The Role of Flexibility in Enhancing Operational Performance Through Sustainability Practices: A Case Study on the US and European Original Equipment Manufacturers

Mohamad Ali Mezher* and Raed El-Khalil
Information Technology and Operations Management Department
Lebanese American University
Beirut, Lebanon
mohammadali.mezher@lau.edu, raed.elkhalil@lau.edu.lb

Abstract

Flexibility and Sustainability are two philosophies that the original equipment manufacturers (OEMs) invested heavily in since the 21st century. This study identified the lack of empirical research investigating the relationship between flexibility and sustainability and their combined interactions with operational performance metrics. Very few studies investigated this relationship in limited depth and breadth. Therefore, this study aims to investigate the interaction between flexibility, sustainability, and their impact on operational performance in the United States (US) and European (EU) OEMs. Based on the contingency theory and resource-based view theory, a conceptual model linking flexibility, sustainability, and operational performance was developed and empirically tested. After reviewing previous literature and consulting academicians and practitioners experienced in the topic, a survey was developed. The survey was conducted with a total of 140 respondents. The respondents are managers at OEMs facilities in Europe and the US. The results indicated a significant and positive relationship between flexibility and operational performance, flexibility and sustainability, and sustainability and operational performance. The results also revealed that sustainability mediates the relationship between flexibility and operational performance. This study can help managers know what flexibility and sustainability practices optimize operational performance.

Keywords
Flexibility, Sustainability, Operational Performance Metrics, Manufacturing, Original Equipment Manufacturers.

1. Introduction

The manufacturing industry became one of the main pillars of Europe and the US economy. And based on that, manufacturing firms started to reassemble their capabilities to gain a competitive edge and survive in the market. In the 1960s, cost was the primary concern for organizations. Throughout decades, and due to rapid industrialization, organizations' priorities changed. Products and services delivery speed and customer satisfaction became as important as quality and cost. Thus, firms started adopting and implementing "flexible" practices in their manufacturing process to be able to cope with the fluctuating market environment.

To identify the drivers of global manufacturing competitiveness, Deloitte Inc., in 2016, conducted a global CEO survey (Deloitte, 2016). Out of the twelve identified drivers, "innovation and talent" was the most crucial one, as stated by the executives. And the primary driver component of innovation was flexibility (Deloitte, 2016). Slack (2005) and El-Khalil (2009) defined flexibility as the ability of the organization to absorb external disruptions without vandalizing the overall process output. Flexible manufacturing plays a significant role in improving efficiency, profit, customer service, and effectiveness (El-Khalil and Darwish, 2019). In the past few years, flexibility has been witnessing an increased interest from scholars and practitioners. Some scholars consider that adopting flexible practices is an important decision that any firm should take to survive in the complex and competitive market.

Due to the brisk industrialization and its severe effect on the environment, various governments and organizations started to focus on implementing sustainable behaviors in the manufacturing process. Manufacturing industries consider implementing sustainable practices as a necessity for survival in the competitive market. The United Nations defined sustainability as the ability of the firm to meet its direct and indirect stakeholders' needs while taking into consideration the needs of the future stakeholders (Tang et al., 2016). The concept of "Sustainability" has been studied in several areas and most notably in the business and manufacturing sector (Gunasekaran and Spalanzani, 2012). Numerous benefits can result from the integration of flexibility and sustainability, such as improved environmental performance, the ability to hold a better competitive position, and reduced cost.

1.1 Objective

Several studies have examined the interaction between flexibility and sustainability. Some studies found a positive relation between flexibility and operational performance (El-Khalil and Dariwsh, 2019), sustainability and operational performance (Geyi et al., 2020), and flexibility and sustainability (Taneja et al., 2014). However, most of these studies were limited in depth and breadth in either selecting the metric or limited to a specific industry and/or country. Additionally, no studies have examined how flexibility can enhance operational performance through sustainability practices in Europe and the US original equipment manufacturers (OEMs). Accordingly, this paper aims to answer the following research question:

Q1: How do sustainability practices mediate the relationship between flexibility and operational performance?

