

Article

A Simulation-Based Intelligent Decision Support Framework for Readiness Assessment of Blockchain–EDI Integration in Supply Chains

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Abstract

Supply chain digitalization has increased the need for reliable systems that support transparency, traceability, trust, and structured interorganizational information exchange. Electronic Data Interchange (EDI) remains widely used for standardized business transactions, while blockchain offers decentralized verification, data immutability, and stronger data governance. However, blockchain–EDI integration depends not only on technical compatibility but also on organizational capacity, partner alignment, financial resources, and regulatory preparedness. Existing studies mainly examine blockchain benefits and adoption barriers, with limited attention to readiness assessment before implementation. This study develops an analytical framework for evaluating organizational preparedness for blockchain–EDI integration in supply chains. Five readiness dimensions are identified from the literature: technological, organizational, partner, financial, and regulatory readiness. These dimensions are measured using a 0–5 scoring system, combined into a weighted readiness score, and linked to a logistic function that estimates integration success under different complexity levels. Deterministic simulation, Monte Carlo simulation, and sensitivity analysis are used to examine the model. The results show a nonlinear readiness–success relationship under assumed parameter values: low readiness is associated with limited estimated success, medium readiness forms a transition zone, and high readiness supports more stable estimated outcomes. The framework is positioned as a methodological readiness assessment model rather than an empirically validated predictive system. It provides a basis for future empirical calibration, pilot testing, and validation using organizational implementation data.

Keywords: blockchain; EDI; intelligent systems; supply chain; readiness model; decision support; simulation



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1. Introduction

The rapid digitalization of supply chains has fundamentally reshaped interorganizational coordination, shifting the competitive frontier from isolated operational efficiency to integrated, simulation-based ecosystems [1]. In this context, the ability to ensure transparency, traceability, and trust across distributed actors has become a critical determinant of supply chain performance and resilience [2,3]. Traditional interorganizational information systems, particularly Electronic Data Interchange (EDI), have long served as the backbone of structured transactional exchanges [4]. However, their centralized architecture and

limited adaptability constrain their ability to address emerging requirements related to real-time visibility, decentralized governance, and secure multi-party collaboration [5].

Concurrently, the transformative potential of blockchain allows for the creation of immutable records, the ability to validate and store value through decentralization, and the ability to automate transactions through smart contracts [6]. The blockchain has generated considerable interest from both scholars and practitioners because it can establish trust among supply chain members, provide an auditable record of transaction activity, and allow for the coordination of supply chain participants [7,8]. Although blockchain does not replace EDI, it complements EDI by providing additional verification, transparency, and distributed trust for standardized, large-volume business transactions [9,10]. Although there is much interest in integrating EDI and blockchain, it continues to represent a significant organizational change rather than simply a technology implementation [11,12].

Existing studies have mainly examined blockchain and EDI from the perspectives of technological capabilities, adoption determinants, and implementation barriers [13–15]. While these contributions provide valuable insights, they often give limited attention to the multidimensional conditions that determine whether an organization is sufficiently prepared to integrate both technologies in practice [4]. In particular, the existing literature does not provide a systematic analytic structure for evaluating the state of readiness for blockchain–EDI implementations and transforming these evaluations into decision support insights [16].

This gap is significant because the Technology–Organization–Environment (TOE) framework and interorganizational systems theory both state that successful digital transformation relies upon more than just technology. Success is determined by a combination of technological capabilities, overall capabilities, alignment with partners, financial means, and regulatory conditions [15,17].

However, in the specific context of blockchain–EDI integration, these theoretical insights remain only partially operationalized. Few studies have translated readiness-related concepts into measurable and predictive models that can support managerial decision-making before implementation [14,18–20]. To address this gap, this study develops a readiness-based analytical framework that conceptualizes blockchain–EDI integration as a multidimensional capability shaped by technological, organizational, partnership, financial, and regulatory conditions.

This proposed method combines both descriptive analysis and structured scoring for both of the criteria used in a model that assesses the likelihood of successful integration at different levels of organizational readiness and complexity of implementation. The research builds on a conceptual synthesis, analytical model, and simulation to create an interface between theoretical and operational decision support systems. In addition, the method also provides a structured way to evaluate organizational readiness, to discover critical constraints in supply chains, and to develop decision support based on simulations related to digital supply chain transformation initiatives.

Thus, this study addresses two research questions: (1) What evidence exists in the literature regarding the conceptualization and measurement of organizational readiness for blockchain–EDI integration? and (2) How can readiness indicators be transformed into a structured analytical framework for the illustrative estimation of integration success under different readiness and complexity conditions? These research questions support the development of a conceptual and methodological readiness framework rather than an empirically validated predictive model. This study presents an integrated framework to evaluate how to incorporate blockchain technology in an EDI setting through readiness assessment, as well as building operational analytical models. This framework involves: multi-dimensional readiness assessment using structured scoring of dimensions, proba-

bility of success estimation, and simulated investigation to assist with both theory and managerial decision-making.

Because the present study does not use primary implementation data, the proposed framework is not positioned as a fully validated operational decision support system. Instead, it is presented as a conceptual and methodological model that operationalizes readiness assessment and demonstrates how scenario-based simulation can support structured managerial reasoning before implementation. Empirical calibration and validation using organizational data are therefore necessary extensions for future research.

The remainder of the article is structured as follows. Section 2 presents the literature review and identifies the scientific gap. Section 3 describes the research methodology. Section 4 develops the multidimensional conceptual framework. Section 5 presents the research propositions and conceptual model. Section 6 presents the analytical model, including the readiness score, logistic success function, parameter-estimation logic, operational scoring system, and analytical scenario-based demonstration. Section 7 presents the results, including deterministic simulation, Monte Carlo simulation, sensitivity analysis, and the intelligent systems perspective. Section 8 discusses the findings and implications. Section 9 presents the limitations and future research directions. Section 10 concludes the article.

2. Literature Review

The rise in academic and managerial attention on supply chains being digitized has been driven by the increased complexity of exchanges between organizations and the need for better information flow, traceability, data security, and coordination with partners [21,22], as well as to improve the accuracy of those exchanges. Electronic Data Interchange continues to be an established infrastructure for standardizing transactions between organizations, while blockchain is increasingly viewed as a complementary technology that could change the way data is verified, shared, and managed [23,24].

Research related to digital technologies within supply chains has been increasing; however, some significant limitations still exist within this area. The majority of the current literature published is fragmented, tech-focused in nature, or identifies possible benefits of the technology without any explanation as to what type of organizational pre-conditions will be necessary prior to implementing it [15,25].

2.1. Blockchain and EDI as Complementary Supply Chain Technologies

The combination of EDI and blockchain has been separately analyzed in the literature [16]. Most articles discuss the value that EDI provides to businesses rather than asking whether blockchain should replace EDI; the more relevant question is how blockchain and EDI can coexist to improve coordination among business relationships [26]. On the other hand, most articles about blockchain focus on its capability to create immutable records, allow tracking of products and shipments, mitigate fraud, provide a higher level of transparency, and use smart contracts for automated processes [27].

Blockchain provides improved transparency, traceability, and trust among multiple parties within the supply chain through the creation of a shared, unalterable, and verifiable record of all transactions [8]. This is particularly critical in multi-company supply chains where there may be issues surrounding the ability to coordinate efficiently due to fragmented documents and the asymmetric flow of information [28].

The contributions discussed above are significant in their own right; however, these contributions have generally focused on the technological capabilities of certain systems rather than the organization's ability to implement those solutions. For example, most of the existing studies provide information about what technology can do, but do not include

determining if the organization has sufficient capabilities to integrate that technology into its existing interorganizational systems.

2.2. Blockchain–EDI Integration Challenges in Interorganizational Supply Chains

Another limitation of the academic literature and practitioners is that many academic and practitioner discussions do not distinguish between emerging and traditional technology as being alternative to each other [29,30]. A frequent example of this is EDI versus blockchain, where blockchain is described as an alternative form of communicating B2B transactions [14,31]. This results in a simplistic view of the relationship between the two technologies. Currently, many organizations rely heavily on EDI for a multitude of reasons, such as being the current industry standard for transmitting high-volume B2B transactions [32]. Rather than asking whether blockchain should replace EDI, it is important to ask the question of how both technologies can coexist, as well as work together to create complementary value [10,29].

