

Education Supply Chain Resilience: A Power-Aware Strategy for Enabling SDG 4

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ABSTRACT

Achieving Sustainable Development Goal 4 (SDG 4) requires not only pedagogical innovation but also resilient supply chains capable of withstanding shocks and ensuring learning continuity. This paper develops an education supply chain resilience (ESCR) framework, highlighting four pillars – visibility, flexibility, collaboration, and risk management – while integrating resource-based theory (RBT) and Cox's theory of power to explain why these capabilities function as strategic resources for education systems. Drawing on case studies such as UNICEF's School-in-a-Box, the World Food Programme's (WFP's) school feeding initiatives, and digital distribution during the COVID-19 pandemic, the analysis demonstrates that ESCR is not merely about efficiency, but about the governance of critical resources such as curriculum, data, and distribution networks. The findings underscore that ESCR must be recognised as a strategic imperative – not a peripheral logistical concern, but a front-line driver of equity and continuity in education. Practical and policy implications are provided for governments, non-governmental organisations (NGOs), and international organisations to institutionalise resilience and safeguard access to inclusive, quality learning worldwide.

Keywords: Supply Chain Resilience, Education, SDG 4, Humanitarian Logistics, Resource-Based Theory, Power Dynamics, Strategic Governance

Introduction

Despite global progress towards universal education, major gaps remain. Today, 109 million children are enrolled in school but lack adequate resources, while another 272 million remain entirely out of school (UNESCO, 2023). These figures underscore the dual challenge of access and quality: millions of children may formally attend school but do so without the textbooks, trained teachers, digital tools, or safe environments necessary for effective learning, while millions more are excluded altogether. Addressing both dimensions is crucial to achieving Sustainable Development Goal 4 (SDG 4), which not only calls for universal enrollment but also for equitable, inclusive, and high-quality education that enables all learners to thrive. To meet this challenge, education systems must be understood through the lens of supply chain resilience, where visibility, flexibility, collaboration, and risk management ensure that learning resources reach every child – even in times of crisis.

Supply Chain Resilience as a Strategic Imperative for SDG 4

SDG strives to provide quality education for all. However, this dream is constantly under siege by shocks – pandemics, natural disasters, war, and political instability. This paper posits that education supply chain resilience (ESCR) cannot be regarded as a peripheral but should be recognised as a core strategic capability. Based on humanitarian logistics, strategic supply chain theory, and the resource-based view, the paper provides conceptual grounding and practical understanding for policymakers, non-governmental organisations (NGOs), and practitioners. Combining Cox's (1999) power-value-appropriation framework with resource-based theory (RBT) (Barney, 1991), we propose a power-aware resilience model for education systems. Imagine a child in an indigenous village in Chiapas, Mexico, and how he would feel after his already flooded

school is destroyed. The textbooks, the notebooks, the pencils – all lost. In a migrant community in China's Jiangsu province, children could soon be cut off from their teachers and the digital windows to the wide world that they provide. These are not theoretical situations; they are real-life experiences that repeatedly challenge the sustainability of educational institutions around the world. This noble aspiration of SDG 4 rests on an often invisible but indispensable foundation: the capacity to put the right materials into the hands of the right learners at the right times, a need that is even more acute when crises break out. For too long, the attention in education has been on what is delivered – the curriculum, the pedagogy – but its complicated machinery of how it is delivered, done at a sort of functional level, has been treated as a secondary, operational afterthought. This essay argues that mindset is a major error of strategy. Logistics and strategy go hand in hand in the work of achieving SDG 4, as recent crises have laid bare long-standing weaknesses in delivery systems for education. There are still structural and situational barriers on the educational supply chains to develop, even in the context of learning progress. Financial barriers, including budget constraints, continue to be a significant obstacle, particularly for low- and middle-income countries, where competing demands for limited resources prevail. Ineffective procedures for procuring necessary equipment cause delays, cost overruns, or corruption that ebb away valuable resources needed to put textbooks, uniforms, and teaching materials into the hands of students. The lack of infrastructure – bad roads, low warehousing options, and poor distribution hubs further compounds these challenges, with rural communities (and other hard-to-reach settings) being at the losing end. These systemic weaknesses were further uncovered by the COVID-19 pandemic. The world's school systems had to move rapidly to remote learning, yet here we are with millions of children without access to the internet or sufficient devices – and sometimes even electricity (UNESCO, 2020). The crisis revealed that educational supply chains were not nimble enough to adjust to shocks, highlighting the critical need for more resilient systems. There are valuable lessons to be learnt from humanitarian logistics, which highlight striking similarities, such as the challenge of maintaining supply chain flow in volatile and uncertain settings (Kovács & Spens, 2019). As with humanitarian agencies that