The significance of this paper lies in its ability to direct managers toward what flexibility tools to focus on based on performance metrics required and what sustainability implementation will help in optimizing performance.

To answer the above research question, 140 OEM managers in the US and Europe were surveyed. The remainder of the paper is organized as follows: Section 2 presents a summary of previous literature. Section 3 discusses the conceptual model used and research methodology. Section 4 presents the results. The conclusions, implications, and limitations of the study are presented in section 5.

2. Literature Review and Hypotheses Development

2.1 Theoretical Framework

This research will focus on the theory of contingency and resource-based view (RBV). The previous work done by Slack (1988), Gerwin (1987), and Parthasarthy and Sethi (1993) suggests that manufacturing flexibility depends on

the organization's external environment and internal operations. According to previous research, the dominant forces influencing manufacturing flexibility are four general areas: technology, organizational attributes, strategy, and environmental factors. The contingency theory will help us understand the relation between flexibility, as a strategic decision, and operational performance in the existence of sustainability as a mediator.
On the other hand, the RBV proposes that firm-level resources should be none-substitutable, rare, valuable, and imperfectly imitable to improve firms' competitive advantage (Barney et al., 2001). In other words, the RBV states that sustained organizational performance is determined and influenced by the resources that firms own (Wernerfelt, 1984). This research considers flexibility tools as a resource and capability that helps us understand its effect on sustainability and operational performance.

2.2 Flexibility

The concept of flexibility was first introduced in 1921 by Lavington (Lavington, 1921), in which he discusses the importance of creating flexibility in manufacturing. Flexibility is present in various topics and research fields, such as production, information technology, decision theory, and economics. Several industries from different countries are implementing flexibility practices to improve productivity, deal with uncertainties, and survive in the competitive market (Boyle 2006; Anand and Ward 2004). Various scholars tried to categorize flexibility dimensions. The most used flexibility classification is the one developed by Vokurka and O'Leary-Kelly (2000), in which they divided flexibility into fifteen types. Later, El-Khalil and Darwish (2019) divided the fifteen flexibility dimensions into three levels: Operational, Tactical, and Strategic, as shown in table 1.

Table 1: Flexibility classification

	Indicator	Flexibility Type	Definition
Operational			
	FMS1	Machine	The system can switch operations with minimal effort
	FMS2	Material Handling	Different part types can be moved efficiently for proper positioning and processing
	FMS3	Automation	Automation is capable of performing different operations and/or add operations
	FMS4	Labor	The number of workers, tasks performed by workers, and responsibilities can be changed
	FMS5	Routing	A part can be produced by alternative routes
	FMS6	Product	New parts can be added or substituted for the existing parts easily
	FMS7	Volume	The system can be operated profitably at different product overall output levels
Tactical			
	FMS8	Operation	Parts can be produced in different ways with alternative process plans
	FMS9	Process	The system can produce a set of part types without major set-up
	FMS10	Delivery	The system ability respond to changes in delivery requests at any time and at any circumstance.
	FMS11	Program	The system can run virtually untended for a long enough period
Strategic			
	FMS12	New Design	The system can easily produce a product with a different shape and/or dimension
	FMS13	Expansion	The system's capacity and capability can be easily increased when needed
	FMS14	Production	The FMS system can produce a big variety of part types
	FMS15	Market	The manufacturing system can easily adapt to a changing market environment

