International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 9 Issue 4 April - 2025, Pages: 222-231

# An Enhanced Framework for the Integration of Data Governance into Collaborative Supply Chain Management model

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***Abstract—*** *In the era of digital transformation and Industry 4.0, supply chain networks are evolving into complex, data-driven systems that demand improved collaboration, visibility, and decision-making. This study proposes an enhanced collaborative supply chain framework that integrates data governance as a strategic component to address persistent challenges related to data accuracy, security, and transparency across supply chain operations. Drawing from the Resource-Based View (RBV) theory, the framework incorporates key data governance dimensions—data sharing, frequency, data anonymization, shared analytics, and conflict resolution mechanisms—into the existing collaborative supply chain model. The research identifies gaps in traditional supply chain systems, particularly the lack of coordinated data handling policies and technologies capable of ensuring secure, reliable, and meaningful data exchange between stakeholders. Using a mixed-method approach involving a structured survey and multi-level regression analysis, the study validates the effectiveness of the enhanced framework in improving supply chain collaboration, performance, and resilience. Empirical results from the analysis confirm that data governance variables, especially data sharing, conflict resolution, and data anonymization, have significant positive impacts on collaborative supply chain performance. This integration not only improves operational efficiency but also fosters trust, mitigates risks, and enables real-time analytics for proactive decision-making. The findings offer valuable contributions to both academic literature and industry practice by presenting a robust and scalable framework adaptable to modern supply chain ecosystems. The study concludes by recommending the adoption of emerging technologies such as blockchain and artificial intelligence to further support data governance, thereby fostering sustainable, secure, and intelligent supply chains.*

**Keywords— Collaborative Supply Chain, Data Governance, Internet of Things (IoT), Supply Chain Management, Supply Chain Integration, Data Sharing, Shared Analytics, Industry 4.0, Supply Chain Resilience, Resource-Based View (RBV), Better Governance.**

## 1. INTRODUCTION

With the rapid advancement of technology, it has become essential for businesses to gain a competitive edge by integrating information technology, IoT, big data, and cloud computing technologies throughout the supply chain. By enhancing transparency and flexibility throughout the supply chain (SC), internet of things (IoT) offers new potential to reduce risks, manage complexity, and bring concrete business benefits (Al-Talib et al., 2020). The supply chain (SC) is a collection of activities and organizations (suppliers, clients, factories, distributors, and retailers) that are motivated to complete client orders. According to the Supply Chain Operations Reference Model (SCOR) supply chain, the core processes of SC are plan, source, make, deliver, return, and enable (Jia et al., 2020). It is difficult to understate the significance of supply chain innovation to operational management techniques, particularly when it comes to creating unique products and services or utilizing digital technology. Supply chain performance must be improved in order to acquire lasting competitive advantages (Malacina & Teplov, 2022).

But there are still complexity and difficulties in the world of supply chain management. Natural disasters, changes in the geopolitical environment, and fluctuations in the economy can all disrupt supply networks. Furthermore, supply chain operations are under more pressure due to modern consumers' needs for quicker deliveries and customized items. Traditional supply chain methods, which were frequently reactive, have found it difficult to keep up with the fast-moving business environment (Wu et al., 2019). A new technology paradigm called the Internet of Things (IoT), often referred to as the Internet of Everything or the Industrial Internet, enables devices to connect with one another via a global network (Lee et al., 2022). The Internet of Things (IoT) is a network of physical objects that are digitally connected to sense, monitor, and interact within an organization and between the organization and its supply chain. This technology enables agility, visibility, tracking, and information sharing to support efficient supply chain planning, control, and coordination. Our proposed definition includes four key features: (i) The requirement for digital connectivity of the physical things in the supply chain; (ii) The nature of this connectivity is proactive allowing for data storage, analysis and sharing; (iii) The communication involves processes within an organization as well as inter-organization transactions covering all major supply chain processes; and (iv) IoT will facilitate planning, control and coordination of the supply chain processes (Bendaya et al., 2017).

