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Technology-Enabled Supplier Collaboration for Circular Economy Adoption in UAE Healthcare Supply Chains: An Industry 5.0 Perspective

Nikita Shaikh[1*], Prof. (Dr.) Sumita Dave[2]

[1*,] Research Scholar, Amity University, Raipur, Chhattisgarh, India Email: nikitapali@gmail.com
[2,] Dean and Pro Vice Chancellor, Amity University, Raipur, Chhattisgarh, India Email ID: sdave@rpr.amity.edu

Corresponding Author: Nikita Shaikh[1*]
[1*,] Research Scholar, Amity University, Raipur, Chhattisgarh, India Email: nikitapali@gmail.com

Abstract
Healthcare supply chains are under increasing pressure to become more sustainable, resilient and transparent. This pressure is especially strong in the United Arab Emirates, where healthcare development, digital transformation and sustainability are closely connected to national policy priorities. Although circular economy thinking has become common in manufacturing and general supply chain research, its application in healthcare remains more complex because hospitals and clinics must balance waste reduction with patient safety, sterility, infection control, regulatory compliance and continuity of care. This paper examines technology-enabled supplier collaboration as a practical route for circular economy adoption in UAE healthcare supply chains from an Industry 5.0 perspective. Drawing on circular economy theory, sustainable supply chain management, the resource-based view, institutional theory and socio-technical systems thinking, the paper argues that circular transformation in healthcare is not achieved by technology alone or by isolated waste management practices. Instead, it emerges when healthcare providers and suppliers share information, redesign materials and packaging, coordinate take-back and reverse logistics arrangements, and use digital systems to make circular practices visible and manageable. The paper uses the empirical logic and findings of a UAE healthcare supply chain study in which supplier collaboration, procurement, logistics, regulatory norms and technology were found to positively influence circular economy adoption, while circular economy adoption and technology improved firm performance. Supplier collaboration appeared as the strongest driver of circular economy adoption, making it the central focus of this paper. The study contributes by developing a human-centered Industry 5.0 framework that links supplier collaboration, digital capability, circular economy adoption and organizational performance. It also offers practical guidance for healthcare managers, suppliers and policymakers seeking to move from sustainability intention to measurable circular action.

Keywords: circular economy, supplier collaboration, healthcare supply chain, Industry 5.0, UAE, technology, sustainability, digital traceability, firm performance

1. Introduction

Healthcare has a direct social purpose: it protects life and improves well-being. Yet the systems that support healthcare are also resource-intensive. Hospitals, clinics and laboratories use large quantities of pharmaceuticals, devices, packaging, plastics, diagnostic materials, personal protective equipment, energy, water and transport services. Many of these products are designed for single use or have strict expiry and sterility requirements. As a result, healthcare supply chains can create significant environmental pressures even while they deliver essential services. This tension has made circular economy thinking increasingly important for healthcare management.

The circular economy challenges the traditional linear model of take, make, use and dispose. Instead of seeing products and materials as waste after a single use, circular systems try to preserve value through better design, reduced consumption, reuse, repair, remanufacturing, recovery and recycling where it is safe and feasible (Geissdoerfer et al., 2017; Kirchherr et al., 2017). In healthcare, however, circularity cannot simply copy the models used in manufacturing. A hospital cannot reuse or recover products only because doing so is environmentally desirable. Any circular practice must also meet clinical, regulatory and ethical requirements. Patient safety, infection prevention, product traceability and evidence of compliance must remain central.

This makes healthcare circularity a supply chain issue rather than only a waste management issue. Procurement determines which products enter the healthcare system. Suppliers influence packaging, product design, material choices, delivery schedules, take-back schemes and the availability of circular alternatives. Logistics affects storage, cold-chain control, delivery reliability, reverse flows and safe handling. Regulation sets the boundaries within which circular practices can be accepted. Technology enables visibility, traceability and data-

based decision-making. These capabilities work together. When they are disconnected, circular economy adoption becomes a slogan rather than an operational reality.

The United Arab Emirates provides a timely setting for studying this issue. The UAE healthcare sector is rapidly developing, competitive, policy-driven and increasingly digital. At the same time, the country depends heavily on global suppliers for many healthcare products and technologies. This creates both an opportunity and a challenge. On one hand, the UAE has strong logistics infrastructure, high policy interest in sustainability and a growing digital health ecosystem. On the other hand, global supply chains, agent-based distribution structures and regulatory requirements may make circularity difficult to coordinate. For this reason, supplier collaboration becomes especially important.

This paper focuses on technology-enabled supplier collaboration for circular economy adoption in UAE healthcare supply chains. The term technology-enabled supplier collaboration refers to the use of digital systems, data sharing platforms, enterprise resource planning systems, artificial intelligence, digital traceability and related tools to improve communication and joint decision-making between healthcare providers and suppliers. These technologies matter because they make collaboration more practical. They allow hospitals and suppliers to track product movement, monitor expiry, evaluate supplier performance, plan demand, reduce excess inventory, verify sustainability claims and coordinate recovery or take-back activities.

The paper is framed through Industry 5.0. Unlike narrow interpretations of digital transformation that focus mainly on automation and efficiency, Industry 5.0 emphasizes human-centeredness, sustainability and resilience (Breque et al., 2021; European Commission, 2021). This perspective is well suited to healthcare. In hospitals and clinics, technology should not replace human judgement or reduce sustainability to a technical exercise. Instead, it should support safer decisions, stronger relationships, responsible resource use and better patient-centered outcomes. Circular healthcare supply chains therefore need both digital capability and collaborative human governance.

The purpose of this paper is to explain how technology-enabled supplier collaboration can support circular economy adoption and improve organizational performance in UAE healthcare supply chains. The paper builds on empirical findings from a UAE healthcare supply chain study in which supplier collaboration was the strongest predictor of circular economy adoption, while procurement and technology also showed meaningful positive effects. Circular economy adoption also had a positive effect on firm performance, and technology had a direct positive effect on firm performance. These findings suggest that circular transformation in healthcare depends most strongly on relationship capability, supported by digital and operational capability.

The paper makes three main contributions. First, it narrows the broad circular healthcare debate to the relationship between suppliers and healthcare providers, which is where many circular decisions begin. Second, it explains technology not as a substitute for collaboration but as an enabler of better collaboration. Third, it presents an Industry 5.0 framework that connects sustainability, resilience, digital traceability and human-centered supply chain decision-making in the UAE healthcare context.

2. Background and Problem Context

Circular economy research has grown substantially, but healthcare remains a challenging and underdeveloped area. Much of the existing circular economy literature has emerged from manufacturing, industrial ecology, product design and waste management. These fields provide useful concepts, but healthcare supply chains have unique features. Medical products may be hazardous, sterile, temperature-sensitive, legally controlled or clinically critical. A delay, stockout, contamination event or traceability failure can affect patient outcomes. For this reason, circular economy adoption in healthcare must be evaluated through both environmental and clinical lenses.

A major problem in healthcare circularity is that many organizations still treat sustainability as a downstream activity. They focus on waste segregation, recycling contracts or disposal methods after products have already been purchased and used. While these practices are important, they address the problem late in the value chain. Circularity is more effective when it starts earlier, at the design, sourcing and procurement stages. Suppliers can help reduce unnecessary packaging, offer reusable transport systems, provide products with longer lifecycles, support maintenance and refurbishment, and participate in take-back programmes. These activities cannot be achieved by hospitals alone.