The use of EDI as a primary means of organizing and exchanging structured data between two or more organizations will continue because it is the standard method for handling recurring and high-volume transactions in the supply chain [33,34]. Consequently, blockchain will need to be looked at not only as a substitute for EDI but as a second layer to reinforce the ability to verify, audit, and have transparency, and maintain an appropriate level of decentralized trust about interorganizational exchanges [10,35].

2.3. Organizational Readiness, Implementation Barriers, and Decision Support

Most studies recognize that blockchain adoption faces several barriers, including implementation cost, technical complexity, interoperability issues, user resistance, regulatory uncertainty, and data security concerns [12,36]. However, these barriers are often discussed broadly, with limited use of structured analytical frameworks.

Similarly, research on EDI primarily emphasizes operational efficiency, while comparatively less research looks into its compatibility with new emerging distributed ledger technologies [37]. This leaves a knowledge gap concerning the types of conditions needed to be in place within organizations so that the integration of both technologies occurs seamlessly.

The main challenges of integrating EDI with blockchain include issues with interoperability between traditional EDI systems, ERP systems, middleware, and blockchain-based solutions; complexity associated with multi-actor governance across the supply chain; and resistance to process re-engineering by organizations [38]. These integration challenges will demonstrate that blockchain–EDI integration is not merely a technical issue but an organizational and interorganizational transformation necessitating aligned governance, partner alignment, standardised data, and management support [38,39].

Integrating blockchain into traditional EDI systems is an organizational transformation process that extends beyond technical compatibility [29]. Successful implementation depends on digital infrastructure, internal governance, external partnerships, financial capacity, and regulatory support [5]. Despite this, few studies provide a structured framework for evaluating these readiness dimensions before implementation [40,41].

The lack of a clear readiness framework makes both theoretical development and practical issues difficult for decision-makers seeking to assess their technological maturity before starting a blockchain–EDI integration project [20].

Existing models lack an operational readiness assessment mechanism capable of translating technological, organizational, partner, financial, and regulatory conditions into measurable indicators [42]. They also provide limited analytical decision support mechanisms for estimating the probability of successful blockchain–EDI integration before implementation. As a result, managers may recognize the strategic potential of blockchain and EDI

integration without having a structured tool to evaluate readiness, identify weaknesses, prioritize corrective actions, and assess implementation risk.

2.4. Research Gap and Positioning of the Present Study

Given these limitations, this study addresses the two research questions stated in the introduction: first, how organizational readiness for blockchain–EDI integration is conceptualized and measured in the literature; and second, how readiness indicators can be transformed into a structured analytical framework for the illustrative estimation of integration success under different readiness and complexity conditions.

To answer this question, the article proposes a multidimensional readiness framework based on five pillars: technological, organizational, partner, financial, and regulatory readiness. The study further transforms this framework into an analytical and semi-quantitative decision support model that enables readiness assessment, integration success estimation, simulation-based demonstration, and intelligent systems extension.

The absence of operational readiness assessments and analytical decision support systems constitutes an ethical issue with respect to blockchain and Electronic Data Interchange (EDI) applications [43,44]. This study goes beyond simply describing the potential benefits of both technologies by developing a quantifiable and actionable framework that helps organizations assess their level of preparedness for integration, estimate their chances of success, and identify what will be necessary for both blockchain and EDI to be implemented successfully.

2.5. Research Contributions

This study contributes to the literature on supply chain digitalization, interorganizational systems, and readiness assessment by proposing a conceptual and methodological framework for evaluating blockchain–EDI integration readiness. The contribution does not lie in providing an empirically validated prediction model, but in integrating readiness dimensions identified in the prior literature into a structured assessment logic that can be calibrated and validated in future empirical studies. Although the five readiness dimensions are grounded in the existing adoption and readiness literature, this study operationalizes them specifically for blockchain–EDI integration by linking them to a scoring system, weighted readiness score, illustrative logistic function, simulation analysis, and managerial decision rules. The distinctive logic of the framework lies in applying these readiness dimensions to the specific integration between EDI and blockchain. In this context, readiness is shaped by the interaction between standardized EDI transaction flows, blockchain-based decentralized verification, and cross-organizational data governance. Technological readiness therefore includes not only blockchain infrastructure, but also ERP/EDI interoperability and data standardization. Partner and regulatory readiness are also central because blockchain-based verification depends on shared participation, auditable records, electronic document recognition, and data protection requirements across organizational boundaries. The framework is therefore positioned as an applied integration of established readiness dimensions, adapted to the specific operational and governance requirements of blockchain–EDI integration.

First, the study contributes to blockchain–EDI integration research by framing integration readiness as a multidimensional assessment problem rather than as a purely technological adoption issue. Additionally, by incorporating technological, organizational, partner, financial, and regulatory dimensions, the framework extends TOE and interorganizational systems perspectives toward a more integrated view of the conditions required for blockchain–EDI integration. Second, this study contributes methodologically by developing a measurable construct for assessing the degree to which an organization is ready

to successfully implement change. The study proposes a scoring system that translates qualitative readiness conditions into measurable indicators, thereby enabling more systematic and comparable readiness assessments than purely descriptive conceptual models. This operationalization of organizational readiness enables systematic and comparable assessments of organizations' readiness levels, as well as potential for future empirical validation and calibration.

Third, the study provides an analytical formulation for representing the relationship between organizational readiness, implementation complexity, and estimated blockchain–EDI integration success. The analytical model uses a logistic specification to estimate integration success as a function of organizational readiness and implementation complexity. The conceptual propositions developed in this study provide a formal basis for describing the nonlinear relationship between organizational readiness, implementation complexity, and blockchain–EDI integration success. This approach shifts readiness assessment from a static descriptive exercise to an analytical and simulation-supported framework. Fourth, this research adds to the growing literature on simulation-based decision support by applying deterministic and Monte Carlo simulation techniques to evaluate the behavior of the proposed model under uncertainty.

From this perspective, simulation supports examination of how changes in readiness, implementation complexity, and model parameters influence the resulting assessment outputs.

Finally, the study provides a basis for creating intelligent decision support systems by describing how the readiness model can be further enhanced with machine learning and predictive analytics. The study provides alternate methods to automate the assessment of readiness through the use of readiness dimensions as classification and prediction model input variables. Collectively, the study represents an integrated, operationally based, and analytically oriented framework for the analysis and management of blockchain–EDI integration in supply chains, shifting the focus from descriptive and fragmented analysis of blockchain–EDI integration to providing a comprehensive framework for integrating the theoretical and practical aspects of blockchain–EDI integration through empirical research and the development of intelligent systems.

3. Research Methodology

This research uses a structured literature review and analytical modeling to develop an analytical and multidimensional assessment framework for assessing the readiness of organizations to integrate blockchain and Electronic Data Interchange (EDI) technologies in supply chains. It does not intend to produce a systematic literature review or an empirical assessment of causal relationships using primary data, but rather to synthesize the relevant theoretical and applied literature around the creation of a framework that can be used for operationalizing assessments of readiness for future empirical validation, as well as for management decision-making.

The literature on supply chain digitization, interorganizational information technology systems, Electronic Data Interchange (EDI), blockchain technology, organizational readiness, and technology adoption provided the academic basis for the study. The literature search consisted primarily of the three major scientific databases, namely Scopus, Web of Science, IEEE Xplore, and other relevant academic sources when available. The main focus of the literature search was to include studies published between 2018 and 2026. However, foundational studies were retained if they were conceptually important.

For the review process of this research, a literature review protocol informed by the PRISMA guidelines was followed [45], without claiming that the process constitutes a complete systematic literature review. The four phases of the review process included the identification phase, screening phase, eligibility assessment phase, and final inclusion

phase. During the identification phase, the authors identified studies that pertained to blockchain technologies, EDI, supply chain integration, digital transformation, and organizational readiness. During the screening process, duplicate and non-academic sources, weakly related studies and studies unrelated to supply chains were excluded. During the eligibility phase, the remaining studies were evaluated regarding the readiness of technology, organization, partner, finance, and regulatory factors. The studies that were the most relevant to the development of a conceptual and analytical framework were selected for inclusion in the model.

