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Original Research Article

ERP-Based Supply Chain Process Optimization for Saudi Arabia's Healthcare and Medical Supply Sector under Vision 2030

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Abstract: The health sector's programme for transformation in Saudi Arabia needs a medical supplies system which can provide the correct product, in the right condition, at the right place, together with reliable information concerning cost and traceability. This study looks at enterprise resource planning as the core element for improving procurement, inventory management, warehousing, distribution, supplier management, and financial control within the Kingdom's healthcare and medical supplies sector. A structured integrative review of 30 sources published between 2020 and 2025 was carried out, with a focus on peer-reviewed literature relating to healthcare supply chains, ERP systems, digital transformation, resilience, analytics, and the Saudi health system, as well as on official Vision 2030 and Ministry of Health documents. The findings show that the value of ERP is mainly derived not from the installation of software but from standardised master data, end-to-end workflows, interoperable interfaces, well-disciplined inventory policies, and timely analytics. It also appears that artificial intelligence, the Internet of Things, blockchain, and business analytics generate greater operational value when they are linked to a stable ERP system rather than when they are introduced as separate applications. For Saudi Arabia, the most important fields for improvement are integrated demand planning, visibility into supplier performance, control of batches and expiry dates, automated replenishment, readiness for recalls, and transparency of spending across both central and provider-level networks. The review suggests a framework for optimisation that is aligned with Vision 2030 and links ERP capabilities to process mechanisms, measurable supply outcomes, and the objectives of the healthcare system. It concludes that a transformation centred on ERP can improve availability, spending efficiency, resilience, localisation, and governance, provided that the implementation is supported by data governance, interoperability standards, workforce development, cybersecurity, and continuous performance management.

Keywords: Enterprise Resource Planning (ERP), Healthcare Supply Chain, Medical Supplies Management, Procurement, Inventory Management, Warehousing.

1. INTRODUCTION

Healthcare supply chains are different from ordinary commercial chains since disruptions might have a direct impact on the continuity of clinical care, on patient safety, and on community confidence. Pharmaceuticals, diagnostic equipment, implants, consumables, devices, and cold-chain products pass through a network which consists of manufacturers, importers, procurement organisations, warehouses, distributors, hospitals, clinics, pharmacies, laboratories, and regulators. Because demand is unpredictable, a great many of the items are time-sensitive, the level of service has clinically important consequences, and the products may be subject to serial numbers, batch controls, temperature requirements, or expiry dates. For this reason, recent reviews have described healthcare supply chain management as an operations discipline in which resilience, sustainability, risk, digitalisation, and service performance are becoming more and progressively interconnected (Ali & Kannan, 2022; Monferdini *et al*., 2024; Avinash & Joseph, 2024).

Enterprise resource planning systems are relevant here due to the way they integrate transactional and planning data covering procurement, inventory, finance, logistics and other related areas. Nowadays, ERP platforms are able to establish a common information layer for things such as purchase requisitions, supplier contracts, purchase orders, goods receipt, inventory movement, consumption, accounts payable and management reporting. Their value goes beyond that of simple centralization; by standardizing transaction rules, item masters, supplier records, units of measure, authorization matrices and replenishment logic, ERP can cut down on the need for duplicate data entry, reduce the time taken for decision making and produce a traceable record of operations. Research into ERP highlights this integrative function, and evidence from hospitals shows that greater adoption of ERP is linked to better supply chain cost performance provided that both technological and organizational readiness exist (Katuu, 2020; Bialas *et al*., 2023).

Saudi Arabia offers a strategically important context in which to study this relationship. Under Vision 2030, healthcare transformation has been focused on access, quality, efficiency, prevention, digital enablement, and coordinated action across the whole system. The Ministry of Health's digital strategy aims to establish an integrated digital ecosystem, and the Health Sector Transformation Program states that there has been an expansion of national digital capabilities and of pharmaceutical tracking. The 2024 transformation report describes the electronic tracking system as extending from the production of pharmaceutical products through to their final consumption by the end-user, showing the policy emphasis on traceability and the need for connected information flows (Saudi Ministry of Health, 2020; Health Sector Transformation Program, 2024). Similarly, Saudi digital-health studies have identified governance, the workforce, interoperability, infrastructure, training, and organizational support as essential factors in the successful implementation of technology (Al-Kahtani *et al*., 2022; Alzghaibi & Hutchings, 2022; Alkhalifah *et al*., 2022).

The Kingdom also has in place centralised arrangements for the procurement, warehousing and distribution of pharmaceuticals, medical devices and supplies for use in the public sector. While this results in significant scale advantages, it at the same time makes it essential to have synchronised demand data, standardised catalogues, visibility of inventory, co-ordination with suppliers and effective exception management throughout a number of facilities. Even if procurement is centralised, a fragmented situation involving local systems, spreadsheets, hospital applications that are not linked and inconsistent product identifiers can damage these benefits. The issue then is not whether or not an ERP system exists, but whether ERP-enabled processes link the signals from planning to purchasing decisions and to actual physical movements in a way that is fast enough, of sufficient quality and transparent enough to support the delivery of care.