Supplier collaboration is therefore central to circular healthcare supply chains. It includes information exchange, joint problem-solving, shared goals, co-development of sustainable product alternatives, coordinated logistics and mutual commitment to improvement. In ordinary purchasing relationships, the buyer may focus mainly on price, delivery and compliance. In circular purchasing relationships, the buyer and supplier must also discuss material composition, packaging, product lifespan, repair options, return routes, waste reduction and performance data. This requires trust and transparency.

Technology can strengthen these relationships. Without reliable data, collaboration remains informal and difficult to scale. Hospitals may not know which products create the most waste, which suppliers perform better on sustainability, which items expire most frequently, or which materials can be recovered safely. Suppliers may not have visibility of real consumption patterns, storage conditions or demand changes. Digital systems can reduce these gaps. ERP systems can link procurement, inventory and finance. AI can forecast demand and reduce overstocking. Blockchain and digital traceability systems can support product provenance and audit trails. Dashboards can translate operational data into sustainability indicators.

The problem is not only whether technology exists, but whether it is used collaboratively. A hospital may have an ERP system but still make procurement decisions based only on short-term cost. A supplier may have sustainability data but not share it in a useful format. A regulator may require compliance data but not provide consistent definitions for circular indicators. The value of digital technology is therefore realized when it is connected to governance, supplier dialogue and practical decision-making. This is why the paper uses a socio-technical understanding of technology.

The UAE healthcare sector faces additional contextual pressures. Healthcare providers operate in a competitive environment shaped by public and private provision, medical tourism, insurance networks, digital transformation and strong regulatory oversight. Many healthcare products are imported, and suppliers may be multinational, regional or agent-based. These features make collaboration both necessary and difficult. UAE healthcare organizations may depend on suppliers for technical knowledge and product innovation, but they must also ensure that circular practices meet local compliance requirements and clinical safety expectations.

The central problem addressed in this paper is therefore the limited understanding of how supplier collaboration, supported by technology, can turn circular economy goals into practical healthcare supply chain action. It is not enough to say that hospitals should become circular. Managers need to know where to intervene, how to work with suppliers, what data to collect and how technology can support safe and measurable circular practices.

3. Purpose, Objectives and Research Questions

The purpose of this paper is to develop a research-based explanation of how technology-enabled supplier collaboration contributes to circular economy adoption and organizational performance in UAE healthcare supply chains. The paper does not treat supplier collaboration as a soft or secondary factor. Instead, it positions supplier collaboration as a strategic capability that helps healthcare organizations move from isolated sustainability efforts to integrated circular supply chain practices.

The first objective is to explain why supplier collaboration is particularly important for healthcare circularity. Healthcare providers rely on suppliers for pharmaceuticals, devices, consumables, equipment, packaging, technical services and digital solutions. Many circular opportunities depend on decisions made outside the healthcare organization. These include product design, packaging reduction, return arrangements, maintenance services and information sharing.

The second objective is to examine how digital technologies support collaboration. Technologies such as ERP, AI, blockchain, inventory platforms and supplier portals can improve visibility, traceability, forecasting and performance monitoring. However, the paper emphasizes that technology must be embedded in collaborative routines. Data only creates value when it is trusted, shared and used for decisions.

The third objective is to connect supplier collaboration and technology with circular economy adoption. Circular economy adoption is understood as the practical implementation of resource efficiency, waste reduction, reuse, recovery, sustainable procurement, lifecycle thinking and reverse logistics where clinically appropriate. The paper explores how collaboration enables these practices by aligning buyer and supplier decisions.

The fourth objective is to link circular economy adoption to firm performance. Firm performance is understood broadly, including operational efficiency, cost control, environmental performance, compliance, reputation, resilience and long-term competitiveness. In healthcare, better performance should not be understood only as financial improvement. It also includes safer, more reliable and more responsible supply chain management.

The paper is guided by the following research questions: How does supplier collaboration support circular economy adoption in UAE healthcare supply chains? How do digital technologies make supplier collaboration more effective? How does technology-enabled supplier collaboration contribute to circular economy adoption and firm performance? How can an Industry 5.0 perspective help healthcare managers design circular supply chains that are sustainable, resilient and human-centered?

4. Research Approach and Scope of the Study

This paper is written as a research-based conceptual and analytical article. It draws on the

empirical foundation of a quantitative study of UAE healthcare supply chain professionals, while developing a more focused discussion around supplier collaboration and technology. The broader empirical model included procurement, supplier collaboration, logistics, regulatory norms and technology as antecedents of circular economy adoption, and examined the effect of circular economy adoption and technology on firm performance. The present paper uses that model as a foundation but develops a narrower publication angle.

The justification for this focus is clear. In the empirical findings, supplier collaboration emerged as the strongest direct predictor of circular economy adoption. Procurement and technology also had important positive effects. These results indicate that circular transformation is not driven by waste management alone. It depends on upstream coordination, strategic sourcing and digital capability. The paper therefore concentrates on the relationship between supplier collaboration and technology because this relationship offers a strong and publishable contribution.

The scope of the paper is the UAE healthcare supply chain. The term healthcare supply chain includes the flow of medical products, pharmaceuticals, consumables, devices, equipment, packaging, information and services among suppliers, distributors, logistics providers, healthcare organizations and waste or recovery partners. The paper does not claim that every healthcare product can be reused or recovered. Instead, it recognizes that circularity must be selective, risk-based and clinically responsible.

The paper uses an Industry 5.0 lens. This means that digital technologies are not presented as automatic solutions. They are understood as tools that must support human judgment, sustainability, resilience, accountability and collaboration. The approach is suitable because healthcare requires responsible technology use. A purely efficiency-oriented digital transformation may reduce costs but still fail to improve sustainability or patient-centered outcomes. A humanized Industry 5.0 approach asks how technology can support better decisions by procurement teams, clinicians, logistics staff, suppliers and regulators.

The article is structured in a format similar to the uploaded journal reference: it begins with an abstract and keywords, proceeds through introduction, background, objectives, theoretical framing, literature review, conceptual framework, discussion, implications and conclusion, and closes with APA-style references. The writing style is deliberately clear and human-centered so that the paper is academically suitable but not unnecessarily mechanical or overloaded with jargon.

5. Theoretical Framing

The paper is guided by four complementary theoretical perspectives: circular economy theory, sustainable supply chain management, the resource-based view and socio-technical systems theory. Institutional theory is also used to explain the role of policy and regulation in the UAE healthcare context. Together, these theories help explain why technology-enabled supplier collaboration matters.

Circular economy theory provides the broad sustainability logic. It argues that organizations should reduce dependence on virgin resources, prevent waste and preserve material value for as long as possible (Geissdoerfer et al., 2017; Kirchherr et al., 2017). In healthcare, this logic must be applied carefully because materials are linked to safety and quality. Circular economy theory therefore explains the goal, but not the full implementation challenge.

