Ed-tech landscape and challenges in Asia and the Middle East and North Africa

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Nisha Arunatilake  Binura Seneviratne
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Abstract

This study aims to provide an overview of the diverse educational technology (ed-tech) programmes, policies and interventions (PPIs) in South Asia, Southeast Asia, and the Middle East and North Africa. It outlines key initiatives in nine countries to provide a description of the primary aims, applications and types of ed-tech in these three regions, and the ways that local governments have prioritised and implemented ed-tech at the national level. Whilst country-level initiatives aim to reach different target populations, what becomes clear is that many of the ed-tech PPIs studied here focus on improving the quality of and access to education.

A cross-country and cross-regional comparison highlights the shared facilitating factors that promote and encourage the uptake of ed-tech at a national level, such as adequate investment and political buy-in. This report also provides a descriptive analysis of factors hindering the uptake of ed-tech, mainly related to infrastructure, cultural factors, and physical access to technological devices. Since the COVID-19 pandemic, there has been a global increase in interest, investment and relevance in ed-tech from all stakeholders. It is this continued evolution of ed-tech that ensures its relevance and sustainability into the future across the regions.
Authors

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## Acronyms and abbreviations

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<th>Description</th>
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<tbody>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GPI</td>
<td>Gender Parity Index</td>
</tr>
<tr>
<td>HIC</td>
<td>High-Income Country</td>
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<tr>
<td>LIC</td>
<td>Low-Income Country</td>
</tr>
<tr>
<td>LMIC</td>
<td>Lower Middle-Income Country</td>
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<tr>
<td>LMS</td>
<td>Learning Management System</td>
</tr>
<tr>
<td>MENA</td>
<td>Middle East and North Africa</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organisation</td>
</tr>
<tr>
<td>SA</td>
<td>South Asia</td>
</tr>
<tr>
<td>SEA</td>
<td>Southeast Asia</td>
</tr>
<tr>
<td>SEAMEO</td>
<td>Southeast Asian Ministers of Education Organisation</td>
</tr>
<tr>
<td>SDG</td>
<td>Sustainable Development Goal</td>
</tr>
<tr>
<td>UMIC</td>
<td>Upper Middle-Income Country</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organisation</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
</tr>
<tr>
<td>UNRWA</td>
<td>United Nations Relief and Works Agency</td>
</tr>
<tr>
<td>Key concepts</td>
<td>Definition</td>
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<td>----------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ed-tech</td>
<td>Hardware, software, infrastructure, or digital content designed or appropriated for educational purposes (Hennessy et al., 2021). Hardware includes, for instance, feature phones, smartphones, radios, televisions, tablets, and laptops. Software may be used by students and teachers; as well as for school management, and monitoring and evaluation processes. Infrastructure typically involves electricity, local connectivity, and access to the internet. Other digital contents involve, for example, open licensing, open innovation, or crowdsourcing (Haßler et al., 2020).</td>
</tr>
<tr>
<td>Ed-tech policies</td>
<td>For the purposes of this paper, we consider ed-tech policies as any government interventions aiming to promote access to Information and Communication Technologies (ICT) for use in the education sector; improve ICT infrastructure to support educational activities; or promote innovations in teaching-learning processes and access to educational services.</td>
</tr>
<tr>
<td>Ed-tech programmes</td>
<td>A program can be defined as an organised set of activities designed to produce concrete results and have a certain impact upon a problem (Shafritz, 2004). In this report, initiatives implemented by the private or civil society sector, or in collaboration with the government, are considered as programmes.</td>
</tr>
</tbody>
</table>
Introduction

The use of educational technology (ed-tech) has been accelerating, particularly since the COVID-19 pandemic, and is expected to introduce profound and long-lasting changes in access to quality education and equitable education outcomes (Kang, 2021; Zubairi et al., 2021). There is also growing momentum behind online self-led learning platforms (Buchanan, 2020; Major et al., 2021) and global investments in ed-tech products have been increasing in the past decade, with predictions for continued growth and global interest (Glasner, 2002). The use of technology in education is therefore becoming more critical to understand as it is prioritised by stakeholders, and as development and implementation varies across contexts.

The COVID-19 pandemic has sparked renewed interest in ed-tech worldwide (Munoz-Najar et al., 2022), leading to diverse impacts in the way it has been integrated into policies, programmes and interventions (PPIs). LMICs in South Asia (SA), Southeast Asia (SEA), and the Middle East and North Africa (MENA) included in this study have been impacted by the growth in ed-tech, as there has been a proliferation of online platforms to support online learning and promote improved learning outcomes (Major et al., 2021). Against this background, this report aims to provide a review of ed-tech PPIs in SA, SEA and the MENA region to explore how technology can advance quality and equitable education. The research questions that frame this report are:

1. How important have ed-tech PPIs been in SA, SEA and the MENA?
2. What are the priorities of ed-tech PPIs within each region and in what ways has ed-tech been used?
3. What factors have facilitated or acted as barriers to the development and implementation of ed-tech PPIs within each region?
4. How has the ed-tech landscape changed in these regions since the COVID-19 pandemic and what is the future of ed-tech in the light of those changes?

This paper is divided into five sections. The subsequent subsections introduce key insights about factors relevant for ed-tech uptake and implementation. Section 2 details...
the methodological framework of this report including research methods, geographical selection, data collection, and scope. The third section discusses the relevance of ed-tech PPIs in each region. The fourth section is dedicated to the thematic analysis of priorities and uses of ed-tech in the regions, key factors facilitating and hindering development of ed-tech PPIs, and changes observed since the COVID-19 pandemic. The last section provides a conclusion and makes recommendations for shaping the future landscape of ed-tech in the regions and in LMICs more widely.

Primary and secondary school enrolment rates

First, exploring the primary and secondary school enrolment rates in the regions becomes relevant, as this provides the context to which ed-tech PPIs are integrated and implemented. There is great variation in learning opportunities, out-of-school rates and GPI levels in relation to primary and secondary education enrolment both within and among regions.

Net primary school enrolment rates average between 90% to 95% in all three regions (The World Bank, 2023). Specifically in LMICs, average net primary enrolment rates are also higher than the world average (89%) and the overall LMICs average (87%), with rates of 90% in SA, 95% in SEA, and 93% in MENA (The World Bank, 2023). However, there are disparities within and across the regions. For example, Sri Lanka has reached a nearly complete (99%) primary school enrolment rate, while Pakistan reports a rate of 68%—the lowest rate in SA. Within SEA, all LMICs are performing above the world average and the LMIC average, with enrolment rates higher than 90%. In the MENA region, all countries have enrolment rates higher than the world average (89%) and the overall LMICs average (87%), except for Djibouti (62%) (Figure 1).

Net secondary school enrolment rates in the three regions are lower, averaging 65% in SA, 61% in SEA and 71% in MENA (World Bank Data, 2018). Except for Pakistan, secondary school enrolment rates in SA are better than the LMIC average (60%), but lower than the world average (66%) (Figure 1). As with primary enrolment rates, Sri Lanka has the highest secondary school enrolment rate (91%) whereas Pakistan has the lowest (37%). It is noteworthy that SEA has the highest average primary enrolment (95%) but the lowest average secondary enrolment rate (61%). Indonesia has reached around 79% in secondary school enrolment, while Papua New Guinea lags around 32%. MENA has the highest average secondary school enrolment rate (71%) among the three regions for the countries included in this study, but great variations are observed, with the highest rate at 87% in West Bank and Gaza, and the lowest at 38% in Djibouti.
Lower secondary school enrolment rates indicate higher levels of out-of-school children, specially in secondary education in the regions. Average out-of-school rates for upper secondary schools are 17 percentage points higher than for lower secondary schools in SA (29%) and MENA (25%), and 19 percentage points higher in SEA (31%) (UNICEF, 2022). Pakistan, Bhutan, and Bangladesh from SA, and Cambodia, Laos, and Myanmar from SEA have the highest out-of-schools rates for both upper and lower secondary education, exceeding the world average of 13% (UNICEF, 2022). The MENA region appears to have relatively lower out-of-school rates compared to SA and SEA, remaining below the world average (UNICEF, 2022).

Figure 1. Net primary and secondary enrolment rates

Note. Elaborated by the authors based on the The World Bank, World Development Indicators (2018, 2023). No data is available for primary enrolment rates for Lebanon in the MENA region. Cambodia and Vietnam in SEA and Lebanon and Tunisia in MENA are not considered in calculating the secondary enrolment rates due to the low availability of data. Net secondary enrolment rates for India, Papua New Guinea, Philippines, Djibouti, and Iran are prior to 2018 due to the lack of data for 2018.

Gender disparities in learning opportunities are also evident between and within the three regions through the Gender Parity Indexes (GPI) for primary and secondary
enrolment.\(^1\) GPI in most countries is at parity, closer to parity, or more advantageous for girls, with a few exceptions, especially in SEA (Figure 2). Both in SA and MENA, girls are more advantaged than boys in most countries, except for Pakistan and Morocco, respectively. In SEA, girls are more disadvantaged in Indonesia, Papua New Guinea, and Laos, whereas boys are more disadvantaged in Myanmar, the Philippines, and Timor-Leste. Cambodia appears to have gender parity in primary and secondary enrolment.

**Figure 2. Gender Parity Index (GPI) – Primary and secondary school enrolment**

![Gender Parity Index (GPI) – Primary and secondary school enrolment](image)

Note. Elaborated by the authors based on the World Bank Data (2018). A GPI of less than 1 suggests girls are more disadvantaged than boys in learning opportunities and a GPI of greater than 1 suggests the other way around. The world GPI is at parity (GPI of 1) and the LMIC GPI is at 0.99. No data is available for Vietnam in the Southeast Asian region and Algeria and Lebanon in the MENA region. 2018 data is not available for Nepal (2019), Cambodia (2020), Iran (2020), and Tunisia (2016). For these countries, data available for the closest year is used.

**Internet and mobile phone penetration rates**

Internet penetration\(^2\) is an enabler in the uptake and implementation of ed-tech as it provides a platform for key stakeholders to access and utilise PPIs. Data shows that

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1 Gender Parity Index (GPI) for gross enrolment in primary and secondary education measures the ratio of female to male gross enrollment in primary and secondary education.

2 Internet penetration captures the percentage of the population using the internet.
average internet penetration rates vary between 36% in SA, 45% in SEA and 73% in MENA (The World Bank Data, 2020a). The lowest average internet penetration rate is seen in South Asia (37%), where only Bhutan has a higher internet penetration rate than the LMIC average of 45% (Figure 3). SEA’s average internet penetration is on par with the LMIC average (45%) but lower than the world average (60%). Within SEA, all countries but Vietnam (70%) have rates below the world average of 60%. In MENA, Djibouti nearly reaches the world’s average of 60%, with a 59% internet penetration rate, whilst all remaining countries have higher rates.

Figure 3. Internet and mobile penetration rates

Note. Elaborated by the authors based on The World Bank Data (2020, 2021a).

Mobile phone penetration rates are significantly higher than internet penetration rates (higher than 100 per cent) (Figure 3). All regions have average mobile penetration rates that are higher than the overall average for LMICs (97%), and nearly half of the countries included in this study (10 out of 22) have rates above the world’s average (107%). SEA has the highest average mobile penetration rate at 110%, SA has a rate of 106%, while the MENA region has the lowest rate at 102% despite its very high

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3 Mobile penetration rates capture mobile phone subscriptions per 100 people.
internet penetration. All the LMICs in SEA, except for Papua New Guinea and Laos, have mobile penetration rates higher than (or closer to) the world average. Similarly, in SA, all countries except for India (82%) and Pakistan (82%) have mobile penetration rates higher than (or closer to) the world average at 107%. In MENA, mobile penetration rates widely vary, with Iran having the highest rate among all countries studied (155%), while Djibouti lags with 44%.

COVID-19 pandemic

With the COVID-19 pandemic and the consequent school closures, there was a need for distance learning using ed-tech. As evidenced later in this study, this gave rise to new ed-tech PPIs in the three regions in addition to an expansion of the coverage of existing PPIs in terms of beneficiaries and content. During school closures, ed-tech played a vital role in facilitating the continuation of students’ education especially through programmes that promoted self-led learning among students through online platforms, learning management systems, educational apps and tv channels.

