Establish and implement a multi-stakeholder oversight body with legal validity to audit and certify AI products. Implement robust data protection laws that are focused on children, but tailored to the local context and based on GDPR principles. Oversight body should have enforcement authority.

9. LIMITATIONS OF THE STUDY

There are a number of limitations with this analysis. First, the comparative framework is based on four countries that might not be comprehensive of the diversity of approaches worldwide. Second, the analysis is mostly secondary and based on published literature and policy documents, with some primary data. Thirdly, some analysis is likely to become outdated due to the speed at which AI is developing. Fourth, there is limited analysis of all aspects of intersectional equity. Lastly, recommendations are necessarily speculative, and will be different in local contexts, but are informed by evidence.

10. REFERENCES

ASER Pakistan. (2023). *Annual status of education report 2023*. Lahore: Idara-e-Taleem-o-Aagahi.

Bevan, C., Kipnis, A., & Rienties, B. (2022). *AI and play in early childhood education: A Finnish perspective*. European Journal of Education, 57(4), 589-604.

Braun, V., & Clarke, V. (2006). *Using thematic analysis in psychology. Qualitative Research in Psychology, 3*(2), 77-101.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Chaudhry, A. B., & Mahmood, K. (2024). *Digital equity in early learning: Challenges and opportunities for AI in Pakistan*. Journal of Educational Technology Development and Exchange, 17(1), 45-62.

Davis, F. D. (1989). *Perceived usefulness, perceived ease of use, and user acceptance of information technology*. MIS Quarterly, 13(3), 319-340.

Dignum, V., Penagos, M., & Correa, N. (2023). *Ethics-first design for AI in early childhood: A European framework.* International Journal of Child-Computer Interaction, 35, 100542.

Hassan, S., & Rizvi, W. (2023). Bridging the divide: Infrastructure and policy barriers to EdTech in Pakistani primary education. Pakistan Journal of Education, 40(2), 112-130.

Heckman, J. J. (2006). *Skill formation and the economics of investing in disadvantaged children*. Science, 312(5782), 1900-1902.

Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

Khan, M. A., & Ahmed, S. (2023). *Developing localized AI tools for Urdu language acquisition in early childhood*. Proceedings of the 2nd International Conference on AI in Education (Asia), 234-241.

Luckin, R. (2022). *AI for school teachers*. CRC Press.

OECD. (2023). *Digital education outlook 2023: Pushing the frontiers with AI, block chain, and robots*. OECD Publishing.

Pakistan Education Statistics Report. (2023). *Pakistan education statistics 2021-22*. Ministry of Federal Education and Professional Training, Government of Pakistan.

Przeworski, A., & Teune, H. (1970). *The logic of comparative social inquiry*. Wiley.

PTA. (2024). *Annual report 2023-24*. Pakistan Telecommunication Authority.

PwC. (2024). *Global artificial intelligence market: Trends and projections*. PricewaterhouseCoopers.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). *The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education.* Computers & Education, 128, 13-35.

Selwyn, N. (2021). *Education and technology: Key issues and debates* (3rd ed.). Blooms bury Academic.

Smith, J., & Ali, A. (2023). *Automated speech analysis for developmental screening: Potentials and pitfalls.* Early Childhood Research Quarterly, 64, 367-375.

Tan, J. P., & Siti, A. B. (2023). *Smart early learning: An exploration of AI integration in Singapore's preschools.* Journal of Educational Technology & Society, 26(1), 112-125.

UNESCO. (2021). AI and education: Guidance for policy-makers. UNESCO.

UNESCO. (2022). *Right from the start: Build inclusive early childhood care and education*. Global Education Monitoring Report.

UNICEF. (2022). *the state of the world's children 2022: Children in the digital world*. UNICEF.
Williamson, B. (2021). *Digital policy and education: Critical perspectives.* Critical Studies in Education, 62*(1), 1-15.
Woolf, B. P., Lane, H. C., & Chaudhri, V. K. (2023). *AI and the future of educational assessment.* Science, 379(6632), eade4988.
Yin, R. K. (2014). *Case study research: Design and methods (5th ed.). Sage*.
Zhang, L., & Huang, R. (2023). The rise of AI in Chinese early childhood education: Applications, debates, and policy responses. Computers & Education, 192, 104661.
Zuboff, S. (2019). *The age of surveillance capitalism*. PublicAffairs.