Sustainable supply chain management explains the operational pathway. It shows that environmental and social objectives must be integrated into sourcing, purchasing, logistics, supplier evaluation and performance management (Seuring & Müller, 2008). This perspective is important because circular economy adoption cannot be limited to a sustainability department. It must be embedded in daily supply chain decisions. For healthcare providers, this means procurement teams must ask different questions: Can packaging be reduced? Can suppliers offer take-back options? Can products be tracked through their lifecycle? Can demand planning reduce expiry and overstocking?

The resource-based view explains why supplier collaboration and technology can improve performance. According to this view, organizations gain advantage when they develop valuable, rare, difficult-to-imitate and well-organized resources and capabilities. Supplier relationships are not easily copied because they depend on trust, shared learning, communication routines and historical cooperation. Digital capability also becomes valuable when it is integrated into processes and used by skilled people. In this paper, technology-enabled supplier collaboration is treated as a strategic capability because it helps healthcare organizations translate sustainability goals into operational outcomes.

Institutional theory adds the role of regulation, policy and legitimacy. Healthcare organizations operate under strong compliance expectations. They must show regulators, patients and stakeholders that circular practices are safe and responsible. In the UAE, sustainability and digital transformation are also shaped by national policy priorities. These institutional pressures can motivate circular economy adoption, but they can

also create reporting and compliance burdens. Supplier collaboration helps organizations respond to these pressures because suppliers often hold critical information about product composition, provenance, environmental performance and recovery options.

Socio-technical systems theory explains the relationship between technology and people. It rejects the idea that technology alone changes organizations. Instead, it argues that outcomes depend on the interaction among technology, work processes, governance, skills and relationships. This is especially relevant for healthcare supply chains. An AI forecasting tool, for example, can reduce expiry only if procurement teams trust the forecast, suppliers receive demand information, inventory records are accurate and clinical departments cooperate. A blockchain system can improve traceability only if product data are entered correctly and shared across partners. Technology is therefore an enabler, not a magic solution.

Industry 5.0 brings these theories together. It asks organizations to use technology in ways that are sustainable, resilient and human-centered (Breque et al., 2021; European Commission, 2021). In this paper, Industry 5.0 means using digital tools to support responsible collaboration between healthcare providers and suppliers. The goal is not simply to automate procurement. The goal is to make better decisions about resources, waste, safety, accountability and performance.

6. Literature Review

The literature on circular economy has moved from a narrow focus on recycling toward a broader understanding of systems change. Scholars argue that circularity includes slowing, narrowing and closing resource loops through design, reuse, repair, refurbishment, remanufacturing and recycling (Bocken et al., 2016; Geissdoerfer et al., 2017). This view is useful for supply chain management because it shifts attention from disposal to the entire lifecycle of products and materials. In healthcare, however, circularity must be interpreted with caution. The aim is not to maximize reuse at all costs, but to identify safe and valuable opportunities for reducing waste and preserving value.

Healthcare circular economy research has increasingly recognized the special nature of the sector. Healthcare organizations produce infectious, hazardous, pharmaceutical, chemical and general waste streams that require careful handling (World Health Organization, 2022, 2024). Some products are suitable for recovery or recycling, while others cannot be safely reused. Circular healthcare therefore requires risk assessment, traceability, compliance and clinical oversight. Studies on circular medical products emphasize that design strategies must consider product criticality, contamination risk and value retention (Kane et al., 2018). Recent reviews also show that circular healthcare literature is still fragmented and often focused on waste rather than supply chain transformation (Moshawih et al., 2025; Saha et al., 2025).

Supplier collaboration is a recurring theme in sustainable supply chain literature. Environmental improvement often requires cooperation beyond the boundaries of a single organization. Suppliers provide knowledge about materials, product design, packaging and production processes. Buyers provide information about use, demand, storage and disposal. When both sides share information and align goals, they can identify opportunities that neither side could implement alone. Ali et al. (2016) argue that supplier collaboration supports green supply chain practices and sustainable performance. Genovese et al. (2017) similarly emphasize that circular supply chain transitions require coordination across supply chain partners.

In healthcare, supplier collaboration is even more important because healthcare products are specialized. Hospitals and clinics cannot easily redesign medical devices, pharmaceuticals, sterile packaging or diagnostic supplies internally. They must work with suppliers to find safer and more sustainable alternatives. Collaboration can involve greener packaging, reusable transport containers, product standardization, maintenance support, refurbishment arrangements, spare-part availability, take-back models and shared sustainability metrics. Without supplier involvement, healthcare providers may be limited to managing waste after it is created.

Procurement literature also supports this argument. Procurement is one of the earliest points at which circularity can be influenced. If a hospital buys products with excessive packaging, short shelf life or limited recovery options, downstream waste becomes difficult to avoid. Sustainable procurement can include lifecycle costing, environmental supplier screening, product durability requirements, packaging reduction, service-based contracts and supplier sustainability evaluation. Vederhus et al. (2025) show that circular procurement in hospitals requires dialogue between buyers and suppliers, not only technical purchasing rules.

Digitalization has become central to healthcare supply chain improvement. Beaulieu and Bentahar (2021) describe digitalization as a way to generate benefits and support healthcare delivery. Digital tools can improve visibility across procurement, inventory, logistics and use. In circular supply chains, visibility is essential because managers need to know where products are, how they are used, when they expire, whether they can be returned

and what environmental costs are linked to them. Monferdini et al. (2024) also emphasize that digitalization creates both opportunities and challenges in healthcare supply chains.

Artificial intelligence can support circularity through forecasting and decision support. Better demand forecasting can reduce overstocking, expiry and emergency purchasing. Predictive analytics can identify products with high waste risk, departments with unusual consumption patterns or equipment requiring maintenance. AI can also help evaluate suppliers by combining cost, quality, delivery and sustainability data. However, AI must be used carefully. If the data are incomplete or biased, forecasts may mislead managers. If models are not explainable, staff may not trust them. In healthcare, human oversight remains essential.

ERP systems provide another important technology layer. ERP platforms integrate procurement, finance, inventory, supplier master data, contracts and performance reporting. For circular economy adoption, this integration matters because sustainability data should not sit outside the main management system. If sustainability indicators are separated from budgeting and procurement, they may not influence decisions. ERP systems can support lifecycle costing, supplier evaluation, inventory accuracy, expiry control and reporting. They can also help connect circular economy practices with firm performance outcomes.

Blockchain and digital traceability systems are relevant when provenance, verification and chain-of-custody are important. In healthcare, product origin and handling history can determine whether an item can be safely reused, recovered or returned. Blockchain can provide secure records of supplier claims, product movement and reverse logistics activities (Queiroz et al., 2020; Razavian et al., 2025). Yet blockchain also depends on accurate data entry and governance. A traceability system cannot correct false or incomplete information at the point of input.

Industry 5.0 literature provides a broader interpretation of technology. The European Commission frames Industry 5.0 around sustainability, resilience and human-centeredness. This is highly relevant for healthcare because technology should support patient safety and responsible decision-making, not merely efficiency. A healthcare supply chain may become faster through automation, but if it increases waste or weakens human accountability, it does not meet the promise of Industry 5.0. Technology-enabled supplier collaboration is therefore an Industry 5.0 capability because it combines digital tools with relational and ethical decision-making.