An evident impact of the COVID-19 pandemic, as identified through this study, is the accelerated use of ed-tech in the three regions. Many of the stakeholders surveyed have observed a rise in the number of ed-tech users. Moreover, the pandemic contributed to a shift in perceptions regarding educational technology. Both the public and stakeholders are now increasingly recognizing the role of ed-tech in enhancing the resilience of education systems. Additionally, there is a growing awareness of the advantages associated with integrating technology into both the learning and teaching processes.

Methodology

Research design and methods

This paper was undertaken using a mixed-methods research design. First, a list of countries was created based on geographical scope, income classification and indicators related to ed-tech enablers and barriers. Second, a desk review was conducted to identify a preliminary list of ed-tech PPIs in the regions since 2010. Out of this list, eighteen PPIs were selected for an in-depth analysis, additionally informed by key stakeholder interviews from across the regions. The research questions were addressed through a deductive reasoning approach and analysed thematically.
Region and country selection

The study focuses on LMICs due to the lack of literature on ed-tech in these countries, the high potential for improvement in educational outcomes using ed-tech, and the relatively higher access to technology in LMICs compared to LICs. Nine LMICs were selected to conduct the study, with a specific focus on eighteen case studies, as detailed below.

The first criterion for country selection was geographical representation. Within the three regions, focus was directed towards GDP Per Capita in identifying LMICs as defined by the World Bank’s income classification (See Table 1). Next, secondary school enrolment rates were considered to capture the diversity of education performance across the region. Primary education was not included as a criterion since primary enrolment rates are relatively similar across the three subregions and have better performance compared to secondary enrolment. Thirdly, levels of internet and mobile penetration rates were assessed to capture the potential of incorporating technology in education. Lastly, the Government Effectiveness Percentile Rank was considered in the context of each country.

These indicators play a vital role in facilitating or hindering ed-tech. Correspondingly, depending on the performance of these indicators, they may be ed-tech enablers or barriers. For instance, countries having high internet penetration and high government effectiveness may have a higher potential to implement ed-tech policies and incorporate ed-tech in their education system, while countries having low internet penetration and government effectiveness are likely to have a lower potential.

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4 The World Bank’s measurement of Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies. Percentile rank indicates the country’s rank among all countries covered by the aggregate indicator, with 0 corresponding to lowest rank, and 100 to highest rank. Percentile ranks have been adjusted to correct for changes over time in the composition of the countries covered by the World Bank Worldwide Governance Indicators (WGI).
These criteria were considered to demonstrate the depth and variation in ed-tech PPIs that exist in the three subregions, as well as to examine the influencing factors that have resulted in prioritising certain PPIs. Based on these criteria, India, Pakistan and Sri Lanka were selected in SA; Cambodia, Indonesia and Vietnam in SEA; and Egypt, Palestine and Tunisia in the MENA region, as highlighted in blue in Table 1.

Table 1. Indicators for country selection

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<tbody>
<tr>
<td><strong>South Asia</strong></td>
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<tr>
<td>Bangladesh</td>
<td>$2,458</td>
<td>LMIC</td>
<td>70</td>
<td>39</td>
<td>109</td>
<td>28</td>
</tr>
<tr>
<td>Bhutan</td>
<td>$3,266</td>
<td>LMIC</td>
<td>91</td>
<td>86</td>
<td>100</td>
<td>74</td>
</tr>
<tr>
<td>India</td>
<td>$2,238</td>
<td>LMIC</td>
<td>78</td>
<td>46</td>
<td>82</td>
<td>61</td>
</tr>
<tr>
<td>Nepal</td>
<td>$1,229</td>
<td>LMIC</td>
<td>84</td>
<td>52</td>
<td>127</td>
<td>16</td>
</tr>
<tr>
<td>Pakistan</td>
<td>$1,505</td>
<td>LMIC</td>
<td>42</td>
<td>21</td>
<td>82</td>
<td>36</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>$3,994</td>
<td>LMIC</td>
<td>91</td>
<td>44</td>
<td>141</td>
<td>49</td>
</tr>
<tr>
<td><strong>Southeast Asia</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Cambodia</td>
<td>$1,625</td>
<td>LMIC</td>
<td>58</td>
<td>60</td>
<td>120</td>
<td>34</td>
</tr>
<tr>
<td>Indonesia</td>
<td>$4,334</td>
<td>LMIC</td>
<td>99</td>
<td>62</td>
<td>134</td>
<td>65</td>
</tr>
<tr>
<td>Laos</td>
<td>$2,536</td>
<td>LMIC</td>
<td>60</td>
<td>62</td>
<td>65</td>
<td>31</td>
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<tr>
<td>Myanmar</td>
<td>$1,211</td>
<td>LMIC</td>
<td>76</td>
<td>44</td>
<td>126</td>
<td>8</td>
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<tr>
<td>Papua New Guinea</td>
<td>$2,645</td>
<td>LMIC</td>
<td>44</td>
<td>32</td>
<td>48</td>
<td>17</td>
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<td>Philippines</td>
<td>$3,461</td>
<td>LMIC</td>
<td>87</td>
<td>53</td>
<td>143</td>
<td>56</td>
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<tr>
<td>Timor Leste</td>
<td>$2,741</td>
<td>LMIC</td>
<td>85</td>
<td>39</td>
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<td>25</td>
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<td>Vietnam</td>
<td>$3,756</td>
<td>LMIC</td>
<td>96</td>
<td>74</td>
<td>139</td>
<td>60</td>
</tr>
<tr>
<td><strong>MENA</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Algeria</td>
<td>$3,700</td>
<td>LMIC</td>
<td>103</td>
<td>71</td>
<td>106</td>
<td>29</td>
</tr>
<tr>
<td>Djibouti</td>
<td>$3,050</td>
<td>LMIC</td>
<td>43</td>
<td>69</td>
<td>44</td>
<td>19</td>
</tr>
<tr>
<td>Egypt</td>
<td>$3,887</td>
<td>LMIC</td>
<td>86</td>
<td>72</td>
<td>95</td>
<td>35</td>
</tr>
<tr>
<td>Iran</td>
<td>$4,084</td>
<td>LMIC</td>
<td>87</td>
<td>79</td>
<td>155</td>
<td>17</td>
</tr>
</tbody>
</table>
These countries were selected in an attempt to capture diversity cross-regionally and inter-regionally in analysis. They include low performing, average performing and high performing countries in relation to the specified criterion. Sri Lanka is the most developed LMIC in SA, with close to universal secondary school enrolment, the highest mobile penetration rate (141%), and a relatively average internet penetration rate (44%). Contrastingly, Pakistan is one of the least developed countries in the region in terms of GDP per capita. It also has the lowest rates in the region for secondary enrolment (42%), internet penetration (21%), and mobile phone penetration (82%). India is more developed than Pakistan but less developed than Sri Lanka in terms of GDP per capita income. India’s rate for secondary enrolment is 78%, internet penetration is 46%, and mobile penetration 82%. In terms of perceived government effectiveness, India has a relatively high rank, followed by Sri Lanka, while Pakistan has a relatively lower rank.

SEA is an emerging growth hotspot particularly in the realm of technology industries. The region is witnessing a surge in technological innovation, attracting significant investments (Wright, 2021). Indonesia is the largest economy in the region, and the most developed LMIC, while Cambodia is one of the least developed LMICs with lower levels of internet penetration (60%), mobile penetration (120%), and secondary school enrolment rates (58%). Vietnam is a well-developed LMIC with a very high level of internet penetration (74%) and mobile penetration (139%). Indonesia and Vietnam have a relatively high rank in government effectiveness, while Cambodia has a very low rank.

Since LMICs in MENA had similar internet penetration and secondary school enrolment rates, a different selection criterion was employed to support the selection. One Francophone nation, Tunisia, was selected with the aim of accounting for the French colonial legacies in the region. On its part, Palestine was selected given its complex socio-political history and the lack of literature on the state of ed-tech in Palestine. Egypt was included as the third country for close analysis in this report.
Desk review

A desk review of national and regional ed-tech PPIs in the selected nine countries was conducted through searching policy documents, unpublished research papers, programme evaluations, and websites. This resulted in a preliminary list of 123 ed-tech PPIs carried out from 2010 onwards. The list included a brief description, scope, country, main stakeholders, target population, and beneficiaries for each PPI. These were categorised according to their overall aims, applications, and types, as shown in Table 2.

Table 2. Aims, applications, and types of ed-tech

<table>
<thead>
<tr>
<th>Aims</th>
<th>Applications</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Improving learning outcomes (SDG4)</td>
<td>a. Supporting education in schools</td>
<td>a. Improving access to hardware</td>
</tr>
<tr>
<td>b. Responding to groups with different educational needs and improving access for more vulnerable groups (i.e., girls, children with disabilities, children from rural areas etc.)</td>
<td>b. Providing non-formal education</td>
<td>b. Improving the development of software</td>
</tr>
<tr>
<td>c. Enhancing the resilience and responsiveness of education systems</td>
<td>c. Supporting teacher pre-service and in-service education enhancement</td>
<td>c. Investments in the environment for Ed-tech to be utilised.</td>
</tr>
<tr>
<td>d. Contributing to other sustainability goals (other than SDG 4) including SDG 10 on reducing inequalities.</td>
<td>d. Supporting school management systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. Technology-enabled behavioural interventions</td>
<td></td>
</tr>
</tbody>
</table>


Out of the initial list, a total of eighteen programmes, two per country, were selected for in-depth analysis. The chosen PPIs were restricted to those that were concretely implemented, as the initial list included regulations and project proposals on ed-tech that were not initiated. Selected PPIs were also limited to those that targeted children aged 6-18 in primary and secondary education.

Case studies

Two programmes from each of the nine countries were chosen for deeper analysis through key informant interviews. One initiative with wide coverage, usually implemented in collaboration with the relevant Ministry of Education; and one considered innovative for its differences with mainstream programmes in the country. The table below outlines the selected programmes for analysis.
### Table 3. Case studies for analysis

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Programmes/ Case Studies</th>
<th>Target group</th>
<th>Lead implementer (public/private/collaboration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Asia</td>
<td>India</td>
<td>Class Saathi</td>
<td>Primary and secondary schools. Focus on rural areas.</td>
<td>Private ed-tech company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OLabs</td>
<td>Upper-secondary school (Grades 9 to 12).</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td></td>
<td>Pakistan</td>
<td>Teletaleem</td>
<td>Primary, secondary, tertiary, and technical education.</td>
<td>Private tech organisation, in collaboration with others from the private and public sectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WonderTree</td>
<td>Special needs children (Autism, Down Syndrome, Global Development Delay).</td>
<td>Private tech startup, in collaboration with international organisations, NGOs, private sector, and public sector</td>
</tr>
<tr>
<td></td>
<td>Sri Lanka</td>
<td>Akura</td>
<td>Public, private, and international schools, including school administration staff</td>
<td>Private software company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nenasa</td>
<td>Primary and secondary schools. Focus on rural areas.</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>Cambodia</td>
<td>Basic Education Equivalency Programme (BEEP)</td>
<td>Youth aged 14 and above, particularly school dropouts</td>
<td>Public sector and international organisations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tesdopi</td>
<td>Secondary</td>
<td>Private startup</td>
</tr>
<tr>
<td></td>
<td>Indonesia</td>
<td>SEAMOLEC Regional Open Learning Centre</td>
<td>Teachers in ASEAN countries, primarily Indonesia.</td>
<td>Regional organisation governed by the Southeast Asian Ministers of Education Organization - SEAMEO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ruangguru</td>
<td>Primary, secondary, college, vocational, corporates</td>
<td>Private ed-tech company</td>
</tr>
<tr>
<td></td>
<td>Vietnam</td>
<td>FPT Education</td>
<td>Primary, secondary, university</td>
<td>Private tech company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marathon Education</td>
<td>Primary, secondary</td>
<td>Private ed-tech startup</td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>Egyptian Knowledge Bank Study Portal</td>
<td>Elementary, primary, secondary, tertiary, researchers</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td></td>
<td>Palestine</td>
<td>Madrasty</td>
<td>Primary, secondary</td>
<td>Private venture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The UNRWA E-learning Platform</td>
<td>Palestine refugee students</td>
<td>International Organisation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The E-learning Curriculum in Palestinian Primary and Secondary Education</td>
<td>Primary and secondary schools</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td></td>
<td>Tunisia</td>
<td>EDUNET 10</td>
<td>Primary and secondary schools</td>
<td>Public-private partnership</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sghartoon</td>
<td>Children with dyslexia (aged 5-8)</td>
<td>Private ed-tech startup with collaborators from the public sector</td>
</tr>
</tbody>
</table>

**Note.** Elaborated by the authors.
Interviews

Once case studies were selected, key informant interviews were conducted with stakeholders using a semi-structured format, enabling flexibility to delve deeper into certain areas depending on the responses given by the interviewees. These stakeholders were identified through the selected 18 ed-tech programmes (case studies). A combination of in person and online interviews were conducted. Overall, twenty-five stakeholders were interviewed, including key government and private sector personnel, co-founders of ed-tech startups, as well as organisations who partner with the government for ed-tech projects (Table 4).

