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Development and Implementation of a Standardized Supplier Certification and Validation Framework for Enhanced Pricing, Lead Time, and On-Time Delivery Performance

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Abstract

This research paper addresses the need for a data-driven framework that incorporates safety, reliability metrics, and technical competencies, alongside traditional performance indicators, to ensure comprehensive supplier validation and effectively address challenges and consumer complaints in supply chain management. The study explores how such a framework can enhance supply chain resilience, mitigate procurement risks, and optimize supplier management strategies to meet market demand. Focusing on the manufacturing supply chain industry, the research aims to identify key performance indicators, develop a standardized validation process, and evaluate their impact on supply chain performance metrics. Methodologies include systematic data collection, leveraging historical data from existing suppliers, industry benchmarking, stakeholder collaboration, and risk assessment models to identify reliable partners who consistently meet performance expectations. The proposed framework assesses supplier performance based on safety, pricing competitiveness, lead time reliability, on-time delivery, and technical skills within a unified supply chain framework. By formalizing standardized procedures and implementing a "Supplier Verification Form" and "Supplier Evaluation Scorecard," the research aims to strengthen supply chain resilience and optimize supplier management strategies. Expected outcomes include improved supplier selection, reduced procurement risks, enhanced cost management, streamlined operations, reinforced industry standards, and standardized practices, ultimately boosting organizational competitiveness in a changing market environment.

Keywords
Supply chain resilience, Validation Framework, Supplier Evaluation, Performance Metrics, and Supplier Management Strategies.

1. Introduction
The global manufacturing landscape is undergoing a significant transformation. Disruptions like pandemics, trade wars, and natural disasters have exposed vulnerabilities in traditional supply chains, highlighting the need for greater

resilience. Manufacturers are increasingly recognizing the importance of establishing strong partnerships with reliable suppliers who can adapt to changing market conditions and ensure a consistent flow of materials.

Supplier verification and evaluation play a critical role in achieving supply chain resilience. However, existing approaches often lack a standardized and data-driven framework that comprehensively assesses supplier capabilities beyond traditional cost considerations. This can lead to subjective decision-making and the selection of suppliers who may not be able to withstand market fluctuations or disruptions. Traditional supplier evaluation methods are no longer sufficient to handle the complexities of modern supply chains. As organizations seek greater efficiency, resilience, and competitiveness, robust and thorough validation processes for suppliers become essential. There is an urgent need for a comprehensive, data-driven framework to validate supplier performance and effectively address the multifaceted challenges and consumer complaints that arise in supply chain management. There is a pressing need to develop and implement a data-driven framework that includes safety, reliability metrics, and technical competencies alongside traditional performance indicators. This framework aims to ensure comprehensive supplier validation, addressing challenges and consumer complaints in supply chain management.

This research proposes a standardized supplier evaluation and validation framework ("Supplier Verification Form" and "Supplier Evaluation – Supplier Scorecard") to address the shortcomings identified in the problem statement. The framework functions as a comprehensive tool for assessing current and potential suppliers, ultimately enhancing supply chain resilience within the manufacturing industry. The Supplier Framework will consist of the following key components: Supplier evaluation criteria encompass a set of quantifiable and qualitative metrics critical for building a resilient supply chain. It includes factors such as the safety which is the supplier's commitment to safety protocols and risk management practices, the pricing competitiveness which is the ability to offer competitive pricing while maintaining quality standards, the lead time reliability which is the supplier's consistency in meeting agreed-upon lead times for deliveries, the on-time delivery performance which is the supplier's track record of delivering materials on time and in full, the technical skills which is the supplier's expertise and capabilities in meeting the technical requirements of the manufacturing process, the supplier verification forms which is the set of these standardized forms will capture data pertaining to each evaluation criterion. Data collection methods may include surveys, supplier self-assessments, audits of supplier facilities, and the supplier evaluation scorecard which is the scorecard that translates the collected data into a weighted scoring system. Each evaluation criterion is planned to be assigned a specific weight based on its relative importance to supply chain resilience. The scorecard then provides a comprehensive assessment of each supplier's strengths and weaknesses, facilitating informed decision-making.

Niranjan et al. (2012) developed a framework for evaluating Vendor-Managed Inventory (VMI) suitability highlighting the importance of assessing supplier capabilities and performance. This research builds upon that concept by focusing on a broader set of criteria critical for building a resilient supply chain. Southard & Swenseth (2008) developed a roadmap for vendor certification that emphasizes maintaining quality standards and operational effectiveness. The Supplier Framework aligns with this goal by evaluating supplier capabilities that directly impact product quality and on-time delivery, contributing to a more efficient and reliable supply chain. Hwang et al. (2006) explored how certification methods can motivate suppliers to improve quality. The Supplier Framework, by providing a transparent evaluation process and highlighting areas for improvement, can incentivize suppliers to enhance their performance, ultimately leading to a more reliable and resilient supply chain.

Similar to these studies, this research expects the Supplier Framework to promote positive changes in supplier behavior through a data-driven evaluation process in manufacturing industries in the United States. This not only benefits manufacturers by mitigating procurement risks and improving supplier performance but also contributes to a more collaborative and efficient supply chain ecosystem.

1.1 Objectives

This project aims to create and apply a standardized framework to evaluate supplier performance, with the goals of strengthening supply chain resilience, reducing procurement risks, and optimizing supplier management strategies. Key objectives include examining current industry practices, pinpointing relevant key performance indicators (KPIs) for supplier assessment, devising a systematic validation method integrating safety, reliability, technical competencies, and conventional performance metrics, assessing the impact of the standardized process on supply chain performance, and formalizing procedures through the introduction of a Supplier Verification Form and Supplier Evaluation Scorecard.

The research objectives are:
1. To develop a comprehensive framework for supplier evaluation that incorporates safety, pricing competitiveness, lead time reliability, on-time delivery performance, and technical skills.
2. To implement standardized data collection tools (That is verification form and scorecard) to facilitate a consistent and objective evaluation process.
3. To assess the effectiveness of the framework in identifying reliable suppliers who contribute to a more resilient and adaptable supply chain.
4. To provide recommendations for implementing the framework within a manufacturing environment.
By achieving these objectives, this research hopes to provide manufacturers with a practical tool for selecting and managing suppliers who can ensure the long-term success and sustainability of their supply chains.

2. Literature Review
The global manufacturing industry is experiencing significant transformations, necessitating a heightened focus on supplier management to enhance supply chain resilience. Existing literature underscores the importance of considering multiple criteria beyond price in vendor selection, such as quality, delivery, and service. Studies by Wind (1968) and Ho et al. (2010) highlight the significance of these factors in supplier evaluation. Research on Vendor-Managed Inventory (VMI) strategies, notably by Bookbinder et al. (2015) and Lockhart & Ettkin (1993), has explored the benefits and considerations of VMI implementation. Additionally, frameworks developed by Niranjan et al. (2012) and Southard & Swenseth (2008) offer valuable insights into assessing supplier suitability and implementing certification processes. However, there is a notable gap in the literature regarding the integration of standardized supplier evaluation with resilience-building strategies. While existing frameworks address these areas individually, a unified approach that enhances supply chain resilience through supplier evaluation is lacking. Contemporary market challenges necessitate supplier selection processes that prioritize adaptability and responsiveness to disruptions. This research aims to bridge this gap by proposing a comprehensive framework that integrates supplier evaluation with resilience-building strategies, leading to a more robust and adaptable supply chain within the manufacturing industry. By combining quantitative and qualitative data analysis, the proposed Supplier Framework seeks to provide manufacturers with a practical tool to evaluate and select reliable suppliers based on objective criteria and performance metrics. The motivation for further research in this area arises from the complexities of the global business environment and the need for manufacturing companies to optimize costs, ensure timely delivery, and maintain product quality. Disruptions such as pandemics, trade wars, and natural disasters have highlighted the vulnerability of traditional supply chains, emphasizing the need for a robust and resilient supply chain.