The literature shows a clear gap. Circular economy, supplier collaboration and digital technology are often discussed separately. Healthcare circularity studies frequently emphasize waste or product design. Digital healthcare supply chain studies often emphasize efficiency or visibility. Supplier collaboration studies often focus on green supply chain management in general sectors. Fewer studies bring these ideas together in the UAE healthcare context. This paper addresses that gap by placing supplier collaboration at the center and explaining how technology makes collaboration more visible, measurable and performance-oriented.

Table 1. Key Literature Streams and Relevance

Literature Stream	Main Idea	Relevance to This Paper
Circular economy	Circularity aims to reduce waste and preserve value through lifecycle thinking.	Provides the sustainability logic for healthcare supply chain transformation.
Healthcare circularity	Circular practices must be balanced with patient safety, sterility and compliance.	Explains why healthcare needs a sector-specific circular approach.
Supplier collaboration	Sustainability and circularity often require buyer-supplier cooperation.	Positions collaboration as the central implementation capability.
Digital supply chains	ERP, AI and traceability tools improve visibility, forecasting and control.	Explains how technology enables practical collaboration.
Industry 5.0	Technology should support sustainability, resilience and human-centered outcomes.	Frames digital collaboration as responsible and healthcare appropriate.

7. Conceptual Framework and Propositions

The proposed framework begins with the idea that supplier collaboration is the relational foundation of circular economy adoption. Healthcare providers depend on suppliers for product knowledge, innovation, packaging decisions, maintenance support and recovery options. When suppliers and healthcare providers communicate only through transactional purchasing, circular opportunities are easily missed. When they work together, they can

redesign supply arrangements in ways that reduce waste and improve resilience.

Technology acts as an enabling layer within this relationship. It improves the quality, speed and usefulness of information shared between partners. ERP systems provide integrated data about procurement, inventory and cost. AI supports forecasting and decision-making. Digital traceability supports product history and compliance evidence. Supplier portals and dashboards create shared visibility. These technologies help partners move from general sustainability conversations to evidence-based collaboration.

Circular economy adoption is the operational outcome of the relationship between collaboration and technology. It may appear in several forms: reduced packaging, better stock rotation, fewer expired items, sustainable procurement criteria, reusable logistics materials, take-back agreements, maintenance-based lifecycle extension, recycling partnerships, and improved waste segregation. In healthcare, adoption must always be risk-based. Circularity should be pursued where it is safe, compliant and value-creating.

Firm performance is the broader organizational outcome. Circular economy adoption can improve performance by reducing waste cost, improving inventory efficiency, strengthening compliance, reducing environmental impact, enhancing reputation and building resilience. Technology may also have a direct effect on performance by improving visibility, reducing errors, supporting faster decisions and improving resource planning. The empirical foundation of the thesis supports these relationships, showing positive and significant paths from supplier collaboration, procurement, technology, logistics and regulation to circular economy adoption, and from circular economy adoption and technology to firm performance.

The framework is not a simple linear chain. In real healthcare settings, the relationships are interactive. Better circular practices create new data needs. New data may change supplier discussions. Supplier innovations may require ERP changes or new traceability fields. Regulatory expectations may influence what information must be captured. Performance outcomes may create stronger managerial support for circular procurement. The framework should therefore be understood as a learning system.

Based on this logic, the paper proposes six propositions. Proposition 1: Supplier collaboration positively influences circular economy adoption in UAE healthcare supply chains. Proposition 2: Digital technology strengthens the quality and effectiveness of supplier collaboration by improving visibility, traceability, forecasting and shared decision-making. Proposition 3: Technology-enabled supplier collaboration has a stronger influence on circular economy adoption than technology or supplier collaboration considered separately. Proposition 4: Circular economy adoption positively influences healthcare firm performance through cost control, resource efficiency, compliance, reputation and resilience. Proposition 5: Technology directly improves firm performance by increasing data quality, operational visibility and decision speed. Proposition 6: Industry 5.0 principles strengthen the relationship between technology-enabled collaboration and sustainable performance by keeping human judgment, safety and resilience at the center.

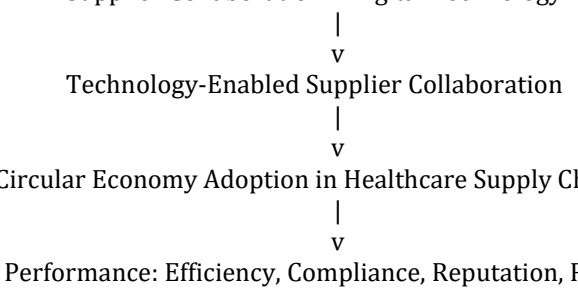
The framework suggests that healthcare managers should not begin circular economy adoption by asking only what can be recycled. A better starting question is: which supplier relationships and which data systems can help us prevent waste before it is created? This shift is important because many healthcare waste problems begin upstream. If products are overordered, poorly standardized, unsuitable for local demand or packaged inefficiently, downstream waste management cannot fully solve the issue.

Table 2. Core Constructs in the Proposed Framework

Construct	Meaning in this Paper	Expected Role
Supplier collaboration	Information sharing, joint problem-solving, co-design and trust between healthcare providers and suppliers.	Primary driver of circular economy adoption.
Technology	ERP, AI, blockchain, supplier portals, dashboards and traceability systems.	Enabler of visibility, forecasting, data quality and coordination.
Circular economy adoption	Safe and compliant implementation of waste reduction, resource efficiency, reuse, recovery, lifecycle thinking and sustainable procurement.	Operational sustainability outcome.
Firm performance	Cost control, efficiency, compliance, reputation, resilience	Organizational outcome.

	and environmental performance.	
Industry 5.0	Human-centered, sustainable and resilient use of technology.	Guiding lens for responsible transformation.

Figure 1. Conceptual Framework



Industry 5.0 lens: human-centeredness, sustainability and resilience guide every stage.

8. Technology-Enabled Supplier Collaboration in Practice

In practice, technology-enabled supplier collaboration begins with shared visibility. Healthcare providers need accurate information about what they buy, how quickly products are consumed, where waste occurs and which suppliers are connected to high-waste categories. Suppliers need visibility of demand patterns, changes in clinical use, inventory pressure and sustainability expectations. When both sides work from partial information, circular decisions remain weak. Shared data creates the foundation for practical improvement.

One practical example is expiry reduction. Pharmaceuticals, diagnostic kits and certain consumables may expire before use if demand is poorly forecasted or procurement is not aligned with clinical consumption. AI-based demand forecasting can help identify patterns and prevent excessive ordering. ERP systems can flag slow-moving items and expiry risks. Suppliers can use this information to adjust delivery frequency, offer smaller batch sizes or recommend alternative ordering models. The circular benefit is not recycling expired products; it is preventing expiry in the first place.

A second example is packaging reduction. Healthcare products often arrive with multiple layers of packaging for safety, sterility and transport. Some packaging is necessary, but some may be excessive or poorly designed. Hospitals cannot reduce this packaging alone because suppliers control product and transport design. Through collaboration, suppliers and providers can identify packaging categories that can be reduced, replaced with recyclable materials or shifted to reusable transport systems. Digital data can show packaging volumes by supplier or product category, making discussions more specific.

A third example is product standardization. Hospitals may use many similar products from different suppliers, which can create fragmented inventory and unnecessary waste. Collaboration between procurement, clinical users and suppliers can identify opportunities to standardize products without compromising care quality. ERP data can reveal duplication, consumption trends and cost differences. Supplier input can explain product alternatives and lifecycle implications. Standardization can reduce waste, improve training, simplify storage and strengthen bargaining power.