Different manufacturing strategies have been studied extensively in the literature, such as lean (El-Khalil et al., 2020) and agility (Geyi et al., 2020). Flexibility, as with other manufacturing strategies, has been examined by numerous scholars. The implementation of volume flexibility will support the manufacturer's ability to operate at different product output levels, leading to improved productivity (Marschack and Nelson, 1962). While, if volume flexibility is coupled with mix flexibility, the manufacturer can have more room for innovation in the production process, which means better quality and positive customer satisfaction (Zhang et al., 2003; Oke, 2013).
In fact, if the organization has the ability and the resources to implement whatever type and level of flexibility, then productivity and efficiency will improve significantly (Wei et al., 2017). However, the implementation should be

coupled with a valid and reliable plan that employees and managers can base their work on. As the departments' coordination improves, flexibility practices will enhance both competitiveness and business performance (Kaur et al., 2017). Moreover, labor flexibility plays a significant role in improving the firm manufacturing performance; if the worker is cross-trained with other units/departments, then the worker's heterogeneity will increase, and thus, the worker performs better (Koste and Malhotra, 1999).
Furthermore, all flexibility types (i.e. operational, tactical, and strategic) might play a major role in improving operational performance (El-Khalil, 2018). However, the impact of each might differ from the other.

Therefore, and based on the above insights, the following hypotheses are formulated:

H1a: Operational flexibility has a positive impact on operational performance.
H1b: Tactical flexibility has a positive impact on operational performance.
H1c: Strategic flexibility has a positive impact on operational performance.

2.3 Sustainability

The origin of sustainability may be traced to over a century from a concept known as Spaceship Earth (George, 2009). Spaceship Earth is a paradigm that encourages all human beings on Earth to live together in harmony with the common good (George, 2009). After the Brundtland Report in 1987 on sustainable development, the concept gained significant interest and popularity among scholars and practitioners (Alhaddi, 2015). The United Nations defines sustainability as the ability of the firm to meet its direct and indirect stakeholders' needs while taking into consideration the needs of the future stakeholders (Tang et al., 2016). Sustainability consists of the triple bottom line (TBL) (Govindan et al., 2016). The TBL is a framework that measures the organizations' success through three dimensions: environmental, social, and economic. First, sustainability was measured only using environmental practices (Elkington, 1997). Through time, the environmental agenda was expanded and integrated other dimensions, such as social and economic, as illustrated in Table 2.

The TBL is the integration of all three dimensions. However, some inconsistencies exist in previous literature regarding the usage of the TBL. For example, some studies only considered the social dimension while examining sustainability (Bibri, 2008). Others used sustainability in terms of the environmental dimension only (Yan et al., 2009). Therefore, to optimize sustainability outcomes, the TBL dimensions must be balanced and implemented simultaneously (Govindan et al., 2016; Epstein, 2008).

An increased interest is witnessed by scholars in studying the effect of sustainability, namely the triple bottom line: economic, environmental, and social dimensions on the operational performance (Govindan et al., 2016). Increasing pressure is put on manufacturing industries to adopt sustainable practices in their manufacturing activities and services (Gunasekaran and Spalanzani, 2011). These sustainable practices are internal (employees' safety, quality, productivity, and cost-saving) and external (government rules and regulations). Faulkner and Badurdeen (2014) developed a sustainability evaluation model for manufacturing systems based on integrating value stream mapping and triple bottom line dimensions. Several studies have stressed the importance of using the triple bottom line dimensions while assessing the manufacturing system performance. Sustainability is not only about performing well environmentally, but it is also the ability of the organization to perform socially and economically (Gunasekaran and Spalanzani, 2011). The more firms invest in sustainable practices, the better the performance (Esfahbodi et al., 2016).

When the organization engages in environmentally sustainable activities, such as reducing the use of hazardous materials and protecting biodiversity, it reduces the waste and energy consumption in its manufacturing process, leading to improved performance (Munasinghe et al., 2017; Rabadán et al., 2019). Also, implementing environmental practices might encourage the customer to deal with the organization, leading to increased sales and better financial performance (Ameer and Othman, 2012; García-Dastugue and Eroglu, 2019).