Table 4. Number of interviews per country

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Number of interviews</th>
<th>Public sector</th>
<th>Private sector</th>
<th>NGO/International organisation/ Regional organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Asia</td>
<td>Sri Lanka</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>MENA</td>
<td>Tunisia</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Egypt</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Palestine</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>Indonesia</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vietnam</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cambodia</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Note. No interviews were conducted for Pakistan and India due to limited professional connections in said countries. Information for the case studies in these two countries were collected through available information in their official websites. Elaborated by the authors.

Thematic analysis

The information collected from the case studies was coded and analysed using the NVivo qualitative data analysis software. For each research question, common themes were identified using a deductive reasoning approach. These sets of codes were expanded based on information arising from the case studies and interviews (See Annex 1).

The importance of ed-tech was assessed based on the PPIs' contribution towards the achievement of Sustainable Development Goal 4 (SDG 4), reducing gaps in access to education for vulnerable groups, reducing the digital divide, solving limited infrastructure
issues, improving the efficiency of education systems, and connecting key stakeholders (students, teachers, parents, administrators).

The facilitating factors of ed-tech PPIs were assessed by looking at key stakeholders and institutions that support the development and implementation of ed-tech in the regions. These included the roles of governments, the private sector, donors, and cross-sectoral collaborations. The factors that hamper the development and implementation of ed-tech were assessed both in terms of supply-side barriers faced by ed-tech implementers and demand-side barriers faced by ed-tech users.

Changes to the ed-tech landscape since the COVID-19 pandemic were assessed by looking at the coverage and offerings of ed-tech for beneficiaries; changes to support mechanisms such as the role of government, policy priorities and funding; changes in attitudes; and challenges and opportunities faced by ed-tech providers in expanding the use of ed-tech since the pandemic.

Limitations

To account for changes in the ed-tech environment influenced by the pandemic, there is a stronger focus on more recent studies on use of ed-tech. Furthermore, some documents, especially local government reports, were available in local languages only. Therefore, there is a bias in this report as the PPIs analysed are restricted to available literature in English. Every effort was taken to locate literature focusing on the countries listed in the sample. No key informant interviews were undertaken for the selected four programs in India and Pakistan due to restricted professional networking in these two countries.

The relevance of ed-tech in Asia and MENA

Ed-tech PPIs have been important in the three subregions under study. Asia's rapid population and economic growth is creating an increasing demand for quality education, and ed-tech plays a vital role in meeting this demand. In the MENA region, ed-tech has been particularly important to bridge the gap in education for conflict affected children, as highlighted later in this report. The following subsections show that interest in the use of ed-tech to improve learning has been present in countries of the three regions prior to the COVID-19 pandemic. National governments have either on their own, or in collaboration with other countries, launched PPIs to promote the uptake of, and opportunities for, integrating ed-tech into mainstream education.
South Asia

The desk review showed that SA has a long history of national-level ed-tech policies, which were intensified during the COVID-19 pandemic. The government of Sri Lanka, for instance, has introduced several initiatives to incorporate ed-tech into the education system. Under the “Government Digitalizations Initiative 2016-2019”, the Information and Communication Technology Agency (ICTA), in collaboration with the Ministry of Education, implemented several projects aimed at developing digital classrooms in government schools, training teachers, establishing digital libraries, developing accreditation frameworks, and establishing interactive networks among stakeholders (Information and Communication Technology Agency, n.d.). These initiatives show that importance is being placed upon the integration of ed-tech within mainstream schooling, showing promising prospects for the future of ed-tech in the country.

The Sri Lankan government is also undertaking concerted measures to intensify ed-tech initiatives by improving infrastructure and supporting student learning and teacher capacities. The “National Education Policy Framework (2020-2030)”, formulated by the National Education Commission (NEC), recognises that all schools, irrespective of geographical location and number of students, must be provided with technological facilities. It recommends that authorities be equipped to handle all ICT related matters and facilitate its use in the General Education system (National Education Commission, 2022).

An ongoing plan of the Ministry of Education is the “General Education Sector Development Plan (2020-2025)”. One of its priorities is to improve and promote digital-based teaching and learning to create a culture that encourages self-learning and innovation through digital technology (Ministry of Education, 2020). This project comprises the establishment of e-libraries, e-textbooks, and smart classrooms; the development of ICT facilities and WI-FI zones in schools; introducing ICT as a subject from grade six onwards; conducting e-learning and digital learning training programmes for education officers, teachers, and principals; providing educators with areas to develop
In addition, the Ministry of Education initiated in 2020 the “E-Thaksalawa” programme, which is the official Learning Management System (LMS) of the General Education system in the country. This platform provides content in five key areas: learning, activities and tasks, means and resources, interactivity, and assessment; and is the largest Massive Open Online Course (MOOC) platform for education in Sri Lanka (E-thaksalawa, n.d.). During the same year, the Ministry of Education also formulated a “Contingency Emergency Response Plan (CERP)” for the Education sector to minimise disruptions resulting from the COVID-19 pandemic (Ministry of Education, 2020). This plan incorporated components to respond to disruptions during and post- COVID-19 for the entire state school education system.

Similarly, the Pakistani government has taken steps to enhance the implementation of ed-tech PPIs across the national school system. The Ministry of Information Technology and Telecommunication (MoITT) has attempted to create an enabling environment for the use of ed-tech in the country (Baloch & Taddese, 2020). Two resulting policies are the “National Information and Communication Technology (NICT) Strategy for Education in Pakistan (2004–05)”, and the “Digital Pakistan Policy (2018)”. The latter and more recent promote ed-tech through initiating projects to provide network accessibility at educational institutes across Pakistan, therefore improving national internet penetration rates (MoITT, 2018). These also support the development of e-portals to use academic texts, research materials, and other supplementary resources for schools, colleges, and universities across the country (MoITT, 2018).

In addition to the national-level policies in Pakistan, there are also ed-tech policies targeting specific provinces. For instance, the “School Education Sector Plan and Roadmap for Sindh province (2019-2024)”, formulated by the School Education and Literacy Department of the Government of Sindh, focuses on several aspects of ed-tech (Government of Sindh, n.d.). This includes the digitalisation of educational materials and assessment methods in public schools which can enable both students and teachers to use technology to enhance e-learning results, support setting up an e-assessment system, and a way to collaborate with organisations that specialise in ed-tech. This collaboration system aims to make content more age-appropriate and accessible for students, particularly for those in rural areas (Government of Sindh, n.d.).

Similarly, the “Punjab IT Policy (2018)”, implemented by the local government, targets the introduction of ICT into the school curriculum, the provision of interactive education to school students through computers and e-learning programmes, intensive computer
training for teachers in all government schools, and the establishment of distance education programmes, including participation in global learning and education networks (Government of Punjab, n.d.). The proliferation of provincial as well as national ed-tech initiatives in Pakistan demonstrates a strong recognition of the importance of digital learning to improve student outcomes.

There are also government initiatives targeting specific student groups, such as the “ICT for Girls Programme” initiated in 2015 by the MoITT (EQUALS Global Partnership, n.d.). The programme aims to provide annual training to 10,000 girls from disadvantaged backgrounds on foundational ICT knowledge and coding skills, based on ‘the four Cs’: Critical thinking, Communication, Collaboration, and Creativity. Under the second phase of this programme, 226 schools in Islamabad were equipped with ICT labs, accompanied by the training of 202 teachers through Microsoft’s Train the Trainer programme in 21st Century Super Skills. The initiative’s primary goal is to ensure that more than 110,000 girls in Islamabad attain computer literacy skills that are on par with global standards. Partners of this programme are the Federal Directorate of Education, Pakistan Bait ul Mal (PBM), the Universal Service Company (USF Co) and Microsoft.

The government of Pakistan also initiated additional ed-tech programmes as a response to the COVID-19 pandemic, such as Radio School, TaleemGhar in Punjab, and the e-taleem portal. These programmes utilise online websites and radio broadcasts to provide educational content to students. The latest undertaking in Pakistan’s ed-tech portfolio at the national level is the Ministry of Federal Education and Professional Training (MoFEPT)’s TeleSchool mobile app (Sheikh & Nadeem, 2023). This TeleSchool mobile app targets kindergarten up to grade 12 and aims to revolutionise formal education in Pakistan through digital technologies, reflecting the government’s commitment to foster innovation in the education sector. The above programmes demonstrate that the Pakistani government is prioritising mainstreaming ed-tech throughout the country in order to meet educational objectives, and the efforts were intensified due to the COVID-19 pandemic.

In India, as with Sri Lanka and Pakistan, research shows a history of promotion of ed-tech use and integration into education systems. India’s “National Policy on Education 1986”, modified in 1992, emphasises the importance of using ed-tech to improve access to, quality, and the governance of education (Rao & Prasad, n.d.). Two central government schemes known as the “CLASS (Computer Literacy and Studies in Classrooms)” and the “Educational Technology (ET)” emerged through this policy (Bhattacharyya et al., 2023). By combining these two in 2004, the government of India introduced the “ICT in Schools” programme, which offers secondary school students an opportunity to improve their technology skills and engage in computer-assisted learning (Rao & Prasad, n.d.).
The programme aims at narrowing the digital divide among students from diverse socio-economic backgrounds and geographical locations (Ministry of education of India, n.d.). It focuses on providing computer-aided education, the establishment of smart schools, teacher capacity enhancement, and development of e-content (Ministry of education of India, n.d.).

In parallel, “The National Curriculum Framework (NCF) 2005” of India recognises the importance of ed-tech while underlining the teacher’s role in the classroom. It emphasises the student's active involvement in their own learning and recommends that educational technology interventions should encourage two-way interaction instead of one-way reception (Bhattacharya et al., 2023). This shows that ed-tech initiatives in India have sought to build on positive rapport between teacher and student, and encourage students to actively participate in their own learning experience.

Additionally, the National Policy on “ICT in School Education”, formulated in 2012, aims to improve ed-tech activities and processes that would contribute to the access, quality, and efficiency in the school system (Ministry of Human Resource Development, 2012). Some components under this policy are ICT for literacy and competency enhancement, teaching–learning processes, supporting educational opportunities for children with disabilities, open and distance learning, school management and ICT infrastructure (Ministry of Human Resource Development, 2012). This shows that the Indian government is prioritising the improvement of ed-tech infrastructure and considering diverse forms of technology in order to support students with different abilities and to increase opportunities available to them.

Moreover, under the new “National Education Policy (NEP), 2020” of the Ministry of Human Resource Development, the integration of technology into education is planned to occur through enhanced digital textbooks, high-quality electronic educational resources for capacity building of teachers and students, and educational software made available for students and teachers of all levels (Ministry of Human Resource Development, 2020). Importantly, the NEP explores the different uses of educational apps and gamification for language acquisition, adaptive assessments for monitoring student progress, personalised learning software, and technology for enhancing teacher skills (Ministry of Human Resource Development, 2020). Additionally, the NEP aims to create a National Educational Technology Forum to offer educational leaders, governments, and other stakeholders access to the latest knowledge and research, along with the opportunity to seek advice and exchange best practices (Bhattacharya et al., 2023). This shows the wide scope of the NEP and how ed-tech is planned to be used as all-encompassing and for different purposes in India.
Lastly, some of the NEP’s priorities have reached fruition through government-sanctioned private endeavours, such as the BYJU’s online learning programme. BYJU’s offers a variety of educational videos on mathematics, science, social studies, and English with the purpose of improving teaching-learning processes (BYJU’s, n.d.; Jha & Jha, 2022). The videos also feature a variety of teaching methods including animations, simulations, and interactive exercises (BYJU’s, n.d.). For teachers, there are a range of educational videos designed to help them improve their teaching skills and create more effective learning experiences, covering lesson planning, classroom management, and assessment (BYJU’s, n.d.). The main purpose of the BYJU initiative is to provide critical support to traditional education institutions to transition to online teaching-learning modes (BYJU’s, n.d.). The initiative has enabled any learner with a smartphone and stable internet connection to gain and strengthen knowledge and skills in a different environment.