In conclusion, this literature review highlights the significance of standardized supplier evaluation in enhancing supply chain resilience and addresses the need for a practical framework that considers a broad range of criteria beyond traditional cost considerations. By fostering data-driven decision-making and promoting collaboration between manufacturers and suppliers, this research aims to contribute to a more resilient and adaptable supply chain ecosystem.

3. Methods
This research employs a mixed methods approach to develop and implement the standardized Supplier Evaluation and Validation Framework within the manufacturing industry. The project methodology employs a systematic approach, gathering historical supplier data, benchmarking industry standards, engaging stakeholders, and utilizing risk assessment models. It involves steps such as collecting data on supplier performance metrics, comparing with industry benchmarks, collaborating with stakeholders for insights, employing risk assessment to identify reliable partners, developing a comprehensive framework integrating various performance criteria, and implementing standardized procedures through the Supplier Verification Form and Evaluation Scorecard.

The researcher conducted the study for two kinds of products, inventory items and non-inventory items. The tools that were used were the developed "Supplier Verification Form" and the "Supplier Evaluation Form". These tools were used to identify suitable vendors and were used to evaluate their performance.
Supplier Evaluation Criteria: This will encompass a set of quantifiable and qualitative metrics critical for building a resilient supply chain. It will include factors such as:
Safety: Supplier's commitment to safety protocols and risk management practices.
Pricing Competitiveness: Ability to offer competitive pricing while maintaining quality standards.
Lead Time Reliability: Supplier's consistency in meeting agreed-upon lead times for deliveries.
On-Time Delivery Performance: Supplier's track record of delivering materials on time and in full.

Technical Skills: Supplier's expertise and capabilities in meeting the technical requirements of the manufacturing process.
Supplier Verification Forms: These standardized forms will capture data pertaining to each evaluation criterion. Data collection methods may include surveys, supplier self-assessments, and audits of supplier facilities.
Supplier Evaluation Scorecard: This scorecard will translate the collected data into a weighted scoring system. Each evaluation criterion will be assigned a specific weight based on its relative importance to supply chain resilience. The scorecard will provide a comprehensive assessment of each supplier's strengths and weaknesses, facilitating informed decision-making.

4. Data Collection

Data for this research was gathered by primary data collection methods through structured forms for verification, to select the vendors for enlistment and evaluation of the performance of the vendors who are already enlisted in manufacturing industry, situated in the United States. Tasks may involve researching potential new suppliers and gathering preliminary data on their capabilities using online resources, industry reports, and contacting suppliers directly. For Existing Suppliers: The forms will be used to gather information on safety protocols, pricing competitiveness, and technical capabilities using the Supplier Evaluation Scorecard. Historical data on lead time and on-time delivery performance will be compiled from existing records. Audits of supplier facilities might be conducted in specific cases.

Potential new suppliers: Online resources and industry reports will be used to identify potential suppliers. Data on their capabilities will be gathered through direct contact and preliminary questionnaires which are coming in the form of the Supplier Verification Form. To support the expected benefits of the Supplier Framework and to have a robust system, data collection and analysis will be crucial.

				Supplier Verification Form(SVF) Version: V1.0
Date: DD/MM/YYYY	**Part #**	**Description Item being sourced :**		
New Vendor ☐ **Existing Vendor** ☐ **Past Performance:** Acceptable ☐ Not Applicable ☐ Not Acceptable ☐		**What product is it used for ?**		
AttentionVendor: Please submit the following documents: 1. Complete Vendor Verification Form (below) 2. Valid (Federal Tax Identification Number/Certificate (W9) within 24 hours to Purchasing ☐ Accounting ☐				
		Company Details		
Company Name :		Type of Business :		
Legal Business Name :		Vendor legal business type :		
Location :	Address :	Vendor Market Presence :		
	City/State/Zip :	Vendor Legal Background Check :		
	Country:	Vendor's Establishment Date:		
Headquarters :		Names of Salesperson :		
No. of Employees :		Name of Key person :		
Accounts Contact :		Years in Business :		
Accounts Email :		Business Hours :		
Purchase order contact number :		Shifts :		
Purchase order Email address :		Vendor's Current security measure :		
Order web address :		Is Vendor's data security policy in place?	Yes ☐ No ☐ Not applicable ☐	
Is Vendor direct/3rd party vendor?		W-9 Form :	Yes ☐ No ☐ Not applicable ☐	
Business Regitration Number :		Sole Source: Yes ☐ No ☐	Third Party Supplied : Yes ☐ No ☐	
Tax Registration Number :		Supplier Status : Conditional ☐ Approved ☐ Other ☐		
		Delivery & Service Commitment		
Customer Support hours :		Mode of shipment:		
Warranty Policy :		Cost of Delivery :		
Maintenance & Repair Services :		If Minimum shipping requirement, specify:		
Current lead time of product delivery :				
		Financial Information		
Financial Strength (D&B) / Bank Reference / Positive Cash Flow and Credit Worthiness : ☐		Check the vendor/payee residency status to take note of any further CA withholding applications and make note of same. ☐		
Vendor's Bank Account Number :		Vendor's Annual Revenue (USD) :		
Standard Cost:		Vendor's Credit Rating : [1(High Risk) -100(Low Risk)]	0	
Quoted Price:		Vendor Credit Limit :		
Is there a price break ?		Deviation from Standard :	$ -	
Vendor Pricing Structure :		If "Yes", what would that be?		
Verify authorized representative signature both on "ASC W-9 / ACH" and the W-9 Form ☐		Is letterhead pad used :	Yes ☐ No ☐	
		Payment		
Payee Name: ______________________ Same as order placement vendor name above ☐		Do you accept Credit Card Payment ?	Yes ☐ No ☐	Note:
		Form of Payment :		
PayeeAddress : ______________________ Same as order address above ☐		Vendor Payment Terms :		
		Federal Tax Identification #: (Provide a copy of W-9 Certificate) ☐		
		Compliance Confirmation		
FDA Inspection Date :		Status : Acceptable ☑ Unacceptable ☐ Not applicable ☐		
		Comment:		
Document - proof for Vendor's legal business status :		1. Business Registration Certificate ☐ 2. Business License ☐ 3. Employer identification Number (EIN) ☐ 4. Articles of Incorporation or Articles of Organization ☐ 5. Certificate of Good Standing ☐ 6. Trademark or Copyright Registration ☐		
		Production Concerns		
Does the vendor have list of Tooling/Machinery required :		Yes ☐ No ☐		
Capacity: Can supplier can manage multiple orders :		Yes ☐ No ☐		
Commitment: Quality System/Certificates/ Inspections :				
Are all delivered products / raw material(s) made in USA?				
Production Control: What systems are in place to ensure changes aren't made without Southern Aluminums's Approval :				
What procedures/ measures are in place to ensure that Southern Aluminum's quality standard are met?				
		Certifications		
Certifications: ☐	**Scheme name**	**Certification scope (incl. country, units and products covered by the certificate)**	**Certificate Number**	**Certificate Expiry Date**
ASTM Certification				
Others:				
Certifications of the Employees				
		Risk Mitigation		
Drawings/Specifications to be Reviewed Prior to Quoting		Status : Acceptable ☐ Unacceptable ☐ Not applicable ☐		
To confirm that vendor is real, validate the below documents with IRS.gov e-Services and/or TINcheck	IRS W9 (US) ☐ or IRS W8 (NonUS/Foreign) ☐	To confirm OFAC compliance, verify the below documents with US Treasury or TINcheck	Bank letter ☐ Vendor letterhead ☐ IRS W9 (US) or IRS W8 (NonUS/Foreign) ☐ Voided Check or Company Branded Banking Setup Form (recommended) ☐	
		Product Approval		
☐ I understand that all samples, design changes & raw materail changes must be approved by Southern Aluminum's quality and purchasing department prior to Agreement/ Authorization. Name : ______________________ Signature : ______________________				
		Point of Contact		
Sales Representative :		Quality Representative :		
Contact Nubmer:	E-mail:	Contact Nubmer:	E-mail:	
Customer Service Representative :		Production Representative :		
Contact Nubmer:	E-mail:	Contact Nubmer:	E-mail:	
☐ I have read and understoon Southern Alumninum's terms and conditions				
Signed by Authorized company representative :				
Name and title of Authorized Representative :				
Contact number :				
Email :		Signature :		
For additional support contact Purchasing Department at ***-***-****, email at "purchasing-all@***.com"or visit: "website"				