The study selection process was completed using a PRISMA-informed workflow to improve the transparency and replicability of the literature selection process. The initial identification phase yielded a total of 94 potential records identified from Scopus, Web of Science, IEEE Xplore and other supplementary academic sources. Following the removal of 16 duplicate records, 78 potential records were screened based upon the title and abstract of each record. At this stage, 26 records were excluded because they were not directly related to blockchain, EDI, supply chain integration, organizational readiness, or technology adoption. The remaining 52 full-text records were assessed for eligibility, and 8 records were excluded because they were outside the scope of the study or lacked sufficient conceptual or methodological relevance. The final corpus comprised 44 references, which were used to support the conceptual framework, readiness dimensions, operational scoring system, analytical model, simulation logic, Monte Carlo analysis, and intelligent decision support perspective.

First, an analysis of recurring themes related to technological capacity, organizational governance, collaborative partnerships, financial feasibility, and regulatory factors was conducted. Second, these themes were grouped into broader explanatory dimensions of organizational readiness. Third, five dimensions were ultimately formalized into an analytical model through the development of a weighted readiness score, operational scoring system, and logistic success function.

Figure 1 summarizes the methodological workflow of the study, from the structured literature selection and conceptual synthesis to analytical model design, simulation-based analysis, and decision support output.

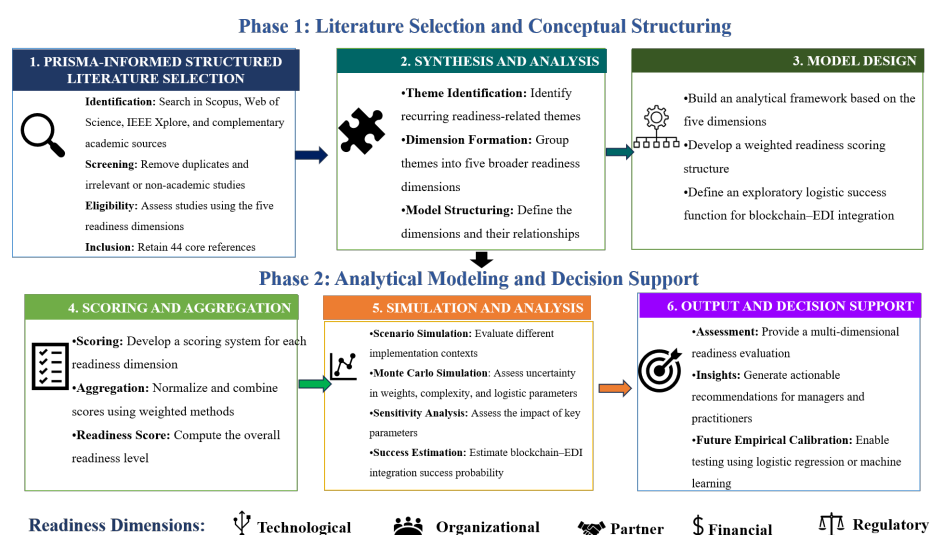


Figure 1. Methodological workflow combining the structured literature selection, analytical modeling, simulation, and decision support outputs.

A methodological design is useful for modeling both conceptually and analytically by increasing the transparency of the literature selection process, while also avoiding

unsupported claims of statistical representativeness. As a result, this study makes a dual methodological contribution. First, it provides a structured conceptual model for understanding the conditions that enable blockchain–EDI integration. Second, it provides an analytical basis for readiness assessment, simulation-based demonstration, and future empirical calibration using logistic regression or machine-learning methods.

4. Development of the Multidimensional Conceptual Framework

4.1. Technological Readiness

Technological readiness refers to an organization's ability to use its technological resources to integrate blockchain with existing EDI systems. Technology readiness typically encompasses several factors: quality of IT infrastructure, ERP-EDI compatibility, cybersecurity readiness, interoperability of different platforms, data quality, and overall availability of reliable real-time data. Organizations that have mature infrastructure are typically better able to implement blockchain-based verification and traceability technologies while reducing integration costs, operational disruptions, and implementation risk [12,29,38].

4.2. Organizational Readiness

Organizational readiness consists of internal governance, leadership commitment, capability to manage change, cross-functional coordination, and a digital culture. Blockchain–EDI integration incorporates multiple functions of the organization, including logistics, purchasing, finance, compliance, and information systems. Top management support, clear strategic objectives, internal digital competence, and cross-functional governance are all vital to achieving implementation consistency and overcoming organizational barriers to change [17–19,39].

4.3. Partner Readiness

Partner readiness is defined as the willingness and capability of supply chain members to cooperate in an initiative that combines EDI with blockchain technology. Examples of this are a willingness of suppliers and customers to work together, a willingness to share data, trust between companies, standardizing data, and aligning processes. In addition, blockchain creates value through the participation of multiple supply chain actors; therefore, a single company cannot obtain the full value of blockchain–EDI integration unless its trading partners are ready to engage in the shared digital ecosystem [8,21,35].

4.4. Financial Readiness

Financial readiness is defined as the presence of the necessary economic resources that are needed for both the implementation and continuing support of blockchain–EDI integration. These resources include an investment budget, an integration cost, expenditure for training, expenditure for maintenance, and expected return on investment. Implementation may be delayed or limited by insufficient funding and uncertainty regarding expected financial benefits, even when the strategic benefits of blockchain–EDI integration are recognized [11,36,41].

4.5. Regulatory Readiness

The term “regulatory readiness” is used to refer to the legal and institutional environment for blockchain–EDI integration. Regulatory readiness involves complying with sector-specific regulations, meeting data protection requirements, ensuring electronic documents are legally recognized, understanding the legal status of smart contracts, having the ability to audit, and being able to trace transactions. For highly regulated industries such

as pharmaceuticals, agri-food, and logistics, regulatory readiness is one of the factors that can determine whether blockchain–EDI integration is feasible and sustainable [27,28,43].

Table 1 summarizes the key readiness dimensions for blockchain–EDI integration, highlighting the technological, organizational, partner-related, financial, and regulatory conditions required for reliable and sustainable implementation.

Table 1. Dimensions of the conceptual framework for blockchain–EDI integration readiness.

Readiness Dimension	Key Components	Expected Contribution
Technological readiness	IT infrastructure, ERP/EDI compatibility, cybersecurity, interoperability, data quality	Smooth and reliable integration
Organizational readiness	Leadership, governance, internal competencies, change-oriented culture	Effective project management
Partner readiness	Supplier and customer cooperation, data sharing, interorganizational trust	Enhanced coordination
Financial readiness	Available budget, investment resources, long-term ROI perspective	Sustainable deployment
Regulatory readiness	Legal compliance, industry standards, data protection, auditability	Risk reduction

4.6. Theoretical Contribution of the Model

The proposed framework advances blockchain–EDI integration research by shifting attention from technical feasibility alone to multidimensional implementation readiness. Successful integration depends on more than just being functionally compatible from a technological viewpoint, as it will also depend on governance, regulatory clarity, partner alignment, and financial ability to implement it. In addition to providing a basis for future empirical testing, this model will allow for comparisons across sectors as well as the creation of diagnostic tools for practice.

5. Research Propositions

This section presents the theoretical propositions derived from the proposed readiness-based analytical framework. The propositions connect the five readiness dimensions to global organizational readiness, then link global readiness to blockchain–EDI integration success and logistics performance outcomes.

The propositions are formulated as conceptual research propositions rather than statistically testable hypotheses, because the present study does not use empirical data. Their theoretical basis derives from the TOE framework, interorganizational systems theory, and prior studies on blockchain adoption, EDI integration, digital transformation readiness, and supply chain collaboration. The framework is also consistent with resource-based and dynamic capabilities perspectives, because readiness is treated as a combination of internal resources, organizational capabilities, partner alignment, and adaptive capacity required for digital supply chain transformation. In this logic, technological, organizational, partner, financial, and regulatory conditions represent complementary readiness dimensions that jointly shape global organizational readiness. Global readiness is then expected to influence blockchain–EDI integration success, which may subsequently affect logistics performance outcomes.