A fourth example is take-back and reverse logistics. Some equipment, packaging systems, devices or reusable logistics materials may be returned to suppliers or specialized partners. This requires clear rules, traceability and documentation. Digital systems can record product movement, condition, custody and compliance evidence. Suppliers can coordinate collection routes or service models. In healthcare, take-back systems must be carefully designed to avoid safety risks, but where feasible they can support circularity and accountability.

A fifth example is supplier sustainability scoring. Circular procurement requires more than price comparison. Healthcare providers can evaluate suppliers on environmental performance, packaging practices, product durability, take-back support, transparency, regulatory compliance and innovation. ERP systems and supplier portals can collect and compare these indicators. Over time, supplier scores can influence contracts, tenders and supplier development plans. This gives suppliers a reason to improve.

A sixth example is collaborative innovation. Suppliers may have access to new materials, reusable product models, service-based contracts or digital tracking solutions. Healthcare providers understand clinical workflows and patient safety requirements. Innovation becomes more realistic when both forms of knowledge are combined.

Industry 5.0 supports this approach because it values human expertise and responsible technology rather than treating sustainability as a purely technical problem.

These examples show that technology-enabled supplier collaboration is not abstract. It can be translated into everyday decisions about ordering, inventory, packaging, product design, returns, contracts and performance reporting. The main managerial challenge is integration. If digital tools, procurement policies and supplier discussions are separated, circular economy adoption remains weak. If they are connected, circularity becomes part of normal supply chain management.

Table 3. Practical Applications of Technology-Enabled Collaboration

Collaborative Area	Technology Support	Circular Value Created
Expiry reduction	AI forecasting, ERP stock alerts, shared demand data	Less overstocking, lower disposal cost and better inventory use.
Packaging reduction	Supplier portals, packaging data dashboards	Reduced material waste and improved supplier accountability.
Product standardization	ERP spend analysis, clinical-procurement data review	Reduced duplication, simpler storage and lower waste.
Take-back models	Digital traceability, reverse logistics records	Improved recovery options and documented compliance.
Supplier scoring	Sustainability dashboards and supplier master data	Better supplier selection and continuous improvement.

9. Empirical Support from the UAE Healthcare Supply Chain Study

The broader UAE healthcare supply chain study provides useful empirical support for the argument developed in this paper. The study used a quantitative cross-sectional design and analyzed responses from healthcare supply chain professionals using PLS-SEM. The constructs included procurement, supplier collaboration, logistics, regulatory norms, technology, circular economy adoption and firm performance. The measurement model demonstrated acceptable reliability and validity, with Cronbach's alpha values above the common threshold of 0.70 and composite reliability values also above acceptable levels.

The structural results showed that all hypothesized relationships were positive and statistically significant. Supplier collaboration had the strongest effect on circular economy adoption, followed by procurement and technology. Logistics and regulatory norms also had positive effects, although their relative influence was smaller. Circular economy adoption had a positive effect on firm performance, and technology also had a direct positive effect on firm performance. These results are important because they confirm that circular economy adoption in healthcare is not explained by one factor alone. It is a system-level outcome shaped by relational, strategic, operational, institutional and technological capabilities.

The most important finding for this paper is the role of supplier collaboration. The stronger effect of supplier collaboration suggests that circularity in healthcare often begins outside the walls of the healthcare organization. Hospitals and clinics may want to reduce waste, but suppliers influence what is possible. They influence packaging, product durability, product information, replenishment systems, service support and return options. When suppliers are not involved, circular economy adoption may be limited to internal waste handling. When suppliers are involved, circularity can move upstream into design, sourcing and planning.

Technology also played a meaningful role. Its positive relationship with circular economy adoption indicates that digital capability helps healthcare organizations implement circular practices. Its direct relationship with firm performance suggests that technology creates broader operational benefits beyond sustainability. This supports the argument that technology should be seen as both an enabler of circularity and a performance capability. However, the results do not imply that technology replaces collaboration. Instead, they suggest that technology and collaboration should be integrated.

The positive effect of circular economy adoption on firm performance is also important. It challenges the assumption that sustainability is only a cost. In healthcare, circular economy practices can improve performance by reducing waste, improving resource planning, supporting compliance, enhancing reputation and making the supply chain more resilient. These outcomes are valuable in a competitive and regulated healthcare environment such as the UAE.

The R-square values indicated that the model explained a meaningful portion of the variance in circular economy adoption and firm performance. This is reasonable for management research, where human behavior, institutions and organizational practices are influenced by many factors. The findings should not be interpreted as saying that supplier collaboration and technology explain

everything. Rather, they show that these factors are significant and managerially relevant.

The empirical findings support the publication angle of this paper. A full thesis model may be too broad for a single journal article, but the supplier collaboration and technology relationship provides a focused contribution. It offers a clear argument, a strong theoretical foundation and practical relevance for healthcare managers and policymakers.

10. Discussion

The central insight of this paper is that circular healthcare supply chains are collaborative systems. They cannot be built by procurement teams alone, by technology vendors alone or by waste contractors alone. Circularity requires alignment across healthcare providers, suppliers, logistics partners, regulators and internal users. Among these actors, suppliers hold a particularly important position because many circular decisions are built into products and services before they enter the healthcare facility.

This insight shifts the conversation from waste disposal to relationship design. Many organizations begin sustainability work by asking how to manage waste after use. This is understandable because waste is visible. Bins, disposal costs and compliance requirements make waste a daily operational concern. However, the deeper circular question is how to prevent avoidable waste from entering the system. Prevention depends on purchasing decisions, product design, packaging, stock planning and supplier support. These are collaborative issues.

Technology makes this collaboration more precise. Without data, supplier meetings may remain general and symbolic. Managers may say they want less waste, but they may not know which product categories create the problem. Suppliers may say they are sustainable, but they may not provide measurable evidence. Digital tools make the conversation more concrete. They can show expiry rates, packaging volumes, consumption patterns, return rates, supplier performance and environmental costs. When data are reliable, collaboration becomes more focused and accountable.

At the same time, the paper warns against technological optimism. Digital tools can also create new problems. Poor data quality can produce misleading dashboards. AI systems can be difficult to explain. ERP systems may not include sustainability fields. Blockchain systems may record inaccurate off-chain information. Staff may resist new tools if they do not understand their purpose. Suppliers may hesitate to share data if trust is weak. These challenges show why Industry 5.0 is useful. It reminds managers that technology must serve people, sustainability and resilience.

The UAE context strengthens the relevance of the argument. The country has a dynamic healthcare sector, strong digital ambitions and policy interest in circular economy. It also has globalized healthcare supply chains and significant dependence on imported products. This means circular economy adoption requires international and local coordination. UAE healthcare providers may need to work with multinational suppliers, local distributors, regulators and technology providers at the same time. Technology-enabled collaboration can help manage this complexity.

The findings also have implications for performance. In many organizations, sustainability initiatives are judged by whether they increase or reduce cost. This is too narrow. Circular economy adoption may improve firm performance through many pathways. It can reduce waste disposal costs, lower expiry losses, improve inventory turnover, strengthen compliance, reduce reputational risk, support accreditation, attract environmentally conscious stakeholders and improve resilience during disruptions. These outcomes are especially valuable in healthcare because performance is multidimensional.