Figure 1: Supplier Verification Form

Figure 1 is the Supplier Verification Form. This would establish a standardized process for verifying suppliers, ensuring reliability and quality assurance. This would involve vital departments in the assessment process, ensuring thorough evaluation and an informed decision-making process.

Supplier Evaluation Form - Supply Chain Management

Date: ____________
Version: V1.0

Supplier Name : ______________________ **Company Address :** ______________________ **Supplier ID :** ______________________
Project / Product : ______________________ **Phone number :** ______________________
Supplier Representative: ______________________ **Delivery Address :** ______________________
Supplier's Project Manager/Representative : ______________________
Department Involved : Quality/ I&D /Purchasing ____________ **Type of work: New Part/ Replacement / Prototype**______________ **Category of Item: Inventory / Noninventory/Consignment** ______________
Frequency of Work: Contractual / One Time ______________ **Length of Service:** ______________ **Does the Supplier maintain a schedule: Yes / No** ______________
Accounting Department's Decision: (Pass/Fail) __________ **Supplier Competency : (Pass/Fail)** __________
PO Number :______________ **Purchase Order Delivery Date:** ______________ **Delivery Note - Invoice No :** ____________
Contract Period: _________ **to** _________ **Quality - Nonconformity Status: _Poor Quality / Incomplete/ Damaged / other failures** ______________

Team Member:		**Department**		
1		Project/ Product:		
2		I&D :	Quality :	
3		Production :		
4	**Purchase Requester :**	Initiator :	Coordinator :	SPOC -

For sub-criteria evaluation enter Y (yes) or NA (not applicable) here

Criteria	Did not fulfill expectations 1	2	3	4	5	6	Has (just) fulfilled expectations 7	8	Has well fulfilled / exceeded expectations 9	Value	Weight
Supplier Management										**9**	3
Did the vendor provide order confirmation for the initiated PO ?											
Were stakeholders informed about shippment progress on a regular basis?											
Were the stakeholders informed about pending decisions on a regular basis?											
Were they responsive to rush or demand increase ?											
Was speed of response to change request(s) satisfactory ?											
Were suppliers flexible and open to changes to design(s) or specification(s)?											
Were payment terms met ?											
Was there any violation observed in legal requirment(s)?											
On Time Delivery										**9**	3
Does the Delivery Date on the order acknowledgement match with the PO line item delivery date ?											
Were all materials (as per lines in PO) delivered on time (within the 3 days of tolerance)?											
Were all items received?											
Quantity										**9**	2
Total Quantity (in unit of entry) ordered [as per PO] equals total quantity received:											
Were all materials received as per the PO?											
Does the supplier have adequate machines and equipments to supply?											
Was quantity printed on delivery ticket?											
Was the order overridden during the entire process of delivery?											
Quality										**9**	3
Did all the received products passed quality inspection?											
Was the initial quality observation passed?											
Final Quality Obersvation = Pass. (If Pass Restricted ,then select the reason code - 1 Poor Quality / 2 Incomplete /3 Damaged / Other quality failure)											
Was the item delivered Returned to Vendor?											
Reason codes for return to vendor - Poor Quality / Incomplete / Damaged / Other Quality Failure											
Was the delivery Complete - (Full - Y / Partial - N)											
Procurement										**9**	2
On Time Delivery (%)											
Quantity Reliability (%)											
Initial Quality (%)											
Total Quality (%)											
Was the PO over or under received ? (Over - Y / Under- N)											
Was the Return (%) within the tolerance?											
Manual override (Y/N)											
Is the accuracy of invoice satisfactory?											
Over all rating			(weighted)	**good**						**9.0**	
Supplier Evaluation Score - Pass/Fail						**Pass**					

Comment

Pass

Note : Any non-compliance activity will attract a penalty in the form of a warning letter and if continued further that will lead to termination of the contract.

Note :	SES	Supplier Evaluation Score
	Payment term	Net30
	OTD Tolerence	3 days
	Score Criteria	Score >6.5,"good", Score>4.5,"satisfactory" Below that "insufficient"

Supplier Evaluation

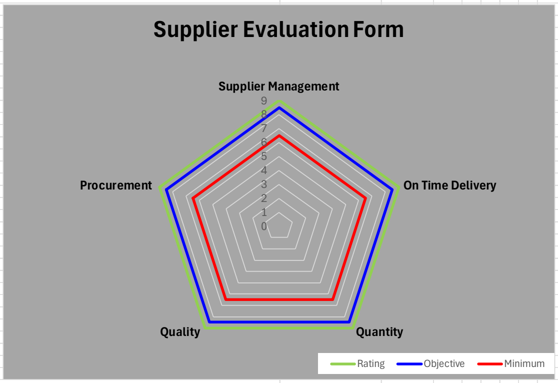
Supplier Name : ____________________ **Company Address :** ____________________

Department Involved : Quality/ I&D /Purchasing ________ Type of work: New Part/ Replacement / Prototype________ Category of Item: Inventory / Noninventory/Consignment ________

Over all rating	Rating (weighted)	good	9.0

Comment

Pass



Detailed Rating:

	Rating	Objective	Minimum	Weight
Supplier Management	9	8.5	6.5	3
On Time Delivery	9	8.5	6.5	3
Quantity	9	8.5	6.5	2
Quality	9	8.5	6.5	3
Procurement	9	8.5	6.5	2

Figure 2: Facilitates ongoing evaluation of enlisted suppliers, enabling them to maintain high standards and address any issues promptly.