P1: Technological readiness positively influences global organizational readiness for blockchain–EDI integration.

P2: Organizational readiness positively influences global organizational readiness for blockchain–EDI integration.

P3: Partner readiness positively influences global organizational readiness for blockchain–EDI integration.

P4: Financial readiness positively influences global organizational readiness for blockchain–EDI integration.

P5: Regulatory readiness positively influences global organizational readiness for blockchain–EDI integration.

P6: Global organizational readiness positively influences blockchain–EDI integration success.

P7: Blockchain–EDI integration success positively influences logistics performance, including resilience, sustainability, operational performance, and visibility.

Figure 2 summarizes the conceptual logic of the proposed framework and shows how the seven propositions are linked. The five readiness dimensions are positioned as antecedents of global organizational readiness, which then influences blockchain–EDI integration success. Integration success is subsequently linked to logistics performance outcomes, including resilience, sustainability, operational performance, and visibility. The feedback loop indicates that implementation experience may contribute to organizational learning and future readiness.

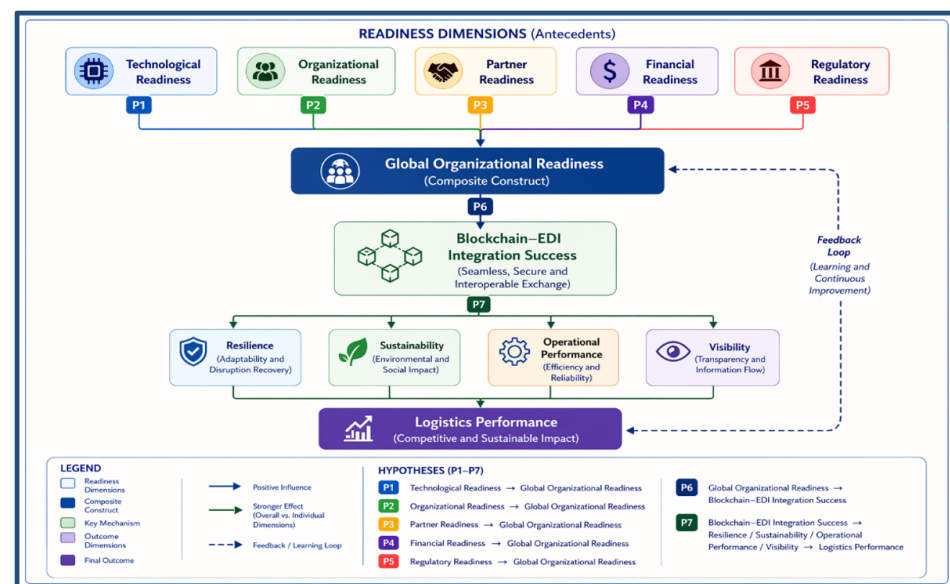


Figure 2. Proposed conceptual model of readiness dimensions and blockchain–EDI integration success.

6. Analytical Model

6.1. Readiness Score

The proposed readiness model provides a transparent structure for quantifying readiness indicators, comparing organizational conditions, and linking readiness and implementation complexity to an estimated integration-success score for pre-implementation decision support.

Let the overall readiness score be denoted by R . The model is based on five readiness dimensions: technological readiness, organizational readiness, partner readiness, financial readiness, and regulatory readiness. The global readiness score is defined as:

$$R = w_T T + w_O O + w_P P + w_F F + w_{Rg} R_g \quad (1)$$

where

$$\sum_{i=1}^5 w_i = 1 \quad (2)$$

In this formulation, R represents the global blockchain–EDI integration readiness score. T represents technological readiness, including ERP/EDI compatibility, interoperability, cybersecurity, IT infrastructure maturity, and real-time data availability. O represents organizational readiness, including top management support, governance maturity, internal digital competencies, change management capability, and digital culture. P represents partner readiness, including supplier and customer collaboration, interorganizational trust, willingness to share data, data standardization, and process alignment.

Financial readiness F consists of available budget, investment ability, cost absorption for implementation, capacity for maintenance and expected return on investment (ROI). Regulatory readiness R_g includes compliance with the law, data protection, recognition of electronic documents, regulatory alignment by the sector and clarity of the institutional environment.

The parameters w_T , w_O , w_P , w_F , and w_{R_g} represent the relative weights assigned to each readiness dimension. These weights may be defined equally in exploratory applications or estimated using expert judgment, analytic hierarchy process methods, regression-based calibration, or machine learning techniques when sufficient organizational data are available.

Each readiness dimension is calculated as the arithmetic mean of its corresponding indicators:

$$T = \frac{1}{n_T} \sum_{j=1}^{n_T} t_j \quad (3)$$

$$O = \frac{1}{n_O} \sum_{j=1}^{n_O} o_j \quad (4)$$

$$P = \frac{1}{n_P} \sum_{j=1}^{n_P} p_j \quad (5)$$

$$F = \frac{1}{n_F} \sum_{j=1}^{n_F} f_j \quad (6)$$

$$R_g = \frac{1}{n_{R_g}} \sum_{j=1}^{n_{R_g}} r_{g,j} \quad (7)$$

where t_j , o_j , p_j , f_j , and rg_j denote the individual indicator scores associated with each readiness dimension, and n_T , n_O , n_P , n_F , and n_{R_g} denote the number of indicators used to measure each dimension.

The readiness score R ranges from 0 to 5. A value close to 0 indicates very low readiness, while a value close to 5 indicates very high readiness for blockchain–EDI integration.

6.2. Logistic Success Function

A logistic success function is used to model the probability of successful EDI integration with blockchain. This model is suitable because the probability of integration success can be viewed as a probability variable with bounds between 0 and 1.

$$S = \sigma(\theta_0 + \alpha R - \beta C)$$

with:

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$

Therefore:

$$S = \frac{1}{1 + e^{-(\theta_0 + \alpha R - \beta C)}}$$

In this equation, S is the probability of the successful integration of blockchain–EDI, R is the global readiness score for every participating enterprise, and C is the complexity of implementing the integration, including technical complexity, organizational complexity, system heterogeneity, partner heterogeneity, regulation uncertainty and intensity of the redesign of processes. θ_0 is the intercept and represents the base conditions necessary for completion of an implementation that are not related to readiness or complexity. α is the reaction of the success of integrating blockchain–EDI to the degree to which the enterprise is organizationally ready, and β establishes the negative impact of complexity on the integration’s success. Finally, σ denotes the logistic function.

The model assumes that higher readiness increases the probability of successful integration, whereas higher complexity decreases it. The logistic specification captures the nonlinear nature of implementation outcomes: small improvements in readiness may have limited effects at very low readiness levels, but significant effects once the organization approaches a critical threshold.

The logistic specification reflects the nonlinear characteristics of implementation outcomes: minor improvements in the organization’s level of readiness might have minimal impacts when the organization is at a low level of readiness; however, substantial impacts may occur when the organization approaches some critical threshold of readiness.

6.3. Parameter Estimation Using Logistic Regression

The parameters θ_0 , α , and β can be estimated using logistic regression when empirical implementation data are available. Each observation should correspond to an organization or blockchain–EDI integration project and should include the global readiness score R , the implementation complexity score C , and the observed integration outcome y , where $y = 1$ indicates successful integration and $y = 0$ indicates unsuccessful integration.

The model can be expressed as:

$$\text{logit}(S) = \theta_0 + \alpha R - \beta C$$

where

$$\text{logit}(S) = \ln\left(\frac{S}{1-S}\right)$$

In this formulation, α captures the positive effect of readiness on the probability of successful integration, while β captures the negative effect of implementation complexity. The intercept θ_0 represents the baseline tendency toward successful integration when the explanatory variables are held constant. If empirical implementation data are available, these coefficients can be estimated using a logistic regression procedure, as illustrated below:

```
from sklearn.linear_model import LogisticRegression
```

```
X = [[R1, C1], [R2, C2], [R3, C3]]
```

```
y = [0, 1, 1]
```

```
model = LogisticRegression()
```

```
model.fit(X, y)
```

```
alpha = model.coef_[0][0]
```

```
beta = -model.coef_[0][1]
```

```
theta_0 = model.intercept_[0]
```

The present study does not use an empirical implementation dataset; therefore, the logistic coefficients are not estimated from observed organizational outcomes. The parameters used in the scenario and simulation are illustrative and should not be interpreted as empirically validated effect sizes. Their purpose is to demonstrate how the proposed framework can be operationalized and how future studies may calibrate the model when data on readiness, implementation complexity, and integration outcomes become available.