There is strong evidence in the literature concerning digital healthcare supply chains, but this evidence is spread out over research on ERP adoption, artificial intelligence, resilience, blockchain, big data, electronic health records, and procurement disruption. The digitalization roadmaps claim that coordinated changes within and outside the organization should be made rather than relying on a series of separate technology projects (Beaulieu & Bentahar, 2021). Resilience studies indicate that maintaining availability when there is a disruption relies on visibility, collaboration, flexible sourcing, and well-designed supplier relationships, not just on inventory buffers (Scala & Lindsay, 2021; Spieske *et al*., 2022). Furthermore, studies show that the capacity to absorb and use data is just as much a function of managerial and organizational capabilities as it is of technical tools (Bag *et al*., 2023). Therefore, it is necessary to position ERP at the heart of an integrated process model rather than regard it as just one of many digital technologies.

The review meets this need by combining the evidence from 2020 to 2025 concerning the use of ERP systems for process optimisation in Saudi healthcare and medical supply. It regards ERP as a system for recording data and as the core of the workflow, one that can be improved through the use of analytics, artificial intelligence, the Internet of Things, and distributed traceability technologies. The contribution consists of three elements: it converts the scattered digital-supply evidence into levers for process-level optimisation; it places these levers in the context of Saudi Vision 2030 and the transformation of the healthcare sector; and it suggests implementation priorities that can be assessed using operational key performance indicators rather than just relying on technology adoption.

2. AIM, OBJECTIVES AND REVIEW QUESTIONS

This study intends to combine the most recent evidence concerning how ERP-driven integration can be used to improve healthcare and medical-supply processes in Saudi Arabia and to create an effective framework that links digital capabilities with the outcomes of Vision 2030. Unlike other reviews which primarily concentrate on technology adoption, the current study stresses process design, data discipline, and measurable supply performance.

The review is based on five objectives. The first of these is to spot healthcare supply processes that have high levels of friction, with a view to reducing information gaps and delays in transactions through the consolidation of ERP systems. The second objective is to examine the evidence linking ERP systems and other adjacent digital technologies to improvements in inventory accuracy, the availability of stock, procurement cycle time, supplier performance, traceability, cost control, and resilience. Third, it looks at how analytics, artificial intelligence, the Internet of Things, and blockchain are able to enhance ERP systems without leading to the creation of new data silos. Fourth, it looks at the implementation conditions that are especially relevant to Saudi Arabia, such as interoperability, workforce capability, governance, cybersecurity, localization, and centralized procurement. Fifth, it creates a staged optimization system together with a KPI structure for health authorities, procurement organizations, hospital networks, and supply partners.

The review therefore poses three questions: which ERP-supported processes have the greatest potential for optimization in the healthcare and medical supplies sectors; what organizational and technological conditions affect the realization of these benefits in the Saudi context; and how can ERP capabilities be turned into assessable supply chain and Vision 2030 results?

3. METHODOLOGY

A structured integrative literature review is employed in this study since the research problem involves information systems, medical services, procurement, logistics, resilience, and national digital transformation, which means that a narrow, clinical systematic review or a statistical meta-analysis would not be appropriate. The review protocol adheres to the transparency principles of structured literature reviews and to the reporting guidelines set out by PRISMA 2020, at the same time maintaining an integrative synthesis that is suitable for a variety of study designs (Page *et al.,* 2021). This approach also conforms to the methodological model of the reference paper provided, that paper using clear research questions, database screening procedures, coding processes, and a structured synthesis in order to minimise the bias that can arise from purely narrative selection.

The time frame for the review was set to cover the period from 2020 through to 2025 so as to include recent developments in cloud ERP, Industry 4.0, supply disturbances caused by the pandemic, the accelerated progress in digital health, and the present stage of the Saudi Vision 2030 implementation. The searches used combinations of terms such as enterprise resource planning, healthcare supply chain, hospital logistics, medical supplies, procurement, inventory, digital transformation, artificial intelligence, business analytics, blockchain, traceability, resilience, Saudi Arabia, the Ministry of Health, and Vision 2030. Where available, peer-reviewed studies that could be found in major scholarly and publisher databases were given priority, with a preference being shown for articles published in indexed journals in the fields of operations management, information systems, health services, and technology management. Official publications from the Saudi Ministry of Health and from Vision 2030 were also included if they provided policy background or evidence of national transformation that could not be obtained from journal articles.

To be included, a study had to have been published between 2020 and 2025, must be in English, and had to clearly relate to healthcare supply networks or to ERP systems or related digital capabilities, or it had to be directly relevant to Saudi Arabia's digital health transformation. Papers were kept only if they provided empirical findings, validated conceptual frameworks, carried out systematic reviews, or offered authoritative policy evidence that could be used to improve processes. The exclusion criteria dealt with any studies that were exclusively about clinical decision support without any operational link, those which dealt with general supply chain technology but had no transferable relevance to healthcare, opinion articles that lacked a clear analytical foundation, duplicate records, and sources outside the specified publication period. The final analytical set consisted of 30 sources, this number showing a balance between evidence specific to the sector and the circumstances of Saudi institutions.