Additionally, when the firm implements social activities, it creates a healthy work environment for the employees, and employees' morale and productivity improve when they feel respected and safe (Kossek et al., 2014; Schoenherr and Talluri, 2013). The same thing applies to economic activities; when the company invests in the infrastructure and local community, it improves its image and reputation in the society (Jin et al., 2017). And when the company

image and reputation improve, more customers will come, leading to more sales and improved profitability (Jin et al., 2017). Therefore, and based on the above facts, the following hypotheses are derived:

H2a: Economic sustainability practices have a positive impact on operational performance.
H2b: Environmental sustainability practices have a positive impact on operational performance.
H2c: Social sustainability practices have a positive impact on operational performance.

Table 2: Sustainability Dimensions and Practices

Sustainability Dimensions	Indicator	Practices
Economic	SUSECO1	The company works towards improving its market share
	SUSECO2	The company works towards improving its image in the society
	SUSECO3	The company works towards improving its position in the market place
	SUSECO4	The company generates sales and profits
	SUSECO5	The company tries to reduce its material purchasing cost
	SUSECO6	The company tries to reduce its utility bills
	SUSECO7	The company tries to reduce waste treatment fees
	SUSECO8	The company tries to reduce waste discharge fees
	SUSECO9	The company tries to reduce environmental accidents
	SUSECO10	The company works towards improving its products/services quality
Social	SUSSOC1	The company has very good relations with the community and stakeholders
	SUSSOC2	Work in the company is safe
	SUSSOC3	The company cares about employees health
	SUSSOC4	The company has a healthy work environment
	SUSSOC5	The company tries to improve the living quality of the surrounding community
	SUSSOC6	The company takes social welfare initiatives
	SUSSOC7	The company complies with laws and standards
	SUSSOC8	The company highly respects human rights
	SUSSOC9	The company has good working conditions
	SUSSOC10	The company treats suppliers fairly
	SUSSOC11	The company ensures product safety
Environmental	SUSENV1	The company minimize the use of hazardous substances
	SUSENV2	The company minimize the use of water
	SUSENV3	The company minimize solid wastes and emissions
	SUSENV4	The company use alternative and renewable energies
	SUSENV5	The company works toward protecting biodiversity
	SUSENV6	The company uses resources efficiently

2.3 Flexibility and Sustainability

Flexibility in manufacturing helps to prolong the useful lifetime of machines and tools by allowing adaptation and thus promoting reusability. Reuse optimizes the use of natural resources while also limiting waste and emissions in the environment, lowering the overall ecological effect (Taneja et al., 2014). It also greatly reduces lifecycle costs and conserves energy resources. The money saved could be used to improve the environment or social equity. Flexibility, in this way, aids (long-term) financial viability in the face of economic instability while minimizing environmental and social impacts (Taneja et al., 2014). A sustainable product is a product that supports the economy, society, and environment while ensuring public and environmental safety during their entire life cycle, from raw material extraction to final disposal (Greden, 2005), and as observed, flexibility makes this possible. Flexibility aims to improve efficiency, productivity, and reduce cost, and this aligns with sustainability objectives. Adaptation has costs, but it has a payoff in the form of reduced ecological effects. As stated by De Neufville et al. (2006), “A flexible design will have a different risk-reward profile than an inflexible system, and thus may be more attractive to investors. Flexible designs will help to advance sustainability goals by specifically addressing future uncertainty at the design stage”. Flexible resource use during operations helps to maximize resource utilization and thereby contributes to sustainability. Organizations can not maintain sustainable outcomes without being flexible (Ojstersek et al., 2019). The customer’s need for new sustainable products and services will drive manufacturing firms to implement flexibility practices (Blome et al., 2014).

Thus, and based on the above arguments, the following hypotheses are formulated:
H3a: Operational flexibility has a positive impact on sustainability practices.
H3b: Tactical flexibility has a positive impact on sustainability practices.
H3c: Strategic flexibility has a positive impact on sustainability practices.
H4: Sustainability practices mediate the relationship between flexibility and operational performance.