The forms are planned to be used to gather information on safety protocols, pricing competitiveness, and technical capabilities (Figure 2). Historical data on lead time and on-time delivery performance will be compiled from existing records. Audits of supplier facilities might be conducted in specific cases. And then, Potential new suppliers: Online resources and industry reports will be used to identify potential suppliers. Data on their capabilities will be gathered through direct contact and preliminary questionnaires. The collected data will be entered into a central database for easy access and analysis. Quantitative data (e.g., lead time, and on-time delivery rates) will be analyzed using statistical methods to identify trends and assess supplier performance consistency. Qualitative data (e.g., safety protocols, and technical skills) will be evaluated based on pre-defined criteria and assigned scores. The Supplier Evaluation Scorecard will calculate a weighted score for each supplier, considering the relative importance of each evaluation criterion. By employing a combination of quantitative and qualitative data analysis, the framework will provide a comprehensive picture of supplier performance, supporting the expected positive outcomes. These will help in the initial data analysis to ensure its effectiveness in evaluating supplier capabilities and enhancing supply chain resilience.

5. Results and Discussion

This research area stems from the ever-changing and increasingly complex global business environment. Manufacturing companies face constant pressure to optimize costs, ensure timely delivery, and maintain product quality. Disruptions like pandemics, trade wars, and natural disasters highlight the vulnerability of traditional supply chains. Developing a robust and resilient supply chain is critical for long-term success. This research aims to contribute to that goal by providing manufacturers with a practical tool for evaluating and selecting reliable suppliers who can adapt to changing market conditions. By fostering a more collaborative and transparent relationship between manufacturers and suppliers, this research has the potential to create a more efficient and sustainable supply chain ecosystem for the future. This study offers several strengths that contribute to its potential impact: Focus on Practical

Application: The research directly addresses the need for a standardized and data-driven approach to supplier evaluation in the manufacturing industry. The proposed Supplier Framework is designed to be a practical tool that can be easily implemented by manufacturers of all sizes. Comprehensive Evaluation Criteria: The framework considers a broad range of criteria beyond traditional cost considerations. By including factors such as safety, lead time reliability, and technical skills, the framework provides a more holistic assessment of supplier capabilities and their impact on supply chain resilience. Data-Driven Decision-Making: The use of quantitative and qualitative data analysis ensures that supplier selection and management decisions are based on objective criteria and performance metrics. This reduces the risk of bias and promotes informed decision-making. These strengths position the research to make a valuable contribution to the field of supply chain management by providing a practical framework for building a more resilient and adaptable supply chain through strategic supplier evaluation.

It's imperative to analyze the collected data, compute supplier scores accurately, and craft insightful reports that present the evaluation results. By actively participating in these tasks, valuable insights can be obtained into supplier management, data analysis, and contributing to the development of a framework that strengthens supply chain resilience. The collected data will be entered into a central database for easy access and analysis using ERP like EPICOR or SAP etc.

5.1 Numerical Results

The Supplier Evaluation Score Card data which is displayed tabulated for various suppliers in the figure above. It shows a quick comparison of the evaluation scores of various suppliers. It highlights the performance of each supplier in meeting the target scores. Suppliers with a higher score than the targeted score indicate better performance. Suppliers with lower bars may need improvement (Figure 3).

Supplier Evaluation Score				
Commodity Parts	**Suppliers**	**Target (no.)**	**Score (no.)**	**Status**
Aluminum - Extrusion	A	6.50	7.80	(Good) Pass
Aluminum - Extrusion	B	6.50	0.00	
Aluminum - Extrusion	C	6.50	8.10	(Good) Pass
Aluminum - Extrusion	D	6.50	0.00	
Misc.- Multiple Parts	E	6.50	0.00	
Laminate- Laminate	F	6.50	0.00	
Fabrication- Back Bars	G	6.50	0.00	
Laminate- Laminate	H	6.50	6.40	Satisfactory (Pass)
Finish- Paint	I	6.50	4.00	Fail
Packaging- Boxes	J	6.50	0.00	
Stainless- Stainless Bar Parts	K	6.50	0.00	
Vinyl- Vinyl Trim	L	6.50	0.00	
Fasteners- Hardware	M	6.50	8.50	(Good)Pass
Fabrication- Small Parts	N	6.50	0.00	

Figure 3: The results from the Supplier Evaluation Score Card

				KPI: OTD - On-Time Delivery		
Sl no.	**Commoditiy - Parts**	**Suppliers**	**Target**	**Score (%)= 2022**	**Score (%)= 2023**	**Score (%)= YTD 2024**
1	**Aluminum - Extrusion**	**A**	**95**	**92**	84%	92%
2	**Aluminum - Extrusion**	**B**	**95**	**70**	98%	83%
3	**Aluminum - Extrusion**	**C**	**95**	**86**	91%	100%
4	**Aluminum - Extrusion**	**D**	**95**	**5**	74%	99%
5	**Misc.- Multiple Parts**	**E**	**95**	**85**	94%	90%
6	**Laminate- Laminate**	**F**	**95**	**N/A**	96%	91%
7	**Fabrication- Back Bars**	**G**	**95**	**95**	100%	0%
8	**Laminate- Laminate**	**H**	**95**	**83**	68%	75%
9	**Finish- Paint**	**I**	**95**	**92**	93%	98%
10	**Packaging- Boxes**	**J**	**95**	**78**	99%	100%
11	**Stainless- Stainless Bar Parts**	**K**	**95**	**69**	70%	91%
12	**Vinyl- Vinyl Trim**	**L**	**95**	**93**	57%	50%
13	**Fasteners- Hardware**	**M**	**95**	**93**	98%	100%
14	**Fabrication- Small Parts**	**N**	**95**	**100**	100%	100%
	Avg (KPI)		**95**	**80.07692308**	**87%**	**84%**

Figure 4: The data for On-Time Delivery for various suppliers.

The data in the above table facilitates the identification of providers that exhibit high On-Time Delivery scores, signifying prompt product delivery. Values lower than the target interpret that the suppliers might need to raise the quality of their on-time delivery. It assists in evaluating supplier reliability and efficiency in delivering products on time (Figure 4).

5.2 Graphical Results

The Supplier Evaluation Score Card for several vendors, (ranging from A – N) is represented graphically in Figure 5. Finding top-performing vendors with high Evaluation Scores is made easier by the graph. Additionally, it identifies providers who can benefit from improvement considering lower Evaluation Scores. It is possible to identify trends in supplier performance by contrasting the bar heights among various providers. Giving a clear summary of supplier performance in a condensed and understandable style, it facilitates decision-making.