A predefined coding matrix was used in the data extraction. Each source was assigned a code for its publication year, setting, research method, principal technology, supply process, stated performance effect, implementation barriers, governance implications, and relevance to Saudi healthcare. The process codes consisted of demand planning, sourcing and procurement, supplier management, inventory control, warehousing, distribution, traceability, financial integration, and performance management. The capability codes comprised master-data integration, workflow automation, predictive analytics, artificial intelligence, Internet of Things, blockchain, dashboarding, and interoperability. The outcome codes were availability, cost, speed, accuracy, waste, resilience, transparency, compliance, and clinical support. This structure enabled the evidence from different methods to be compared without considering unlike outcomes as being statistically equivalent.

The synthesis was carried out in three stages. In the first stage, the recurring relationships between digital capabilities and the outcomes of processes were identified. In the second stage, these relationships were grouped into ERP-focused optimisation mechanisms, with a distinction being made between foundational capabilities and advanced extensions. The basic capabilities were defined as shared master data, integrated transaction processing, standardised workflows, role-based controls, and timely reporting. The advanced extensions consisted of predictive forecasting, anomaly detection, sensor-based monitoring, distributed traceability, and decision intelligence. In the third stage, these mechanisms were linked to the priority areas of the Saudi health system, namely spending efficiency, the availability of medical products, digital integration, localisation, and service quality. The approach adopted was interpretive not causal; the associations mentioned in the literature were not turned into unverified effect sizes.

The methodological quality was assessed in terms of relevance, the clarity of the methods used, the journal in which it was published, its empirical basis, and its agreement with other evidence. Particular importance was attached to systematic reviews, studies involving multiple organizations, and empirical research that explained the conditions under which implementation took place rather than simply stating the apparent benefits. Since the evidence base includes different countries, technologies, and types of organizational structure, any attempt to apply the findings to Saudi Arabia was treated cautiously. When drawing on studies from outside Saudi Arabia, the focus was on identifying the mechanisms and implementation lessons; meanwhile, any assertions regarding national priorities were based on research conducted in Saudi Arabia and on official documents. Making this distinction helps avoid the mistake of assuming that a result observed in one health system will automatically occur when Saudi procurement, regulatory, and organizational practices are involved.

There are two intentional limits to the method. The first is that this review does not present a meta-analytic estimate of ERP performance since different studies measure indicators such as stockout rates, cost performance, resilience, and adoption maturity in various ways. The second point is that it does not consider the presence of advanced technology to mean that processes have been optimised; a technology was only regarded as being beneficial when the relevant study connected it to a sound functional mechanism, for example improved visibility, faster replenishment, better traceability, or enhanced decision support. This focus on processes is necessary since the review is intended to help with implementation rather than to encourage the acquisition of technology.

Table 1: Review protocol and evidence-selection logic

Element	Specification	Rationale
Review design	Structured integrative literature review with PRISMA 2020 reporting logic	Appropriate for heterogeneous ERP, healthcare operations, digital technology, resilience, and policy evidence.
Publication window	2020–2025	Captures current ERP, Industry 4.0, pandemic resilience, and Vision 2030 transformation.
Evidence base	Peer-reviewed journal studies plus official Saudi MoH / Vision 2030 sources	Balances academic rigor with national institutional context.
Core search concepts	ERP; healthcare supply chain; medical supply; procurement; inventory; digital transformation; AI; analytics; blockchain; resilience; Saudi Arabia; Vision 2030	Combines process, technology, sector, and country dimensions.
Inclusion	English; 2020–2025; empirical, review, framework, or authoritative policy source; direct relevance to ERP/digital HSC/Saudi context	Ensures recent and decision-relevant evidence.

Element	Specification	Rationale
Exclusion	Clinical-only digital studies; generic technology with no transferable supply-chain mechanism; duplicate, opinion-only, or out-of-window sources	Prevents scope drift.
Analytical corpus	30 retained sources	Matches the evidence synthesized and the reference list.
Coding domains	Process, technology, outcome, barriers, governance, Saudi relevance	Supports cross-study thematic comparison.
Synthesis logic	Foundation → process integration → intelligence → ecosystem connectivity	Separates prerequisites from advanced digital extensions.

4. REVIEW FINDINGS

4.1 ERP as the Backbone for Integration

The main and most consistent benefit of an ERP system, as shown by all the evidence, is the creation of a single operational record. Healthcare organisations often face a discrepancy between clinical demand, procurement transactions, warehouse stocks, supplier status, and financial data. An ERP system removes this discrepancy by linking together requisitions, orders, receipts, inventory movements, invoices, and consumption through the use of common records. Bialas *et al*., (2023) found that greater adoption of ERP within hospitals was associated with improved supply chain cost performance, and Katuu (2020) pointed out the continued development of ERP as an enterprise integration platform. In Saudi healthcare, this kind of architecture is especially pertinent because a large public network has to match central purchasing policies with the consumption and service needs at the facility level.

Value can only be obtained by properly governing master data, since in the absence of such governance one item could have different descriptions, pack sizes, catalog numbers, or units of measure in different facilities. Such inconsistencies cause distortions in demand aggregation, duplicate-item detection, contract compliance, and inventory visibility. Therefore, when adopting an ERP-focused approach it is necessary to establish common definitions for items, suppliers, locations, batches, expiry dates, and units of measure before carrying out advanced analytics. The same applies to organizational hierarchies and authorization matrices: if the roles, thresholds, or approval routes are badly designed, automated workflows will tend to result in errors. Studies conducted in Saudi Arabia on health information systems show again and again that interoperability, infrastructure, leadership, and user support influence the success of digital implementation, thus highlighting the importance of solid organizational foundations (AlSadrah, 2020; Alzghaibi & Hutchings, 2022).