3. Methodology and Conceptual Model

3.1 Conceptual Model

Following the work of Sethi and Sethi (1990), O'Leary-Kelly and Vokurka (2000), and El-Khalil and Darwish (2019), among others, this study developed a similar model, as illustrated in figure 1. Moreover, and after going through previous literature and practitioners' feedback, this study filled the literature gaps. For example, in El-Khalil and Darwish (2019) paper, they did not consider sustainability practices in their study. Furthermore, the study was limited to the US automotive industry. Other studies like Wei et al. (2017), Zhang et al. (2013), and Koste et al. (2004) were also limited to a particular industry/country or did not examine all flexibility dimensions simultaneously. This is the first study that examines Flexibility and Sustainability practices in the US and European OEMs.

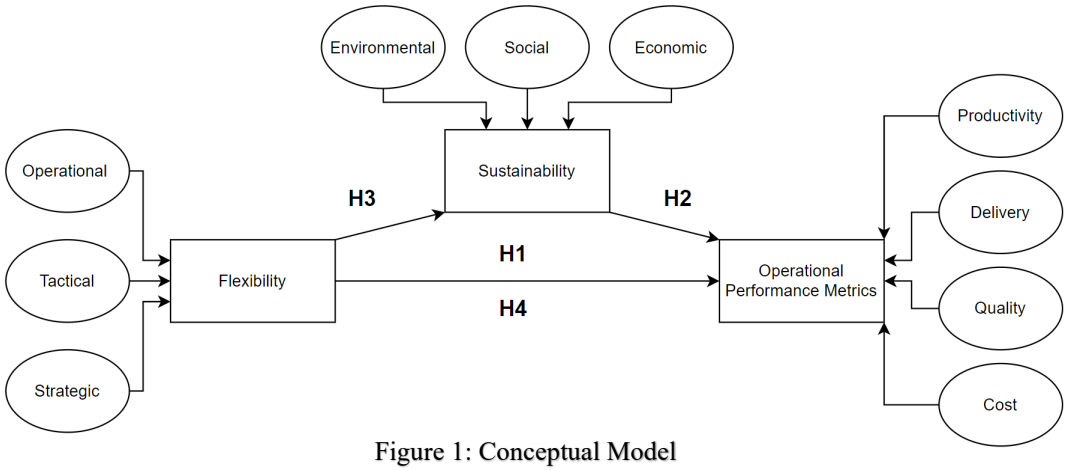

Figure 1: Conceptual Model

3.2 Survey Development

The research aims to determine the current state of sustainability and flexibility implementation and their impact on the US and European OEMs' operational performance. The developed survey was adopted from several studies, such as Chauhan and Singh (2013), Shah and Ward (2007), Slack (2005), and El-Khalil and Darwish (2019). The final version of the survey was shared with senior operational managers at big manufacturing companies and academicians with extensive experience in the industry. The survey was divided into two parts. The first parts consist of demographic questions, such as gender, facility location, job position, level of education, years of experience, company annual sales, number of employees, years of flexibility implementation, and years of sustainability implementation. The second part contains fifteen questions about the level of implementation of the fifteen flexibility tools (Table 1) and sustainability practices (Table 2). Then the participants were asked how the implementation of these practices affected productivity, cost, quality, and delivery. The survey items were based on a seven Likert scale, where 1 is no implementation (0%), and 7 is complete implementation (100%).

4. Results

The analysis of the collected data was done using Smart PLS and SPSS. These two software packages are widely used by a variety of scholars.

4.2 Exploratory Factor Analysis

Before conducting the exploratory factor analysis, the suitability of data for factor analysis was examined. The results of the correlation matrix revealed coefficients >= 0.7. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was 0.962, which is more than the recommended value of 0.6 (Kaiser,1974), and Bartlett's Test of Sphericity (Bartlett, 1954) is 0.000, supporting the correlation matrix factorability.

