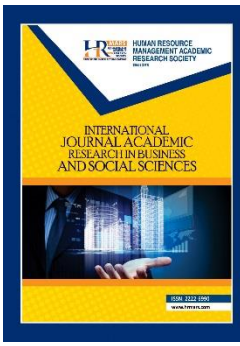

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Supplier Development and Sustainability Performance: A Meta-analytic Study

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Abstract
The intention of this study is to explore the influence of supplier development on the sustainability performance as well as on the economic, social and environmental dimensions of a manufacturing organization. The research was done using multiple different sources of data collection, such as Scopus, Science Direct, Emerald, Sage, Wiley Online Library, Web of Science (WoS) and Proquest. According to the findings, supplier development has a positive effect on sustainability performance. The most influential and supportive correlations are between supplier development and sustainability environmental performance and between supplier development and sustainability social performance. As a result, the study's significant contributions are related to: a) the prevalence of a positive and influential relationship between supplier development and sustainability performance; b) proof of supplier development effect size on sustainability performance (combined effect size coefficient at r (0.438)); c) an evaluation of the gaps in the scientific literature assessing the impact of supplier development on organisational sustainability. Future research in this area may focus on meta analyses that incorporate moderating and mediating constructs on the relationship between supplier development and sustainability performance.
Keywords: Supplier Development, Sustainability Performance, Economic, Social, Environment, Supply Chain

Introduction

Supplier development and sustainability is a critical collaboration that brings manufacturers and suppliers together on the path to achieving social, financial, and ecological progress that is sustainable (Ağan et al., 2017). Supplier development has been described as a powerful mechanism for achieving long-term sustainability (Wu, 2017). Due to the increasing demand for consumer goods, the unsustainable use of natural resources continues to rise. As a result of this growing demand, factories produce waste and pollution. Potential ecological destruction, health deterioration, and loss of basic necessities pose a threat to society and future generations. Therefore, supplier development towards sustainability ascertains that manufacturers and suppliers work together to achieve a shared objective of protecting the environment and people while still generating financial benefits (Yadlapalli et

al., 2018; Subramaniam et al., 2019; Kumar and Rahman, 2016; Yang and Zhang, 2017; Cole and Aitken, 2019; Yawar and Suering, 2018).

Despite these mountains of studies, supplier development inadvertently encourages the manufacture of more goods with greater trust, resulting in greater environmental and human effects as a result of the combined efforts of both the manufacturer and the supplier (Saghiri and Mirzabeiki, 2021). Besides that, some manufacturers also consider supplier development to be a poor investment strategy (Wang and Dai, 2018; Kumar and Rahman, 2016).

However, despite many businesses considering supplier development as a strategy that encourages improved performance at the cost of the environment and ultimately resulting in a loss of investment, supplier development is still a constructive solution that has a positive effect on the economy, society, and biodiversity as a whole (Kumar et al., 2017; Govindan et al., 2014). The word "triple bottom line" was coined to describe the sustainability performance of organisations that concentrate on issues related to environmental, economic, and social issues (Abdul-Rashid et al., 2017).

The end results of supplier development are not clearly apparent due to the ambiguity of the development effort if it is performed in an environment where shared trust does not exist between the manufacturer and supplier (Sucky and Durst, 2013; Bag et al., 2018). The study performed in previous studies does not depict the existence of studies evaluating the combined effect of supplier development on sustainability, nor the extent of the impact from the perspective of the organisations where efforts are made.

The focus of this research is on the effect of supplier development initiatives by manufacturers on the manufacturers sustainability performance.

There are studies that addresses obstacles to supplier development for global supply chains' long-term sustainability (Busse et al., 2016); the tradeoffs made willingly for implementing supplier development strategies to enhance supplier sustainability performance (Rogers et al., 2019); reasons for implementing supplier development approaches to manage sustainability (notably social issues) in an emerging country's supply chains (Yawar and Kauppi, 2018); effect on supplier performance through green procurement and green supplier development (Blome et al., 2014); discover green supplier development initiatives that will help suppliers boost their efficiency (Dou et al., 2014); identify barriers to green supplier development initiatives in manufacturing organizations (Bai and Satir, 2020); supplier selection, development and sustainablity (Trapp and Sarkis, 2016); impact of supplier development programs on small and medium sized organizations (Arráiz et al., 2013); supplier development activities as in interorganizational new development projects as part of a collaborative information-sharing mechanism (Lawson et al., 2015); supplier development to establish long term relationships to improve the supplier's performance (Glock et al., 2017); socially responsible supplier development efforts to tackle supplier ethical issues (Lu et al., 2012); environmental supplier development programs concentrated on low carbon management (Sillanpää et al., 2015); on social based supplier development programs in automobile industry supply chains (Habek et al., 2020); supplier selection, evaluation and development for sustainability reliant supplier risk management (da Silva et al., 2020), among others. In this study, the article examines the effect of supplier development on sustainability performance, which considers three dimensions: economic, environmental and societal.