ERP systems can also connect financial decisions with operational ones. In order to carry out their responsibilities, healthcare supply managers need to know not only whether an item is available but also the committed spend, the contract price, the value of open orders, the carrying cost, the expiry exposure, and the budget impact. Using integrated procure-to-pay data, managers are able to identify maverick purchasing, price variances, delayed receipts, duplicate ordering, and unmatched invoices. These capabilities are in line with the broader Vision 2030 emphasis on the efficient use of resources and transparent digital operations and also provide a solid data foundation upon which dashboards and predictive models can operate without having to reconstruct inconsistent information from the various systems at each reporting cycle.

4.2 Procurement and Supplier Management

Procurement optimisation means moving beyond simply processing transactions to sourcing in accordance with demand. Evidence from the pandemic indicated that healthcare supply chains became vulnerable each time organisations lacked upstream visibility, had not diversified their suppliers, and did not have collaborative relationships (Scala & Lindsay, 2021; Spieske *et al.,* 2022). An ERP system can draw on these lessons by using purchase orders that are linked to contracts, introducing governance regarding the supplier master data, monitoring lead times, keeping an eye on open orders, and establishing organized procedures for dealing with exceptions. Instead of assessing the success of procurement solely on the price obtained in tenders, companies may create supplier scorecards which take into account on-time delivery, fill rate, quality incidents, responsiveness, lead-time variability, and contract compliance.

For Saudi Arabia, centralised procurement provides the chance to pool its national purchasing power and at the same time make use of the consumption data obtained from an ERP system in order to prevent over-ordering or local shortages. The key design problem in this situation is data latency; if the consumption figures from hospitals are reported with a delay or are added up by hand, the central decisions regarding replenishment may be based on past rather than current demand. It is therefore necessary that the facilities' ERP systems transmit, through standard interfaces, validated consumption figures together with the quantity of stock currently held, the amount of stock which is en route, and indicators of critical shortages. The procurement teams will then be able to tell the difference between real demand growth and data errors, delayed entries, hoarding, or temporary increases in usage.

It is essential to incorporate supplier collaboration minus compromising the controls. Using portals and electronic data interchange, suppliers are able to confirm orders, change the delivery dates they have promised, send advance shipment notifications, and give information about batches or serial numbers. The information provided in this manner helps in preparing for the arrival of goods and improves the ability to identify exceptions. Studies regarding resilience show that joint bridging measures can secure the supply chain more effectively than just relying on additional inventory, especially in the case of serious disruptions (Spieske *et al.*, 2022). Therefore, an ERP system supports resilience when it acts as a shared coordination platform rather than just as an internal accounting system.