In addition to these policies, there are also technology-based education platforms initiated by the government of India, such as the Digital Infrastructure for Knowledge Sharing (DIKSHA) portal and mobile app, and the Study Webs of Active Learning for Young Aspiring Minds (SWAYAM). The NEP and other recent policies illustrate the ongoing importance placed on ed-tech by the Indian government to facilitate improved learning outcomes for students across the country.

Selected countries in SA have placed a growing importance both on improving ed-tech opportunities and initiatives available for students and teachers nationally, and on developing country-wide policies to facilitate the uptake and implementation of technology to improve learning outcomes.

**Southeast Asia**

There is evidence of ed-tech PPIs at the regional and national levels in SEA. Stakeholders in the selected countries have shown a keen interest in supporting and improving their educational systems through ed-tech.

At the regional level, the strategic plan of the Southeast Asian Ministers of Education Organizations (SEAMEO) for 2021-2030, targets improving regional cooperation, sharing best practices, and contributing toward educational and human resource development in the region. The Smart School Programme SEAMEO 4.0 (2021- 2030) aims to improve

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5 The SEAMEO is a regional intergovernmental organisation established in 1965, with the aim of promoting regional cooperation in education, science, and culture (SEAMEO, n.d.). SEAMEO includes eleven member countries from SEA, nine associate member countries from the region and several affiliated organisations.
access to education by introducing technology into the classroom (SEAMEO, n.d.). This initiative emphasises the use of digital technologies and artificial intelligence to create a more innovative, inclusive, and future-ready education system in the region. The “4.0” in its name refers to developing skills for the 4th Industrial Revolution (SEAMEO, n.d.). It is notable that this collaboration focuses on the integration of ed-tech in the classroom and how it is attempting to systematise the use of ed-tech regionally, as it shows the possibility to be scaled-up and mainstreamed in the future.

In addition, the selected countries in the region have developed and implemented national ed-tech policies. The Ministry of Education and Culture in Indonesia has developed a strategic plan and roadmap for 2021-2025 to incorporate technology into education that includes the allocation of 2.5 trillion IDR (approximately 173 million USD) for the development of ed-tech and digital literacy programmes (Ministry of Finance Republic of Indonesia, 2021). The ed-tech roadmap (2021-2025) lays out a strategic plan for integrating technology into Indonesian education, with goals to enhance digital infrastructure, content, and literacy while promoting various ed-tech platforms (Desouza, 2023).

Moreover, the Ministry of Religious Affairs (MORA) ed-tech partnership (2020) seeks to enhance religious education quality by collaborating with ed-tech companies to provide resources and support to religious institutions through the MORA Ed-tech Partnership 2020 (Suriastini et al., 2020). This shows that the Indonesian government is investing substantial funds and resources into the infrastructure and development of PPIs, which will, in the long term, contribute to the sustainability and increased uptake of ed-tech in the country.

Cambodia has also taken steps to implement ed-tech PPIs to improve educational outcomes in recent years. The government has spent nearly 1.8 million USD through the “Education Management Information System” (EMIS) Master Plan 2014-2018, aimed at improving access to quality education for children at all levels of schooling (Ministry of Education, Youth and Sports, 2014). This strategy includes training and tools to improve the availability of information for better planning and administration of education services (Ministry of Education, Youth and Sports, 2014). The EMIS Master Plan also aims to strengthen data-driven decision-making in education. It has been designed to gather, process, and analyse information on schools, teachers, and students to help decision-makers identify gaps, allocate resources effectively, and track progress (Ministry of Education, Youth and Sports, 2014). By enhancing data collection and application, the government aimed to address education challenges and improve the overall quality of education.
In addition, the “Policy Guidelines for New Generation Schools (For Basic Education in Cambodia)” aims to transform selected schools through the use of modern technology in the classrooms, called New Generation Schools (NGS) (Ministry of Education, Youth and Sports, 2016). The NGS model strives to deliver high-quality education by adopting innovation and technology, fostering student-centred learning, and nurturing a culture of continuous improvement (Ministry of Education, Youth and Sports, 2016). By implementing these guidelines, the Cambodian government hopes to establish schools that can serve as examples of best practices and stimulate widespread reforms across the education sector (Ministry of Education, Youth and Sports, 2016).

Furthermore, the government of Cambodia launched in 2018 the “Policy and Strategy on Information and Communication Technology in Education” to improve teaching, learning and administrative processes (Ministry of Education, Youth and Sports, 2018). It promotes the use of technology to facilitate student-centred learning, encourages digital literacy, and prepares students to be part of a technologically advanced workforce. The policy also highlights the necessity of offering teacher training and support to guarantee the successful implementation of ed-tech (Ministry of Education, Youth and Sports, 2018). The different policies initiated in Cambodia illustrate a similar situation as in Indonesia, as prioritisation is being given to increasing the use of ed-tech in nationwide policies and mainstreamed into formal education.

In the case of Vietnam, the Ministry of Education and Training (MoET) focused on improving quality education and training from 2016-2020, by strengthening the use of ICT in order to manage and support teaching and learning activities and scientific research (Ministry of Education and Training, 2017). In this context, the government implemented several policies and initiatives to promote the integration of ed-tech in teaching and learning, including the “Decision No. 117/QD-TTg” (Jan 2017), aimed at enhancing the use of technology in managing and supporting teaching-learning activities and scientific research; and the “Circular No. 21/2017/TT-BGDĐT” (Sep 2017) concerning ICT in training activities for teachers, staff, and managers working in educational institutions (Ministry of Education and Training, 2017).
Moreover, the government has been steadily increasing its investment in ed-tech, with plans to further boost funding in the future. According to the World Bank, Vietnam plans to increase its research and development investment to 1.5-2% of GDP by 2030, with a focus on innovation in digital technology and education (Cameron et al., 2019). As with Indonesia and Cambodia, Vietnam is prioritising the investment in ed-tech in order to contribute to long-term initiatives that will improve the quality of education and training.

MENA

The ed-tech PPIs in most countries in the MENA region date back to 2010, the earliest year for which data was gathered for this study. The selected countries have integrated ed-tech as a solution for improving access to quality education in their strategic programmes for the education sector. The use of ed-tech for improving access and quality of education is seen even in the conflict affected Palestine, mainly due to bilateral and multilateral donor assistance to bridge gaps in education.

Since 2006, the Tunisian Ministry of Education has integrated ed-tech as part of a national e-administration project designed to make the administration of education more open, more efficient, and accessible to citizens. This orientation was supported by the 2010-2014 e-strategy for developing e-government, which sought to transform administrative procedures and operating modes in relation to key factors such as IT infrastructure, the legal framework and IT security.

Additionally, “The National Strategy for ICT Integration in Education, 2010-2015” was initiated for the development of infrastructure, human resources and educational content, as well as to provide technological equipment and to promote the use of ICT in educational management (Association for the Development of Education in Africa, 2014). The programme was spearheaded by the Ministry of Education (MoE) and Centre National des Technologies en Education (CNTE) and ran in parallel the “Digital Schools Program”, which was first started in 2014, and then reviewed in 2022. This programme focused on improving educational content for primary and secondary school children in the form of a digital toolkit (Orange Foundation, n.d.). As part of this programme, children are provided with tablets and access to servers, which enables students to obtain educational content without internet access. This is an initiative by the telecommunication company Orange in collaboration with the MoE and allows children who do not have internet access to continue to have access to educational materials (Orange Foundation, n.d.).

This was followed by the “Digital Solution for All” initiative, which is a component of the “Education Sector Strategic Plan 2016-2020” for Tunisia to improve the use of
ed-tech (European Training Foundation, 2020). The initiative aims to develop strategies to improve the use of ICT in the teaching-learning process in the country, as well as in the management and administration of education services (European Training Foundation, 2020). In parallel, Tunisia's EDUNET 10 (2021-2024) programme seeks to expand the connectivity of education institutions by providing them with access to the internet (CommsUpdate, 2023). This is a joint initiative by the MoE and the Ministry of Communication and Technologies and implemented with funding from the International Bank for Reconstruction and Development (IBRD), the Asian Development Bank (ADB), and the Tunisian government (CommsUpdate, 2023). These high-level stakeholders investing in ed-tech in Tunisia demonstrates the prioritisation being given to technology in order to better facilitate learning in the country for students.

In the case of Palestine, the Ministry of Telecommunications and Information Technology and the Ministry of Education & Higher Education oversee technology integration in education nationally. Digital education is a part of the education sector’s strategic plan for 2017-2022 (Ministry of Education and Higher Education, 2017) and, in previous years, the Ministry of Education and Higher Education has received support from Belgium for e-learning from 2011-2015 to improve the use of technology in the teaching-learning processes in schools, expand modern equipment and the digitisation of education, as well as to strengthen teacher training (Medium, 2016; Belgian Development Agency, n.d.). This highlights the importance of technology in nationwide policies on education and the emphasis being increasingly placed on teacher training in the uptake of ed-tech.

Additionally, as part of the response plan to the COVID-19 pandemic, Palestine initiated the “Education Cluster Strategy” 2020-2021 implemented by the Partners for Sustainable Development (PSD) and UNICEF, with support from a consortium of donors including UN-agencies such as the UNRWA, UNICEF and United Nations Educational, Scientific and Cultural Organization [UNESCO] (Education Cluster & UNICEF, 2020). This initiative incorporated distance learning as a main objective under its COVID-19 response plan, aiming to provide children and parents with access to free online platforms, worksheets and lessons to ensure the continuation of learning (Education Cluster & UNICEF, 2020).

Egypt has also integrated the use of ed-tech within the “Education Strategic Plan, 2014-2030”, which includes the use of technology and capacity building for innovation as one strategic component (Ministry of Education, n.d.). In line with the Education Strategic Plan, the “Education 2.0 Reforms” 2018-2030 aims for a full transformation of the education system, to promote skill-based and digital learning for primary and secondary school children (Moustafa et al., 2022). This policy targets the improvement of
digital learning for children from marginalised backgrounds and those with disabilities. Further, the Ministry of Education introduced ICT as a subject in schools with the objective of enhancing technological culture and fostering digital literacy skills among students through the “Ministerial Resolution No. 194 of 2020” (Global Education Monitoring Group, 2023). As with Tunisia and Palestine, Egypt has also placed importance on the use of ed-tech to improve learning opportunities for children, and it is through the systematisation of ed-tech PPIs that opportunities for the growth of ed-tech can be nurtured.

To conclude, the review of policies in the nine selected countries demonstrates early interest in employing ed-tech to enhance learning, even before the onset of the COVID-19 pandemic. National governments have initiated multiple PPIs to encourage the adoption and integration of ed-tech into education systems.

Analysis of the ed-tech landscape

Ed-tech aims, applications and types

An analysis of the 123 ed-tech PPIs found in the regions reveals that the most prevalent aims of ed-tech in the selected countries have been to improve learning outcomes, as related to SDG4, and to enhance the resilience and responsiveness of education systems in relation to disruptions (Figure 4). This is particularly relevant in relation to the COVID-19 pandemic, which gave rise to new ed-tech PPIs that were implemented or initiated to cope with the disruption in education. Improving access to education for vulnerable populations and responding to different educational needs is also a focus of ed-tech PPIs in these countries.