The set of articles selected for this study, as well as the system used to screen them, were based on Field and Gillett's methods (Field and Gillett, 2010). The technique has been used widely in many studies involving meta-analytic approaches on environmental and

business topics. The empirical papers were identified and searched using quantitative data that could be combined in the effects of meta-analysis. The papers were found in Scopus, Science Direct, Emerald, Web of Science, and Wley Online Library, all of which are high impact databases. The search was conducted between April and May of 2021. The order in which the papers were selected was not dictated by chronological order. A selection of keywords were used to construct the search strings, as well as Boolean operators such as OR and AND to add further combinations, based on the problem's search questions. The search strings are: “supplier development” AND “sustainability” OR “sustainable practices” OR “sustainable operations” AND “quantitative”. The search yielded 6102 articles, with general terms being used to ensure the greatest number of hits. The final screened papers were 16 after further screening of the listed articles. There were 33 studies and 12131 total effects in the final articles.

The following is how the meta-analysis study based on existing literature contributes to the academic world. (1) Relationship between supplier development and sustainability is positive and significant, supporting previous research in the field of supplier management and sustainability; (2) Supplier development has a positive and significant effect on each aspect of sustainability performance, including economic, social, and environmental; (3) Supplier development has a positive influence on an organization’s sustainability performance; (4) The analysis contributes evidence that supplier development practices benefits organizations and supports them to attain better sustainability performance.

Supplier development is an effective technique used by manufacturing companies to enhance their suppliers' ability to deliver high-quality goods on time. The manufacturing organization's ability, the team's expertise, and the production activities' know-how are all rare and valuable resources unique to an organisation. From a management perspective on supplier development, these activities pave the way for long-term sustainability for both the supplier and the manufacturer, the opportunity to collaborate and corroborate together, and improved bottom lines for both parties involved. The advantages of implementing numerous joint development projects that enhance operations, decision-making, and management processes will result in more effective use of raw materials and resources, reduced waste, and contributions to society's development. To put it another way, the greater degree of supplier development efforts will have a substantial and beneficial impact on an organization's social, economic, and environmental sustainability results.

Finally, in addition to the introduction section, this article is divided into four parts. The theoretical perspective of supplier development and sustainability, as well as indicators for each of the sustainability performance dimensions, are covered in the following section. The research methodology is described in depth in section on meta analysis. The analysis and discussion of the research findings are presented in the section on results and discussion, and the contribution from a managerial perspective and the study's limitations are in last section.

Supplier Development and Sustainability

The need for sustainability has globalized with the introduction of regulations and various targets across continents such as the aim of achieving low carbon economy status by lowering greenhouse gas emissions. Apart from environmental considerations, adopting social standards such as the Social Accountability Standard (SA8000) and the mandatory reporting criteria in many countries for companies to announce sustainability accomplishments as part of their annual performance report are examples of how businesses should understand the triple bottom line dimensions of sustainability (Le et al., 2012). The

level of advancement in an organization's performance while upholding the organization's responsibilities for mankind's existence is referred to as sustainability performance (Yang et al., 2011). In an organisation, sustainability must be approached from the top down, beginning with top management and their corporate plans and ultimately leading to long-term operations focused on sustainability (Morioka and Carvalho, 2016). While several organisations have made sustainability a priority, there is still a substantial gap between real environmental impact mitigation and sustainable raw material use.

According to the Resource Based View theory, unique resources lead to unique capabilities, and these unique capabilities provide organisations with the ammunition they need to boost their competitive edge (Yu et al., 2017). Natural resource based view is an extension of Hart's Resource based view theory, which incorporates the environment into the basic RBV theory (Hart, 1995). A main strategy is for manufacturing companies to purchase raw materials from suppliers in order to emulate a product life cycle that promotes environmental sustainability (Mishra et al., 2019; Das et al., 2018). Supplier development, through supplier assessment and collaboration work, is where the organisation gets directly involved in developing the capabilities of suppliers in order to help them enhance their sustainability performance. This will improve the organization's long-term sustainability performance as well as the production capabilities of its suppliers (Subramaniam et al., 2019; Yadlapalli et al., 2018).

According to the theories, supplier assessment and supplier collaboration should have a positive effect on the three pillars of sustainability performance: economic, environmental, and social (Akhavan et al., 2018; Dalvi and Kant, 2018). However, due to supplier assessment, a fundamental supplier development activity that evaluates a supplier and offers recommendations for improvement against a pre-set list of requirements, the results do not always demonstrate improvements. Suppliers view this as a way for companies to test them in the short term without having to invest a lot of money (Chavhan et al., 2017). Supplier collaboration, on the other hand, entails a high level of joint development and joint studies between both parties and large investments, which are viewed as poor investment decisions internally in the organisations because the investments are to external organisations, in this case the suppliers (Proch et al., 2017). However, for the long-term growth, supplier development is clearly a strategy that benefits both parties and forms the foundation of a prolonged partnership, not merely a customer-supplier relationship (Cole and Aitken, 2019; Yang and Zhang, 2017).

