

The Implementation Of Erp In Post-Pandemic Logistics: Multi-Criteria Decision Model

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Article Details	Abstract
Received: 27 July 2024 Accepted: 26 Oct 2024 Published: 27 Dec 2024 ¹Dr. Ashraf Jamal ²Hamdan Khattak Copyright @Author Corresponding Author: *Dr. Ashraf Jamal	The implications of the post-pandemic period have created significant macroeconomic shocks that have revealed the structural fragilities in global supply chain networks and logistics infrastructure. Logistics firms have been in a rush to move to modern-day Enterprise Resource Planning (ERP) frameworks with a view of being reactive, agile, and able to see assets in real-time. Yet the implementation of these systems inside post-pandemic supply chains is still very volatile, with high failure rates derived from multi-dimensional constraints in the organizational, technical and macro-environmental dimensions. A comprehensive Multi-Criteria Decision Model (MCDM) is proposed in this paper, which is specially designed to isolate, categorize and rank barriers to implementation for twenty logistics companies. Based on the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), an empirical hierarchy of disruption is set up. The empirical results show that Technological Architectural Incompatibility and Dynamic Workforce Disconnects are the top two vector weights, surpassing traditional capital constraints. The paper presents a generative mechanism matrix to mitigate enterprise operators under Dynamic Capabilities Theory.

Keywords: Enterprise Resource Planning (ERP), Post Pandemic Logistics, Supply Chain Resilience, Multi-Criteria Decision Model (MCD Model), and Analytic Hierarchy Process (AHP) and TOPSIS.

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INTRODUCTON:

The logistics and supply chain industry is undergoing a structural shift like never before. The shocks of the global health crises and compounded by geopolitical tensions, roiled energy corridors and splintered labor ecosystems have clearly disrupted the sustainability of legacy and deterministic operational models. In the past, logistics services were served within a mathematically defined space with clear parameters and constraints focused on minimizing logistics costs and optimizing logistics locally, for example by using rigid Just-In-Time logistics paradigms. In the post-pandemic world is not enough, as these frameworks have failed to meet the new competitive requirement, which is now dynamic resilience. A fast deployment of complete Enterprise Resource Planning (ERP) systems is key to attaining this resilience. Today's ERP systems are the digital equivalent of the backbone of modern logistics and can be used to connect in real-time and seamlessly the cross-functional aggregation of unstructured telemetry data throughout global warehouse networks, a wide range of multi-modal fleets and customs clearing interfaces, and real-time predictive demand nodes. A seamless ERP system eliminates informational silos to ensure that an entire enterprise functions as one hyper-responsive unit that can route transactions dynamically, reallocate stock on the fly and provide nuanced automated forecasting.

Yet, in spite of the obvious tactical sense, the true story of ERP adoption in the logistics sector is a tale of high levels of strategic frustration. Industry cross sectional data shows that more than 70% of complex ERP configurations either never achieve the operational benchmarks they set for themselves, run into huge budget overruns or are cancelled mid-deployment. In the post-Covid logistics value chain, these implementation failures are exacerbated by the scarcity of resources at the local level, technical debt in legacy customs solutions, and the extreme friction among employees about the effect on processes of technology.

To overcome this high stakes industrial problem, academics and the operations managers need to get beyond mono-causal explanations of project failure. ERP integration is a multi-attribute problem with competing organizational priorities,

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technical constraints and fiscal constraints that is highly non-linear. This complexity is the direct concern of this study and it has developed a rigorous Multi-Criteria Decision Model (MCDM). This paper uses the mathematical parsing method of the Analytic Hierarchy Process (AHP) and the relative distance tracking method of the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to systematically identify, weigh and prioritize the main implementation barriers to the 20 representative logistics providers. The goal is to develop a predictive framework and realize the transformation of raw operational anxiety into structured and actionable strategic interventions.

2. Literature Review & Conceptual Mapping

The Post-Pandemic Logistics Disruption Continuum, 2.1

The post-pandemic operating context involves a 'permachrisis' (continuous, intersecting disruptions) that complexity theorists describe. In logistics, this is seen in fluctuating spot freight rates, unpredictable congestion at maritime gates, quick changes in the number of workers in terminal workforces and evolving omni-channel consumer demand. New investigations suggest that these disruptions are not short-term cyclical swings but rather the restructuring of global trade in a permanent way. This means that information systems need to change from batch processing to real time streamed data on the edge.

The second challenge is logistic and ERP architecture alignment failure. The second challenge is 2.2 ERP Architecture and Logistics Alignment Failure.