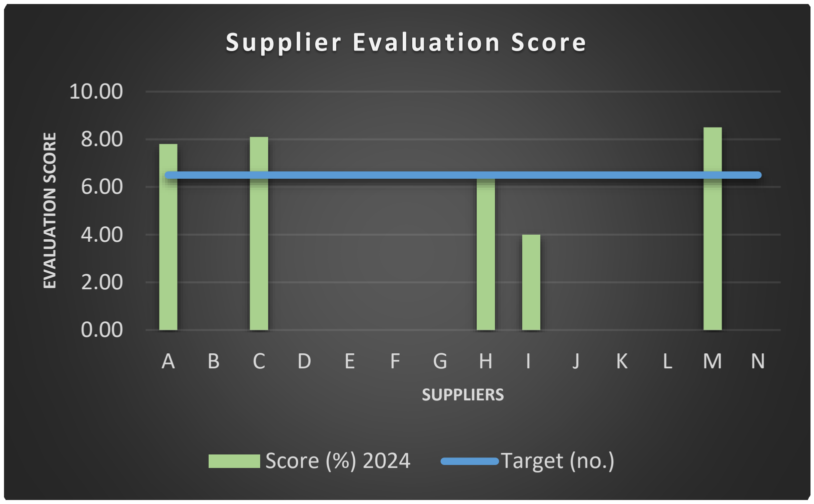


Figure 5: The graphical representation of the Supplier Evaluation Score Card for a range of suppliers

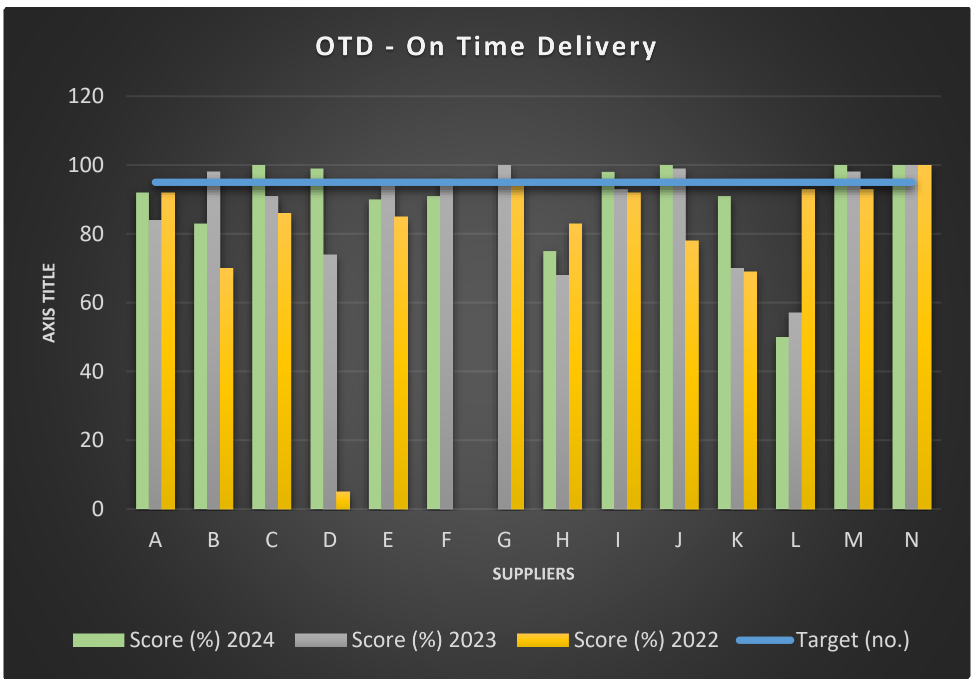


Figure 6: The graphical representation of On-Time Delivery of products for various suppliers.

Figure 6 presents a clear picture of each supplier's performance in terms of reaching the On-Time Delivery goals. It visually highlights how well each supplier is meeting the On-Time Delivery targets. The heights of the bars across several vendors can be compared to see trends in the performance of On-Time Delivery. It helps assess the dependability and effectiveness of suppliers in meeting deadlines for product delivery. This data can be used by stakeholders to evaluate supplier performance and make choices that will increase the effectiveness of the supply chain. The graph makes it easy to compare the performance of several suppliers in terms of On-Time Delivery.

The research findings demonstrate significant enhancements in supply chain performance metrics following the adoption of the standardized supplier performance framework. Key results include improved supplier selection processes, reduced procurement risks through rigorous validation, better cost management due to enhanced supplier performance, streamlined operations through standardized procedures, and reinforcement of industry standards, fostering a more resilient supply chain ecosystem aligned with organizational goals and industry best practices.

Quantitative data (for instance lead time, and on-time delivery rates, material shortage, supplier evaluation score) will be analyzed using statistical methods to identify trends and assess supplier performance consistency. Qualitative data (for instance safety protocols, and technical skills) will be evaluated based on pre-defined criteria and assigned scores. The Supplier Evaluation Scorecard will calculate a weighted score for each supplier, considering the relative importance of each evaluation criterion. By combining quantitative and qualitative data analysis, the framework will provide a comprehensive picture of supplier performance, supporting the expected positive outcomes. The use of quantitative and qualitative data analysis ensures that supplier selection and management decisions are based on objective criteria and performance metrics. This reduces the risk of bias and promotes informed decision-making. These strengths position the research to make a valuable contribution to the field of supply chain management by providing a practical framework for building a more resilient and adaptable supply chain through strategic supplier evaluation.

This research on the standardized Supplier Evaluation and Validation Framework yielded several positive impacts: Enhanced Supply Chain Resilience: By systematically evaluating suppliers based on safety, pricing competitiveness, lead time reliability, on-time delivery, and technical skills, the framework would enable manufacturers to identify and select reliable partners who can withstand market fluctuations and disruptions. This would lead to a more robust and adaptable supply chain, minimizing risks and ensuring a consistent flow of materials. Improved Supplier Management Strategies: The framework provided a data-driven approach to supplier selection and management. The Supplier Evaluation Scorecard offers clear insights into supplier strengths and weaknesses, enabling manufacturers to optimize supplier relationships, negotiate better pricing, and foster collaboration for continuous improvement. Reduced Procurement Risks: The framework's focus on safety and reliability helped manufacturers identify potential risks associated with suppliers early on. This proactive approach minimized disruptions in the production process and mitigated potential financial losses. Streamlined Supplier Evaluation Process: The standardized forms and scorecard streamlined the supplier evaluation process, saving time and resources for manufacturers. The consistent and objective evaluation criteria ensure fair and unbiased assessments of all suppliers.