This partnership, which is developed by supplier development practices, explains how an organisation and its suppliers can compete with other well-established companies in the industry by focusing on quality, expense, flexibility, distribution, and other operational metrics, as well as sustainability objectives (Jin et al., 2019; Ağan et al., 2018). Suppliers of raw materials, parts, and services can be found all over the world, with a significant number of them in developing countries with unstable governments and social policies. Furthermore, such countries are often linked to concerns such as non-compliance with health and safety regulations, the misappropriation of human rights, and the use of child labour. Organizations' social based development activities and requirements will not only place suppliers on the right track, but will also help them build and govern the right policies (Subramaniam et al., 2019).

Supplier assessment and supplier collaboration activities have an effect on both suppliers and manufacturing organisations' sustainability results. As a result, the community and environment in which suppliers and manufacturing organisations operate must be

secured, which can be accomplished by cooperating on supplier development efforts. Organizations may invest in the future of suppliers by offering training and exchanging expertise, in addition to joint development projects. Some studies have shown a correlation between supplier development and sustainability performance, such as Luzzini et al. (2015), who discovered that inter-firm development activities enable organisations to share sustainability risks associated with their supply base while also benefiting from suppliers' inherent expertise to mutually improve their performance.

Supplier development is an independent variable, and sustainability performance is the dependent variable, according to the study's hypotheses. According to the past research works, there is a clear and positive connection between supplier development and sustainability performance. As a result, hypothesis 1 (H1) is established as follows:

H1. Supplier development has a significant and positive impact on the manufacturing organization's sustainability performance.

Supplier Development and Performance in Economic, Social and Environmental Sustainability

Supplier development plays a crucial role in the operations of every manufacturing organization. The point to note is that manufacturing organizations will continue to expand their suppliers in order to boost their performance (Zhang et al., 2017). Logically, the organizations should be addressing and balancing the economic and environmental concerns while they represent an organization that encourages fairness, social engagement with stakeholders, the protection of the underprivileged, and the elimination of gender discrimination (Ağan et al., 2018; Bag et al., 2018).

Regardless, organizations pursuing sustainability should be concerned not only with supplier development in improving their supply chain, but with all of the pillars of sustainability, and the benefits should include people and the environment (Zhang et al., 2017). The impacts on vendors, cultures, and communities beyond the organization's walls, as well as employees inside the organization's walls, that could be affected by supplier production activities are the issues of social dimension (Cole and Aitken, 2019). On the other hand, environmental concerns include the effect on polluting emissions and the utilisation of natural resources, all of which can be affected by a joint venture that produces more durable goods (Liu et al., 2018). Meanwhile, the economic dimension, which is focused on the organization's profit and loss, is another dimension that may be influenced by supplier development activities, which involve investment by both parties (Yawar and Seuring, 2018). According to the research, there is a direct and positive relationship between supplier development and economic sustainability performance. Therefore, hypothesis 2a (H2a) is elaborated as follows:

H2a. Supplier development has a significant and positive impact on the manufacturing organization's economic sustainability performance

The supplier development process is automatically susceptible to improvement and development when considering the sustainability dimensions, resulting in a comprehensive, exhaustive, and complex process. However, these developments in the supplier development process force organisations to concentrate their efforts on the entire supplier management process, from supplier selection to supplier monitoring to collaborative supplier development (Chavhan et al., 2017). Sustainability is not something that can be accomplished in a short period of time, given its importance; it is a long journey of constant adjustments,

enhancements, and transitions that necessitates the participation of all stakeholders and a conscientious review of each of the sustainability dimensions (Huma et al., 2020).

Efforts to develop suppliers, such as assessing and collaborating with them, facilitate the interface between organisations and suppliers, increasingly incorporating the use of the organization's expertise and experience to develop suppliers as necessary (Sancha et al., 2019). The advancement of technology in materials and processes, as well as supplier development activities, encourages the use of the latest up-to-date technology in manufacturing processes, which benefits employees' social aspects such as a better working atmosphere and more productive production, resulting in a higher profit margin (Mathivathanan et al., 2019). Furthermore, the joint effort between the organisation and the suppliers benefits the communities in which the businesses work as well as the end users of the goods manufactured because the technologies used reduce environmental pollution (Cole and Aitken, 2019). As a result, it is anticipated that there will be a direct and positive relationship between supplier development and organization social sustainability results. Therefore, hypothesis H2b is elaborated as follows:

H2b Supplier development has a significant and positive impact on the manufacturing organization's social sustainability performance.