Another important point is that supplier collaboration is a capability, not a one-time activity. It cannot be created only by adding a sustainability clause to a contract. It requires routines: regular supplier reviews, shared metrics, joint improvement projects, transparent data, cross-functional teams and senior leadership support. Procurement professionals, clinicians, finance teams, logistics staff and sustainability officers must work together. Supplier collaboration becomes stronger when it is built into governance structures.

The discussion also shows why circular economy adoption must be selective. Healthcare organizations should not pursue circular practices in ways that create clinical risk. Some products should remain single use. Some waste streams require strict disposal. Some recovery activities may not be appropriate. A mature circular healthcare supply chain does not force circularity everywhere. It identifies where circularity is safe, compliant and beneficial, and uses data and collaboration to scale those opportunities.

Overall, the paper argues for a balanced approach. Circular healthcare supply chains need supplier collaboration because many solutions are inter-organizational. They need technology because circularity requires visibility and traceability. They need Industry 5.0 thinking because technology must be guided by human judgment, patient safety and sustainability values.

11. Managerial Implications

For healthcare managers, the first implication is to treat suppliers as strategic partners in

sustainability rather than only as vendors. Traditional procurement often emphasizes price, delivery and compliance. These remain important, but circular procurement adds new questions. Can the supplier reduce packaging? Can products be delivered in better quantities to avoid expiry? Can the supplier support maintenance or refurbishment? Can take-back arrangements be designed? Can sustainability data be shared in a reliable format? These questions should become part of supplier management.

Second, managers should build circularity into procurement criteria. Tender documents, supplier evaluations and contract reviews can include lifecycle cost, packaging impact, product durability, environmental certifications, take-back support, traceability and waste reduction plans. This does not mean choosing the greenest product without considering safety or cost. It means evaluating value more broadly and transparently.

Third, healthcare organizations should use technology to identify priority areas. Managers do not need to circularize everything at once. A practical starting point is to analyze procurement and inventory data to identify high-waste categories, high-expiry products, high-packaging suppliers or products with frequent emergency purchasing. These categories can become pilot areas for supplier collaboration.

Fourth, managers should create cross-functional circular supply chain teams. Procurement cannot do this alone. Clinical departments understand use and safety requirements. Finance teams understand cost. Logistics teams understand storage and movement. Sustainability teams understand environmental goals. Suppliers understand product design and recovery options. A cross-functional team can make better decisions than any one department.

Fifth, supplier performance dashboards should include circular indicators. Examples include percentage of sustainable procurement, packaging reduction, expiry reduction, take-back participation, recovery rate, supplier sustainability score, lifecycle cost and compliance evidence. These indicators should be reviewed regularly and linked to supplier development plans.

Sixth, managers should invest in data quality. Technology-enabled collaboration depends on reliable information. Product codes, supplier records, inventory data, expiry dates, waste categories and cost information must be accurate. Without disciplined data governance, digital systems will produce weak or misleading outputs.

Seventh, healthcare organizations should communicate that circular economy adoption supports performance. Staff may resist sustainability initiatives if they see them as extra work. Managers should explain how circular practices can reduce waste, improve availability, lower expiry, strengthen compliance and support patient-centered care. This humanized message is more persuasive than technical language alone.

Table 4. Managerial Roadmap

Managerial Action	Practical Step	Expected Benefit
Make suppliers strategic partners	Hold regular circularity review meetings with key suppliers.	Improves innovation and shared accountability.
Embed circular criteria in tenders	Add lifecycle cost, packaging and take-back requirements.	Moves sustainability upstream.
Use data to prioritize pilots	Identify high-waste or high-expiry categories through ERP data.	Creates focused and measurable improvement.
Build cross-functional teams	Include procurement, clinical users, finance, logistics and suppliers.	Balances sustainability with safety and cost.
Develop circular dashboards	Track expiry, waste, packaging, supplier scores and recovery rates.	Makes performance visible and manageable.

12. Policy and Regulatory Implications

Policymakers and regulators also have an important role. Healthcare organizations may be willing to adopt circular practices but uncertain about what is permitted, how to measure outcomes or how to report performance. Clear guidance can reduce uncertainty and encourage responsible innovation. In the UAE, where healthcare regulation and sustainability policy are both important, policymakers can support circular healthcare supply chains by creating practical frameworks.

First, regulators can define circular healthcare indicators. Without shared definitions, organizations may measure circularity differently. One hospital may report recycling volume, another may report waste cost and another may report procurement changes. Standard indicators could include waste intensity, sustainable procurement share, expiry reduction, packaging reduction, recovery rate, supplier traceability and lifecycle cost. These indicators should be designed with healthcare safety requirements in mind.

Second, policy can encourage supplier participation. Circular healthcare supply chains require suppliers to provide product data, packaging information, environmental performance evidence and take-back options. Public procurement rules and healthcare purchasing standards can encourage suppliers to disclose such information. Over time, this can shift the market toward more circular products and services.

Third, regulators can support digital traceability. Traceability is important for patient safety, compliance and circularity. Policy guidance on data standards, product identification, supplier reporting and reverse logistics documentation could help healthcare organizations build reliable systems. This is especially important where products move across international supply chains.

Fourth, policymakers can promote pilot projects. Circular healthcare adoption is complex, and organizations may need evidence from local experiments. Pilot projects could focus on packaging reduction, expiry prevention, reusable logistics containers, maintenance-based equipment models or supplier take-back schemes. Lessons from pilots can be shared across the healthcare sector.

Fifth, regulators should ensure that sustainability does not compromise safety. Circular economy guidance in healthcare should clearly distinguish between safe circular opportunities and areas where strict disposal or single-use practices remain necessary. This balanced approach will help build trust among clinicians, patients and suppliers.

Finally, policymakers can align circular economy efforts with ESG reporting, healthcare accreditation and digital health strategies. When circular supply chain practices are connected to broader performance and reporting systems, they are more likely to be taken seriously by senior management.

13. Supplier and Ecosystem Implications

Suppliers are not passive actors in circular healthcare supply chains. They can shape the sustainability options available to healthcare providers. Suppliers can redesign packaging, provide clearer product information, offer smaller or more frequent deliveries, support product maintenance, develop take-back systems and provide environmental performance data. These activities can become a source of competitive advantage.

For suppliers, the first implication is that sustainability should be part of value proposition. Healthcare providers are increasingly concerned not only with price and quality but also with resilience, traceability, compliance and environmental impact. Suppliers that can provide credible circular solutions may become preferred partners.

Second, suppliers should improve data transparency. Circular economy adoption requires information about product materials, shelf life, packaging, storage requirements, repairability, recyclability and end-of-life options. Suppliers that provide this information in usable digital formats can strengthen buyer trust.

Third, suppliers can collaborate on demand planning. By using shared consumption and inventory data, suppliers can help reduce overstocking and expiry. This benefits both sides. Healthcare providers reduce waste and cost, while suppliers build stronger relationships and more stable demand patterns.

Fourth, suppliers can support training and implementation. Circular product alternatives may require changes in handling, storage, use or return procedures. Suppliers can provide staff training, technical guidance and documentation. This is important in healthcare because poor implementation can create safety or compliance risks.