6.4. Evaluation Model and Operational Scoring System

The proposed scoring system operationalizes the five readiness dimensions using a 0–5 evaluation scale. Each indicator may be assessed by experts, managers, auditors, or project teams involved in supply chain integration, digital transformation, information systems, compliance, and logistics governance.

Before calculating the global readiness score, each indicator is evaluated using a common 0–5 maturity scale. To improve scoring consistency and reduce evaluator subjectivity, the scale is defined using behavioral and evidence-based anchors. These anchors indicate the type of observable evidence that should support each score, such as formal procedures, documented governance mechanisms, measurable capabilities, partner agreements, compliance records, or continuous improvement practices. The scoring scale used to evaluate the maturity level of the readiness indicators is provided in Table 2.

Table 2. Scoring scale for readiness assessment.

Score	Interpretation	Operational Meaning
0	Not present	The capability, resource, or condition is absent.
1	Very weak	The capability exists only informally or at a very limited level.
2	Weak	The capability is partially present but insufficient for implementation.
3	Moderate	The capability is acceptable but requires improvement before deployment.
4	Strong	The capability is well developed and supports implementation.
5	Very strong	The capability is fully mature, measurable, and scalable.

The next step, after defining the scoring scale, is to define the operational indicators for the conceptual readiness dimensions. The evaluation grid used to link the conceptual readiness dimensions to operational indicators is presented in Table 3. Each readiness dimension will be evaluated against specific criteria and scored.

The indicators were derived from synthesizing the recurring themes identified in each of the reviewed literature, and only those that demonstrate observable organizational, technological, interorganizational, financial, or regulatory characteristics related to the use of blockchain technology for EDI were retained. The initial model uses equal weighting for exploratory application; however, organizations may adapt weights according to sectoral risk, regulatory exposure, partner dependence, and implementation complexity.

To improve scoring consistency, evaluators should assign each score based on documented evidence rather than general perception. For example, a high score for digital culture should be supported by evidence of cross-functional digital initiatives, employee training, openness to process redesign, and prior experience with digital transformation projects. A high score for interorganizational trust should be supported by a stable collaboration history, reliable data exchange, agreed governance rules, and mechanisms for dispute resolution. Similarly, a high score for legal clarity should be supported by documented legal review of electronic documents, digital signatures, blockchain-based records, smart contracts, liability allocation, and data governance requirements.

Table 3. Operational evaluation grid for blockchain–EDI integration readiness.

Readiness Dimension	Evaluation Criterion	Indicator Description	Assigned Score
Technological readiness	ERP/EDI interoperability	Current ERP and EDI systems can share information in standard formats with blockchain systems, through some combination of standards, APIs or middleware.	s_{T1}
	Cybersecurity maturity	Availability of access controls, encryption methods, user verification, cyber security policies, and information security incident response capabilities.	s_{T2}
Organizational readiness	Top management support	Degree of executive commitment, strategic sponsorship, resource allocation, and managerial involvement in the blockchain–EDI integration project.	s_{O1}
	Digital culture	Openness to digital transformation, process redesign, collaboration across functional areas, and the use of simulation techniques.	s_{O2}
Partner readiness	Data sharing	Suppliers, customers, and logistics partners are generally willing and able to provide other business partners with reliable, timely, and standardised operational data.	s_{P1}
	Trust level	The degree of interorganizational trust will vary regarding data accuracy, transaction validation, confidentiality, shared governance, and collaborative accountability.	s_{P2}
Financial readiness	Available budget	Financial resources are available to support infrastructure, software integration, consulting, training, deployment, and maintenance requirements.	s_{F1}
	Expected ROI	Clarity and credibility of expected benefits, including reduced documentary errors, faster transactions, improved traceability, lower coordination costs, and long-term value creation.	s_{F2}
Regulatory readiness	Compliance	Alignment with applicable regulations related to electronic transactions, data protection, supply chain documentation, traceability, and auditability.	s_{Rg1}
	Legal clarity	Degree of legal clarity regarding electronic documents, digital signatures, blockchain-based records, smart contracts, liability, and data governance.	s_{Rg2}

Each assigned score s_{ij} ranges from 0 to 5 according to the scale presented in Table 2. The score is not fixed in advance; it is assigned by experts, managers, auditors, or project evaluators according to the observed maturity of each indicator. For example, if ERP/EDI

interoperability is strong, it may receive a score of 4, while cybersecurity maturity may receive a score of 3 if it is moderate. The technological readiness score is then calculated as:

$$T = \frac{s_{T1} + s_{T2}}{2}$$

For example, if $s_{T1} = 4$ and $s_{T2} = 3$, then:

$$T = \frac{4 + 3}{2} = 3.5$$

The same aggregation logic is applied to the other readiness dimensions. The global readiness score is then obtained by applying the weighted aggregation formula:

$$R = w_T \cdot T + w_O \cdot O + w_P \cdot P + w_F \cdot F + w_{Rg} \cdot R_g$$

This weighted aggregation approach allows the model to remain both structured and adaptable. Decision-makers can alter the significance of each dimension based on the requirements of the sector, implementation risk, or strategic focus. As such, readiness comparison between organizations will be through common calculations using dimensions as a consistent basis for determining readiness levels. In an exploratory setting, equal weights may be used:

$$w_T = w_O = w_P = w_F = w_{Rg} = 0.20$$

In more advanced applications, the weights can be adjusted according to sectoral priorities. For instance, regulatory readiness would have a higher weight than technological readiness in pharmaceutical, agri-food, and international logistics supply chains, whereas technological readiness has a higher weight in highly automated manufacturing operations.

Once the global readiness score is calculated, the various classification thresholds in Table 4 can be used to interpret that score and translate it into a practical level of readiness.

Table 4. Interpretation of the global readiness score.

Global Readiness Score R	Readiness Level	Interpretation
0.00–1.99	Low readiness	Preparation Level of the Organization is not high enough; Risk of Implementation is High.
2.00–3.49	Medium readiness	Partially Prepared, but Improvements are Required for Target Goals.
3.50–5.00	High readiness	Organization has very favorable conditions for integrating blockchain–EDI

The classification intervals reported in Table 4 provide an initial interpretive scheme for translating the continuous readiness score into low, medium, and high readiness levels. In the absence of empirical implementation data, these intervals are defined as exploratory analytical categories intended to support comparative interpretation and managerial prioritization. Future empirical applications may refine these intervals through expert elicitation, sector-specific benchmarking, or calibration against observed blockchain–EDI implementation outcomes.

6.5. Analytical Scenario-Based Demonstration

A hypothetical scenario is provided to showcase the application of the model. In this case, the example is a manufacturing company assessing its current state of preparedness for implementing blockchain–EDI into its supply chain. This manufacturer has been using

EDI transactions within its supply chain and is looking to add new capabilities with blockchain technology that may offer enhanced traceability and verification for a subset of transactions in the supply chain.

In this scenario, the five readiness dimensions are assessed using the operational criteria defined in the evaluation grid, with illustrative values used to demonstrate the calculation procedure.

By using the evaluation grid, the hypothetical organization achieved a total score, shown in Table 5. This total score results in the overall score for readiness.

Table 5. Readiness scores in the analytical scenario.