5.3 Proposed Improvements

One of the suggested improvements is to have a guided supplier verification and evaluation standard operating procedure, which can include a standardized newly purchased part request form (Figure 7). That is required to identify new parts to be purchased based on the provided information. The Supplier Verification Form (SVF) is crucial for establishing a standardized process to verify suppliers, ensuring their reliability and quality. Before any suppliers are enlisted, they must complete the SVF, which is subsequently evaluated using the "SVF- Supplier Verification Form- Result Assessment – Purchasing." The newly developed SVF - Supplier Verification Form - Result Assessment - Purchasing is important as it involves critical departments such as Supply Chain and Accounting in the assessment process, ensuring a thorough evaluation and informed decision-making. The newly developed Rubric for SVF Evaluation is important because it provides a structured framework for assessing suppliers, enhancing consistency and objectivity in the evaluation process. The rubric for SVF Evaluation is important because it provides a structured framework for assessing suppliers and enhancing consistency and objectivity in the evaluation process. The Request for Quotation (RFQ) Form is important as it streamlines the quotation process, ensuring efficient and consistent communication with suppliers (Figure 8). One suggested sample is attached in Figure 9. It enables the formal solicitation of pricing and other relevant details from potential suppliers for specific goods or services. This process streamlines vendor selection, facilitates comparison among multiple suppliers, and empowers informed decision-making based on factors like cost, quality, and delivery terms. Ultimately, the RFQ enhances procurement efficiency, transparency, and competitiveness, contributing to cost savings and optimal supplier relationships.

1. Researchers proposed improvements can be tabulated as below:

Supplier Verification & Evalution - guideline

Sl no.	Activity	Owner	File
1	**New purchased part request form -** to identify new parts to be purchased based upon the filled in information	PR requisitioner	New Purchased Part Request Form.pdf
2	**Supplier Verification Form (SVF)** - Importance: Establishes a standardized process for verifying suppliers, ensuring reliability and quality. - Before enlisting any suppliers, they must complete the SVF, which is then evaluated using the "SVF- Supplier Verification Form- Result Assessment – Purchasing."	Purchasing / I&D - send to vendor ; Purchasing & Accounting : Verify Information from Vendor	SVFForm.xlsx
3	**SVF- Supplier Verification Form- Result Assessment – Purchasing:** - Importance: Involves critical departments in the assessment process, ensuring thorough evaluation and informed decision-making.	Purchasing	SVF-Purchasing.xlsx
4	**Rubric for SVF Evaluation : (to assist puchasing scoring)** - Importance: Provides a structured framework for assessing suppliers, enhancing consistency and objectivity in evaluations.	Purchasing	Rubric SVF Purchasing.xlsx
5	**Request for Quotation (RFQ) Form:** - Importance: Streamlines the quotation process, ensuring efficiency and consistency in communication with suppliers.	Purchasing - Buyer	RFQ .xlsx
6	**Quality Inspection Form:** - Importance: Defines criteria for assessing the quality of received materials, crucial for maintaining product standards and customer satisfaction.	Purchasing & QA	Quality Inspection Form.xlsx
7	**Warehouse Inspection Criteria:** - Importance: Ensures that products received undergo thorough inspection, preventing defects and ensuring adherence to quality standards.	Purchasing & QA	Receive Material spection Criteria.p
8	**Supplier Evaluation Form (SEF) :** - Importance: Facilitates ongoing evaluation of enlisted suppliers, enabling us to maintain high standards and address any issues promptly.	Purchasing	SEF Supplier Evaluation Form.xlsx
9	**Action Chart for Continuous Improvement:** - Importance: Enables us to track and address action points regularly, ensuring ongoing improvement and alignment with key performance indicators (KPIs) – (suggested the KPIs in order to sustain then new process in place.)	Purchasing	KPI & Action Chart.xlsx

Note : By adopting these standardized processes and tools, we enhance our ability to excel and maintain high standards in managing our suppliers. I urge everyone to become acquainted with these procedures and actively participate in ensuring their successful implementation.

Figure 7: Verification and Evaluation Guideline.

The Quality Inspection Form is vital as it defines the criteria for assessing the quality of received materials, which is crucial for maintaining product standards and ensuring customer satisfaction. The Warehouse Inspection Criteria are essential for ensuring that received products undergo thorough inspection, preventing defects, and ensuring adherence to quality standards. The Supplier Evaluation Scorecard plays a pivotal role by enabling the continual assessment of contracted suppliers, ensuring the upkeep of superior standards, and swift resolution of any potential concerns (Figure 10).

Request for Quotation (RFQ) Version: V1.0

Company Name					
Quotation Number	RFQ Title		RFQ ID	Date : MM/DD/YYYY	Quote Valid Until: MM/DD/YYYY
Project Lead Name & Title		Contact Phone		Contact Email	
Sales person	P.O Number	Ship Date	Ship Via	F.O.B Point	Terms
Item ID	Product ID	Description	Quantity	Unit Price	Cost
					$ -
					$ -
					$ -
					$ -
				Sub Total Price	$ -
				Tax Rate	
				Sale Tax	
				Other	
				Total	$ -
Shipping Information :					
Comments or Special Instructions:					
Prepared by :					

Figure 8: Proposed Request for Quotation Form.

Quality Inspection — Version: V1.0

Sl no.	Vendor Name	Item Status: Initial Quality Observation (Pass/ Fail)	Initial Quality Observation	Final Quality Observation (during production hour) (Pass/Fail)	If Fail (Reason Code: 1- Poor Quality; 2- Incomplete; 3- Damaged; Other Failures)	Total Quality (Pass- IIF both initial & Final Quality is Pass)	Reason code to return to Vendor	Justification of Why you maintain early / late delivery tolerances	Delivery Complete - Full /Partial
1			**a. Aluminum Extrusion (ELGP & ESMP):**						
2			Measurment of Board (tolerance met as per drawing)						
3			Angularity : +/- 1						
4			Flatness (allowable deviation from Flat .023 concave or convex - over the entire board)						
5			Radius (as per drawing)						
6			**b.Tubing**						
7			Extrusion Measurements (tolerance met as per drawing)						
8			**c. Paint (PNT):**						
9			Scratch / Adhesion test						
10			Boil test						
11			Alcohol rub test						
12			**d. Laminate (LAM) (Laminate, Compact, Thinscape & Solid surface):**						
13			Any defects (scratches/ spots/ cloudiness/ cracks)						
14			Size						
15			Color						
16			Finishing of product						
17			Thickness						
18			**e. Cardboard Fitness (BOX):**						
19			Does the cardboard fit properly?						
20			**f. Vinyl (VNL):**						
21			Does vinly go in smoothly ?						
22			Color						
23			Thinkness						
24			Width						
25			Is the durometer tolerance within the range of (85-90) ShoreA?						
26			**g.ADH (Adhesive):**						
27			Adhesion strength						
28			Clean up						
29			Recommendations for humidity						
30			**h. BAR(Stainless for front bar):**						
31			Finish of product						
32			Peel coat applied?						
33			Fit						
34			Dent and scratch free						
35			**j. COV (Spandex covers & Snap drape skirting)**						
36			Fit						
37			Material						
38			**k. CSTR (Casters weight limit / material/ height/ fork requirements/rubber mats):**						
39			Do they meet requirements?						
40			Are they the correct material for the intended use?						
41			Ease of rolling						
42			**l. CTRK (Table Truck/ Paint materials) :**						
43			Does paint pass crosshatch and scratch test?						
44			Do tables fit?						
45			**m. FSNR (Fasteners) :**						
46			Correct grade						
47			**n. 1. PKG (Foam) :**						
48			Does this supply the protection intended?						
49			Is size correct?						
50			Is correct material used - to prevent damage to product						
51			**o. 2. PKG (Pallets - Heat Treated) :**						
52			Does pallet have appropriate stamp if heat treated?						
53			Pallet correct size?						
54			Does pallet jack and/or forks fit under pallet correctly?						
55			**p. PWR (Surge protectors / Power Cards) :**						
56			Does the strip supply the appropriate amps and volts?						
57			Is the size of the strip correct?						
58			Is the cord the correct length?						
59			**q. TUCH (Touch up paints / Micro fiber Rags)**						
60			Color match?						
61			**r. Other parts**						
62									