Fifth, logistics providers, waste management firms, technology vendors and regulators should be included in the ecosystem. Circularity often requires coordination among multiple partners. For example, a take-back model may involve the supplier, hospital, logistics provider and regulator. A digital traceability model may involve the ERP vendor, supplier database, procurement team and compliance officer. Ecosystem thinking is therefore essential.

14. Contribution to Theory

This paper contributes to theory in several ways. First, it extends circular economy theory by emphasizing supplier collaboration as a central mechanism in healthcare circularity. While circular economy theory often highlights material loops, this paper shows that loops are created through relationships, information sharing and coordinated decisions. In healthcare, circularity is not only a material challenge; it is a collaborative governance challenge.

Second, the paper contributes to sustainable supply chain management by linking supplier collaboration with technology. Many studies discuss collaboration and digitalization separately. This paper argues that the most useful lens is technology-enabled collaboration. Digital tools improve visibility and traceability, but collaboration gives those tools direction and meaning. This combined view is especially relevant for service sectors such as healthcare.

Third, the paper contributes to the resource-based view by identifying technology-enabled supplier collaboration as a strategic capability. Supplier relationships and digital systems create value when they are organized around circular goals. They are

difficult to imitate because they depend on trust, routines, data quality, cross-functional learning and context-specific knowledge. This helps explain why some healthcare organizations may adopt circular practices more successfully than others.

Fourth, the paper contributes to Industry 5.0 literature by applying its principles to healthcare supply chains. Industry 5.0 is sometimes discussed in broad terms, but this paper translates it into a practical supply chain framework. Human-centeredness means involving clinicians, procurement staff, suppliers and regulators in responsible decisions. Sustainability means reducing waste and preserving value. Resilience means improving supply reliability and adaptability. Technology supports these goals when it is governed well.

Fifth, the paper contributes to healthcare management research by moving beyond a narrow waste-management view. It explains circular economy adoption as a system of procurement, supplier collaboration, technology, logistics, regulation and performance. This systems view is more suitable for healthcare because patient safety and compliance require coordinated action.

15. Limitations and Future Research Directions

The paper has limitations. First, it is focused on the UAE healthcare context. The UAE is a useful and timely setting, but the findings and framework may not fully apply to countries with different healthcare financing, regulation, supplier structures or digital maturity. Future studies could compare UAE healthcare organizations with those in other GCC countries or with healthcare systems in Europe and Asia.

Second, the paper focuses on supplier collaboration and technology. Other factors such as leadership, organizational culture, clinician engagement, patient expectations, waste contractor capability and financial incentives may also influence circular economy adoption. Future research could expand the framework to include these variables.

Third, the paper treats healthcare supply chains at a general level. Different product categories may require different circular strategies. Pharmaceuticals, surgical instruments, diagnostic equipment, personal protective equipment, packaging and hospital furniture all have different safety and recovery characteristics. Future research could examine product-specific circular pathways.

Fourth, the empirical foundation is cross-sectional. Cross-sectional data are useful for identifying relationships, but they do not show how circular capabilities develop over time. Longitudinal studies could examine how supplier collaboration, digital systems and circular performance evolve as healthcare organizations implement new practices.

Fifth, future research could use qualitative case studies. Interviews with procurement managers, suppliers, clinicians, regulators and technology providers would provide deeper insight into barriers and success factors. Case studies could show how circular collaboration is negotiated in practice and how trust is built.

Sixth, future studies could test moderation and mediation effects. For example, technology may moderate the relationship between supplier collaboration and circular economy adoption. Circular economy adoption may mediate the relationship between supplier collaboration and firm performance. Regulatory support may strengthen the effect of technology-enabled collaboration. These models would provide stronger theoretical explanation.

Seventh, future research should develop measurement tools for circular healthcare supply chains. Healthcare-specific circular indicators are needed because general circular economy measures may not capture sterility, safety, compliance and clinical risk. Developing validated measurement scales would support both research and practice.

16. Conclusion

Circular economy adoption in healthcare is important, but it is not simple. Healthcare organizations must reduce waste and improve resource efficiency while protecting patient safety, sterility, compliance and service continuity. This paper has argued that technology-enabled supplier collaboration is one of the most practical routes for achieving this balance in UAE healthcare supply chains.

Supplier collaboration matters because many circular decisions begin upstream. Suppliers influence product design, packaging, delivery patterns, maintenance, take-back options and sustainability data. Healthcare providers cannot achieve circularity alone if suppliers are not involved. Collaboration creates the conditions for joint problem-solving, shared learning and circular innovation.

Technology matters because collaboration needs reliable information. ERP systems, AI, digital traceability, supplier portals and dashboards can help healthcare providers and suppliers understand demand, inventory, expiry, packaging, product movement, waste and performance. These tools make circular practices visible and manageable. However, technology only creates value when it is supported by data quality, governance, human judgment and trust.

Industry 5.0 provides the most suitable lens for this topic because it places human-centeredness, sustainability and resilience at the center of technological transformation. In healthcare, this is essential. Technology must support safer, more

responsible and more sustainable decisions. It should not be used only to automate transactions or reduce short-term costs.

The UAE healthcare sector offers a strong setting for this discussion because it combines healthcare growth, digital ambition, sustainability policy and global supply chain dependence. For healthcare managers, the message is clear: circular economy adoption should begin with supplier dialogue, data visibility and targeted circular opportunities. For suppliers, circular capability can become a source of competitive advantage. For policymakers, clear indicators and traceability standards can help scale responsible circular practices.

In conclusion, circular healthcare supply chains are built through relationships as much as through technology. The future of sustainable healthcare in the UAE will depend on the ability of healthcare providers, suppliers and regulators to work together, use data wisely and keep patient safety at the heart of circular transformation.