face sudden increases in needs in resource-constrained environments, educational systems faced a global emergency with little room for manoeuvre. Climate-induced disasters and geopolitical conflicts also pose a threat to educational supply chains, alongside systemic risks. Floods, earthquakes, and extreme weather events damage school infrastructure and sever transportation links, disrupting the delivery of supplies. Populations are displaced by political instability and war, which disrupts national education systems and forces communities to rely on temporary or emergency learning environments. Taken together, these challenges contribute to the increasing equity gap, and already marginalised learners are most at risk of being left out when supply chains break down. Meeting these challenges will require not just structural reforms, but also creative solutions that incorporate resilience, flexibility, and collaboration across sectors at the heart of education systems.

The ESCR Framework

Building on RBT (Barney, 1991; Wernerfelt, 1984; Peteraf, 1993; Miles, 2012) and Porter's (1985) insights on competitive advantage, the ESCR framework conceptualises resilience as a set of strategic capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN). These capabilities are articulated through four interrelated pillars – visibility, flexibility, collaboration, and risk management – which together strengthen the ability of education systems to withstand shocks while safeguarding continuity of learning. Rather than treating supply chains as fragile pipelines, the ESCR framework positions them as strategic assets that can be cultivated and leveraged to achieve SDG 4 (UNESCO, 2020; Christopher & Peck, 2004).

Visibility

Visibility ensures the transparent monitoring of resource flows across procurement, transport, and delivery, reducing diversion and increasing accountability. In Mexico, national dashboards track textbook distribution; however, rural bottlenecks frequently escape oversight, limiting equitable access (Aurino, Tranchant, & Gelli, 2020). By contrast, China's distribution of digital devices during COVID-19 reflected high-level visibility, with centralised monitoring systems tracking

progress nationwide. However, digital divides in remote provinces revealed persistent inequities (UNESCO, 2020). Emerging tools such as blockchain-enabled platforms and real-time dashboards demonstrate how enhanced visibility can reshape educational logistics (Kovács & Spens, 2019).

Flexibility

Flexibility reflects the adaptive capacity of education systems to modify sourcing, distribution, and delivery strategies during disruption. In Mexico, centralised textbook production illustrates limited flexibility: once disrupted, distribution delays extend for weeks. By contrast, China's rapid scaling of online education platforms during the pandemic highlighted institutional flexibility, although heavily dependent on concentrated partnerships with major technology firms (UNESCO, 2020). Alternative models – such as leveraging local production for school meals or experimenting with drone-based transport for rural schools – show how flexibility can buffer against disruption (Christopher & Peck, 2004).

Collaboration

Collaboration emphasises the formation of strong partnerships among governments, NGOs, international organisations, private firms, and communities to align resources and share expertise. The World Food Programme's (WFP's) school feeding programmes in Mexico exemplify this approach by sourcing food locally, simultaneously strengthening community economies while delivering nutrition in schools (Aurino et al., 2020). In China, partnerships with telecom operators facilitated the rapid expansion of digital learning, although they introduced dependencies on private-sector infrastructure (UNICEF, 2018). Collaboration ensures that resilience is not the responsibility of a single actor, but is distributed across networks of support (Kovács & Spens, 2019).