Readiness Dimension	Score
Technological readiness T	4.2
Organizational readiness O	3.8
Partner readiness P	3.5
Financial readiness F	4.0
Regulatory readiness R_g	3.2

Assuming equal weights:

$$w_T = w_O = w_P = w_F = w_{R_g} = 0.20$$

The global readiness score is therefore:

$$R = 0.20(4.2) + 0.20(3.8) + 0.20(3.5) + 0.20(4.0) + 0.20(3.2) = 3.74.$$

The resulting readiness score of 3.74 indicates a high level of organizational readiness for blockchain–EDI integration. With moderate implementation complexity ($C = 2.5$), and using illustrative simulation parameters $\theta_0 = -2.30$, $\alpha = 1.40$, and $\beta = 0.60$, the estimated probability of successful blockchain–EDI integration is:

$$S = \frac{1}{1 + e^{-(-2.30 + 1.40(3.74) - 0.60(2.5))}}$$

$$S \approx 0.81$$

According to the exploratory parameter values identified in this scenario, the result is indicative of favorable conditions for implementation. Furthermore, it demonstrates the model’s ability to translate preparation scores and implementation difficulties into usable decision-support output. As a result, this estimate will be viewed more as a representation of the model logic than as valid or verified by empirical data. The example suggests that technological and financial readiness are relatively strong, while partner and regulatory readiness remain areas requiring continued attention.

This example illustrates how the proposed framework can support readiness assessment by converting multiple readiness dimensions into an interpretable readiness score and an illustrative scenario-based success estimate.

7. Results

A simulation was performed to better understand how the proposed analytical model works. The focus of this study was to develop a simulation that examines the effect of readiness R , implementation complexity C , and the probability of successful blockchain–EDI integration S . The logistic function used in the simulation allows us to assess the

relationship between varying levels of readiness and success at integrating blockchain-based EDI under three levels of implementation complexity.

The simulation examines the structural behavior of the model and its usefulness for pre-implementation decision support under explicitly stated parameter assumptions. The readiness score R varies from 0 to 5, while implementation complexity is examined under three illustrative levels: low complexity ($C = 1.5$), moderate complexity ($C = 2.5$), and high complexity ($C = 3.5$). These exploratory values are selected to represent a plausible pattern in which low readiness corresponds to low estimated success, medium readiness forms a transition zone, and high readiness corresponds to higher estimated success under moderate implementation complexity. These values are used to examine how the logistic specification behaves across different readiness and complexity conditions.

To address parameter uncertainty, the sensitivity analysis varies the readiness coefficient α , the complexity coefficient β , and the intercept θ_0 across alternative illustrative settings. This allows the analysis to examine whether the qualitative behavior of the model changes when stronger or weaker readiness effects, stronger or weaker complexity penalties, and different baseline implementation conditions are assumed.

Figure 3 presents the exploratory simulation of blockchain–EDI integration success probability under three levels of implementation complexity.

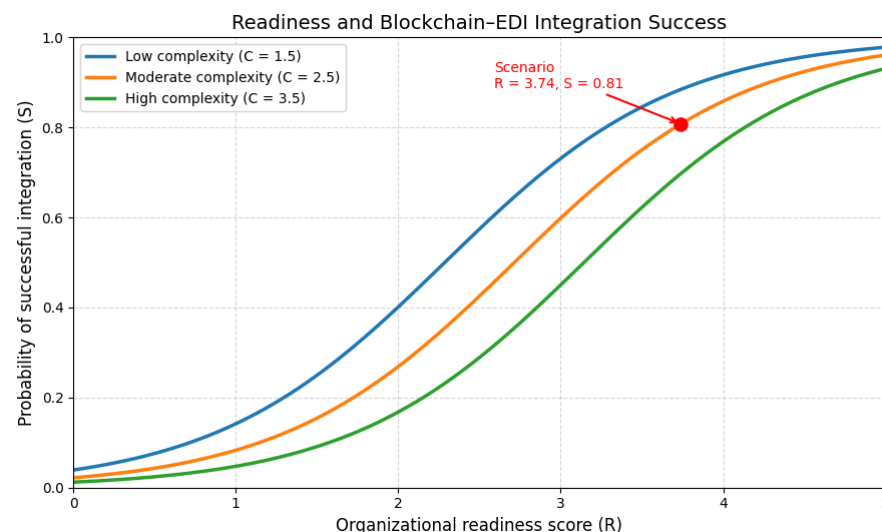


Figure 3. Exploratory simulation of blockchain–EDI integration success probability.

The curves exhibit a logistic shape, indicating that the estimated probability of success is not linearly related to readiness. Low estimated success reflects the assumed absence or weakness of technological, organizational, partner, financial, or regulatory readiness conditions. The estimated success probability increases rapidly as organizations enter the medium-readiness range, which represents a transition zone where managerial intervention can produce substantial improvements. At higher readiness levels, the curve gradually flattens, reflecting diminishing marginal returns.

The illustrative simulation suggests that implementation complexity shifts the estimated success curve downward under the assumed logistic specification. When complexity is low, organizations are able to achieve high levels of success probability at lower levels of readiness. As complexity increases to moderate amounts, the readiness levels need to be increased in order to obtain similar probabilities of success. In high complexity, the probability of success remains significantly lower than that associated with moderate to low complexity unless the organization exhibits a very high level of readiness. The illustrative data point shown in red represents an organization with $R = 3.74$, $C = 2.5$,

and $S = 0.81$, and illustrates favorable conditions for blockchain–EDI integration under moderate complexity.

The deterministic simulation illustrates three structural patterns implied by the assumed logistic specification. First, very low readiness levels ($R < 2$) are associated with low estimated success under the assumed parameter values. Second, medium readiness levels ($R \approx 3$) represent a transition zone in which improvements in readiness produce larger changes in the estimated probability of success. Third, high readiness levels ($R > 4$) are associated with more stable and higher estimated success. These patterns should be interpreted as structural implications of the illustrative model rather than as empirical findings.

7.1. Monte Carlo Simulation

To complement the deterministic simulation, a Monte Carlo simulation was conducted to examine the robustness of the proposed model under parameter uncertainty. In contrast to fixed-value illustration, the Monte Carlo approach varies readiness scores, implementation complexity, indicator weights, and logistic parameters within predefined ranges. This allows the model to generate a distribution of possible success estimates rather than a single deterministic value. Because no empirical implementation dataset is available, these input distributions are used for illustrative uncertainty analysis rather than empirical distribution estimation.

In each Monte Carlo iteration, the five readiness dimensions were randomly generated within the 0–5 maturity scale, reflecting the bounded scoring logic of the framework. Indicator weights were sampled from a Dirichlet distribution because this distribution produces non-negative weights that sum to one, consistent with the weighted-readiness model. Implementation complexity was varied across low to high levels to represent alternative project conditions, while the logistic parameters were varied within illustrative ranges to reflect uncertainty regarding the relative influence of readiness and complexity. Accordingly, the Monte Carlo simulation explores how the model behaves under uncertainty across predefined input ranges for readiness, complexity, weights, and logistic parameters.

Specifically, readiness dimensions were sampled uniformly over the 0–5 maturity scale, while weights were sampled from a symmetric Dirichlet distribution to ensure non-negative values summing to one. Implementation complexity was sampled over the 0–5 scale. The illustrative logistic parameters were varied around the baseline scenario values, with $\theta_0 \in [-2.50, -1.80]$, $\alpha \in [0.90, 1.50]$, and $\beta \in [0.50, 1.20]$. These ranges were used for exploratory uncertainty analysis and should be empirically calibrated in future applications. The Monte Carlo simulation was repeated 10,000 times. For each iteration, the global readiness score and the corresponding probability of successful blockchain–EDI integration were calculated. The summary results used the mean, median, and percentiles for creating the uncertainty intervals. Results of the Monte Carlo simulations with uncertain readiness scores, implementation complexity, indicator weights, and logistic analysis are shown in Figure 4.

The mean probability of integration and the uncertainty associated with that are represented by the solid line (mean probability) and the shaded area (95th percentile probability), respectively. Both of these estimates increase nonlinearly with regard to the readiness of the firm, as indicated by the logistic relationship between both average and median curves.

Medium readiness levels have a broader uncertainty band, indicating that outcomes related to implementation will be impacted by varying contexts in this area of transition; there is less variability at low and high levels of readiness. Successful implementation outcomes are limited for low readiness levels and consistent for high readiness levels with most outcomes being positive. This supports the theory of having a readiness threshold,

and the complexity associated with each implementation affects success during integration based on the level of readiness achieved.