The reviewed PPIs were found to be most commonly used to support education in schools, offer self-led learning programmes and implement technology-enabled behavioural interventions (Figure 5). The former facilitate the learning process in school, while self-led learning programmes enable self-paced learning for students at home or outside of the school environment. Most self-led learning programmes also support education in schools as they generally include Learning Management Systems (LMS), e-learning platforms, educational apps, and television or radio channels that are dedicated to students. Technology-enabled behavioural interventions refer to those that affect or stimulate the mental state of students and/or seek to cause behavioural changes.
**Figure 4. Aims of ed-tech**

<table>
<thead>
<tr>
<th>Aims</th>
<th>Sri Lanka</th>
<th>India</th>
<th>Pakistan</th>
<th>Indonesia</th>
<th>Vietnam</th>
<th>Cambodia</th>
<th>Tunisia</th>
<th>Palestine</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve learning outcomes (SDG 4)</td>
<td>35</td>
<td>32</td>
<td>31</td>
<td>23</td>
<td>29</td>
<td>25</td>
<td>38</td>
<td>37</td>
<td>39</td>
</tr>
<tr>
<td>Contribute to other SDGs</td>
<td>18</td>
<td>12</td>
<td>20</td>
<td>21</td>
<td>17</td>
<td>6</td>
<td>15</td>
<td>14</td>
<td></td>
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<tr>
<td>Improve access for vulnerable groups</td>
<td>10</td>
<td>27</td>
<td>27</td>
<td>31</td>
<td>21</td>
<td>25</td>
<td>19</td>
<td>15</td>
<td>14</td>
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<tr>
<td>Enhance education resilience</td>
<td>37</td>
<td>29</td>
<td>22</td>
<td>38</td>
<td>29</td>
<td>33</td>
<td>35</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

**Note.** This figure is based on the identified 123 ed-tech PPIs. The number of PPIs per country are normalised to 100 and indicated within bubbles. The size of bubbles reflects the number of PPIs (normalised to 100), such that the larger the bubble, the larger the number of ed-tech PPIs having a particular aim. Elaborated by the authors using the preliminary list of 123 ed-tech (primarily 2010 onwards).

**Figure 5. Applications of ed-tech**

<table>
<thead>
<tr>
<th>Application</th>
<th>Sri Lanka</th>
<th>India</th>
<th>Pakistan</th>
<th>Indonesia</th>
<th>Vietnam</th>
<th>Cambodia</th>
<th>Tunisia</th>
<th>Palestine</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-led learning program</td>
<td>21</td>
<td>26</td>
<td>23</td>
<td>21</td>
<td>9</td>
<td>17</td>
<td>19</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Behavioural intervention</td>
<td>25</td>
<td>24</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>22</td>
<td>19</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>School/Education management</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>10</td>
<td>13</td>
<td>11</td>
<td>14</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Teacher training</td>
<td>7</td>
<td>5</td>
<td>16</td>
<td>14</td>
<td>19</td>
<td>22</td>
<td>12</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Non-formal education</td>
<td>14</td>
<td>11</td>
<td>13</td>
<td>17</td>
<td>13</td>
<td>7</td>
<td>11</td>
<td>15</td>
<td></td>
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<tr>
<td>Support education in schools</td>
<td>27</td>
<td>24</td>
<td>19</td>
<td>14</td>
<td>25</td>
<td>22</td>
<td>29</td>
<td>22</td>
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</tbody>
</table>

**Note.** This figure is based on the identified 123 ed-tech PPIs. The number of PPIs per country are normalised to 100 and indicated within bubbles. The size of bubbles reflect the number of PPIs (normalised to 100), such that the larger the bubble, the larger the number of Ed-tech PPIs of a particular application. Elaborated by the authors using the preliminary list of 123 Ed-tech PPIs (primarily 2010 onwards).
Furthermore, improving the development of software programmes were the most common type of ed-tech PPIs (Figure 6). Investments in the facilitating ed-tech environment, such as training teachers to use technology is also prevalent, and is an important priority area for the future of ed-tech. The least prevalent type of intervention is improving access to hardware, which mainly includes the distribution of devices such as laptops and tablets, as well as providing electricity and internet accessibility to students and schools mostly from rural and underprivileged areas.

Figure 6. Types of ed-tech PPIs

Note. This figure is based on the identified 123 ed-tech PPIs. The number of PPIs per country are normalised to 100 and indicated within bubbles. The size of bubbles reflects the number of PPIs (normalised to 100), such that the larger the bubble, the larger the number of ed-tech PPIs of a particular type.

The in-depth review of 18 case studies and key informant interviews provides further insights into, and examples of, the aims, applications and types of ed-tech PPIs observed in the regions. Overall, the 18 initiatives analysed have sought to contribute towards at least two SDG 4 targets, as summarised in the table below.

Specific initiatives like Indonesia’s Ruangguru are tailored to improve learning using techniques such as gamification to motivate students and keep them engaged with their studies. This platform offers customised, high-quality educational content and services, designed to meet individual student needs and foster self-learning practices (Ruangguru, 2022). By utilising data analytics and machine learning algorithms, this platform creates personalised learning paths for each student, tracking their progress and identifying areas where they need extra help, then recommending appropriate learning materials and tutors (Ruangguru, 2022).

Similarly in Vietnam, the Marathon Education initiative seeks to meet all students’ learning and personal development needs across the country (Venturra, 2022). Marathon
Education employs a test-bank that allows students to create assessments and do mock tests independently (Venturra, 2022). In utilising digital learning technologies to personalise the learning experiences of students, these ed-tech initiatives in Indonesia and Vietnam help to improve engagement with learning, creating a facilitating environment in which better educational outcomes are possible.

Table 5. Contribution towards SDG 4

<table>
<thead>
<tr>
<th>Country</th>
<th>Ed-tech Programme</th>
<th>SDG 4 Targets</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>4.1</td>
</tr>
<tr>
<td>India</td>
<td>Class Saathi</td>
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<tr>
<td></td>
<td>OLabs</td>
<td>x</td>
</tr>
<tr>
<td>Pakistan</td>
<td>WonderTree</td>
<td>x</td>
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<td></td>
<td>TeleTaleem</td>
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<tr>
<td>Sri Lanka</td>
<td>Nenasa</td>
<td>x</td>
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<tr>
<td></td>
<td>Akura</td>
<td>x</td>
</tr>
<tr>
<td>Cambodia</td>
<td>BEEP</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Tesdopi</td>
<td>x</td>
</tr>
<tr>
<td>Indonesia</td>
<td>SEAMOLEC</td>
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<tr>
<td></td>
<td>Ruangguru</td>
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<tr>
<td>Vietnam</td>
<td>FPT Education</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Marathon Education</td>
<td>x</td>
</tr>
<tr>
<td>Egypt</td>
<td>Egyptian Knowledge Bank (EKB)</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Madrasty</td>
<td>x</td>
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<tr>
<td>Palestine</td>
<td>The UNRWA Elearning Platform</td>
<td>x</td>
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<tr>
<td></td>
<td>E-learning Curriculum in Palestinian Primary and Secondary Education</td>
<td>x</td>
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</table>

6 SDG 4 Targets: 4.1 Universal primary and secondary education; 4.2 Early childhood development and universal pre-primary education; 4.3 Equal access to technical/vocational and higher education; 4.4 Relevant skills for decent work; 4.5 Gender equality and inclusion; 4.6 Universal youth literacy; 4.7 Education for sustainable development and global citizenship; 4.a Effective learning environments; 4.b Scholarships; 4.c Teachers and educators.
Other initiatives have sought to complement formal education where traditional infrastructure has not been adequate. For instance, OLabs in India has particularly focused on making lab resources available remotely for students from rural schools (Amrita, n.d.). “Nenasa” in Sri Lanka has similarly made educational content available to rural students by connecting schools to the Nenasa TV channels (Dialog Foundation, n.d.). The e-Library Nenasala Programme has further encouraged people in rural areas to visit public libraries and religious community centres that provide them with free access to computers and the internet (Komasaru, 2011).

Edunet10 in Tunisia has also focused on developing infrastructure to better support the implementation and integration of ed-tech through improved connectivity and access to digital resources. The initiative has aimed at establishing a robust digital infrastructure to support the development of high-quality digital educational services and content (CommsUpdate, 2023). Its main objective is to make high-speed broadband network access available in all schools and to provide reliable and fast broadband connectivity for teachers and students (CommsUpdate, 2023).

Nafham (“We Understand”), a free online K-12 educational video platform, was launched in Egypt in 2012, as the government was unable to build new schools fast enough in order to accommodate the surge in enrolments because of high birth rates (Jalbout & Farah, 2016). The platform allows teachers, parents and students to post educational videos on the topics of the school curriculum. The videos are accessible through their website and mobile application, and students who participate in teaching have been found to perform the best (Jalbout & Farah, 2016). By 2015, Nafham had 600,000 monthly active users with over 23,000 videos - 9,000 of which are original content (Jalbout & Farah, 2016).

On its part, Class Saathi in India has sought to reduce educational gaps resulting from the lack of adequate infrastructure by developing offline technology. It uses Bluetooth clickers to provide students and teachers without internet and electricity with access to online content using offline technology (Taghive, n. d.). In conceptualising and implementing ed-tech as a supplement to traditional modes of learning, these two initiatives strengthen existing teaching and learning modalities where traditional infrastructure has not been adequate with the use of digital learning technologies.
Four of the initiatives studied have sought to improve access to education by targeting vulnerable or marginalised student groups that have not been supported adequately by mainstream education. This is the case of the Basic Education Equivalence Programme (BEEP) in Cambodia, that specifically caters to the needs of lower secondary school dropouts (UNESCO, 2023). The programme aims at supporting young Cambodians aged 14 and older to complete their basic education through online courses without disrupting their employment. The BEEP initiative also targets indigenous women and youth with disabilities (UNESCO, 2023).

Similarly, the WonderTree programme in Pakistan aims at filling gaps in existing educational programmes by supporting children with disabilities. This is a technology-enabled behavioural intervention that uses ed-tech to enhance the mental state of students, demonstrating the important role that ed-tech can play in education outside of traditional classroom environments (WonderTree, 2023). The initiative caters to the educational needs of children from various spectrums of motor and cognitive difficulties including Autism, Down Syndrome, and Global Development Delay through Augmented Reality (AR) based games, seeking to support the development of coordination skills, motor skills (such as agility, balance, speed and reaction time), cognitive skills (sustained attention, speed of information processing, multiple simultaneous attention, working memory and pattern recognition) and functional skills (therapeutic exercises) (WonderTree, 2023).

The Sghartoon platform in Tunisia was also developed to provide parents and therapists with tools and educational games to help children improve their reading, writing, and spelling skills while providing a constructive and interactive experience. The digital teletherapy platform, targeted at children with dyslexia, is used by 2,000 children and 50 therapists.7

Finally, the Madrasty programme in Egypt targets students living with chronic health conditions and disabilities, to provide access to pre-recorded and live educational programmes prepared by teachers. Its assessment tool also provides personalised feedback and AI tutoring and is offered free of charge (Care Egypt Foundation, 2021). The project is implemented as a component of CARE International in Egypt’s Education Program, and has 14,4000 registered and 19,000 subscribers (Care Egypt Foundation, 2021).

By ensuring social inclusion and tailored support, such ed-tech programmes contribute to reducing educational and socio-economic disparities. Due to the fact that

7 See more about Sghartoon: https://sghartoon.com/
these initiatives focus on specific target groups, their coverage is not large-scale nor nationwide, but the user statistics emphasise how ed-tech programmes can play a vital role in improving access to education for vulnerable or marginalised populations.

Other distance learning initiatives, not included in the case studies, have similarly focused on improving access to education by specifically targeting out-of-school children. A noteworthy example is the GIRLS Inspire project in Bangladesh, India, and Pakistan, that uses open and distance learning to reach girls who have been prevented from attending school due to early marriage, cultural norms, and distance (Commonwealth of Learning, 2019). The project was found to have a positive impact on girls’ access to economic opportunities and the ability to make health decisions, understand social rights, and access resources, thus benefiting them to become more active citizens, to advocate for themselves and making wider opportunities available to them (Commonwealth of Learning, 2019).