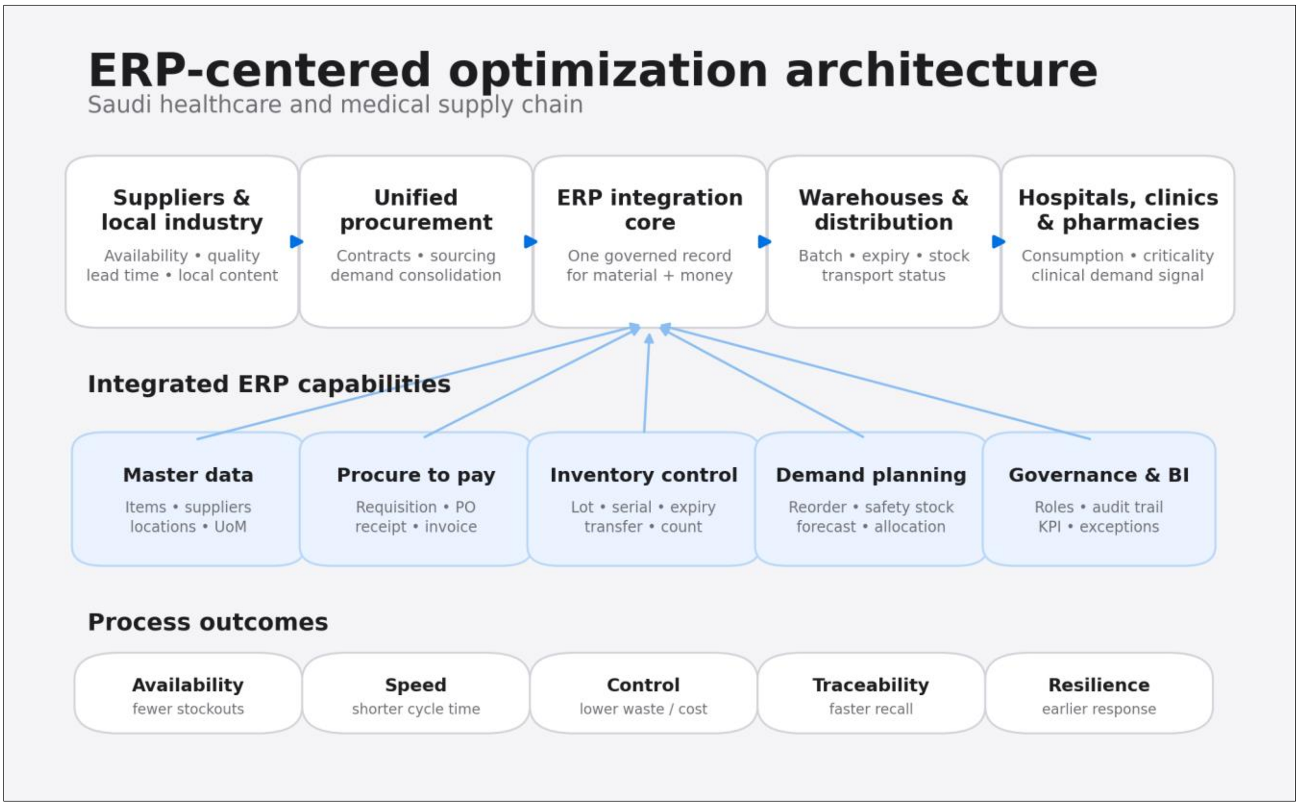

Figure 1: ERP-centered optimization architecture

4.3 Inventory, Warehousing and Demand Planning

The most evident benefits achieved through the use of ERP are noticeable to both clinicians and patients when looking at the inventory section. The objective is not to keep the smallest possible stock, but rather to achieve appropriate clinical availability at the lowest possible total cost, having regard to the expenses involved in holding stock, encountering shortages, dealing with obsolescence, and having to make emergency purchases. Since healthcare demand is characterised by a high degree of uncertainty and changes depending on the level of criticality, the reorder points should be supplemented by dividing the items into different categories. Different service levels and restocking policies are needed for critical life-saving medicines, for routine consumables, for slowly moving implants, for cold-chain products, and for expensive devices. ERP supplies the transaction history and inventory status necessary to apply these policies consistently in various locations.

Because accurate perpetual inventory calls for careful administration of the various transactions relating to receiving, storage, issuing, returning, transferring, and making adjustments, failure to record the physical movement of goods immediately may cause automated planning to give a false sense of confidence. As part of the basic process design, cycle counting, the use of discrepancy reason codes, bin-level control, barcode scanning, and the recording of batch or expiry dates should therefore be incorporated. In the instance of medical supplies, expiry management is especially important since surplus stock can become unusable even if the financial inventory seems to be in a good condition. ERP alerts can be used to prioritise a first-expiry-first-out allocation, to identify stock that is about to expire for redistribution, and to highlight cases in which the quantity purchased exceeds actual consumption.

Digital technologies have the facility to enhance these functions. For example, Internet of Things sensors can provide location or temperature data for delicate products; blockchain can improve the provenance of items that are involved with several parties and ensure that traceability is tamper-resistant; and artificial intelligence can increase the ability to sense demand or spot anomalies. Reviews of the use of blockchain in healthcare supply chains highlight traceability, security, and information sharing, as well as referring to the problems relating to interoperability, scalability, governance, and adoption (Reda *et al*., 2020; Chukwu & Garg, 2020; Dutta *et al*., 2020; Jadhav & Deshmukh, 2022; Fiore *et al.,* 2023; Ritchi *et al*., 2024). The result is that advanced technology should be used to supplement ERP records rather than establish a separate data universe.

Predictive analytics also depends on the quality of the data; even though some studies have associated big data and artificial intelligence with better collaborative abilities, greater integration of green processes, and improved performance in healthcare supply chains, technological capability is only one of the factors that can lead to success (Benzidia *et al*., 2021; Bag *et al*., 2023; Kumar *et al*., 2023). When preparing their forecasts, the Saudi providers should consider historical consumption patterns as well as seasonality, clinical activity, formulary changes, public health events, scheduled procedures, and the existing supply limitations. The forecasts should be assessed separately by item class and by planning horizon since accuracy when looked at as a whole might mask dangerous errors in some categories.

4.4 Traceability, Resilience plus Advanced Digital Capability

In order for a healthcare supply chain to be resilient it has to be capable of detecting any disruption, understand the impact that it will have on operations, and then take action before patient care is affected. Research carried out as part of Industry 4.0 indicates that digitalisationas well as resiliencee reinforce each other provided that organisations acquire the capabilities needed to make use of real-time information (Tortorella *et al*., 2023). Furstenau *et al*., (2022) identified a number of digital technologies which support resilience inside the healthcare sector, and Singh and Parida (2022) demonstrated the importance of decision models when facing a disruption. ERP helps by keeping an eye on the baseline network status such as approved suppliers, stock levels, orders, lead times, consumption, substitute items, and budget limitations.

The system makes use of exception handling. When a shipment is delayed, it can be assessed by looking at the number of days' supply, current demand, the other warehouses, substitute products, and the different alternative suppliers. A recall can be initiated from the moment the batch is received right through to when it reaches its storage and distribution points. If there is a sudden increase in demand, this can be compared with past patterns and with the current level of capacity. Even if artificial intelligence is employed to prioritise anomalies, the response still relies on accurate transaction history and on the existing governance structure. Research into Industry 4.0 in healthcare supply chains also shows that technology is able to enhance performance, provided that organizational readiness and environmental conditions allow for its adoption (Hossain & Thakur, 2021; ChatterjeeThe importance of traceability is illustrated by Saudi Arabia's national strategy for digital health. According to the Health Sector Transformation Program, the country has acquired the capability to track pharmaceuticals electronically at all stages, from production to consumption, and there has been a significant decrease in shortage reports following the introduction of a supply and demand service (Health Sector Transformation Program, 2024). An even greater benefit is obtained from the nation's capabilities when the ERP systems used by providers contain consistent identifiers and up-to-date movement data, since this allows faster recall operations, permits continuous monitoring of shortages, supports anti-counterfeit measures, and promotes shared situational awareness among procurement, regulatory, and provider organisations.er organisations.