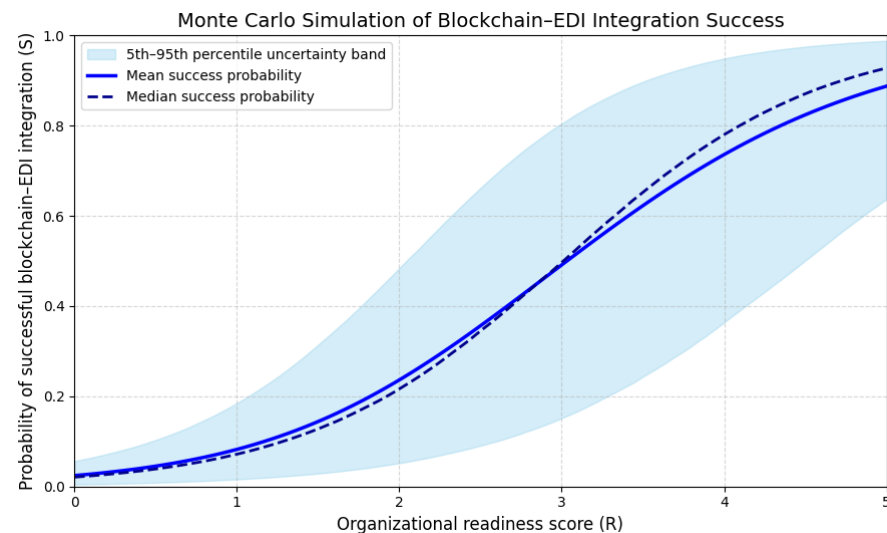


Figure 4. Monte Carlo simulation of blockchain–EDI integration success probability.

7.2. Sensitivity Analysis

A sensitivity analysis was conducted by varying α , β , and θ_0 to evaluate how the illustrative success estimates change under different modeling assumptions. The analysis examines whether the expected direction of the readiness–success and complexity–success relationships remains consistent across alternative parameter settings.

To examine the effect of different readiness and complexity assumptions on the estimated probability of successful blockchain–EDI integration, five illustrative parameters were defined for use in simulations. Table 6 shows these simulation settings and how they relate to each of the five parameters being considered.

Table 6. Simulated logistic regression coefficients for readiness and complexity.

Model	α Readiness	β Complexity	Intercept θ_0	Interpretation
M1	1.20	0.80	−2.10	Readiness dominant, moderate complexity impact
M2	1.00	1.00	−2.00	Balanced influence
M3	1.40	0.60	−2.30	Strong readiness effect, weak complexity penalty
M4	0.90	1.20	−1.80	Complexity more penalizing
M5	1.10	0.70	−2.00	Realistic mid-range scenario

The simulated coefficients are designed to represent alternative assumptions about the relative influence of readiness and complexity. Across these illustrative settings, readiness is specified as a positive contributor to estimated success, while complexity is specified as a negative contributor. The sensitivity analysis therefore explores how alternative assumptions about readiness effects, complexity penalties, and baseline implementation conditions influence the estimated success curve.

The variation across parameter settings illustrates how different assumptions about readiness effects, complexity penalties, and baseline implementation conditions influence the estimated success curve. The simulated models use normalized input conditions ($R, C \in [0, 5]$) to allow comparability across scenarios. The consistency of the coefficient directions across these illustrative settings supports the internal coherence of the proposed model, but it should not be interpreted as evidence of empirical stability or predictive validity.

7.3. Intelligent Systems Perspective

The proposed framework currently provides a structured readiness assessment and decision support logic rather than an implemented intelligent system. Its present contribution consists of five elements: an indicator-based scoring grid, dimensional readiness scores, a global readiness score, simulation-based interpretation, and managerial decision rules. These elements allow managers to conduct a transparent pre-implementation assessment and identify weak readiness dimensions before blockchain–EDI deployment. A practical decision process can be structured as follows. First, the organization evaluates each readiness indicator using the 0–5 scoring anchors. Second, the five readiness dimensions are calculated and compared to identify the weakest areas. Third, the global readiness score is computed. Fourth, implementation complexity is assessed. Fifth, the illustrative logistic model may be used to generate a scenario-based success estimate. Finally, managers interpret the results using decision rules that link readiness levels to recommended actions.

From a machine learning perspective, the five readiness dimensions and implementation complexity can be used as input variables:

$$X = [T, O, P, F, R_g, C]$$

The target variable may be defined either as a binary implementation outcome:

$$Y \in \{0, 1\}$$

where 0 indicates unsuccessful integration and 1 indicates successful integration, or as a multiclass readiness level:

$$Y \in \{Low, Medium, High\}$$

Organizations can be classified as low, medium, or high levels of readiness through the use of models such as logistic regression, decision trees, random forests, support vector machines (SVM), gradient boosting and neural networks. Logistic regression is easy to interpret, and Tree-Based Models and Ensemble Methods can identify the non-linear relationships among the readiness factors.

There are four phases of operation for an intelligent decision support system. First, using a readiness scoring grid, data are collected from the organization. Second, from this input data, dimensional scores as well as a global readiness score are calculated. Third, using the calculated readiness dimensions, the organization is assigned to one of the readiness categories. Finally, recommendations are provided according to the weakest readiness dimensions and the level of implementation complexity.

To clarify how managers may use the framework in practice, Table 7 presents initial decision rules linking readiness scores, weak dimensions, and implementation complexity to recommended managerial actions. These rules are not intended as universal empirical thresholds; rather, they provide a transparent interpretation logic that can be adapted to sector-specific risk, regulatory constraints, partner dependence, and project complexity.

In practice, these decision rules should be adapted to sector-specific risk, regulatory constraints, partner dependence, and project complexity. For example, highly regulated sectors may require stronger regulatory readiness before implementation, even when the global readiness score is high.

For instance, if an organization displays strong technological capability but poor partner readiness, managers should prioritize supplier data-sharing agreements, standardize interorganizational data formats, and establish governance rules for participation in the blockchain network before full implementation.

Table 7. Practical decision rules for managerial use of the readiness framework.

Condition	Interpretation	Recommended Action
$R < 2.00$	Low readiness	Postpone full implementation and address readiness gaps.
$2.00 \leq R < 3.50$	Medium readiness	Consider pilot implementation only after correcting weak dimensions.
$R \geq 3.50$	High readiness	Proceed with feasibility analysis, partner coordination, and phased implementation planning.
Any dimension < 2.00	Critical weakness	Treat the weak dimension as a blocking risk before implementation.
High complexity	Higher implementation risk	Strengthen governance, resources, and partner alignment before deployment.

The proposed framework can also be translated into managerial outputs that support structured pre-implementation assessment. Table 8 summarizes these outputs, including readiness classification, weak-dimension diagnosis, scenario-based success estimation, implementation recommendation, and future calibration input.

Table 8. Managerial outputs of the proposed readiness framework.

Output	Managerial Use
Readiness classification	Classifies the organization as having low, medium, or high readiness based on the global readiness score.
Weak-dimension diagnosis	Identifies the lowest-scoring readiness dimensions and indicators that require corrective action.
Scenario-based success estimate	Provides an illustrative estimate of integration success under assumed readiness, complexity, and parameter conditions.
Implementation recommendation	Suggests whether managers should postpone implementation, conduct a pilot project, or proceed with phased implementation planning.
Future calibration input	Provides structured readiness data that can later be used for empirical validation, logistic coefficient estimation, or machine-learning-based classification.

Machine-learning models, predictive analytics, and automated recommendation functions remain future extensions of the proposed framework. Such extensions would require real-world organizational data to calibrate coefficients, train classification models, evaluate predictive accuracy, and validate decision rules across different supply-chain contexts.

8. Discussion

This study reframes blockchain–EDI integration from a primarily technology-focused issue to a readiness assessment problem. The findings suggest that successful integration depends on the simultaneous alignment of technological infrastructure, organizational governance, partner collaboration, financial capacity, and regulatory preparedness. This interpretation is important for supply chain digital transformation because blockchain–EDI integration requires not only system compatibility, but also coordinated managerial, interorganizational, and institutional conditions before deployment.