The traditional ERP models were conceptualized in a period of relative stability in the environment. They assume a linear flow of transactions: procurement, storage, fulfillment and accounting. Contrastingly, digital-first logistic ecosystems require a hyper-flexible network model. It happens when the business logic in a commercial off-the-shelf (COTS) ERP package is hardcoded and doesn't fit the very flexible, ad-hoc workflows needed to deal with supply chain anomalies. In such cases, logistics operators often skirt the main software suite and use spreadsheets as a disorganized, offline alternative. This is the very behavior that the ERP was purchased to remove.

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The Taxonomy of Strategic ERP Implementation Barriers has been created.

This study, having considered the variety of information systems literature available and its underlying framework, classifies the many factors that hinder ERP deployment into four broad categories: Technical, Organizational, Financial, and Macro-Environmental. This structural categorisation guarantees that the choice model comprises internal socio-technical factors as well as external factors such as regulations and/or economy.

Macro-Dimension Core Criteria Code Operational Operational Definition & Characteristics

Technical (TECH) C1: Legacy Incompatibility

Data Cleaning Speed: C2.

C3: API Middleware Failures: Cloud ERP modules are not able to securely connect with proprietary customs and port telemetry systems and EDI pipelines without significant data latency.

Executive Disengagement (EXEC): C4

C5: Resisting workplace attrition

Cultural resistance from traditional operations staff on automated decision loops and lack of a robust governance presence at the c-suite from operations sponsors.

Unplanned Customization Costs Financial (FIN) C7

C8: Licensing Inflation

C9: Post-Go-Live Operational Drain Severe depletion of capital due to significant re-writing of the structural code and failure to account for the total cost of ownership (TCO) in times of inflation.

Macro-Environmental (ENV) C10: Cross-Border Regulatory Shifts

The environment in which a region is operating. The region's cyber threats.

Ransomware attacks targeting physical server hubs or localized infrastructure nodes cause external supply shocks and changing compliance requirements that lead to Multi-Modal Port Congestion.

3. Mathematical MCDM Framework

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This research applies a hybrid Multi-Criteria Decision Model to properly rank the implementation barriers mentioned in section 2. The architecture is designed to calculate the exact criterion weightings based on the Analytic Hierarchy Process (AHP) with mathematically verified results and to rank the performance profiles of the twenty logistics companies participating in the simulation using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS).

The Analytic Hierarchy Process (AHP) Protocol is used in 3.1.

AHP phase breaks down the decision challenge in a structured hierarchy. The pairwise comparison matrices are performed by an expert panel using the standard 1-9 Saaty scale, with a value of 1 indicating equal importance of a strategy and 9 indicating a dominating importance of a strategy. The mathematical formulation is to make a matrix $A = [a_{ij}]$ with the entries a_{ij} being the relative importance of criterion i over criterion j . The derivation of the core weight is done by calculating the principal eigenvector:

$$A \cdot w = \lambda_{\max} \cdot w$$

Each matrix has a Consistency Ratio (CR) to ensure mathematical validity. The Consistency Index (CI) is given as: $(\lambda_{\max} - n) / (n - 1)$. Any comparison matrix with a CR greater than the strict 0.10 limit is redone until it satisfies the limit. If a comparison matrix produces a CR greater than the strict 0.10 limit, the matrix is redone until it meets the limit, removing logical inconsistencies.

3.2 TOPSIS Alignment Formulation

After obtaining the exact criteria weight matrix (w_j) by AHP, the alternative matrix of twenty different logistics enterprises (A_i) would be assessed by TOPSIS. The method is used to identify both the Positive Ideal Solution (A^*) and the Negative Ideal Solution (A^-) over the normalized and weighted decision space. Each alternative is separated from other alternatives by a mathematical Euclidean distance given by:

$$S_i^* = \sqrt{\sum (v_{ij} - v_j^*)^2} \quad \text{and} \quad S_i^- = \sqrt{\sum (v_{ij} - v_j^-)^2}$$

The relative Closeness Coefficient (CC_i) of an enterprise in relation to the ideal threshold of operational performance is calculated as $CC_i = S_i^- / (S_i^* + S_i^-)$.

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The higher the CC_i , the more the organization has neutralized barriers to implementation.

The student identifies the results and analyzes the data from an empirical investigation.

The inputs to the decision model were structured from executive panels of twenty different logistics organisations which ranged from maritime freight forwarders, to third party logistics providers (3PL), to cold chain operators, through to digital-native last-mile delivery networks. The global weights of the enterprises of the consolidated AHP and the enterprise cluster ranks obtained by the TOPSIS algorithms are shown in Table 2.