A study by Lee and Lee (2020) identified five main IoT technologies used in IoT-based services and products: RFID, cloud computing, middleware, wireless sensor networks (WSN), and IoT application software. RFID uses radio waves to automatically identify people or items, increasing the system's efficiency and storage capacity. WSN uses autonomous sensors to track objects, while middleware facilitates the integration of legacy technologies. Cloud computing allows pool members to share configurable source computing on-demand. These technologies are widely used in various industries, including logistics, pharmaceuticals, manufacturing, and retail. Data governance defines standards and procedures to ensure the proactive and effective handling and guidance of data management practices such as data replication, data archival, security, data backup, meta data management (MDM), data traceability and lineage, business glossary mapping, governance council, release and change management, master data and business (Dasgupta et al., 2019). The practice of authority and control over the administration of data is referred to as data governance. Data governance aims to maximize the value of data and reduce risk and expense associated with it (Abraham et al., 2019). In answering the call of (Ben-Daya et al., 2022) to include a data governance in the supply chain that seeks to address the problem associated with which data will be shared, how often, data anonymization, shared analytics, and a mechanism for conflict resolution.

In this study a conceptual collaborative supply chain framework is enhanced with the addition of data governance to create a more powerful model to improve the performance of supply chain management in business organizations. In the framework of industry 4.0, (Müller et al., 2020) the study looked into the social capital and other influential capital as a requirement for information sharing between buyers and suppliers. The study also seeks to identify the goal that providers pursue while exchanging digital information that may include extensive services that their clients may offer. Their study's findings demonstrate a strong relationship between social engagement, beneficiary trust, and digital information exchange for suppliers.

According to Sanders and Ganeshan, (2018), typical manufacturing supply chain management systems don't have a platform for information sharing, which makes it difficult to transmit business information, logistics, and capital in a timely manner. These elements have caused data silos and skewed data flow, making supply chain integration ineffective. The manufacturing supply chain for low-carbon products was examined by (Wei et al., 2023). They looked at the data barriers and lack of technical information flow throughout the supply chain, which resulted in high energy consumption, wasteful material use, and subpar production of green products. They concluded that the level of supply chain data governance needed to be improved in order to improve the supply chain's sustainability.

However none of these literatures incorporated data governance with particular emphasis on what data will be shared, how often, data anonymization, shared analytics, and a mechanism for conflict resolution for a data governance framework. A conceptual framework is put out by Ben-Daya et al., (2022) to help comprehend how the Internet of Things (IoT) is affecting supply chain management (SCM). Using the resource-based perspective theory, they contend that IoT resources increase the competitiveness of the supply chain by enabling internal supply chain capacities to handle external issues. Additionally, they discussed how IoT affects supply chain skills and how it subtly improves SCM competitive advantages, both of which aid in overcoming SCM difficulties. In addition to highlighting the shortcomings of the suggested framework and outlining potential future study areas, they offer some management implications and demonstrate the necessity for new decision models driven by the IoT environment. As emphasis by Ben-Daya et al., (2022) in their conceptual framework for future research direction, A data governance framework should outline what data will be shared, how often, data anonymization, shared analytics, and a mechanism for conflict resolution.

Therefore, there is a need to enhance this framework to ensure data is protected from unauthorized change by ensuring it accuracy, timeliness relevance and completeness. The aim to enhance the framework for understanding the role of Internet of Things in Supply Chain Management by integrate data governance in the collaborative supply chain framework model and then evaluate the enhanced framework through validation.

## 2. Materials and methods

### 2.1 Resource-Base View Model

Figure 1 show the Resource-Based View (RBV), also known as the Resource-Based Theory (RBT), is a management framework used to determine the strategic resources a firm can exploit to achieve sustainable competitive advantage (Bharadwaj, 2000).These theory has become one of the most widely applied theoretical perspectives in explaining how the resources that an organizations have under their control can lead to differences in performance in their organizations (Barney, 2020).

The theory also emphasizes the importance of valuable, rare, inimitable, and organization (VRIO) resources that a firm possesses (Eisenhardt & Martin, 2000). The VRIO framework, proposed by Jay Barney in 1991, is a business framework that forms part of a firm's larger strategic scheme, and analysis tool used to assess the competitive advantage of a firm's resources and capabilities. The model proposes the new criteria of the organizational embeddedness of a resource (Utami & Alamanos, 2022).