Figure 9: Proposed Quality Inspection Form

Version: V1.1

Possible KPIs	Suggested Targets	Score	Note	
Quantity Ordered versus Quantity Received	100%			
Delivery On-time	95%			
Order Accuracy	100%			
Supplier Lead Time / Lead time Accuracy	3 Days		0-3 Days acceptable	
Vendor Evaluation Score:	6.50		Score Criteria	Score >6.5,"good", Score>4.5,"satisfactory" Below that "insufficient"
Inventory Turn over:	3.00			
Material Shortage Rate:	2.00		Score Criteria	Avg no more than 2 outage per month is okay
Perfect Delivery Rate:	100%			
Time to on board new vendor:	2 Weeks			
Order processing time	2 Weeks			
PR processing time	2 Weeks			

Figure 10: Suggested KPI

Moreover, the Action Chart for Continuous Improvement is vital as it allows us to consistently monitor and tackle action points, ensuring continual improvement and alignment with key performance indicators. It is recommended to utilize KPIs to maintain the efficacy of newly established processes over time. KPIs are designed to measure the effectiveness of the framework in improving supplier performance in crucial areas such as pricing, lead time, and on-time delivery. By establishing clear and measurable metrics, the project's impact over time can be tracked and informed decisions can be made to optimize supplier relationships and enhance supply chain efficiency.

Moreover, Vendor-managed inventory (VMI) can be a good idea to implement in the industry. Research by Bookbinder et al. (2015) and Lockhart & Ettkin (1993) explores the potential benefits and considerations for implementing VMI strategies. Implementing Vendor Managed Inventory (VMI) in manufacturing is crucial as it streamlines supply chains, improves efficiency, fosters collaboration, and enhances operational agility and competitiveness. However, current literature on supplier management highlights key areas such as vendor selection criteria, vendor-managed inventory (VMI), and supplier evaluation frameworks. Wind (1968) and Ho et al. (2010) emphasize the importance of considering multiple criteria beyond price, including quality, delivery, and service, for vendor selection. Research by Bookbinder et al. (2015) and Lockhart & Ettkin (1993) examines the benefits and challenges of VMI strategies. Supplier evaluation frameworks by Niranjan et al. (2012) and Southard & Swenseth (2008) provide insights into assessing supplier suitability and certification processes. However, there is a gap in research that combines standardized supplier evaluation with resilience-building to enhance supply chain resilience and address contemporary market challenges. This study aims to fill this gap by proposing a comprehensive framework that integrates supplier evaluation with resilience-building strategies, fostering a robust and adaptable supply chain in the manufacturing industry.

Another proposed improvement is to have supplier visits in place as per the regular work schedule. Supplier visits are essential for procurement teams in manufacturing organizations to enhance performance for various reasons. Firstly, they offer firsthand insight into the supplier's operations, processes, and capabilities, enabling a better understanding of their strengths and weaknesses. This allows procurement teams to assess the supplier's reliability, quality control measures, and adherence to deadlines, ensuring smoother procurement processes. Additionally, supplier visits foster stronger relationships between the manufacturer and the supplier, promoting better communication, collaboration, and trust. By comprehending the supplier's operations and challenges, procurement teams can work together with suppliers to identify areas for improvement, negotiate better terms, and implement strategies to enhance overall performance and efficiency in the supply chain. These recommendations include guidelines for training procurement teams, integrating the evaluation framework with existing supplier management systems, and continuously monitoring and updating the evaluation criteria to adapt to changing market conditions and organizational needs.

5.4 Validation

The results of this research align with the findings of several existing studies on supplier management:
Niranjan et al. (2012): Their framework for evaluating Vendor-Managed Inventory (VMI) suitability highlights the importance of assessing supplier capabilities and performance. This research builds upon that concept by focusing on a broader set of criteria critical for building a resilient supply chain. Southard & Swenseth (2008): Their roadmap for vendor certification emphasizes maintaining quality standards and operational effectiveness. The Supplier Framework aligns with this goal by evaluating supplier capabilities that directly impact product quality and on-time delivery, contributing to a more efficient and reliable supply chain. Hwang et al. (2006): Their research explores how certification methods can motivate suppliers to improve quality. The Supplier Framework, by providing a transparent evaluation process and highlighting areas for improvement, incentivizes suppliers to enhance their performance, ultimately leading to a more reliable and resilient supply chain.

The validation of the proposed framework was conducted through a comprehensive simulation in an industrial setup. The following validation steps were undertaken:

1. Pilot Testing: The framework was initially tested with a small group of suppliers to ensure feasibility and effectiveness.
2. Feedback Mechanism: Regular feedback was collected from key stakeholders, including the purchasing, accounting, and R&D departments, to refine the processes.
3. Performance Monitoring: Continuous monitoring of supplier performance metrics ensured that the framework delivered the intended improvements.
4. Comparison with Baseline Data: The performance data post-implementation was compared with baseline data to validate the effectiveness of the new processes. The significant improvements in KPIs validated the framework's efficacy.

The combination of pilot testing, stakeholder feedback, performance monitoring, and baseline comparison provided robust validation of the framework, demonstrating its potential for widespread adoption across various industrial setups.
Like these studies, this research leveraged the Supplier Framework to promote positive changes in supplier behavior through a data-driven evaluation process. This approach not only benefits manufacturers by mitigating procurement

risks and improving supplier performance but also contributes to a more collaborative and efficient supply chain ecosystem.

6. Conclusion

This study offers several strengths that enhance its potential impact, including a practical application focus, comprehensive evaluation criteria, and data-driven decision-making. It addresses the need for a standardized, data-driven approach to supplier evaluation in the manufacturing industry with a practical framework that can be easily implemented by manufacturers of all sizes. Going beyond traditional cost considerations, the framework incorporates factors such as safety, lead time reliability, and technical skills, facilitating a holistic assessment of supplier capabilities and their impact on supply chain resilience. By employing quantitative and qualitative data analysis, the framework ensures objective, performance-based decisions, reducing bias and promoting informed decision-making, thereby significantly contributing to the field of supply chain management. In summary, the study emphasizes the importance of establishing and implementing a standardized supplier performance framework to bolster supply chain resilience and refine supplier management tactics, ultimately enhancing organizational competitiveness and sustainability. By utilizing quantitative and qualitative data analysis, it ensures objective, performance-based decisions, reducing bias and promoting informed decision-making, thus contributing significantly to the field of supply chain management.