Risk Management

Risk management constitutes the anticipatory capacity to embed contingency planning, pre-position resources, and safeguard continuity of learning under uncertainty. UNICEF's School-in-a-Box initiative

illustrates how immediate continuity can be provided in emergencies, including in disaster-prone regions of Mexico (UNICEF, 2018). Meanwhile, China established emergency protocols during the COVID-19 pandemic, ensuring educational broadcasting on state television and pre-loading digital content to support remote learners (UNESCO, 2020). Long-term resilience requires embedding such practices into national systems, including the establishment of early-warning mechanisms, emergency procurement frameworks, and staff training to sustain continuity (Christopher & Peck, 2004; WFP, 2021).

Case Studies: Resilience in Action

Although the ESCR regime has not been formally institutionalised, its principles are embedded in ongoing humanitarian and development initiatives.

- *UNICEF's School-in-a-Box*: This programme is based on pre-positioning of standard core learning kits for immediate distribution following a disaster or during a conflict, thus making risk and visibility management operational. Schools reopen within days, and learning continues. However, overdependence on international donor supply channels highlights the risks of dependency and the limitations of crisis interventions (UNICEF, 2018).
- *WFP School Feeding*: In focusing on both nutrition and education, the WFP's programmes demonstrate co-operation and adaptability. Localised procurement – from smallholder farmers in sub-Saharan Africa to fortified biscuits in Southeast Asia – is an example of the resilience created by context-specific supply chain design. Evidence demonstrates that attendance, attention, and long-term learning outcomes have improved (Aurino, Tranchant & Gelli, 2020). However, these efforts are not aligned with systemic resilience strategies.
- *COVID-19 Digital Device Distribution*: The pandemic illuminated both resistance and brittleness in educational supply lines. Decentralisation led to uneven results in Mexico, leaving many rural students behind. On the other hand, China's centralised procurement and national platforms allowed for rapid scaling up but encountered continued digital divides in remote provinces.

These diametric examples demonstrate Craighead, Blackhurst, Rungtusanatham, and Handfield's (2007) contention that the extent of disruption is equally a function of supply chain design as it is about the crisis (UNESCO, 2020).

The combination of these cases suggests that resilience is not an intangible ideal, but rather a reality that no

one can ignore. They demonstrate that the fate of children is mediated through power relations, systems of governance, and manipulative control over resources. Piecemeal, reactive responses can offer short-term relief, but consistent implementation of ESCR principles could pave the way for them to evolve into sound and equitable instruments for protecting learning continuity.

Table 1: Summary of Education Initiatives Aligned with ESCR Framework

Case	Key Objective	Strengths (ESCR Pillars)	Weaknesses / Vulnerabilities	Integration with ESCR Framework
Mexico – CONALITEG Textbook Distribution	Nationwide provision of free textbooks	Scale, digital monitoring (visibility)	Low flexibility; last-mile delivery fragile, disrupted by earthquakes	Demonstrates visibility, but resilience requires decentralization and risk management
Mexico – School Feeding (WFP + Ministry)	Improve student nutrition & attendance	Local sourcing (collaboration, flexibility)	Vulnerable to funding shortages and food price volatility	Strong collaboration model, enhances resilience through community linkages
China – COVID-19 Digital Education Response	Maintain learning continuity during school closures	Rapid mobilization of platforms & device distribution (visibility, flexibility)	Rural–urban digital divide; dependency on few tech providers (power asymmetry)	Shows strategic power use; resilient if equity gaps addressed
UNICEF – School-in-a-Box	Rapid re-establishment of education in crises	Immediate continuity (risk management)	Only basic supplies; lacks systemic integration	Short-term resilience tool, not a long-term solution
WFP – School Feeding (Global)	Retain students in school & support nutrition	Local sourcing + integration with education (collaboration, flexibility)	Exposed to global food market shocks	Effective when embedded in national planning and supported by long-term funding
COVID-19 Global Device Distribution	Provide access to remote learning	Partnerships with private sector (flexibility)	Inequitable access; weak visibility; delays in marginalized areas	Highlights need to combine visibility with equitable governance

Source: Author's own contribution.