For sustainability, the goals are accomplished by creating suitable indicators to measure them. Indicators are a way of explaining the effects of an experiment, and they describe a definition of reality based on a collection of data describing parameters that represent the state of the environment (Junior et al., 2018). Sustainability indicators are used to assess and monitor improvements in an organization's operations with an emphasis on sustainability advancement (Joyce et al., 2016). The indicators representing the sustainability performance dimensions are: (1) Social: Stakeholders' health and safety (employees, society, and consumers), human rights or fair treatment, and stakeholder participation, especially in term of the community (2) Economic: Cost reduction by increasing the efficiency and effectiveness of production by lowering the cost of inputs, reducing waste generated, and making better use of resources and energy; Reduced operating costs by lowering the cost of purchased inputs, electricity use, and operational expenditures including waste management (3) Environmental: Reducing environmental mishaps (accidents, spills, and violations), as well as waste and pollution from operations like wastewater, greenhouse gases, solid wastes, and chemicals; reducing the usage of utilities such as food, water, and electricity; reducing the purchase and use of non-renewable resources and commodities; utilizing alternative manufacturing techniques and redesigning goods to allow for recycling and the use of renewable energy (Yusoff et al., 2019; Huo et al., 2019; Cantobelli et al., 2019; Ikram et al., 2019; Shao et al., 2019; Yadlapalli et al., 2019; Zaid et al., 2018).

The emphasis of the organisations will be on developing suppliers through various assessment and development activities with the goal of improving their profitability and increasing their market share, based on the sustainability performance dimensions and the metrics that reflect them (Joshi et al., 2017). Regardless of the profit based bottom line, the environmental and social aspects are equally important. As a result, companies engage in supplier development activities by engaging in programmes that drive value and profitability for both the company and the suppliers (Yang and Zhang, 2017). Supplier development is the independent variable in this analysis, and sustainability performance is divided into three dimensions: environmental, economic, and social. Thus, each of the 3 dimensions is investigated separately as dependent variables as well. According to previous research, there should be a direct and positive relationship between supplier development and an

organization's environmental sustainability performance. Therefore, hypothesis H2c is elaborated as follows:

H2c. Supplier development has a significant and positive impact on the manufacturing organization's environmental sustainability performance.

Meta-analysis

Field and Gillett's procedure and methods were used to identify and screen the articles (Field and Gillett, 2010). Many meta-analytic studies in the fields of business and the environment have adopted the proposed approach and measures (Zubeltzu-Jaka et al., 2018; Abreu-Ledón et al., 2018; Endrikat et al., 2014; Hou et al., 2016; Tsai et al., 2020). Furthermore, meta-analytic studies on the relationship between supply chain management studies and sustainability have been conducted by Mishra et al. (2021), Govindan et al. (2020), and Fang and Zhang (2018). Empirical papers with quantitative data were searched and identified using the procedures to investigate the combined effect of data in the meta analysis.

Key databases used in this study were Wiley Online Library, ProQuest, Emerald Sage, ScienceDirect, Scopus, Web Of Science. The study to search was conducted between April and May 2021. The articles in this study were not selected in any particular order. Furthermore, only papers and articles in press from any studies related to Business, Management, and Accounting were identified; any other formats were ignored.

The keywords used in the search were structured using the boolean operators AND and OR to create different combinations for the search. The keyword search string used was: “supplier development” AND “sustainability” OR “sustainable practices” OR “sustainable operations” AND “quantitative”. The search string was used to get the most aptitude on the articles included in the search. The abstracts, titles, and keywords of the papers were searched, and the results are tabulated and summarised in Table 1.

Papers Stratification

Combinations	Subject/Base	Paper
Supplier development and sustainability *"supplier development" AND "sustainability" OR "sustainable practices" OR "sustainable operations" AND "quantitative"*	Scopus	102
	Web of Science	1000
	ScienceDirect	1000
	Sage	1000
	Emerald	1000
	ProQuest	1000
	Wiley Online Library	1000
Total		**6102**

Table 1: Keywords and combinations

Since the number of articles returned was huge, decided to select only the first 1000 articles based on relevance as a criteria. The extracted articles, the abstracts, keywords and titles were examined to ensure they followed the categorization. The following are some of the guidelines that were met during the review and completion of the final report:: i) only works that are focused on a direct relationship between supplier development and sustainability performance are used; ii) used articles in English only; iii) only used empirically based papers within the framework of the meta-analysis; iv) used articles with sufficient data that enable the calculation of effect size only. To obtain the correlation coefficients between the variable and the data, a conversion method proposed by Borenstein et al. (2021) was used. Furthermore, a study that is to be included in a meta-analysis must have correlation coefficients between variables studied or sufficient statistical data to accommodate for the

calculation of the size effect (Peterson and Brown, 2005). After that, the references of the papers were verified to determine if any other related research was overlooked (Field and Gillett, 2010), but the search yielded no results indicating that all the relevant articles were taken into account in the analysis.