**Figure 1:** Resource-Base View Model. Source: (Barney, 2020)

The study of (Barney et al., 2011) suggests that a firm's external factor such as resources and capabilities can lead to superior performance when effectively leveraged. Apart from the use of human and complementary organizational resources, technology are also required to leverage investments. These, and other previous research consistently show how effective the RBT is, in explaining the connection between organizational resources and firm performance.

In this study, the resource chosen is data governance and IoT, this is because IoT resources empower internal supply chain capabilities to address external challenges and, in the process, enhance the supply chain competitiveness.

### 2.2 Impact of IoT On Supply Chain Collaboration

Figure 2 shows the Collaborative Supply Chain Framework by (Simatupang and Sridharan, 2010). It has highlighted the key role of IoT in enhancing the key elements of collaboration. These elements include information and resource sharing, goal congruence, decision synchronization, effective communication, and joint knowledge creation, he noted that for an effective collaboration to take place, these elements need to be addressed simultaneously. Ben-Daya et al., (2022) in their study proposed a Collaborative Supply Chain Framework (CSCF) adapted from (Simatupang & Sridharan, 2010) which was made up of the following interconnected elements: collaborative performance system (CPS), information sharing, decision synchronization, incentive alignment, and integrated supply chain processes.


**Figure 2:** Collaborative Supply Chain Framework (Ben Daya et al., 2022)

### 2.3 Enhanced Collaborative Supply Chain Framework

The exercise of authority and control over data management is referred to as data governance (Abraham et al., 2019). Data governance aims to reduce risk and expense associated with data while optimizing the value of data. Even if data governance has become more significant recently, a comprehensive approach to data governance that might direct scholars and practitioners. According to Gartner, it is the process of assigning decision-making authority and accountability for an asset, creating policies that support business goals, investing in resources that support those goals, putting in place safeguards to ensure corporate policy compliance, and guaranteeing proper corporate risk management (Dasgupta, 2021).

The goal of this study is to bridge the gap and provide a conceptual framework for supply chain management by including data governance and taking into Data sharing, Frequency, Data anonymization, Shared analytics and Conflict resolution mechanism. In order to achieve the objective of this research, the figure 4 below represent the factors that will be consider under data governance

(Data sharing, frequency, data anonymization, shared analytics, and conflict resolution mechanism) and how it can be integrated into a collaborative supply chain framework.

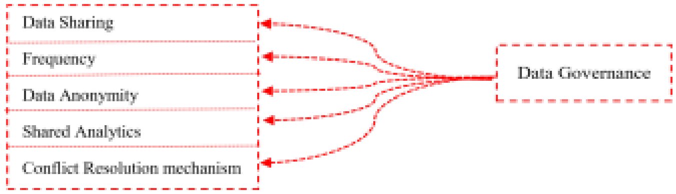


**Figure 3:** Data Governance factors

Figure 4 shows the Enhanced collaborative supply chain framework with Data Governance factors integrated into the model.