Table 1 provides an overview of how various education initiatives align with the ESCR framework. Each initiative is carefully analysed to showcase its unique strengths and challenges. For example, some initiatives excel in ensuring the visibility of educational resources, such as distributing textbooks consistently to schools, which promotes accessibility and equity among students. Others demonstrate flexibility in their school feeding programmes, adapting to the changing needs of students and communities, ensuring that all children have access to nutritious meals that support their learning. However, these initiatives also face significant vulnerabilities that need to be addressed. Issues such as unequal access to educational resources highlight disparities among students in different regions or socioeconomic backgrounds. In addition, the fragility of delivery systems can lead to inconsistent support, jeopardising the effectiveness of these educational programmes. Ultimately, many initiatives struggle with a heavy dependence on external funding and resources, which can ultimately hinder their long-term sustainability. In conclusion, the cases collectively illustrate that true resilience in education can only be achieved when key elements – such as visibility,

flexibility, collaboration among stakeholders, and robust risk management strategies – are seamlessly integrated into the education supply chain, thereby creating a more effective and equitable educational environment for all students.

Policy and Practical Implications

There are significant implications from a power-aware, resource perception of an education supply chain. Far too often, movement of textbooks, food, and technology is perceived as a background process – something that happens silently after curriculum or pedagogy has been set. Paradoxically, though, resilience theory is unambiguous that logistics cannot be left in the dark. (Christopher & Peck, 2004; Cox, 1999, 2001), It needs to be accepted as a strategic cornerstone of SDG 4, which is on par with the reform of curricula and the professional development of teachers. However, for policymakers, this means leading with our hearts and our heads. Governments must cling steadfast to the core of what education is – what children learn, how

they are measured, and the security of their data – while being open to collaboration with logistics experts to distribute resources. Investments in digital visibility solutions, such as real-time dashboards and predictive analytics, can enable the monitoring and protection of educational supplies to help them reach classrooms when it matters most (Dubey et al., 2021). Procurement systems, too, should be flexible, as both are equally important. Policy frameworks must move beyond rhetoric and incorporate tools that assess resilience across procurement, distribution, and governance. Pettit, Croxton and Fiksel (2013) emphasise the importance of assessment instruments for embedding resilience into organisational practice. Likewise, education systems require institutionalised diagnostic tools that enable governments, NGOs, and practitioners to monitor vulnerabilities and adapt strategies effectively. National co-ordination is necessary because responsibilities for such programmes are dispersed among the states in Mexico, and it has to be ensured that every child – from Chiapas or Nuevo León, for example – gets textbooks and meals delivered on schedule. Instead, in China, where education governance is extremely centralised, resilience involves embedding local flexibility so that a one-size-fits-all national policy can work in a megacity such as Shanghai as well as in remote provinces. Contexts vary, requirements change, but the final goal is the same: to create systems that are robust enough to keep on learning even when everything else falls apart. For the much-needed design practitioner, the stakes are equally high. Teachers, administrators, and community leaders are not just users of these systems – they are stewards of resilience. The child who has the most need does not always receive the resources; it is their day-in, day-out behaviour and activities that usually determine who gets what. When our national system of distribution fails, it is the local printer who prints the exams, or the farmer who sends food in for school lunches. This means making transparency a priority, keeping tabs on supplies, and working not just within their own groups but in concert with others across their communities if need be. They also make the spaces in which problem solving takes place, pulling together parents, local leaders, and officials, to keep education moving. A meal on a desk, or a book in the hand of a child, may seem unremarkable, but in an insecure system, these basic assurances are profoundly radical. Resilience

also requires a balanced management of collaboration. Ministries, NGOs, donors, and private partners all have vital roles to play, but must do so in a way that enhances, not undermines, national sovereignty. As Olorunfoba and Gray (2006) caution, haphazardly configured hybrid supply chains can exacerbate rather than alleviate dependence. Real resilience comes from striking a balance: strong sovereign control over the essential resources we have, and a deep sense of accountability and collaboration to transform them across sectors. Indeed, if education systems implement the ESCR framework, they will shift their focus from reactive action only once a crisis has occurred to a system-level, proactive model of resilience. Future-proofing education systems will involve everyday governance that integrates visibility, agility, collaboration, and risk management. According to both Mexico and China, despite the dissimilarity between their governance models, it is a lesson that remains depressingly relevant: Resilience means no crisis stands in the way of every child learning. This right is not a luxury but an imperative that must be protected (UNESCO, 2020; WFP, 2021).