The final return articles were 16 articles, of which 33 studies were obtained and 12131 total effects were identified. The method for scanning and selecting articles was focused on the dependent variable and the dimensions that compose the variable of sustainability performance: environmental, economic, and social dimensions. Based on the relationship developed for this analysis, the independent variable used is supplier development, which has an impact on sustainability performance. The sustainability performance and supplier development definitions in the articles identified are explained in a similar manner, using the same theoretical content and methodology, ensuring that the analysis is constructed thoroughly and precisely. The whole selection process is depicted in Figure 1.

In this study, the random effects model was used, and there are two forms of variability i) sampling error and ii) meta-analysis design, which are based on different methods for measuring the effects of supplier development on sustainability performance. Since the relationship may not be homogeneous under various conditions, this research uses a random effect model, as per the studies by Cherian et al. (2019), Jakpar et al (2018), and Borenstein et al (2009).

For the relationship between supplier development and sustainability performance, the weighted correlation coefficient average must be determined by converting the coefficients to a normalized metric as suggested by Fisher's Zr (Field and Gillett, 2010). All the studies were taken into account, as well as the weight assigned to each one. The third step is to calculate the internal level of confidence (upper and lower CI), with a level of confidence of 95%. The mean effect and confidence interval values are transformed to correlation to obtain the combined effect.

Furthermore, two kinds of statistics can be used to analyse the homogeneity of empirical correlations: I Conchram's Q and ii) Higgins I2, the former to demonstrate heterogeneity and the latter to measure heterogeneity degree in percentages (Field and Gillett, 2010).

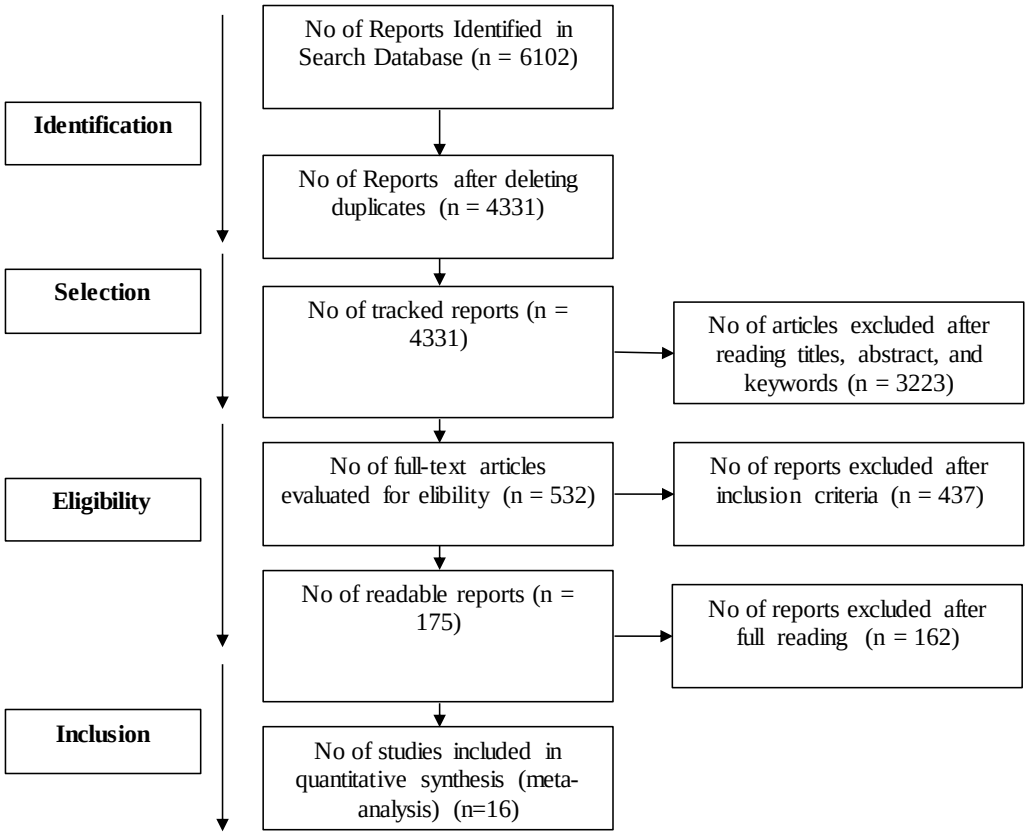

Figure 1: Process for article selection and screening

Results and Discussion

The number of articles found using the selection criterion, adhering to the study flow, and following data mining procedures was 16 articles, all of which are clearly presented in Table 2.