4.5 Saudi Vision 2030 Alignment and Implementation Conditions

In Saudi Arabia the digitalisation of healthcare has proceeded very quickly, but research also indicates a lack of consistency regarding the level of maturity and the fact that implementation problems have still not been settled. Al-Kahtani *et al*., (2022) discovered that the different facilities varied in their capability for digital transformation, predictive analytics being slower to develop than the other areas. As AlSadrah (2020) noted, the difficulties arose from user attitudes, computer literacy, the need for customisation and IT support, while Alzghaibi and Hutchings (2022) stated that financial support, leadership, project management, usability, training and user involvement were important factors for achieving success. The results are directly relevant to ERP supply-chain programmes since the people working in the warehouse, in procurement, in finance, in clinical services and in IT all have an effect on data quality.

The digital strategy of the Saudi Ministry of Health places great emphasis on interoperability, common digital capabilities, governance, and the creation of a patient-oriented ecosystem (Saudi Ministry of Health, 2020). ERP optimisation should therefore be integrated into the overall enterprise and national architecture rather than being regarded as a separate logistical project of a single department. It must include interfaces with the systems responsible for clinical ordering, electronic health records, asset management, finance, supplier platforms, regulatory traceability, and centralised procurement, as well as provide facilities for localisation. The Vision 2030 aims at enhancing local capability and at achieving more productive public spending. Expenditure can be analysed using ERP data according to supplier, product origin, category, facility, and contract; local-content commitments should be regularly reviewed; and it may be possible to identify those categories in which demand concentration would make a case for local manufacturing or strategic sourcing. However, localisation should be assessed together with quality, continuity, lead time, and total cost. A product that is obtained locally even if it reduces dependence on imports but has poor quality or insufficient capacity may not strengthen resilience. Scorecards made possible by the ERP system can make these trade-offs clear rather than leaving them as nothing more than symbols.

5. DISCUSSION. A FRAMEWORK FOR IMPROVING ERP SYSTEMS BASED ON REVIEW

5.1 Discussion: A Review-Derived Erp Optimization Framework

The synthesis proposed has four layers. The first of these is data validity and includes standardised item and supplier masters, location structures, units of measure, contract references, batch and expiry records, and role-based ownership; this first layer is essential since without it all the other capabilities would be unstable. The second layer deals with process integration and covers the requisition-to-order, order-to-receipt, receipt-to-stock, stock-to-consumption, transfer, return, recall, and invoice matching processes, as it is this layer that turns the data model into integrated operational activity. The third layer is about intelligence and makes use of dashboards, predictive analytics, artificial intelligence, and risk alerts in order to detect deviations and to forecast requirements. The fourth layer concerns ecosystem connectivity and involves establishing links between the providers and the central procurement system, the suppliers, the logistics partners, the regulators, and the national digital frameworks.

That is why even technology programs which apply sophisticated software can fail. Healthcare organisations tend to introduce analytics or blockchain before they have solved the problem of inconsistent identifiers, reduced the delays in inventory postings, or defined clear responsibility for different processes. The end result is information that, although it is technically advanced, is operationally unsound. Research into digitalisation indicates that it is better to have sequenced roadmaps and to build up capabilities than to carry out separate deployments (Beaulieu & Bentahar, 2021; Monferdini *et al.*, 2024). The ERP-focused framework puts this principle into action by treating advanced tools as extensions of reliable transactional data and by assessing performance according to process outcomes rather than on the number of applications that have been implemented. In practice as well, this approach leads to a simpler investment logic, since organisations can check whether the quality of the basic transactions, their compliance with master-data rules, and their adherence to workflows are improving before giving any undue credit for performance improvements to more expensive analytics, automation, or ecosystem-level integrations.

The framework also links supply performance to clinical objectives; a product which costs little to purchase will provide little value if it arrives late, expires before it is used, or needs frequent emergency replacement. On the other hand, higher safety stocks may be suitable for an essential item which has a long and variable lead time. Optimisation thus involves making decisions on the basis of more than one objective. Examples of key performance indicators are stockout rate, service or fill rate, inventory accuracy, days of supply, forecast error, the value of expiry and obsolescence, emergency purchase rate, supplier on-time-in-full performance, procurement cycle time, contract-compliance rate, recall closure time, and inventory turnover. These measures should be analysed according to clinical criticality so that improvements in low-risk areas do not mask deterioration in critical supplies.

The KPI framework is applicable at various levels. For example, a hospital might monitor the accuracy of its deliveries and the availability of its wards; a cluster could compare its inventory levels and reassign stock which is about to expire; a central procurement body could keep track of supplier performance and national demand; and decision-makers could watch trends in shortages, the degree of localization, and spending efficiency. It is essential to have agreed definitions; otherwise, if each organisation calculates stockouts or service levels in its own way, the dashboards will appear to offer transparency without in fact being comparable. Governance must therefore define the KPI formulas, identify who the data owners are, set the thresholds, establish the escalation procedures, and decide how often the arrangements should be reviewed.