Enhancing the efficiency and productivity of the education system and reducing costs are also important objectives to the use of ed-tech in the region, which is mainly achieved through Education Management Information Systems (EMIS). For example, the Akura initiative in Sri Lanka enables schools to connect with parents, individually and collectively, to communicate school activities, send invoices, and provide feedback on student learning outcomes (Akura, 2019). By facilitating clearer and easier communication between schools and parents, the Akura initiative represents a successful ed-tech PPI which has improved the confidence of parents in the education system by enhancing transparency and accountability of schools.

Some of the initiatives previously mentioned, such as the Nenasa TV and Nenasa App in Sri Lanka, OLabs in India, Marathon in Vietnam, and BEEP in Cambodia also exemplify ed-tech initiatives envisioned to enhance the resilience of education systems, particularly in response to crises. These initiatives implemented or initiated self-led learning programmes through e-learning platforms, educational apps and television channels during the COVID-19 pandemic, to cope with the disruption in education by enabling students to carry out their studies from home.

In addition, the Digital Learning Platform (DLP) in Palestine provides insights on how ed-tech can enhance the education systems’ resilience and responsiveness particularly in contexts of conflict. The DLP is an online educational platform developed by the UNRWA (United Nations Relief and Works Agency for Palestine Refugees in the Near East [UNRWA], 2021). It serves as a digital learning hub, providing uninterrupted access to remote learning materials and resources for students to improve digital literacy skills, enhance their own learning, and promote equitable access to quality education.
(UNRWA, 2021). The platform aims to ensure continuity of learning for Palestine refugee students, who are often unable to physically attend schools (UNRWA, 2021).

Similar ed-tech solutions have been implemented in other conflict-affected areas outside this report’s scope. Afghanistan’s Community-Based Education (CBE), for instance, has enabled children in remote or conflict-affected areas to continue their education from the safety of their homes while providing an alternative to formal education (Nagesh et al., 2021). This has been the case particularly for girls and groups of students who are unable to attend schools due to insecurity, distance, or other constraints (Nagesh et al., 2021).

This section has outlined the aims, applications and types of ed-tech PPIs found in SA, SEA and MENA. The examination has revealed a multifaceted landscape for diverse learners. The prevailing aims of these initiatives are centred on improving learning outcomes and enhancing education resilience. While gamification, personalised learning, and self-learning strategies have been implemented to improve learning, other initiatives primarily focus on complementing formal education by making resources available in under-served areas, improving infrastructure, or developing offline technology. Some programmes particularly target vulnerable student groups that have not been supported adequately by mainstream education, including school dropouts, children with disabilities and out-of-school children.

Ed-tech in the three regions has been mainly used to support education in schools, foster self-led learning programs and promote behavioural interventions. This includes efforts to enhance the education system generally, but also by developing distance learning systems to respond to crises or support children in conflict-affected areas. Software development and investment in the creation of facilitating environments for ed-tech underscore the technological foundation of these initiatives. As the ed-tech landscape continues to evolve, this report emphasises the dynamic and adaptive nature of these initiatives, providing insights into the potential future directions and priorities for ed-tech development.

Factors facilitating the development and implementation of ed-tech

The following subsection outlines two main factors that have facilitated the development and implementation of ed-tech PPIs in SA, SEA and MENA. The first is political and public backing that can help drive the use of ed-tech regionally and nationally, as adequate infrastructure and funding can provide a catalyst for growth. Second, the success of ed-tech initiatives is strongly influenced by the presence of multi-stakeholder
partnerships and a strong private ed-tech sector, both of which can foster innovation in developing products suitable for a variety of audiences.

**Political and public backing**

Political and public backing helps to drive the use of ed-tech, as adequate infrastructure and funding can provide a catalyst for growth (Regan & Khwaja, 2019; Rowell, 2010). In Sri Lanka, for instance, the vision and plan to invest in the future of education, along with the support and interest from the Ministry of Education have been major facilitators for the implementation of the Nenasa programme. Interviewees attributed this to the knowledge and experience of certain government officials who recognised the importance of investing in technology for education (anonymous, personal communication, 2023).

In SEA, institutional cooperation within the region has effectively facilitated the growth of ed-tech. As explained above, the Ministries of Education operate through SEAMEO to promote ed-tech uptake at an overarching institutional level. The SEAMEO Regional Open Learning Centre (SEAMEOLEC) supports the development of e-learning and blended learning programmes, teacher capacity building, and the use of technology in education within the subregion (SEAMEO, n.d.). Various ed-tech start-ups and Massive Open Online Courses (MOOCs) have emerged, such as Topica (Vietnam), Ruangguru (Indonesia) and Thai-MOOC (Thailand) (Curtis et al., 2022). This indicates that state-sanctioned backing to online courses can provide a bedrock for scaling up the use of ed-tech.

Some SEA countries are also actively enhancing digital literacy by providing comprehensive training and resources for both students and teachers to become adept in technology use. In addition to introducing versatile online learning platforms that cater to diverse users and can be accessed from various locations, these nations are investing significantly in developing necessary infrastructural support (Mallet, 2019). This includes establishing robust broadband internet connections, Wi-Fi networks, and equipped computer labs in educational institutions (Mallet, 2019).

Similarly, prioritising ed-tech within national policies and providing adequate infrastructure as the foundation for ed-tech have been facilitating factors in its development and implementation in MENA (Weber, 2019). For example, one core facilitator for ed-tech highlighted in Tunisia is the national telecommunication network, which covers the entire geography and integrates high-speed multifunctional switches that support telephone, internet, and multimedia traffic (anonymous, personal communication, 2023). Different technologies are employed for data transmission, thus ensuring the use of reliable and modern infrastructure networks, equipment, and services (International
Telecommunication Union, n.d.). With strong infrastructure in internet access and connectivity, there is a higher probability that target groups are able to access ed-tech reliably and consistently.

There has also been a significant development in digital infrastructure in Palestine, where wired and wireless communications have been enhanced and internet connectivity has improved (Awam et al., 2015). This has contributed to providing the necessary infrastructure for effectively implementing e-learning and accessing educational resources online (anonymous, personal communication, 2023). The government of Egypt has similarly made efforts to bridge the digital divide by improving access to technology and digital resources to students from all backgrounds, including those in under-served areas (Elgohary, 2022). Efforts to improve infrastructure have been coupled with initiatives to provide laptops and tablets to students and to expand internet connectivity (Elgohary, 2022). These two measures have facilitated ed-tech uptake.

**Multi-stakeholder partnerships**

The presence of productive partnerships between multiple ed-tech stakeholders, as well as the contributions of donors and other funding institutions is a factor that appears to strongly influence the success of ed-tech PPIs (Fabre & Straub, 2021; Pillay & Hearn, 2009). Both public sector and private sector stakeholders, individually and collaboratively, contribute to this space, and the types of collaborations are varied. They include public-private partnerships, donor-private partnerships and private-private partnerships (e.g. telecommunication companies and electricity companies).

The case of Class Saathi in SA is exemplary. Seed funding was provided by Samsung Ventures in 2017 and two years later, Class Saathi was successfully piloted in India. With multiple stakeholders taking part in this initiative, including Samsung C-Labs, Google, KAIVALYA Education Foundation, Progressive Foundation, FORD Foundation, Forest Partners, i-Scream Media, HCL, Madhya Pradesh government, and Uttar Pradesh government, the company raised $2.5million to expand its operations (Business Standard, 2022). In cases such as the ‘Akura’ school management system in Sri Lanka, which was developed as a Corporate Social Responsibility (CSR) program with no government involvement, support from other private companies facilitated its implementation. For example, the Mobitel company has supported this system by providing telecommunication services through Amazon Web Services (AWS) as the server provider (anonymous, personal communication, 2023).

In SEA, the presence of around 342 private ed-tech companies operating across the region is a key facilitator of ed-tech (Skills Nation, 2022). Collaborative initiatives between
the public and private sector, as well as the involvement of international development agencies, also help to continue and improve the uptake and implementation of technology (ADB, 2020). The BEEP programme in Cambodia, for instance, entails the participation of numerous stakeholders, including the Ministry of Labor and Vocational Training and the Ministry of Education, Youth, and Sport, Decent Employment for Youth in Cambodia (DEY), UNESCO, UNIDO, UNICEF, and ILO. In addition, the Skills Development Fund offers financial support and skills training, while Smart Axiata supplies the internet infrastructure, enabling students to learn with free internet access (Smart, n.d.).

Countries in MENA have also sought alternate financing models through private sector partnerships with tech giants, Microsoft, Apple and Intel, as well as through collaborations with World Bank and UNESCO. These relationships have facilitated the financing of infrastructure development to improve connectivity and access, material assistance, and the development of high-quality educational content for students and teachers (anonymous, personal communication, 2023). The K-12 Egyptian Knowledge Bank (EKB) Study Portal in particular has had a remarkable impact. Among other factors, the programmes' success has been attributed to its horizontal management structure, facilitated through a private-public partnership model that involves over 150 partners (Reimers & Opertti, 2021; anonymous, personal communication, 2023). The continued leadership and support from government officials, including the Minister of Education, Dr. Tarek Shawki, have played a crucial role in the EKB’s development and integration into the formal education system (Mogheith et al., 2019; anonymous, personal communication, 2023).

**Barriers to the development and implementation of ed-tech**

Various factors were found to pose barriers to the development and implementation of ed-tech in the three regions. These include a lack of financial resources and ICT infrastructure, low-levels of teachers’ capacity in the use of ed-tech, and resistance to change associated with social and contextual factors. This section details specific challenges for the development and implementation of ed-tech in the three regions.
Uneven access to ICT infrastructure and high operational costs

Lack of infrastructure, unequal access to technological resources, and the high costs associated with accessing ed-tech were cited by interviewees as a main constraint for the use and implementation of ed-tech in the three regions (anonymous, personal communication, 2023).

In SA, there is a large digital divide within countries. For instance, only about 24% of people in India have access to the internet, and the percentage for rural households is 15% (Jha & Jha, 2022). Access to electricity is also uneven, with 16% of India’s households receiving 1 to 8 hours of electricity daily, 33% receiving 9-12 hours, and 47% receiving more than 12 hours a day (Jha & Jha, 2022). Furthermore, many students do not have access to adequate tools to benefit from ed-tech. While 24% of Indians own a smartphone, only 11% of households own desktop computers, laptops, notebooks, or tablets (Jha & Jha, 2022). A survey conducted by the National Council of Educational Research and Training further reveals that about 27% of students did not have access to smartphones or laptops to attend online classes in 2020 (Nagari, 2020).

Reported barriers to the Class Sahti initiative in India include the cost of ed-tech programmes limit ed-tech uptake in some schools, specially depending on the number of students, local funding, and allocation protocols (anonymous, personal communication, 2023). Despite Class Saathi circumvents the need for the internet, access to electricity and hardware such as mobile phones is still required to make use of the programme, which limits access for students in under-served areas. Similar remarks were made by interviewees from the Nenasa programme in Sri Lanka, highlighting that even when infrastructure and connectivity are provided, the access to and affordability of hardware for users remains a challenge, especially considering the country’s high inflation (anonymous, personal communication, 2023). High operational costs have also been barriers for the uptake of the Akura programme, including among others, the cost of hiring software engineers (anonymous, personal communication, 2023).

The digital divide in SEA similarly limits access to equal ed-tech opportunities because of the prevalence of limited infrastructure access, resources issues, and skills shortages. In Indonesia, approximately 72% of primary school students had access to mobile phones in 2022, but in contrast, only around 5% of students had access to computers (Statista Research Department, 2023). Regions with higher incomes, large cities, and greater educational facility capacity tend to yield students with better learning outcomes compared to areas with lower income and capacity (The World Bank, 2020b). In addition, building the necessary technological infrastructure for implementing ed-tech PPIs is a significant challenge. Despite the Ministry of Informatics’ efforts to provide
internet access through the BAKTI Kominfo project, financial disputes have led to slow progress and an uncertain timeline for implementation (Global Education Monitoring Report Team & SEAMEO Regional Open Learning Center, 2023). Further contributing to this situation are the high educational costs and digital divide in Indonesia, exacerbated by the COVID-19 pandemic (Afkar & Yarrow, 2021).