The extracted studies employ a variety of methods and considerations in accordance with the subject under investigation, reflecting the breadth of possible outcomes studied in the field. The research bridges the gap in the literature by combining and expressing the interpretation of the supplier development process in a business and management scope, with sustainability performance as the dependent variable. It's worth noting that, according to the time to print, the studies are spread out over the last decade, with a focus on the second half of the decade, more emphasis on sustainability, which encompasses a wide range of related publications. Furthermore, the consolidation of researches is not based on a single journal that publishes on the topic.

The research articles are published in a variety of journals which encompasses a wide range of sustainability-related topics. The majority of these journals, such as Business Strategy and the Environment, International Journal of Production Economics and Journal of Cleaner Production, deal with management and business-related impact factors, indicating that the subject is widely discussed, researched, and addressed in key journals in this field.

Descriptive and Empirical Categories Definition

Dimensions were compartmentalised and prescribed based on key descriptive elements, economy type, method of research, and economic sector to classify the research studies. The codes and categories are as below

(1) Economy type references to reviewed country's economic status, coded as 1A representing developed economy, 1B representing emerging economy, 1C representing developing economy and 1D as miscellaneous;

(2) Economic sector references to type of business conduted by the companies studied, coded as 2A to denote industry, 2B to denote services and 2C to denote industry and services;

(3) Method of research references to research method that was used to gather the data, coded as 3A to represent survey methods and 3B to represent experimental methods;

(4) Data collection channel references to the methods used to obtain the data, coded as 4A to denote gathering data online or mail and 4B to denote gathering data via face to face meetings.

Table 2 exhibits the categorization of each analysis dimension.

Descriptive Categories

Authors	Type of economy	Economy Sector	Method	Collect
Kumar and Rahman, 2016	1B	2A	3A	4A
Shou et al., 2019	1A	2A	3A	4A
Luzzini et al., 2015	1A	2A	3A	4A
Yadlapalli et al., 2018	1C	2A	3A	4A
Sancha et al., 2015	1A	2A	3A	4A
Gualandris et al., 2014	1A	2A	3A	4A
Lu et al., 2016	1A	2A	3A	4A
Kang et al., 2018	1A	2A	3A	4A
Awan et al., 2018	1B	2A	3A	4A
Ahmed et al., 2020	1B	2A	3A	4A
Gimenez et al., 2012	1A	2A	3A	4A
Wang and Dai, 2016	1B	2A	3A	4A
Paulraj, 2011	1A	2A	3A	4A
Muhammad Auwal et al., 2020	1B	2A	3A	4A
Shahid et al., 2020	1B	2A	3A	4A
Foo et al., 2021	1B	2A	3A	4A

Table 2: Descriptive goal analysis categories

The state of the economy's growth is a decisive factor that influences the approach and specific actions taken while investigating social and environmental issues (Barbeiri et al., 2020; Yusoff et al., 2019). The tendency to engage in sustainable activities is linked to the development of positive relationships with key stakeholders, as well as a commitment to reduce the consumption of resources such as raw materials and energy (Yusoff et al., 2019). The majority of the studies presented as meta-analysis studies are geared toward developed countries in North America, Europe and Asia (Shou et al., 2019; Kang et al., 2018), only Europe (Sancha et al., 2015), mix of America and Europe (Luzzini et al., 2015), combination of countries in Europe, China, Japan and Korea (Gualandris et al., 2014; Gimenez et al., 2012), North America (Paulraj, 2011) and Taiwan (Lu et al., 2016). The publications examined also included articles on emerging economies such as China (Wang and Dai, 2016), Pakistan (Awan et al., 2018; Ahmed et al., 2018; Shahid et al., 2020), Malaysia (Muhammad Auwal et al., 2020; Foo et al., 2021) and India (Kumar and Rahman, 2016). On the other hand, some studies related to developing countries such as Bangladesh (Yadlapalli et al., 2018) were included in the study as well.

The investigation into sectors of the economy discloses a number of different sections, the most critical of which is the industry, as opposed to other areas where most of the study is concentrated. For sectors of activity, the key category is manufacturing.

The data collection methods in the papers under consideration are all survey-based, with none related to experiments. Ghisetti and Rennings (2014) discovered a similar substantiating trend in their research. The data collection protocol follows a consistent pattern, owing to the fact that all data is collected through online survey questionnaires, allowing the research team to access a broad sample size.

The results of meta-analysis study is exhibited in Table 3.

The weighted sum of squared differences between weighted mean effect and observed effects is the Q statistic or also known as Cochrane's Q (Borenstein et al., 2021). Variance measured around the the mean is the Q statistic. Furthermore, p value stands at 0.000. All significance tests, including null hypothesis test, are subject to the same limitations. A low p value indicates the probability of some uncertain level of heterogeneity occurring. The observed variance ratio is calculated using I2 and represents the true effect size divergence. The I2 derived in this study is 95.80%, indicating that the variable studies in this meta-analysis were not conducted on the same population. In terms of the effect size scale, T2 (z) and T (z) are used to calculate the distribution of true effect sizes across different studies. The Rosenthal fail-safe value is 1,280, which means that any unrevealed data needed to transform the observable effect size insignificant will require a huge number of documents, making the presence of any publication bias impossible.