The seven conceptual propositions provide the basis for interpreting the analytical results. These propositions are examined through the internal logic of the analytical framework, which also provides a structured basis for future empirical testing. Propositions P1–P5 are reflected in the aggregation of technological, organizational, partner, financial, and regulatory readiness into a global readiness score. Proposition P6 is represented analytically through the logistic relationship between global readiness and estimated integration success. Proposition P7 is represented conceptually through the link between blockchain–EDI integration success and logistics performance outcomes. Therefore, the

results support the internal logic of the proposed framework, but they do not constitute empirical confirmation of the propositions.

The analytical formulation supports pre-implementation decision-making by translating readiness conditions and implementation complexity into interpretable assessment outputs. This enables managers to identify weak readiness dimensions, prioritize corrective investments, and evaluate implementation risk before committing to full blockchain–EDI deployment. The deterministic and Monte Carlo simulations illustrate how the proposed logistic specification represents a nonlinear readiness-success relationship under assumed parameter values. In the illustrative model, organizations below the readiness threshold are associated with higher implementation risk, whereas medium and high readiness levels are associated with higher estimated success. The Monte Carlo analysis also illustrates that uncertainty is wider near the transition zone because of variations in weights, complexity, and logistic parameters. These patterns should be interpreted as model-based illustrations rather than empirical findings.

The framework provides a basis for future predictive decision-making through data science and intelligent systems after empirical calibration and validation. Future studies will gather data from businesses and industries about their readiness in order to calculate empirical data for modeling and to develop classification algorithms, as well as to recommend automatic recommendations. It will also transform this model from being qualitative in nature and will eventually become an intelligent system that will aid in the digitization of strategic supply chains.

8.1. Theoretical Contributions

The study contributes to blockchain–EDI integration research by explaining why readiness in this context differs from general blockchain adoption. In conventional blockchain adoption studies, readiness is often examined as a broad technological or organizational adoption condition. In blockchain–EDI integration, however, readiness emerges from the interaction between standardized EDI transaction flows, blockchain-based decentralized verification, and cross-organizational data governance. This combination requires organizations to assess not only whether blockchain can be adopted, but also whether existing EDI infrastructures, trading-partner processes, verification rules, and compliance requirements can be aligned within a shared interorganizational system.

The study also extends TOE-based and organizational-readiness research by operationalizing readiness as a measurable, multidimensional construct. Rather than treating technological, organizational, environmental, financial, and partner-related conditions as separate adoption factors, the proposed framework links them through a weighted readiness score and connects this score to implementation complexity. This provides a structured logic for translating qualitative readiness conditions into comparable assessment outputs that can support pre-implementation decision-making.

Finally, the research also contributes to the body of knowledge on intelligent decision support by demonstrating how to transform readiness indicators into analytical inputs used for simulations, sensitivity analyses, and predictive modeling of future events using calibration methods. The design of the current framework provides a scoring and logic system for interpreting the results of the decision support systems. Future empirical studies can extend this logic by providing alternative classifications using calibrated logistic models, machine learning algorithms, and automated recommendation systems.

8.2. Managerial Implications

This proposed framework is designed to provide guidelines for practitioners to assess an organization's ability to integrate blockchain–EDI technology. The scoring grid allows

managers to score an organization's readiness for implementing blockchain and EDI by identifying deficiencies in technology capabilities, governance structures, partner collaboration, financial resources, and regulatory compliance. A readiness score can be assessed and viewed as an organization's overall preparedness for blockchain EDI integration, whereas the logistics function allows management to evaluate potential implementation risks resulting from varying levels of complexity.

Using this framework to establish the priority of investments, an organization that shows low readiness in its ability to use and manage computer systems may have to first implement the capability to use Enterprise Resource Planning (ERP) systems, develop the ability to exchange data electronically (EDI), and improve its cybersecurity capabilities before being able to use blockchain technology. In the same way, a partner that shows low readiness would have to develop data sharing agreements, adopt data standards, develop trust, and provide other basic functionalities before it could implement blockchain technology.

Before implementing blockchain technology, an organization with low regulatory readiness should first conduct compliance audits, clarify the legal implications of its business processes, and establish appropriate data governance mechanisms.

The framework connects uncertainty analysis to an Organization's Readiness Assessment and the corresponding decision support framework of the Model. As a result, if organizations follow the guidance of this framework, they will have all the resources they need to turn their abstract digital transformation objectives into reality by providing them with the background to develop their digital transformation projects.

9. Limitations and Future Research

There are several limitations associated with this research. First, the framework is conceptual and methodological rather than empirically validated. The scoring weights, logistic coefficients, scenario results, Monte Carlo simulation, and sensitivity analysis are illustrative and should not be interpreted as direct empirical estimates of blockchain–EDI integration success. Their purpose is to demonstrate the operational logic of the proposed readiness framework and to provide a structured basis for future calibration using organizational implementation data. Future research should validate the model using data from real-world organizations and blockchain–EDI implementation projects. Such validation may involve pilot studies, expert scoring, inter-rater reliability assessment, estimation of logistic coefficients from observed implementation outcomes, and comparison across industries, organization sizes, and supply chain contexts. A staged validation process may begin with expert-based content validation, followed by pilot testing, case-study application, and larger-scale empirical calibration.

Second, it is critical to recognize that several factors, including the industry sector, the organization size, the technology state, regulatory and supply chain characteristics, will dictate how these weighted criteria will be applied in practice based upon their impact on the evaluation's development. Further research is also required regarding how the contextual characteristics of organizations affect both the criteria's application and validation.

Third, there is a need for more thorough accuracy and trustworthiness in order to be able to confirm that these indicators are valid and reliable, and additional refinements will be required through expert review, the creation of a survey instrument, and tests for statistical reliability.

Fourth, the simulation parameters are only illustrative and, when used to generate data for future research, should be validated with actual implementation data. Monte Carlo Simulations will validate the analytical proof-of-concept of the proposed model; however, they still rely more on theoretical parameter distributions than actual organizational data.

To validate the model, future research should draw on empirical datasets from a range of relevant industries and sectors. Quantitative analysis can be performed to derive the coefficients of the logistic success function based on actual implementation outcomes. Comparative analyses can also be done to see if small and medium-sized businesses differ from large businesses regarding their preparatory weightings.

In the future, additional research will be required to train machine-learning models using organizational readiness data. These models should help classify levels of readiness, predict how successfully blockchain-based EDI will be integrated into supply chains, and recommend the best way to implement a new technology. If this empirical approach is implemented, the proposed framework could develop into a real-time decision support system for companies to use when digitally transforming their supply chains.

10. Conclusions

This article proposes an analytical readiness model to integrate blockchain with EDI in supply chains. In doing so, the study utilizes a multidimensional readiness framework, a weighted scoring system, a logistic function for success, an analytical scenario demonstration, deterministic simulation, a Monte Carlo simulation, sensitivity analysis, and intelligent systems perspectives to illustrate how a conceptual framework can support future decision support development.

The proposed model suggests that successful blockchain–EDI integration depends not only on technology but also on broader organizational readiness. In particular, organizational governance, the collaborative approach between partners, financial capability to invest, regulatory clarity regarding how it will be used, and the complexity of implementing it are all elements needed for successful integration. Through the analysis of these variables through analysis scenarios, these variables are measured using a scoring system that will assist in determining how well prepared we are to complete the planning phase and execution phase in a non-linear fashion based on the measurable output of expected simulation results. A high degree of risk is involved with implementing a low degree of readiness, whereas a medium degree of readiness would provide an opportunity for making enhancements to the target area that would positively impact the odds of achieving a successful outcome by enhancing that area.

In comparison, a high readiness score represents a condition of greater stability along with a success probability approaching its peak value. The use of the Monte Carlo simulation technique serves to validate how uncertainty in assumptions regarding weighting, implementation complexity, and logistics-related conditions may substantially alter the estimated probability of success.

This research supports supply chain digitalization through a simulation-based framework focused on intelligent systems to allow both the academic community for their analyses and decision-making to managers of supply chains. This framework can also be used as the foundation for future empirical research in validating machine learning-based classifications of readiness, as well as the development of intelligent decision support systems between blockchain and EDI for integrating supply chains.

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