Macro-Dimension	AHP Weight	Highest Driving Criterion	Enterprise Cluster Impact
Technical (TECH)	0.385	C1: Legacy Incompatibility	Serious integration conflict with customs portals in the cloud. 0.412 (Low Performance)
Organizational (ORG)	0.294	C5: Workforce Change Resistance	Widespread process workarounds by field crew. 0.528 (Moderate Performance)
Financial (FIN)	0.182	C7: Unplanned Customization	Significant budget inflation halfway through implementation. 0.645 (High Performance)
Macro-Env (ENV)	0.139	C10: Cross-Border Compliance	Sudden regional trade data law changes disrupts Cross-Border Compliance (ENV). 0.589 (Moderate Performance)

The data shows a very pronounced absence from the pre-pandemic information systems literature. Raw capital restraints (Financial Dimension) have been the main problem cited for the success of ERP implementation for mid-market companies historically. In the post-pandemic parameters, however, the Technical Dimension is the most important one in the model, having a global weight of 0.385. This change signals a project bottleneck in a hyper-connected and volatile logistics network, regardless of funding, when it can't perform real-time API data exchanges with external supply chain partners.

5. Formulation of research propositions that can be tested.

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Based on the empirical learning from the mathematical model, we build three testable research propositions to be empirically validated in the context of information systems governance.

Proposition 1: Active cloud-native use of microservice middleware contributes negatively to the severity of Technical Architectural Incompatibility during the post-pandemic ERP deployment.

The level of top management psychological involvement and transparent internal messaging strongly moderates the negative effect of Workforce Change Resistance on ERP go-live operational metrics (P2).

P3: Logistics companies with high Dynamic Capabilities metrics have significantly lower Unplanned Customization Costs thanks to their capacity for the structured re-engineering of processes that they can implement quickly.

The discussion and strategic mitigation matrix.

Combining factors of AHP and TOPSIS shows that the most important problem faced by the modern logistics operators is not just the financial implications of technology acquisition, but the structural and socio-technical adaptation to it. To help enterprise executives put the findings into practice, a broad-based Strategic Mitigation Matrix has been created based on the dynamic capabilities framework.

Leveraging Effectiveness Known Gap Targeted Action to Address Gap

C2: Legacy Architectural Incompatibility Sensing & Reconfiguring Prohibit using any other middleware architecture except a cloud-first approach. Replace rigid on-premise EDI engines with RESTful API web hooks for processing real-time data streaming with global shipping registries.

C1: Workforce Change Resistance Create cross-functional implementation groups that work together to co-design user interfaces, directly connect automated logging with labor safety metrics.

Structural Cost Transform into Unyielding 'Vanishing Vanilla' deployment model Unplanned Customization Drain Optimize business processes to match the standardized, embedded processes of the ERP system instead of programming the inner workings of the system to perform the same tasks as in the past.

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8. Methodological Limitations & Future Scope

The proposed hybrid MCDM framework has good mathematical clarity, but some inherent methodological constraints need to be recognized. First, the input into the evaluation matrix is still limited to the subjective qualitative assessments made by the expert panels, thus subjecting the first level of data to cognitive bias. Second, the sample size of 20 enterprises is suitable for a detailed tracking of the TOPSIS, but is limited to a local sample which may not fully reflect structural differences between smaller third party logistics companies in the developing countries.

It would be beneficial for future academic research to develop the model into a real-time decision dashboard. The MCDM can be populated with machine learning algorithms and enterprise telemetry feeds (for example, tracking production environment API latency or the differences in the daily budgets) and the MCDM evolve from a passive diagnostic tool to an active and automated early-warning system for enterprise risk management.

8. Conclusion

The shift in the global logistics industry that has occurred in the wake of the pandemic has made information systems alignment a top priority. The hybrid Analytic Hierarchy Process (AHP) and TOPSIS Multi-Criteria Decision Model was successfully developed and applied in this study to systematically identify the key barriers to successful ERP deployment. The empirical data shows that technological incompatibility and human change resistance are the real strategic friction points in today's supply networks and outpace traditional financial resource measures by a long shot.

This study aligns with the concept of Dynamic Capabilities Theory by defining these multi-dimensional barriers and visualizing specific prescriptive interventions in the sensing, seizing and transforming dimensions of the theory, providing a clear view for logistics executives to reduce risks in technology execution. Finally, sustainable alignment must be linked to a socio-technical perspective on ERP

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systems that recognizes them as dynamic operating systems and not as static back-office applications.

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