Figure 2 presents the combined effects.

#	Study name	N	Effect Size	CI Lower Limit	CI Upper Limit	Weight	Hypothesis
1	Kumar and Rahman, 2016	157	0.705	0.616	0.776	2.93%	H2a
2	Kumar and Rahman, 2016	157	0.661	0.563	0.741	2.93%	H2b
3	Kumar and Rahman, 2016	157	0.735	0.654	0.8	2.93%	H2c
4	Shou et al., 2019	708	0.104	0.031	0.176	3.16%	H2a
5	Shou et al., 2019	708	0.417	0.354	0.476	3.16%	H2b
6	Shou et al., 2019	708	0.262	0.192	0.329	3.16%	H2c
7	Luzzini et al., 2015	383	0.365	0.275	0.449	3.10%	H2a
8	Luzzini et al., 2015	383	0.289	0.194	0.378	3.10%	H2b
9	Luzzini et al., 2015	383	0.289	0.194	0.378	3.10%	H2c
10	Yadlapalli et al., 2018	267	0.795	0.746	0.835	3.05%	H2a
11	Yadlapalli et al., 2018	267	0.77	0.716	0.815	3.05%	H2b
12	Yadlapalli et al., 2018	267	0.715	0.651	0.769	3.05%	H2c
13	Sancha et al., 2015	120	-0.115	-0.288	0.066	2.85%	H2a
14	Gualandris et al., 2014	336	0.17	0.52	0.72	3.09%	H1
15	Lu et al., 2016	135	0.5	0.362	0.617	2.89%	H2a
16	Lu et al., 2016	135	0.5	0.362	0.617	2.89%	H2b
17	Lu et al., 2016	135	0.52	0.385	0.633	2.89%	H2c
18	Kang et al., 2018	931	0.21	0.148	0.271	3.18%	H2a
19	Kang et al., 2018	931	0.36	0.303	0.415	3.18%	H2b
20	Kang et al., 2018	931	0.27	0.209	0.329	3.18%	H2c
21	Awan et al., 2018	239	0.29	0.169	0.402	3.03%	H2b
22	Ahmed et al., 2020	126	0.591	0.464	0.694	2.87%	H2a
23	Ahmed et al., 2020	126	0.658	0.546	0.747	2.87%	H2c
24	Gimenez et al., 2012	678	0.153	0.079	0.226	3.16%	H2a
25	Gimenez et al., 2012	678	0.235	0.163	0.305	3.16%	H2b
26	Gimenez et al., 2012	678	0.253	0.181	0.322	3.16%	H2c
27	Wang and Dai, 2016	172	0.459	0.332	0.57	2.96%	H2a
28	Wang and Dai, 2016	172	0.408	0.275	0.526	2.96%	H2b
29	Wang and Dai, 2016	172	0.568	0.457	0.661	2.96%	H2c
30	Paulraj, 2011	145	0.32	1.66	0.459	2.91%	H1
31	Muhammad Auwal et al., 2020	300	0.685	0.62	0.741	3.07%	H1
32	Shahid et al., 2020	283	0.157	0.041	0.269	3.06%	H1
33	Foo et al., 2021	163	0.308	0.162	0.441	2.94%	H1

Combined Effects Size	
Correlation	0.438
Confidence Interval LL	0.35
Confidence Interval UL	0.52
Prediction Interval UL	-0.06
Prediction Interval LL	0.76
Z-value	9.08
One-tailed p-value	0.00
Two-tailed p-value	0.00
Heterogeneity	
Q	767.36
P_Q	0.00
I^2	95.83%
T^2 (z)	0.06
T (z)	0.25

Table 3: Meta analysis for the relationship between supplier development and sustainability performance

The outcomes of the meta-analysis study show that the tested hypotheses on supplier development, which are based on constructs, have a strong positive relationship with organisational sustainability performance. Table 4 details the information.

Every independent variable has a clear and positive relationship with the dependent variables. Furthermore, looking at the combined effect size coefficient at r = 0.438 (p-value 0.000) leverages the effects of the individual hypotheses H1, H2a, H2b, and H2c, where the test shows if supplier development has a positive or negative impact on sustainability performance. The relationship between supplier development and sustainability performance has been investigated in previous quantitative studies published in academic journals, but no definitive results have been found. As a result, this study article bridges the gap by conducting a meta-analytic study to determine the impact of supplier development on sustainability performance.