References

1. Abyaneh, A. G., et al. (2025). An analytical review of artificial intelligence applications in supply chain management: Concepts, benefits, and sustainability implications. Cleaner Logistics and Supply Chain, 100278.
2. Aldosari, R. B., et al. (2025). The benefits and challenges of blockchain in healthcare supply chain management: A systematic review. Journal of Infection and Public Health, 18(1), 102458.
3. Ali, A., Bentley, Y., & Cao, G. (2016). The influence of supplier collaboration on green supply chain management practices and sustainable firm performance in UK food supply chain SMEs. Proceedings of the Logistics Research Network Conference, 1-11.
4. Beaulieu, M., & Bentahar, O. (2021). Digitalization of the healthcare supply chain: A roadmap to generate benefits and effectively support healthcare delivery. Technological Forecasting and Social Change, 167, 120717.
5. Bebbington, J., Unerman, J., & O'Dwyer, B. (2014). Sustainability accounting and accountability (2nd ed.). Routledge.
6. Bigliardi, B., Bottani, E., & Filippelli, S. (2022). The digitalization of supply chains: A review. Procedia Computer Science, 200, 79-88.
7. Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308-320.
8. Breque, M., De Nul, L., & Petridis, A. (2021). Industry 5.0: Towards a sustainable, human-centric and resilient European industry. European Commission.
9. Burritt, R. L., & Schaltegger, S. (2010). Sustainability accounting and reporting: Fad or trend? Accounting, Auditing & Accountability Journal, 23(7), 829-846.
10. Cano, N. S. S. L., et al. (2025). Advancing the circular economy of healthcare plastics. Resources, Conservation and Recycling, 214, 108054.
11. Dave, S., & Shaikh, N. (2022). Technological innovations in supply chain management towards a circular economy in the healthcare sector of the UAE. In Handbook of research on green, circular, and digital economies as tools for recovery and sustainability (pp. 142-155). IGI Global.
12. De Villiers, C., Rinaldi, L., & Unerman, J. (2014). Integrated reporting: Insights, gaps and an agenda for future research. Accounting, Auditing & Accountability Journal, 27(7), 1042-1067.
13. Duque-Uribe, V., Sarache, W., & Gutierrez, E. V. (2019). Sustainable supply chain management practices and sustainable performance in hospitals: A systematic review and integrative framework. Sustainability, 11(21), 5949.
14. Ellen MacArthur Foundation. (2019). Completing the picture: How the circular economy tackles climate change. Ellen MacArthur Foundation.
15. European Commission. (2021). Industry 5.0: Towards more sustainable, resilient and human-centric industry. European Commission.
16. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy: A new sustainability paradigm? Journal of Cleaner Production, 143, 757-768.
17. Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. C. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. Omega, 66, 344-357.
18. Global Reporting Initiative. (2020). GRI 306: Waste 2020. GRI.
19. Gray, R. (1992). Accounting and environmentalism: An exploration of the challenge of gently accounting for accountability, transparency and sustainability. Accounting, Organizations and Society, 17(5), 399-425.
20. Gray, R., Kouhy, R., & Lavers, S. (1995). Corporate social and environmental reporting: A review of the literature and a longitudinal study of UK disclosure. Accounting, Auditing & Accountability Journal, 8(2), 47-77.
21. IFRS Foundation. (2023a). IFRS S1 General requirements for disclosure of sustainability-related financial information. International Sustainability Standards Board.
22. IFRS Foundation. (2023b). IFRS S2 Climate-related disclosures. International Sustainability Standards Board.

23. Kane, G. M., Bakker, C. A., & Balkenende, A. R. (2018). Towards design strategies for circular medical products. Resources, Conservation and Recycling, 135, 38-47.
24. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221-232.
25. Monferdini, L., et al. (2024). Challenges and opportunities of digitalization in the healthcare supply chain: A literature review. Procedia Computer Science, 232, 1642-1651.
26. Moshawih, S., et al. (2025). Transforming healthcare sustainability: Circular economy framework for healthcare systems. Sustainable Futures, 9, 100523.
27. Queiroz, M. M., Fosso Wamba, S., Telles, R., & Bonilla, S. H. (2020). Blockchain adoption in operations and supply chain management: Empirical evidence from an emerging economy. International Journal of Production Research, 58(20), 6087-6103.
28. Razavian, S. B., et al. (2025). Blockchain-enabled healthcare supply chain management. Engineering Applications of Artificial Intelligence, 141, 109991.
29. Saha, K., Farhanj, Z., & Kumar, V. (2025). A systematic review of circular economy literature in healthcare: Transitioning from a post-waste approach to sustainability. Journal of Cleaner Production, 505, 145427.
30. Scarpellini, S., Marín-Vinuesa, L. M., Aranda-Usón, A., & Portillo-Tarragona, P. (2020). Dynamic capabilities and environmental accounting for the circular economy in businesses. Sustainability Accounting, Management and Policy Journal, 11(7), 1129-1158.
31. Schaltegger, S., & Burritt, R. (2018). Business cases and corporate engagement with sustainability: Differentiating ethical motivations. Journal of Business Ethics, 147(2), 241-259.
32. Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. Journal of Cleaner Production, 16(15), 1699-1710.
33. Shaikh, N., & Dave, S. (2024a). The impact of smart procurement methods on firm's performance in the healthcare sector for circular economy: A special reference made to Dubai's healthcare sector. International Journal of Humanities Education, 12(2), 129-153.
34. Shaikh, N., & Dave, S. (2024b). Green supply chain practices driving sustainability in modern businesses in UAE. International Journal of Humanities Education, 12(2), 154-181.
35. Shaikh, N., & Dave, S. (2026). Digital circular economy accounting and accountability in healthcare supply chains: A conceptual framework with special reference to the UAE healthcare sector. Journal of Theoretical Accounting Research, 22(2S), 138-147.
36. Tamy, L., et al. (2025). Harnessing big data analytics and AI for sustainable healthcare supply chain management. Procedia Computer Science, 255, 4587-4596.
37. UAE Government. (2025). UAE Circular Economy Policy 2021-2031. The Official Portal of the UAE Government.
38. Vederhus, E., et al. (2025). Circular procurement in hospitals: Supplier dialogue and institutional conditions for healthcare circularity. [Manuscript/source cited in thesis literature].
39. World Health Organization. (2022). Global analysis of health care waste in the context of COVID-19: Status, impacts and recommendations. World Health Organization.
40. World Health Organization. (2024). Health-care waste. World Health Organization.

Appendix A. Suggested Measurement Items for Future Empirical Testing

The following items may be adapted for a future survey-based version of the paper. They are written in simple language so respondents from procurement, logistics, supplier management and healthcare operations can understand them clearly. Each item may be measured on a five-point Likert scale ranging from strongly disagree to strongly agree.

Supplier collaboration: Our organization shares sustainability-related information with key suppliers. Our suppliers participate in discussions on packaging reduction and product improvement. We work with suppliers to identify circular alternatives where safe and feasible. Our suppliers support take-back, repair, maintenance or recovery arrangements where appropriate. Supplier relationships help us reduce waste in the healthcare supply chain.

Technology-enabled collaboration: Our organization uses digital systems to share demand and inventory information with suppliers. Digital tools help us monitor expiry, product use and waste patterns. Technology improves traceability across procurement, storage, use and disposal. Supplier portals or dashboards help us evaluate supplier sustainability performance. Digital systems support joint decision-making with suppliers.

Circular economy adoption: Our organization considers lifecycle cost and environmental impact in procurement decisions. We actively work to reduce unnecessary packaging and material waste. We use safe and compliant reuse, recovery or take-back options where possible. Circular economy goals are integrated into supply chain planning. Our

organization monitors circular economy performance through measurable indicators.
Firm performance: Circular supply chain practices help reduce unnecessary costs. Circular practices improve our resource efficiency. Circular practices strengthen compliance and accountability. Circular practices improve our reputation with stakeholders. Circular practices improve the resilience of our healthcare supply chain.

Appendix B. Practical Checklist for Healthcare Managers

- Identify the top ten product categories by waste, expiry or packaging volume.
- Select two or three suppliers for pilot collaboration rather than attempting sector-wide change immediately.
- Review whether ERP systems capture expiry, packaging, supplier sustainability and recovery information.
- Create a cross-functional working group including procurement, clinical users, logistics, finance, sustainability and supplier representatives.
- Agree on practical circular indicators such as expiry reduction, packaging reduction, supplier take-back participation and lifecycle cost.
- Document safety, sterility and compliance requirements before introducing any reuse or recovery practice.
- Use pilot results to revise procurement criteria and supplier evaluation templates.
- Report progress internally using simple dashboards that connect circularity with cost, compliance and service quality.