The same literature states that resilience should be built into ordinary ERP procedures rather than merely being brought into play when a crisis occurs. Research carried out during the pandemic showed the benefits of collaboration, flexibility, having a variety of sourcing options, and possessing real-time visibility (Scala & Lindsay, 2021; Spieske *et al.,* 2022). While carrying out normal operations the ERP system should retain approved alternative suppliers, keep substitute-item relationships, apply minimum critical-stock policies, and watch supplier risk indicators. When a disruption does occur, the same data can then be used for scenario analysis and for the prioritised allocation of resources. Hence, resilience is transformed from being a concept linked with an emergency response into a continuously managed operational capability.

In the end, ERP should be considered to be socio-technical infrastructure. Research into the adoption of technology in Saudi health settings have demonstrated that user involvement, leadership, training, financial support, and interoperability all have a significant impact on implementation (Al-Kahtani *et al*., 2022; Alzghaibi & Hutchings, 2022; Alzghaibi, 2023). Even the most strong architecture will fail if users skip the scanning process, set up duplicate entries, postpone processing receipts, or keep shadow spreadsheets. Governance must therefore include process owners, super-users, data stewards, ongoing training, and visible support from senior executives. The focus on socio-technical aspects means that the proposed framework is in line with both the operational evidence and the wider institutional objectives of Vision 2030.

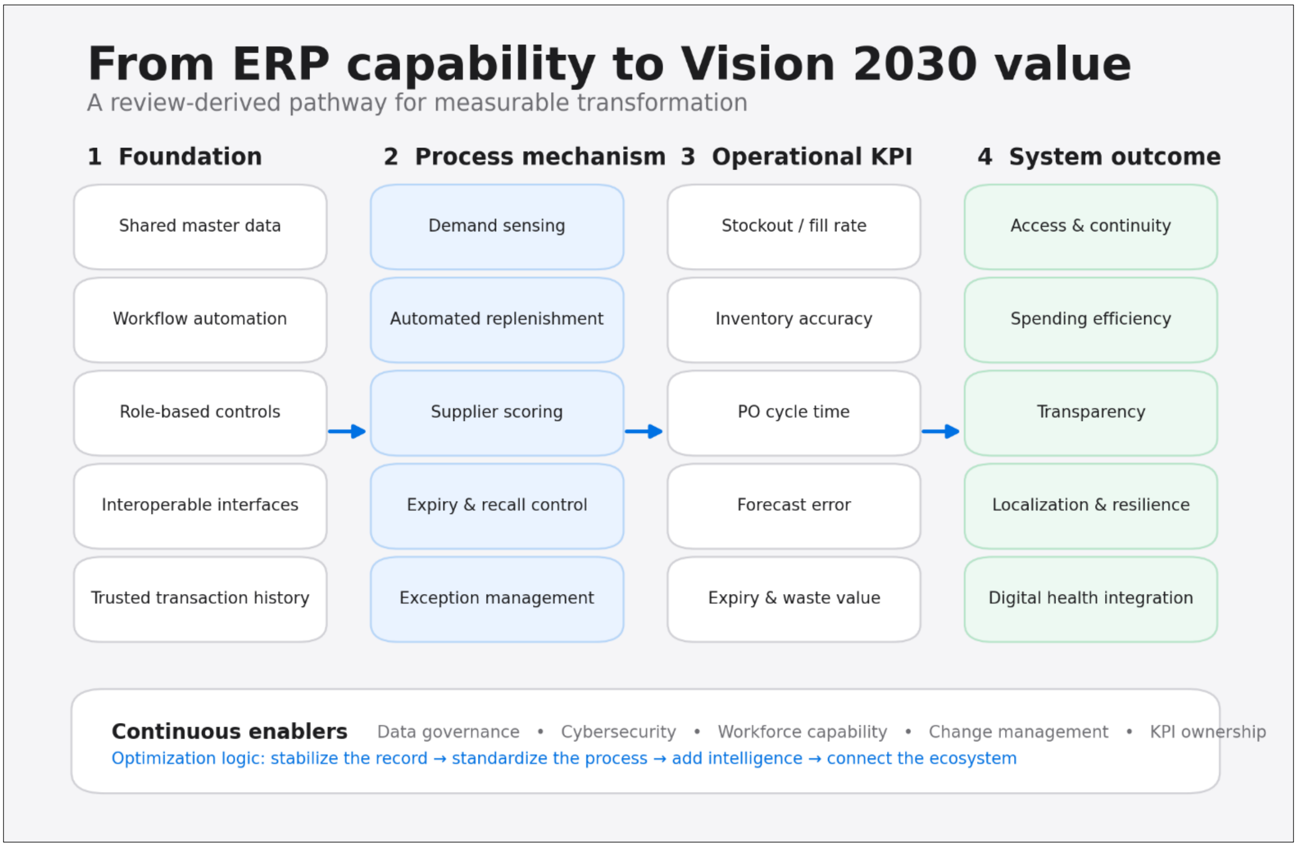

Figure 2: Review-derived pathway from ERP foundations to measurable Vision 2030 system value. Source: author synthesis