The research methodology aims to provide a structured and systematic approach to developing, implementing, and evaluating the Supplier Evaluation and Validation Framework, ultimately contributing to the enhancement of supply chain resilience within the manufacturing industry. This research has successfully achieved its primary objectives, resulting in a robust framework for supplier evaluation that addresses key dimensions such as safety, pricing competitiveness, lead time reliability, on-time delivery performance, and technical skills. The development of this comprehensive framework involved the careful integration of these critical factors to ensure a holistic and effective evaluation of suppliers. This timeframe for achieving the research goals encompasses the following stages: first involves reviewing existing literature on supplier evaluation and supply chain resilience, finalizing the specific evaluation criteria and weighting system for the Supplier Framework, and developing the data collection tools (surveys, forms)., second is Data Collection: This stage involves gathering data from existing suppliers through surveys and historical record analysis. Data collection on potential new suppliers will also occur during this time. Audits of supplier facilities (if applicable) would be scheduled within this timeframe. Third, is Data Analysis and Framework Refinement where the collected data will be analyzed to identify trends, assess supplier performance consistency, and calculate supplier scores using the Supplier Evaluation Scorecard. The framework might be refined based on initial data analysis to ensure its effectiveness. Then, propose the solution based on the research findings, analyze the effectiveness of the Supplier Framework, and provide recommendations for its implementation within a manufacturing environment.

In conclusion, the developed supplier evaluation framework serves as a practical and valuable tool for manufacturers. It enables them to select and manage suppliers more effectively, ensuring the long-term success and sustainability of their supply chains. By adopting this framework, manufacturers can achieve greater reliability and efficiency in their supply chain operations, ultimately contributing to their competitive advantage in the marketplace. Future research could focus on refining the framework further and exploring its applicability across different industries and geographic regions to broaden its utility and impact. Developing a robust and resilient supply chain is critical for long-term success. This research aims to contribute to that goal by providing manufacturers with a practical tool for evaluating and selecting reliable suppliers who can adapt to changing market conditions. By fostering a more collaborative and transparent relationship between manufacturers and suppliers, this research has the potential to create a more efficient and sustainable supply chain ecosystem for the future. The study outcomes are expected to inform and reinforce industry standards, thereby boosting organizational competitiveness in rapidly changing market environments.

References

Bookbinder, J. H., Gümüş, M., & Jewkes, E. M., Calculating the benefits of vendor-managed inventory in a manufacturer-retailer system. *International Journal of Production Research*, 48(19), 5549–5571, 2010. https://doi.org/10.1080/00207540903095434

Wind, Y., & Robinson, P. J., The determinants of vendor selection: the evaluation function approach. *Journal of purchasing,* 4(3), 29-42, 1968.

Niranjan, T., Wagner, S., & Nguyen, S., Prerequisites to vendor-managed inventory. *International Journal of Production Research*, 50(4), 939–951, 2012. https://doi.org/10.1080/00207543.2011.556153

Ho, W., Xu, X., & Dey, P. K., Multi-criteria decision-making approaches for supplier evaluation and selection: A literature review. *European Journal of Operational Research, 202(1), 16-24, 2010.*

Lockhart, M., & Ettkin, L., Vendor certification: Seven steps to a better product. *Production and Inventory Management Journal*, 34(1), 65, 1993.

Nair, A., Jayaram, J., & Das, A., Strategic purchasing participation, supplier selection, supplier evaluation, and purchasing performance. *International Journal of Production Research,* 53(20), 6263–6278, 2015. https://doi.org/10.1080/00207543.2015.1047983

Agrawal, N., Smith, S. A., & Tsay, A. A., Multi-vendor sourcing in a retail supply chain. *Production and Operations Management*, 11(2), 157-182, 2002.

Hwang, I., Radhakrishnan, S., & Su, L. (Nancy), Vendor Certification and Appraisal: *Implications for Supplier Quality. Management Science,* 52(10), 1472–1482, 2006. https://doi.org/10.1287/mnsc.1060.0557

Talluri, S., & Narasimhan, R., Vendor evaluation with performance variability: a max-min approach. *European journal of operational research*, 146(3), 543-552, 2003.

Araz, C., & Ozkarahan, I., Supplier evaluation and management system for strategic sourcing based on a new multicriteria sorting procedure. International journal of production economics, 106(2), 585-606, 2007.

Sundtoft Hald, K., & Ellegaard, C., Supplier evaluation processes: the shaping and reshaping of supplier performance. *International Journal of Operations & Production Management,* 31(8), 888-910, 2011.

Zhang, L. J., Liu, R., Liu, H. C., & Shi, H., Green supplier evaluation and selections: a state-of-the-art literature review of models, methods, and applications. *Mathematical Problems in Engineering*, *2020*, 1-25, 2020.

Southard, P. B., & Swenseth, S. R., Evaluating vendor-managed inventory (VMI) in non-traditional environments using simulation. *International Journal of Production Economics*, 116(2), 275-287, 2008.

Ebrahimpour, M., & Johnson, J. L., Quality, vendor evaluation, and organizational performance: a comparison of US and Japanese firms. *Journal of Business research*, 25(2), 129-142, 1992.

Biographies

Tasfia Tarannum graduated from North South University with a Bachelor of Science in Electrical Engineering in 2014. She is doing a Master of Science in Business Analytics and Supply Chain Management Certification. She has been an experienced professional in Engineering and Supply Chain Management roles for almost seven years. She worked on sustainability performance management and in continuous improvement in the context of FMCG and supply chain management. Her research interests include supply chain management sustainability, service operations management, continuous improvement, as well as business innovations, vendor management, industrial sustainability, industry management, optimization, reliability, and manufacturing resilience among others.

Hayder Zghair is an assistant professor of Industrial Engineering in the Department of Engineering and Physics, and the director of Industrial Engineering Development in the College of Science and Engineering at Southern Arkansas University. Dr. Zghair is chairing and member of several committees at the department, college, and university levels. Before joining SAU, served in several academic appointments including Assistant Teaching Professor of Industrial and Manufacturing Engineering at Pennsylvania State University and lecturer of Industrial and Manufacturing Engineering at Kettering University. He completed a B.S. and an M.S. from the University of Technology, where he majored in Industrial and Production Engineering. Dr. Zghair earned his second master's degree in Manufacturing Systems Engineering and Doctor's Degree in Manufacturing Systems Engineering from Lawrence Technological University, Michigan, USA. He has several professional affiliations: Affiliate Researcher at Penn State Institute of Energy and the Environment and Member of Directors Board of the Environmental Engineering Division (EED) at American Society of Engineering Education (ASEE). Dr. Zghair's research interest covers a wide area of industrial and manufacturing engineering including Flexible-Automated Manufacturing, Robotics, Human Factors and Ergonomics, Sustainability Engineering, Analytical Modeling & Simulation, and Optimization, and has published journal and conference papers. Dr. Zghair continues to explore new and cutting edges areas for research and education in engineering disciplines and got recently had an extensive interest in industry 4.0 and 5.0 tech such as AI, IIoT, smart sensors, and cloud computation and control. He is a professional member of ASEE, Institute for Operations Research and Management Sciences (INFORMS), Society of Automotive Engineers (SAE), and Industrial Engineering and Operations Management Society (IEOM). Dr. Zghir is the faculty advisor of the SAE students' chapter and SAU Baja and IEOM students' chapter at SAU.