Key insights

Resilient education supply chains must be recognised as a strategic priority rather than a background function. In Mexico, this requires strong national co-ordination across decentralised states to guarantee equitable delivery of resources. In China, it means embedding flexibility into a highly centralised system so that policies work equally well in megacities and rural provinces. For both policymakers and practitioners, the challenge is the same: ensuring that textbooks, meals, and technology reliably reach every child, every time – even during a crisis.

Suggestions for Further Research

Although linking the ESCR with RBT is a theoretical contribution, a lot of empirical research is required to validate and develop our model in a practical context. Comparative work could investigate how visibility, flexibility, collaboration, and risk management – revisited as levers to enable ESCR (see Lepak et al., 2005; van

Maanen, 1979) – show subtle variations across settings. For example, visibility and flexibility are to a hefty degree driven by strong state co-ordination in China’s centralised system, while it runs through co-ordination among several states and ministries in Mexico’s decentralised system. Scrutiny of these distinctions would serve to show how accommodating the ESCR model can be in high, middle-income, and transitional settings. Further work would need to extend beyond conceptually analysing and into evidence-informed policy. Quantitative models and simulations – of the system dynamics or agent-based variety, for example – would be useful to calculate how investments in visibility or diversified sourcing pay off in improved attendance, higher test scores, and long-term equity. This type of empirical evidence could help make resilience strategies actionable for policymakers. Moreover, ESCR should be embedded into existing strategy frameworks such as the VRIO (value, rareness, inimitability, and organisation), the resource-based view, and Porter’s

competitive advantage model. This demonstrates that resilient education supply chains are about more than operational survival during crises; they represent a strategic advantage over time. For example, Mexico and China alike would do well to consider which of their existing capacities – centralised procurement networks or local partnerships – are truly inimitable and thus offer long-term security. Last, governance and collaboration models deserve very significant focus. Researchers could investigate how ministries of education, NGOs, and private sector partners share responsibility in practice. While Mexico relies on subnational actors and China employs national-local partnerships, these distinct models could inform good practices around institutionalising resilience at scale. Grounding theory in such real-life governance models will also help ESCR to remain the subject of constant modification and empirical testing, as well as to be applicable to the world if SDG 4 is not enough.

Table 2: Suggested Research Directions

Research Question	Theoretical Lens	Methodology
How do power-dependence relationships between actors constrain or enable ESCR?	Power-value framework (Cox)	Comparative case study
Which ESCR capabilities provide a sustained competitive advantage for education systems?	VRIO/RBT	Qualitative interviews, archival analysis
How do ecosystems of NGOs, suppliers, and states co-evolve in response to crises?	Organisational ecology	Longitudinal network analysis

Conclusion

Education supply chains are never neutral; they are highly political, power-laden, and strategic. The ability of a child to continue learning during an emergency depends on whether ministries and agencies choose to lead the response or surrender control over vital supplies. By embracing a power-aware ESCR framework that fuses operational excellence with strategic ownership and acknowledging the competitive logics at play, education systems can not only survive shocks but fulfil SDG 4’s promise. Case studies really bring home this point. In Mexico, patchy procurement by states has led to delays in the distribution of textbooks and digital devices, underscoring the need for more robust national

co-ordination and contingency planning. Centralised governance in China enabled the swift deployment of online learning platforms during COVID-19; however, such success relied on local partnerships with telecom firms to ensure rural inclusion. These divergent stories are also a reminder that resilience is not some fanciful concept – it is a real need, and one that will make or break whether an education persists. Ultimately, building resilient education supply chains is not only about surviving crises but about ensuring equity and continuity for every learner, everywhere. To achieve this, policymakers must treat logistics as central to education policy; practitioners must safeguard delivery on the ground; and systems must be designed to protect the right to learn, regardless of what the future brings.

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