As for factor extraction, a principal component analysis was utilized. The results show 7 factors with eigenvalue >1, explaining the variance (Hair et al., 2014). All loadings were above 0.5, thus, none of the 46 items were removed (Marshall et al., 2007). Component 1 represents operational flexibility (FLXOP), component 2 represents tactical flexibility (FLXTAC), component 3 represents strategic flexibility (FLXST), component 4 represents economic sustainability (SUSECO), component 5 represents environmental sustainability (SUSENV), component 6 represents social sustainability (SUSSOC), and component 7 represents operational performance metrics (OPM).

4.2 Psychometric Properties

A test for reliability and validity was conducted using Cronbach's alpha. The results indicate a Cronbach's alpha value of 0.94 for operational flexibility, 0.88 for tactical flexibility, 0.92 for strategic flexibility, 0.943 for economic sustainability, 0.956 for social sustainability, 0.93 for environmental sustainability. All Cronbach's alpha coefficient values are above the required 0.7 (Furr, 2018), which indicates a very strong consistency and reliability. As for the convergent validity, it was measured using average variance extracted (AVE), composite reliability (CR), and item loading. The values of AVE, CR, and item loading are above the required value of 0.5, 0.7, and 0.5, respectively (Furr, 2018).

4.3 Hypotheses Testing

Testing the hypotheses results was done using path coefficient, p-value, and t-statistics, all illustrated in tables 3, 4,5, and 6. H1a,b,c, H2a,b,c, and H3a,b,c are all supported at significance level of 0.01. As for the mediation (H4), a Sobel test was conducted. And it was also significant at the 0.01 level (Table 6).

Table 3: Testing Hypothesis 1

Hypothesis	Path	Direct Effect	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Result
1a	FLXOP -> Cost	0.893	0.894	0.017	53.485	0.00	Supported
	FLXOP -> Delivery	0.814	0.812	0.038	21.646	0.00	
	FLXOP -> Productivity	0.783	0.781	0.035	22.652	0.00	
	FLXOP -> Quality	0.847	0.844	0.033	25.377	0.00	
1b	FLXTAC -> Cost	0.854	0.855	0.02	41.81	0.00	Supported
	FLXTAC -> Delivery	0.802	0.803	0.032	25.13	0.00	
	FLXTAC -> Productivity	0.788	0.787	0.037	21.18	0.00	
	FLXTAC -> Quality	0.838	0.837	0.026	32.177	0.00	
1c	FLXST -> Cost	0.826	0.826	0.032	25.981	0.00	Supported
	FLXST -> Delivery	0.794	0.794	0.037	21.6	0.00	
	FLXST -> Productivity	0.74	0.741	0.041	18.206	0.00	
	FLXST -> Quality	0.836	0.834	0.03	28.157	0.00	

Table 4: Testing Hypothesis 2

Hypothesis	Path	Direct Effect	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Result
2a	SUSECO -> Cost	0.854	0.852	0.026	32.57	0.00	Supported
	SUSECO -> Delivery	0.831	0.829	0.026	31.947	0.00	
	SUSECO -> Productivity	0.79	0.788	0.031	25.703	0.00	
	SUSECO -> Quality	0.832	0.83	0.03	27.879	0.00	
2b	SUSENV -> Cost	0.861	0.861	0.022	38.916	0.00	Supported
	SUSENV -> Delivery	0.838	0.837	0.029	28.46	0.00	
	SUSENV -> Productivity	0.846	0.847	0.021	39.869	0.00	
	SUSENV -> Quality	0.842	0.842	0.028	29.681	0.00	
2c	SUSSOC -> Cost	0.882	0.883	0.019	47.259	0.00	Supported
	SUSSOC -> Delivery	0.841	0.838	0.027	30.835	0.00	
	SUSSOC -> Productivity	0.843	0.843	0.025	33.196	0.00	
	SUSSOC -> Quality	0.854	0.852	0.028	30.688	0.00	