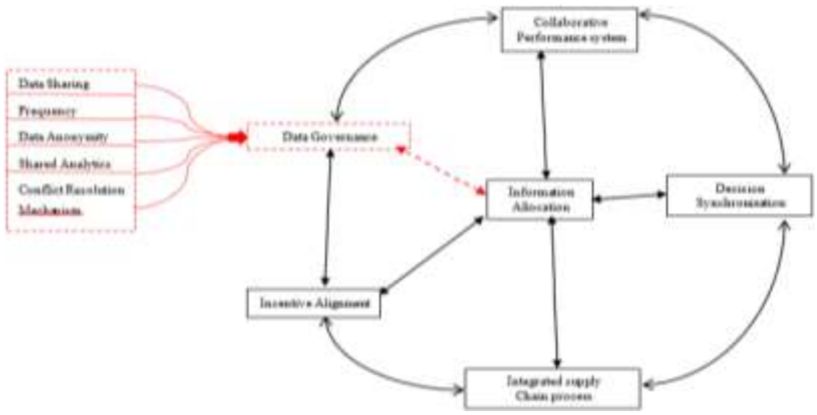


**Figure 4:** Enhanced collaborative supply chain framework.

## 3. RESULT AND DISCUSSION

### 3.1 Empirical Testing and Analysis

The aim of this study is to enhance a collaborative supply chain framework by integrating data governance into it. The questionnaire was administered to 160 participants, of which 147 responses were received and 112 of the responses were recorded and analyze as valid data. The correlation between variables and their moderating effects are examined using multi-level regression analysis. Correlation Test: Multi-level regression analysis is done in this work using SPSS software. The reasons for the use of this method is that the computational procedure is fairly simple and not complicated as compared with other techniques. And the method has been used by different researchers with fairly satisfactory results been gotten (Doganay & Ergun, 2017: Mikalef & Gupta, 2021; Cai et al, 2022).

### 3.2 Determining how well the model fits

The Table 1 shows Identification of the variables. Table 2 provides the R, $R^2$, adjusted $R^2$, and the standard error of the estimate, which can be used to determine how well a regression model fits the data.

**Table 1:** Identification of the variables

| S/No | Variable Name | Variable Abbreviation |
|---|---|---|
| 01 | Collaborative Supply Chain | CSC |
| 02 | Data Sharing | DS |
| 03 | Data Frequency | DF |
| 04 | Conflict Resolution Mechanism | CRM |
| 05 | Data Anonymization | DA |
| 06 | Shared Analytics | SA |

**Table 2:** Model Summary[b]

| Model 1 | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin Watson |
|---|---|---|---|---|---|
| 1 | .736[a] | .541 | .519 | 11.61337 | 2.104 |

a. Predictors: (Constant), DA, DF, CRM, DS, SA
b. Dependent Variable: CSC

From the model summary, the value of R = 0.736 represents the Pearson correlation. This value is positive and indicates very strong positive linear relationship between the dependent variable, CSC and the independent variable DS, DF, CRM, SA, and DA. The value of Durbin Watson was 2.104 which is greater than 1 and less than 3. This shows that there is an independence of observation (no auto correlation) and therefore it is statistically significant. And the independent variables used are truly independent. The $R^2$ value was 0.541 which showed that 54.1%, variations in CSC is explained by DS, DF, CRM, SA, and DA and the remaining 45.9% of the variation in CSC is accounted for by other factors not captured in this model. An R square value can differ due to that it deals with human behavior, which is very difficult to predict, a high value of R-squared is almost impossible. However, this does not mean that any predicted model to such a case is always useless; a good model can have a low R2 value. On the other hand, a biased model can have a high R2 value! A variety of other circumstances can artificially inflate R2. A good model can have a low R2 value (Adhikari, 2022).

### 3.3 F- STATISTIC TEST (ANOVA)

This test the overall reliability of the method at 5% level of significance. It is the test of stability of the regression coefficient. That is, whether the parameter estimates will remain stable overtime. The F- test is also called the analysis of variance (ANOVA). Both the analysis of variance and regression analysis have as their objective, the determination of the various factors which cause variation of the dependent variable, and this resemblance has led to the combination of the two methods in most scientific fields Koutsoyiannis (2003). The F-test is used to find out whether the explanatory variables actually have any significant influence on the dependent variable.

**Table 3:** ANOVA

| Model 1 | Sum of Square | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression<br>Residual<br>Total | 16858.847<br>14296.260<br>31155.107 | 5 106<br>111 | 3371.769<br>134.870 | 25.000 | .000[b] |

a. Dependent Variable: CSC
b. Predictors: (Constant), DA, FRQ, CRM1, DS, SA

### 3.4 STATISTICAL SIGNIFICANCE OF THE MODEL

The F- ratio in the ANOVA table. The table Shows that the independent variables statistically significantly predict the dependent variable, $F(5,106) = 25.000$, $p(0.000)<0.05$. That is, the regression model is a good fit of the data. It further explains

**International Journal of Engineering and Information Systems (IJEAIS)**
**ISSN: 2643-640X**
**Vol. 9 Issue 4 April - 2025, Pages: 222-231**

that the variation that occurs in CSC is due to the use or introduction of artificial into f the independent variables DS, DF, CRM, SA, DA. In other words, there is a significant relationship between CSC and DS, DF, CRM, SA, DA. Also, there is an improvement in the prediction of the variables. This is because the F ratio is greater than 1.