In Vietnam, the lack of facilities for online teaching and learning was cited as a key challenge for the development of e-learning, as not all teachers and students own computers or smartphones. This factor is further exacerbated given the price-sensitive education market in Vietnam, where higher-income parents in urban areas tend to spend more on private tutoring for their children compared to those in rural areas (Nguyen et al., 2021). Recently, more and more city-living parents register for online and offline supplementary pre-school classes for their children, which is not as popular in rural areas (Nguyen et al., 2021). The disadvantage experienced by families with lower levels of income in Vietnam means that they are unable to purchase the necessary resources or support to effectively engage with ed-tech PPIs, thus widening the digital divide and equal access to ed-tech.

Obstacles pertaining to the lack of connectivity and network coverage are also two of the most stated barriers across the countries of study in the MENA region. Insufficient network coverage and the lack of high-speed internet impedes the successful adoption of ed-tech, particularly in rural areas, as communities do not have access to adequate infrastructure (anonymous, personal communication, 2023). Infrastructural availability, impacts the ability of ed-tech policies to be rolled out, and even if they are rolled out, affects the usability of such platforms (anonymous, personal communication, 2023).

Low-levels of teacher capacity

Research has shown that teachers who are well-trained in using ed-tech are more likely to select the right ed-tech tools for their students, to use them in a way that is aligned with their teaching goals, and to provide students with the support they need to use ed-tech effectively (Mandal & Srinivas, 2022). Being well-trained involves pre-service and in-service teacher training and therefore cannot be integrated as a standalone, one-off training (Mandal & Srinivas, 2022). Evidence also shows that teachers who are enthusiastic about using ed-tech are more likely to create a positive learning environment for students (Trust et al., 2016).

Low-levels of teacher capacity remain a major barrier towards successfully implementing ed-tech. Interviewees in Sri Lanka reported that finding expert teachers
with relevant knowledge and available time has caused important delays in the Nenasa's programme implementation (anonymous, personal communication, 2023). The imbalances created between infrastructure shortages, systematic workload, and teacher awareness and training, act as a barrier that can prevent the adoption of ed-tech PPIs. In disadvantaged areas with a lack of teachers, the adoption of ed-tech initiatives requiring skilled teachers would be harder, and it is difficult to predict how ed-tech could compensate for the loss of learning and instruction in underprivileged regions without skilled teachers.

Lack of teachers' digital skills and appropriate training were also mentioned as important barriers for the implementation of ed-tech in SEA. For example, interviewees explained that teachers in Cambodia are often unprepared to navigate online platforms, understand digital content, and effectively use digital devices for learning (anonymous, personal communication, 2023). There is also a lack of support for teachers on using digital tools and platforms, which may hinder their ability to deliver online education effectively (anonymous, personal communication, 2023). It is therefore important that when reviewing the barriers to the implementation and uptake of ed-tech PPIs in the region, consideration is given toward providing adequate teacher training and support for parents and families.

**Social and contextual factors**

Social and contextual factors can also play a significant role in the integration of technology into education. Resistance and negative attitudes and mindsets towards the incorporating technology within the education system by key stakeholders, including parents, teachers, principals, and government officials, was cited by interviewees as an important barrier to the development of ed-tech in countries of the three regions (anonymous, personal communication, 2023). In Sri Lanka, however, some mentioned that this is changing after the COVID-19 pandemic, since school closures highlighted some of the benefits and value of ed-tech (anonymous, personal communication, 2023).

Resistance to adopt new technological tools for education was more apparent in certain contexts. For instance, the Akura program has encountered more reluctance from public school administrators to adopt ed-tech programs like the Akura school management system, as compared to private schools, despite it has been designed for ease of use both in rural and urban areas (anonymous, personal communication, 2023). Similarly, interviewees in Indonesia reported that the use of smartphones is not permitted in religious boarding schools (pesantren), as they are considered to distract students from learning (anonymous, personal communication, 2023).
Social factors were highlighted as a hindering factor in Cambodia and Vietnam as well, however this was attributed to the traditional educational culture that is still predominant in these countries. In Vietnam particularly, senior teachers were said to display a higher level of resistance to adopting online platforms and digital tools (anonymous, personal communication, 2023). Exposure to the digital world can thus be limited and the integration of ed-tech in educational practices hindered due to contextual and social factors. As a result, some students may not adopt technology to complement traditional learning or build online self-learning practices.

In MENA, stakeholders' resistance to change was also cited as a main barrier to ed-tech uptake, coupled with the lack of a vision and strategy with respect to its adoption and use. For instance, one of the first challenges encountered by the Sghartoon program was the initial reluctance of therapists to adopt technology in their practices (anonymous, personal communication, 2023). This hesitation stemmed from concerns that the technological tool might replace or undermine their role in therapy. Similarly, a main barrier encountered by the Madrasty program has been scepticism from some parents and educators regarding the effectiveness of e-learning (anonymous, personal communication, 2023).

It is apparent that social attitudes toward technology and contextual factors continue to be a considerable barrier to the adoption of ed-tech PPIs across the regions studied. Resistance to upskilling and learning new technological skills is common among senior teachers and public school administrators, who may perceive it as burdensome or unnecessary. This reluctance to embrace technology in the classroom prevents the full realisation of ed-tech's potential in enhancing the learning experience. A negative conception of technology's impact in education from other key stakeholders, such as parents and government officials can further limit the implementation of ed-tech strategies.

**Changes to the ed-tech landscape due to COVID-19**

**Increased interest in ed-tech**

The COVID-19 pandemic precipitated an intensification of ed-tech PPIs across the three regions. For instance, the number of users of OLabs in India was reported to have doubled from 1,600,000 pre-pandemic to 3,200,000 after the pandemic, with over 12,000 schools in the country using them in 2021 (Bhubaneswar, 2021). The Class Saathi programme, also in India, expanded from 10 schools to more than 1,800 schools, and is expected to record a 300% year-on-year growth ahead (Times of India, 2022). Similarly, in Sri Lanka, according to interviewees, the Akura school management system
has experienced a 20% increase in its coverage of schools post-pandemic, despite it being a considerably small-scale ed-tech programme in the country (anonymous, personal communication, 2023).

This expansion of the number of beneficiaries and users of ed-tech during the pandemic has also resulted in the expansion of coverage. For example, the Nenasa programme in Sri Lanka launched two new ed-tech initiatives, namely, the “Nenasa educational app”, which catered to more than 33,000 users, and the “Nenasa 1916” toll-free distance learning helpline (anonymous, personal communication, 2023). Prior to the pandemic, the content provided by the Nenasa initiatives was to be delivered in the Tamil language, with the intention of catering to the minority community of Sri Lanka. In Bangladesh, the Parliament Television started broadcasting thousands of lessons for primary, secondary, madrassa, and vocational education reaching students in the tens of millions during COVID-19. It is therefore apparent from the success of these programmes that the pandemic has encouraged the expansion of ed-tech PPIs.

The demand for distance learning owing to lockdowns and the consequent school closures also fostered government support for ed-tech programmes within the region during the pandemic (anonymous, personal communication, 2023). Similar steps were undertaken by the other governments in the region outside of this study’s scope, such as Nepal (Lisa et al., 2021) and the Maldives (Sosale et al., 2020), which collaborated with the private and non-profit sectors to make free and open access educational content available for all learners amid school closures. This support has continued post-pandemic with the general public and stakeholders now expressing being more aware of the important role played by ed-tech in improving the resilience of education systems and the benefits of incorporating ed-tech into mainstream education and learning processes (anonymous, personal communication, 2023). Movement restrictions during COVID 19 created high demand for distance education, and new opportunities for the expansion of the ed-tech sector.

Some ed-tech providers also have plans to incorporate offline tech modes as a part of their existing ed-tech programmes as a response to the challenges faced during the COVID-19 pandemic by students from underprivileged areas, who do not have access to internet connection (anonymous, personal communication, 2023). There are some examples that already exist, such as television channels for students as provided by Nenasa in Sri Lanka, and Bluetooth clickers as provided by Class Saathi in India, among others. Such ed-tech initiatives incorporating offline tech solutions would improve access to ed-tech in the future, since the digital divide is another main barrier to the adoption of ed-tech in the region. Similarly, some other ed-tech PPIs aim to expand geographical coverage as well as to include minority languages (including sign language).
in their programmes, which would further contribute toward reducing inequalities in education (anonymous, personal communication, 2023).

In Indonesia, the education technology company Ruangguru, which offers a range of educational content and access to online tutors, saw an increase in demand for its online learning services during COVID-19. As students and parents sought alternative educational solutions, Ruangguru expanded its offers by introducing new features such as live streaming classes and making downloadable content so that materials were accessible without an internet connection (anonymous, personal communication, 2023). Ruangguru also increased collaborations with educational institutions throughout the country and experienced a significant increase in funding. This funding was mainly through venture capital and equity companies during the pandemic, making it one of the largest ever funded start-ups in the history of the Indonesian start-up ecosystem (Pratama, 2019). According to Pratama (2021), Ruangguru experienced over 50% growth in its user base to reach over 20 million students and 400,000 teachers in 2020. The success of Ruangguru during the pandemic demonstrates that the changes to the ed-tech landscape caused by COVID-19 have helped private ed-tech companies drastically expand their footprint and profitability, whilst simultaneously providing more opportunities for students.

Funding for ed-tech also increased in Vietnam. For instance, Marathon Education for students across Vietnam was established in 2021, immediately post-COVID-19, in the midst of a boom in ed-tech businesses. It raised more than 7 million USD within twelve months of its launch (Abudheen, 2022). It is apparent from the success of Marathon Education during and since the pandemic that the demand for digital learning technologies has seen private ed-tech companies expand and improve what they offer and became more profitable, therefore accelerating digital transformation in Vietnam. The Vietnam ed-tech market was estimated to exceed 3 billion USD by 2023 with around 260 ed-tech businesses in the country, most of which are startups and business-to-customer companies which attract the interest of both local and foreign venture capital funds (Nguyen, 2022).

The MENA region also saw significant changes in the ed-tech landscape as a result of COVID-19. In Egypt, the government distributed tablets to students, provided free access to online learning materials and digital platforms, and awarded ICT certifications to teachers through the International Computer Driving License (ICDL) programme (Ministry of Communications and Information Technoloy, 2020; 2021). The Ministry of Communications and Information Technology increased home internet download quotas by 20% for free (anonymous, personal communication, 2023). In much the same vein, the National Center for Education Technologies (CNTE) in Tunisia established a digital workspace for primary schools and developed a digital content platform to provide
access to educational resources online anonymous, personal communication, 2023). This demonstrates the important role that COVID-19 played in increasing access to online learning materials and resources, as well as infrastructure for higher levels of internet penetration.

**Exposed gaps and vulnerabilities associated with ed-tech implementation**

Despite the positive gains offered by ed-tech, there are still many students who do not benefit from it. A case study conducted by Vegas et al., (2021) focusing on Chennai in India, found that 1 in 5 of children were in schools that offered no remote instruction during COVID-19. This study was based on a phone survey of 201 households and 271 primary school aged children conducted in February 2021. It further found that only slightly above half of the children enrolled in schools that did provide remote instruction attended all classes; and ed-tech was more accessible for children from private schools and high socio-economic backgrounds.

The pandemic also exposed several challenges to conducting standardised classroom teaching in schools. In Vietnam, for instance, online teaching and studying were challenging for both teachers and students as this was a relatively new form of learning in the country (anonymous, personal communication, 2023). Additionally, newly established online learning platforms faced technical issues like system overloads, mismatches between the number of student registrations and online classrooms, unstable transmission signals, and host errors (anonymous, personal communication, 2023). In Cambodia, ed-tech was mainly used after the pandemic in education as a form of communication and information sharing, rather than improving quality of or access to education (anonymous, personal communication, 2023). The incorporation of ed-tech into schools is still at a micro-level and has not been systematically integrated into mainstream education.

The COVID-19 pandemic also highlighted barriers to equal access to technology, especially in rural areas and among disadvantaged communities. For example, students
that had to attend online learning in Tunisia encountered challenges due to limited
internet connectivity barring access to online learning resources (Smaali Bouhlila et al.,
2022). Pellini et al. (2021) recommend that in the short term, a multimodal approach, which
is a combination of high-, low-, and no-technology, increases opportunities for children
from marginalised backgrounds to continue learning, particularly during emergencies. In
the longer term, ed-tech combined with evidence-based approaches known to work well
in education can help close learning gaps by providing diverse opportunities to students
in hard-to-reach areas. This emphasises the importance of implementing inclusive PPIs
that reduce the digital divide and ensure equitable access, as opposed to exacerbating
the issue.