Table 2: ERP optimization levers, expected effects, and indicative KPIs

Process domain	ERP capability	Expected effect	Vision 2030 alignment	Indicative KPI
Demand planning	Integrated consumption history; segmentation; forecast workflows	Fewer avoidable shortages and excess	Availability, prevention, resource efficiency	Forecast error; critical-item stockout rate
Procurement	Contract-linked requisition-to-order workflow	Shorter cycle time; less maverick spend	Spending efficiency; transparency	PO cycle time; contract compliance
Supplier management	Lead-time tracking; OTIF scorecards; exception alerts	Greater accountability and supply reliability	Resilience; quality; localization	OTIF; lead-time variance; quality incident rate
Inventory control	Perpetual stock; batch/expiry; cycle counts; FEFO	Higher accuracy; lower expiry and emergency buying	Access; cost control; patient safety	Inventory accuracy; expiry value; emergency purchase rate
Warehousing & distribution	Barcode/scan control; transfer visibility; allocation rules	Faster movement and network balancing	Service continuity; regional access	Fill rate; transfer time; days of supply
Traceability & recall	Serial/batch genealogy; status and recall workflow	Faster product location and withdrawal	Safety; regulatory transparency	Recall closure time; trace completeness
Analytics & AI	Exception dashboards; demand sensing; anomaly detection	Earlier decisions and proactive response	Digital health; resilience	Alert-to-action time; forecast improvement
Governance & interoperability	Master-data ownership; interfaces; roles; audit trail	Trusted, comparable cross-network information	System integration; accountability	Data completeness; interface error rate

6. MANAGERIAL AND POLICY IMPLICATIONS

What healthcare executives should do is to regard ERP optimization as a process transformation rather than merely as software configuration. The programmes must start with a clean-up of master data and the mapping of processes, then establish a stable transaction discipline before introducing predictive or distributed technologies. The teams involved—including procurement, pharmacy, warehouse, finance, clinical services, quality assurance, and IT—should together determine the key data fields and the exception rules. A cross-functional governance board should be set up to prioritize the issues according to their impact on patient safety and supply risk rather than based on departmental preferences.

Supplier scorecards for procurement and supply groups should be based on operational data and connected to sourcing decisions. Contracts should include specifications regarding data exchange, shipment visibility, batch information, service levels, and corrective-action procedures. In the case of hospital networks, inventory policies must be varied according to clinical criticality, demand variability, value, expiry risk, and lead time. The ability to have a network-wide view of inventory can help to enable redistribution prior to making emergency purchases and can also reduce waste by means of systematic near-expiry management.

For policymakers, just as much importance should be attached to interoperability and the use of common data standards as to centralizing procurement. National digital initiatives should promote the use of consistent product identifiers, common interface standards, uniform cybersecurity controls, and shared definitions of key performance indicators among providers and supply partners. The digital ecosystem set out in the Vision 2030 and Ministry of Health strategy will then be able to support not only the exchange of clinical information but also supply assurance, spending transparency, readiness for recalls, and evidence-based localization. Taking these steps enables ERP investments to result in tangible system capacity rather than merely in isolated institutional automation.

7. Limitations and Future Research

The review brings together a variety of different kinds of evidence and so is unable to arrive at a single estimate of the effect of ERP on healthcare supply performance. Since the majority of the empirical studies come from outside Saudi Arabia, the extent to which the findings can be applied depends on the procurement structure, the level of regulation, the maturity of the hospitals, and the data architecture. Future research carried out in Saudi Arabia should make use of longitudinal studies involving multiple hospitals in order to assess the changes that take place before and after implementation in terms of stockouts, expiry, cycle time, supplier service, and cost. Comparative studies should also examine whether advanced analytics generate additional value once the quality of master data and the maturity of the ERP processes have been taken into account.

8. CONCLUSION

ERP has the potential to give Saudi Arabia's healthcare and medical supplies sector an operational foundation that links together demand, procurement, inventory, logistics, finance, and governance. The evidence examined shows that the greatest benefits are achieved when integrated data is turned into standard operating procedures, effective exception handling, and performance measures that can be held accountable. Although artificial intelligence, the Internet of Things, blockchain, and analytics can enhance forecasting, monitoring, traceability, and resilience, their advantages rely on reliable ERP records and on the organisation's readiness. ERP-based optimisation therefore ought to follow an approach aligned with Vision 2030 by progressing the transformation in the order of data integrity, then process integration, followed by intelligence and finally ecosystem connectivity. Provided that interoperable standards are in place, skilled users are available, cybersecurity is ensured, and key performance indicators are continuously governed, it is possible to improve the availability of medical products, reduce waste and the need for emergency purchases, increase supplier accountability, promote localisation, and make healthcare supply decisions more transparent and resilient.

The framework, in terms of operation, sets digital maturity apart from service maturity. Even with advanced software it is possible to deal with shortages if transactions are delayed or the data are unreliable. On the other hand, the use of an ERP system in a disciplined manner can yield benefits before any costly extensions are introduced. This order of implementation safeguards the investment, makes accountability clearer, and establishes a body of evidence for automation within the Saudi networks.

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