Table 5: Testing Hypothesis 3

Hypothesis	Path	Direct Effect	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Result
3a	FLXOP -> SUSECO	0.917	0.917	0.015	63.176	0	Supported
	FLXOP -> SUSENV	0.893	0.891	0.018	50.144	0	
	FLXOP -> SUSSOC	0.93	0.929	0.013	72.813	0	
3b	FLXTAC -> SUSECO	0.873	0.872	0.02	42.87	0	Supported
	FLXTAC -> SUSENV	0.897	0.895	0.017	51.505	0	
	FLXTAC -> SUSSOC	0.9	0.898	0.019	48.126	0	
3c	FLXST -> SUSECO	0.905	0.904	0.017	52.908	0	Supported
	FLXST -> SUSENV	0.884	0.884	0.02	44.842	0	
	FLXST -> SUSSOC	0.881	0.881	0.02	43.144	0	

Table 6: Testing Hypothesis 4

Direct Effect Without Mediation Variable			With mediation variable					Sobel Test Statistics	Decision
Path	Effect	P Values	Path	Effect	Std. Error	T Statistics	P Values	10.2 (p value = 0.0**)	Supported
FLX -> OPM	0.93	0.0**	FLX -> OPM	0.132	0.084	1.583	0.114		
			FLX -> SUS	0.96	0.008	113.138	0.0**		
			SUS -> OPM	0.83	0.081	10.182	0.0**		
**** significant at the 0.01 level (2-tailed)**									

5. Dicussion

5.1 The effect of flexibility on operational performance

The results of this study indicate that all flexibility types have a significant positive impact on all performance metrics. Therefore, the higher the level of flexibility implementation, the greater the improvements in operational performance metrics. Thus, H1a,b,c is supported. The results also reveal that operational flexibility has the highest impact on all performance metrics, followed by tactical flexibility and strategic flexibility. The results are in line with previous studies that stated that flexibility has the highest impact on cost and quality (Narsalay et al., 2016; El-Khalil and Darwish, 2019, Oke, 2013; Wei et al., 2017). This significant improvement in operational performance is due to the advanced level of flexibility implementation.; all OEMs implement flexibility practices in their manufacturing process, and all of them have more than ten years of implementing flexibility.

5.2 The effect of sustainability on operational performance

The results indicated that the effect of all sustainability dimensions on all performance metrics was positive and significant. Thus, H2a,b,c is supported. The results support previous work done by El-Khalil and Mezher (2020), Lin et al. (2006), Esfahbodi et al. (2016), and Geyi et al. (2020), in which all of them prove that sustainability practices lead to improvement in operational performance metrics. The higher the sustainability practices implementation, the more significant the improvement in operational performance metrics. Most of the sustainability dimensions have the highest correlation with cost and quality. This is because sustainability practices focus on reducing waste and enhancing the quality of products and services, leading to reduced cost and better quality. Some scholars argue that sustainability practices do not enhance performance. However, research has shown that sustainability practices enhance performance in the long term. And that is why some practitioners resist implementing sustainability practices because they expect to see results immediately.

5.3 The effect of flexibility on operational performance

The results of the study indicate that all flexibility types have a significant positive impact on all sustainability dimensions. Therefore, the higher the level of flexibility implementation, the greater the improvements in sustainability. Thus, H3a,b,c is supported. This is the first study that shows that each flexibility type has a high impact on a different sustainability dimension. For example, for the best social performance, operational flexibility should be focused on. For the best environmental performance, tactical flexibility should be focused on. And for the best economic performance, strategic/operational flexibility should be focused on.

5.4 The mediating role of sustainability

This study confirms the mediation of sustainability practices in the relationship between flexibility and operational performance metrics. Thus, H4 is supported. Most of the previous studies focused on studying the direct relationship between flexibility and operational performance. This is the first study that examines the developed model in the US and Europe OEMs. The Sobel test was used to test the mediation, and it resulted in a value of 10.2 and a p-value of 0.0. Therefore, mediation exists and is significant at the 0.01 level. However, the mediation is complete mediation

since the p-value from the direct relationship from flexibility to operational performance metrics is 0.114, as illustrated in table 6. So, without the mediator, the relationship between flexibility and operational performance metrics is not significant.