Conclusion

Though diverse in nature, SA, SEA, and MENA provide an important platform on
which to explore ed-tech. Within the countries selected for this study, a multitude of ed-
tech PPIs have been developed, utilised and implemented since 2010. The importance
given to ed-tech varies across the countries and regions, but all demonstrate interest
in the investment in and development of ed-tech PPIs. Though still a new phenomena,
many ed-tech PPIs date back a decade or more. Additionally, ed-tech uptake has in fact
grown as a result of COVID-19.

Within the countries selected for this study, ed-tech has contributed to improving
specific educational goals and infrastructure, and to reducing gaps in access to education
(United Nations, 2023). The initiatives examined in this paper were implemented
throughout 2010 to 2022 to reach populations that were otherwise considered hard
to reach. Some of these PPIs aimed to increase digital literacy and enhance access to
quality education, particularly for vulnerable groups such as refugees and children with
disabilities. Other programmes were designed to facilitate self-paced learning among
children, provide teacher training, and facilitate school management.

Some research exists that casts a shadow over the positive role of technology in
reducing the disparities in education and questions whether ed-tech addresses the
issues faced by marginalised groups in LMICs (Hennessy et al., 2021). However, ed-tech
platforms within SA, SEA and MENA appear to have facilitated the achievement of
Sustainable Development Goal (SDG) 4, which aims to ensure inclusive, equitable,
quality education and promote lifelong learning opportunities for all. With this in
mind, programmes that were able to support the uptake and improvement of quality
education, particularly throughout COVID-19, could be considered as exemplary in the
future landscape of ed-tech.
All ed-tech initiatives reviewed in this paper were found to target the achievement of quality education (SDG 4) and many of the PPIs examined addressed the educational needs of students from vulnerable contexts or children with disabilities. Emphasis was also given, especially since COVID-19, to improving the resilience and responsiveness of education systems to disruption. Some initiatives also supported SDG 10 to reduce inequalities. Initiatives that contributed towards the achievement of SDG 10 specifically focused on reducing the urban-rural divide in access to education and technology, and other programmes primarily focused on supporting marginalised groups.

One of the most common aims of the selected PPIs was to contribute towards improving learning outcomes. Ed-tech itself provides programmes with supplementary resources by providing access to additional knowledge, aiding teachers to prepare tests, and functioning as an electronic tutors for students. Self-learning initiatives in SEA are particularly sophisticated as these provide high-quality educational content and services tailored to student needs and learning preferences. These initiatives are also a means for creating their own assessments by using data analytics and machine learning algorithms. Ed-tech applications that provide technology-based behavioural interventions and aim to influence behavioural changes were noted, as they use student-friendly approaches, such as games.

The most common types of ed-tech in SA, SEA and MENA focus on supporting education in schools, providing self-led learning programmes, and implementing technology-enabled behavioural interventions. Capacity building for teachers has also been important for the integration of ed-tech within classroom settings, and in-service and pre-service training has been defined as critical in the utilisation of ed-tech at school (Mandal & Srinivas, 2022). Similarly, by improving the investment in ed-tech start-ups and open online courses, there has been an increase in the amount of resources available online for teachers and students, which has facilitated learning, teaching and preparation for examinations. Ed-tech therefore brings potential to the regions in meeting SDG 4, as it can increase teacher capacities, provide free access to education for all, and support the facilitation of adequate learning opportunities.

Key stakeholders, particularly individuals and institutions with legislative and policy decision-making power, have played an important role in facilitating the implementation of ed-tech in the three regions. These stakeholders are equipped to facilitate ed-tech by increasing political and public buy-in, teacher training opportunities, financial investment and the improvement of infrastructure. By prioritising ed-tech at the national (and regional) level, the ed-tech landscape during and post-COVID-19 has generated opportunities that were otherwise absent from PPIs. Stakeholders with decision-making power, often public entities such as local governments, are an important part to the development and implementation of ed-tech within the regions.
The involvement of different types of stakeholders in ed-tech varied according to country and regional contexts. The political interest in ed-tech is highest in SEA, where regional-level coordination and strategic efforts are in place to drive ed-tech through SEAMEO. There are no regional-level ed-tech policy initiatives in SA nor MENA, but ed-tech-related policies have been present for several years, with the earliest in India dating back to 1986. Many of the policies are being implemented in collaboration with donor agencies, such as the World Bank, UNICEF or the ADB, private sector stakeholders, or other ministries. Partnerships with such agencies have provided expert knowledge and funding opportunities to develop ed-tech in the region that can potentially lead to scaling up and the sustainability of ed-tech. In countries with lower levels of education, donors have been more involved in implementing ed-tech PPIs with the aim of reaching out to the most vulnerable communities and students.

These policies are evolving, particularly since COVID-19, and include components for the development of educational content, teacher training, improving access to digital resources, online assessment tools, and support for administering education. Largely, the COVID-19 pandemic acted as a facilitator of ed-tech PPIs in the region, since the pandemic pushed countries to incorporate technology into education following school closures and the inevitable switch to online learning. All selected countries witnessed a rise in demand for ed-tech during the pandemic. This was broadly witnessed through greater adoption of ed-tech initiatives, increased user bases, and the expansion of services offered by suppliers of ed-tech. On the other hand, the pandemic brought to light several challenges with respect to the ed-tech landscape, most predominantly unequal access to technology and the digital divide.

Though notable opportunities fostered by ed-tech exist, there are also barriers to its development and implementation, intertwined with contextual factors. The lack of basic infrastructure in SA, SEA and MENA impacts the extent to which ed-tech PPIs can be implemented, as access to the internet and electricity is not uniform. Even when students do have access to both, online education has been found to be heavily reliant upon access to technological devices such as mobile phones, laptops or tablets. Internet and mobile phone penetration rates in SA, SEA and MENA are high, but limitations in access to technology continue to impact those in rural areas or living in contexts of poverty.

Low levels of teacher capacity within these regions at present also poses a challenge to its wide scale adoption. Some teachers are not equipped with the adequate knowledge, tools or resources to implement ed-tech programmes or to integrate technological platforms into lesson plans (Mandal & Srinivas, 2022). This means that mainstreaming the use of ed-tech in public and state education is not yet adequately invested in or integrated into classroom settings.
Contextual factors can also provide obstacles to the successful adoption of ed-tech as some cultural attitudes and social expectations place greater importance on more traditional modes of learning than on innovative ed-tech approaches (Pellini et al., 2021). Similarly, political fragility and instability has led to an environment that is not conducive to developing and implementing new PPIs on ed-tech.

Several important conclusions can be drawn from the current state of ed-tech in SA, SEA and MENA in order to address key challenges and inform future research into current gaps in research. Firstly, ed-tech initiatives need to be more coordinated and impact-oriented. Although information on different ed-tech policy initiatives is available, limited information exists on the impact of these initiatives. In some countries, policies and projects with similar aims are ongoing. In others, policies are relaunched with similar aims, which is possibly due to technology advancements necessitating re-evaluation of earlier projects. It could also be due to implementation gaps. Also, the impact of different programmes needs to be assessed to improve the design and implementation of future projects, as well as their sustainability.

Secondly, since ed-tech is evolving quickly, education policies also need to adapt. It is important to have policy committees with representatives from different sectors, such as education, technology, and innovation, to assess and revise existing ed-tech policies for students and teachers. SEAMEO represents a best practice in this regard as it brings together beneficiaries, donor countries, and experts to develop policies to initiate ed-tech PPIs in the region.

Thirdly, it is apparent that different opportunities and challenges faced by the subregions have resulted in interest and investments in ed-tech. For example, in India, the vast population of digitally literate young people have received the interest of venture capitalists and bilateral donors. In Pakistan, poor educational outcomes have resulted in higher interest from NGOs and donor agencies. A better understanding of these dynamics can be used to leverage funds for expanding access to quality education using ed-tech.

Ed-tech programmes have been launched mainly with the intention of improving access to quality education. Although many programmes have paid attention to reducing the digital divide, the emphasis given to this is less. Given the fast pace at which ed-tech is developing and the high costs involved in improving access to digital services, inequalities in access to education are likely to increase unless more efforts are made to reduce the gaps in access to digital services.

There is high interest by the private sector to invest in ed-tech given the potential for profit making. These should be leveraged to promote ed-tech development yet, at the
same time, better information on access to ed-tech services needs to be made available so that donors are encouraged to invest in local ed-tech PPIs.

Some of the challenges in improving access to ed-tech are socio-cultural. Hence, along with investing in infrastructure and improving access to digital devices, attention should be paid to building awareness in the importance of allowing child-safe access to the digital environment.

In the future, there is a lot of capacity for growth as the incorporation of technology is still currently a relatively new concept in the region. Over the years there has been a rapid acceleration in the use and implementation of ed-tech in Asia, particularly since and as a result of the COVID-19 pandemic. Future research on ed-tech in the region should focus on building a stronger base of quantitative data with which to measure the impact and success of initiatives and to improve them for the future. Through these recommendations and learnings from existing PPIs, it is clear that ed-tech has the potential to reach many more students, as well as teachers and families, to improve quality education and to reduce inequalities. It is a constantly evolving landscape and will grow as PPIs adapt around it, but the future of ed-tech is bright and holds the possibility of contributing to improving education for all students.
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Annexes

Annex 1. Codes/Themes identified in the analysis

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Themes/Codes</th>
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<tbody>
<tr>
<td><strong>Importance of Ed-tech</strong></td>
<td>Contribute towards SDG4 &quot;Quality Education&quot;</td>
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<td></td>
<td>Reduce gaps, inequalities/Improve access to vulnerable groups (SDG 10)</td>
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<td></td>
<td>Solving the issue of lack of infrastructure, resources</td>
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<td>Success of Ed-tech based on the number of beneficiaries and expansion over time</td>
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<td></td>
<td>Caters to children with disabilities</td>
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<td>Improve the resilience of the education system</td>
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<td>Innovative education</td>
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<td>Support self-learning</td>
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<td>Reducing costs</td>
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<td>Improve efficiency and time saving</td>
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<td>Teacher in-service education/training</td>
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<td>Connecting students, teachers, parents, admin staff</td>
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<td>Ed-tech as a supplementary resource in schools</td>
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<td></td>
<td>Improve connectivity</td>
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<td>Contribute towards SDG3 &quot;Healthy lives and wellbeing&quot;</td>
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<td></td>
<td>Laws, policies, and regulations</td>
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<td>Accountability</td>
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### Facilitating factors of ed-tech
- Collaborations
- Alternate financing
- Policy priorities
- Teacher training
- Infrastructure availability
- Improved access to technology
- CSR projects
- Improved attitudes towards Ed-tech
- Increased use of technology
- Internal frameworks
- Will and interest of governments
- Will and interest of the private sector
- International organisations - Stakeholders
- Private sector stakeholders
- Public sector stakeholders

### Barriers to ed-tech
- Lack of teacher training
- Limited resources (infrastructure, hardware etc.) availability - users
- Affordability (users)
- Unequal access (users)
- Insufficient network coverage (users)
- Limited human resources (experts, personnel etc.) – supply side
- Lack of funding (supply side)
- Governance and Institutional inadequacies
- Negative attitudes towards Ed-tech (users)
- Inadequate coverage (Supply side)
- Cultural factors
- Lack of vision and strategy
- Inadaptability of organisations
- Lack of student competencies
- Deterioration of infrastructure
- Lack of maintenance
## Impact of COVID-19

<table>
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<tr>
<th>Code/Theme</th>
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<tr>
<td>Accelerated use of Ed-tech</td>
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<tr>
<td>Impact of COVID-19</td>
</tr>
<tr>
<td>Laws, regulations, and support mechanisms</td>
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<tr>
<td>Supply-side expansion of Ed-tech</td>
</tr>
<tr>
<td>New collaborations</td>
</tr>
<tr>
<td>Future planning</td>
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<tr>
<td>Lessons learnt</td>
</tr>
</tbody>
</table>

**Note.** The codes/themes are listed in the order of importance such that the themes that were cited the most are listed first. Elaborated by the authors.