**Table 4:** Coefficients

| Model 1 | Unstandardized Coefficients | | Standardize d Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Toleranc e | VIF |
| (Constant) | 26.615 | 4.593 | | 5.794 | .000 | | |
| DS | 1.291 | .375 | .301 | 3.443 | .001 | .567 | 1.763 |
| DF | .066 | .302 | .017 | .218 | .828 | .699 | 1.431 |
| CRM | .874 | .367 | .209 | 2.383 | .019 | .563 | 1.777 |
| SA | .789 | .370 | .195 | 2.133 | .035 | .517 | 1.934 |
| DA | .832 | .326 | .207 | 2.553 | .012 | .656 | 1.524 |

The constant 26.615, is the predicted value for the dependent variable when all of the independent variables are held constant or assumed to be 0. This means that we will expect an average increase of 26.615 in CSC. The unstandardized coefficient indicated how much the dependent variable (CSC) varies with the independent variables when all other independent variables are held constant. The regression coefficient provides the expected change in the dependent variable (CSC) for a unit increase in the independent variable referring to the coefficients (table3) above the unstandardized coefficients for DS is 1.291. This means that for every unit increase in DS there is 1.291 increase in CSC. Which is statistically significant as p (0.001) < (0.05) which proves that there is substantial contributions from DS to CSC. Also, the unstandardized coefficients for variables CRM, SA, and DA are; 0.874, 0.789, and 0.832 respectively. Which also shows that a unit increase in any of these independent variables holding others constant will bring about an increase in the dependent variable CSC by 0.874 for CRM, 0.789 for SA and 0.832 for DA with their p values (0.019, 0.035, 0.012) < 0.05 which shows that each of these independent variables when used independently contributes substantially to CSC as they are all statistically significant. The value for the unstandardized coefficients of the independent variable DF was 0.066.with it p value (.828) > 0.05 which means that a unit increase in DF will bring about an increase in CSC by 0.066 but does not substantially contribute to CSC. The study can further connote that since it is not statistically significant, with the use of other variables, it is no longer needed in the model.
Multicollinearity problem does not exist in the model as the VIF for all variables < 10 and Tolerance is > 0.1)

***The Multiple regression take the form of***

$Y = \beta_0 + \beta_2 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \ldots \beta_n X_m + \mathcal{M}i$ ………………………………..(4.1)

Where $\beta_0$ = Regression Constant

$\beta_1$, $\beta_2$, $\beta_3$, $\beta$ … $\beta_n$ are the coefficient of the variables $X_1$ = Value of the independent variable
Y = Dependent Variable

$\mathcal{M}$i = Error Term

## 4. CONCLUSION

The study investigates how data governance can be incorporated into an already-existing framework. It emphasizes the importance of this integration in enhancing supply chain collaboration through an examination and review of relevant literatures. Quality of data, security, and overall efficiency are highlighted in the report. The article advances supply chain management methods in the era of improved cooperation and data governance by offering insightful analysis and useful suggestions. By addressing some important data governance components such as Data sharing, frequency, data anonymity, shared analytics and conflict resolution mechanism. The study's conclusion enhances supply chain management performance in commercial organizations by incorporating data governance into a conceptual collaborative supply chain architecture. The findings of this dissertation offer valuable insights for both academia and industry, paving the way for further exploration of innovative technologies and strategies to enhance supply chain collaboration. Future research could focus on the application of emerging technologies such as artificial intelligence and blockchain to further augment data governance and supply chain performance. Ultimately, the enhanced collaborative supply chain framework with integrated data governance has the potential to drive significant advancements in the field, supporting more agile, resilient, and sustainable supply chains in an ever-changing global market.

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