5.5 Theoretical Implications

This is the first study that links the contingency theory with the resource-based view theory within this context. Under the contingency theory, the results showed how sustainability plays a significant role in the relationship between manufacturing flexibility and operational performance. Also, under the resource-based view theory, the results revealed that by applying the right flexibility and sustainability practices, better operational performance can be achieved. Manufacturing firms around the world are shifting towards integrating sustainable practices within their manufacturing process. By adopting innovative practices, such as flexibility and sustainability, organizations will be able to compete in the market. When adopting such practices, organizations are not only benefiting themselves. They are also benefitting all stakeholders, including the surrounding community. For example, adopting flexibility and sustainability practices will not only enhance quality, productivity, or quality, but it will also benefit the community, employees, and customers while reducing the impact on the environment.

This study enhances our understanding of the interactions between flexibility, sustainability, and their impact on operational performance metrics in the US and European OEMs. The findings in this paper prove that flexibility has a significant positive impact on operational performance and sustainability. This study contributes to the literature by providing empirical evidence on the effect of flexibility on operational performance and sustainability. This is the first study that investigates this relationship in this depth and breadth. Also, it shows that sustainability plays a significant role in supporting the impact of flexibility on operational performance.

5.6 Managerial Implications

This study provides an insight into the role of flexibility in enhancing operational performance metrics through sustainability practices. Increased competition, scarcity of resources, globalization, and market uncertainties will necessitate firms to implement sustainable practices. The TBL dimensions will improve the competitive stance of the organization, leading to improved performance. Sustainability and flexibility practices must be implemented simultaneously to exploit their benefits and improve performance. Managers can use the developed model to know what flexibility and sustainability practices optimize operational performance. And managers should refrain from implementing certain practices if they intend to improve a specific performance metric. Also, organizations should prioritize flexibility types by their importance and plan when to implement each type.

6. Conclusion

The results presented in the study enhanced our understanding of flexibility and sustainability practices used by the European and US OEMs. We provided empirical evidence that flexibility has a significant and positive impact on sustainability and operational performance. Sustainability has a significant and positive impact on operational performance, and sustainability mediates the relationship between flexibility and operational performance. The results also showed that higher implementation of flexibility and sustainability practices would lead to better operational performance metrics. Sustainability is necessary to maximize the impact of flexibility on operational performance metrics. The study also provides managers with the ability to know which flexibility type enhances which sustainability practices and operational performance metrics.

In this paper, the performance metrics were limited to four. Thus, future studies should include more metrics, such as morale and sales. Additionally, future research should include more variables in their study, such as Industry 4.0, lean tools, supply chain, among others. Another limitation is that the study was conducted in European and US OEMs. Therefore, the results might not be accurate in other countries/regions. Further research can replicate and extend the study in other countries and with bigger samples.

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Biographies

Mohamad Ali Mezher is a second-year MBA student at the Lebanese American University. He works as a research assistant at the information technology and operations management department. His research focuses on subjects within the manufacturing industry such as flexibility, agility, lean manufacturing, sustainability, and Industry 4.0.

Dr. Raed El-Khalil is an associate professor and Chairperson of the information technology and operations management department at the Adnan Kassar School of Business, Lebanese American University. He holds a Doctorate in Industrial and Manufacturing Engineering from Lawrence Technological University. He has a rich background in numerous areas, including an MS in Engineering Management, Industrial and Manufacturing

Engineering, as well as a BSc in Industrial Engineering, Manufacturing Engineering, and Computer Science, both from the University of Michigan. In addition, he works as a consultant for several companies in the U.S. such as Chrysler, General Motors, and Boeing, in the areas of operations management. His research focuses on subjects within the manufacturing industry such as lean manufacturing, flexibility, sustainability, robotics, and overall organizational efficiency.