The findings of the meta-analysis review are included in the recent academic works. Supplier development and sustainability have been shown to have a constructive and important relationship, supporting the findings of scholarly articles (Shou et al., 2019; Luzzini et al., 2015; Kang et al., 2018).

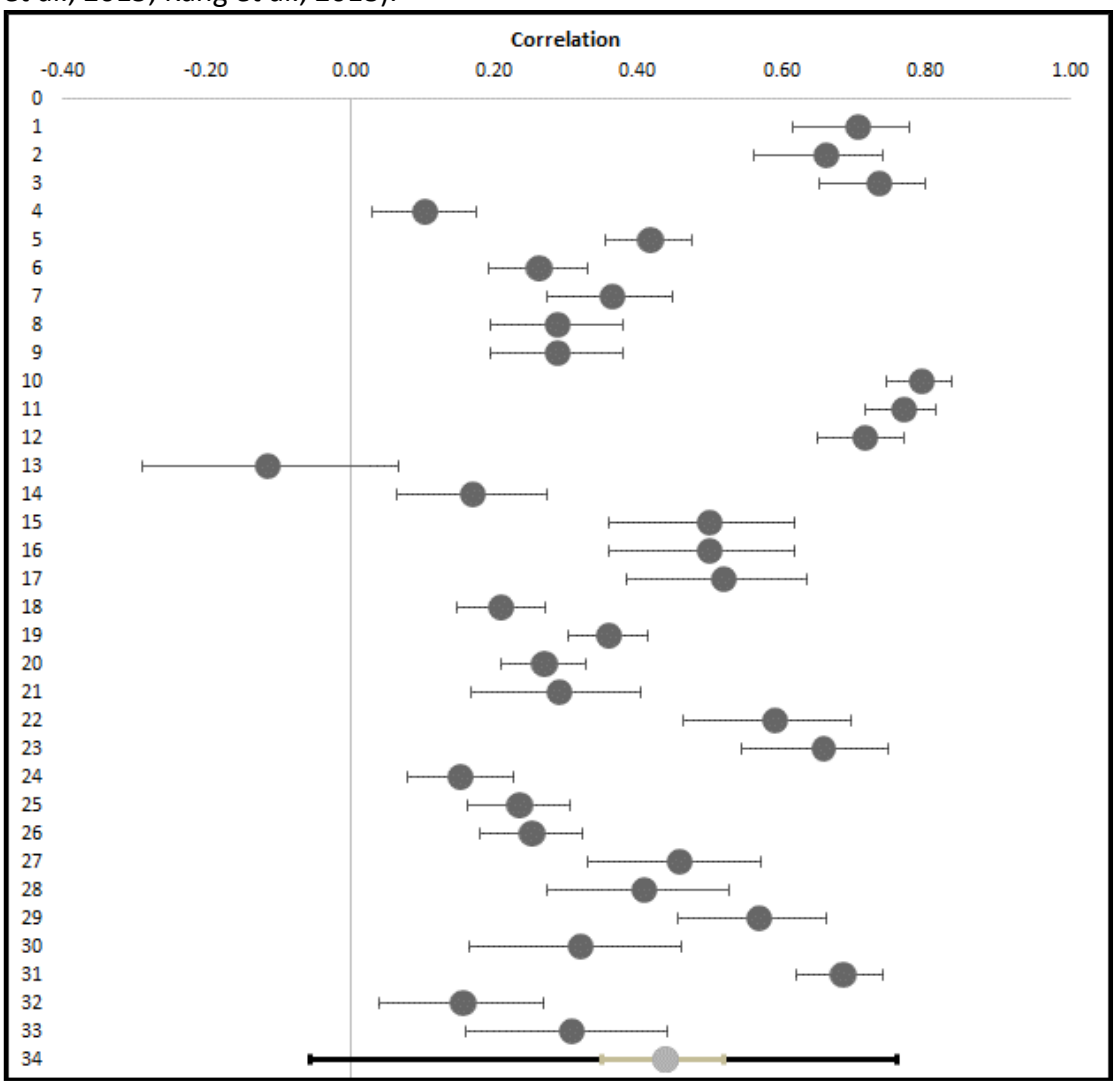

Figure 2: Forest plot for combined effects. The results of each of the selected studies are graphically represented in the figure. Each study's correlation can be visualised and compared to the others, as well as the observance in relation to the average, can be determined. Finally, we have the effects' approximate average correlation.

Hypothesis		r	p-value	Supported
H1	Supplier development → Performance in Sustainability	0.348	0.000	Supported
H2a	Supplier development → Performance in Economic Sustainability	0.414	0.000	Supported
H2b	Supplier development → Performance in Social Sustainability	0.455	0.000	Supported
H2c	Supplier development → Performance in Environmental Sustainability	0.494	0.000	Supported

Table 4: Summary of results

Furthermore, the influence of supplier development on individual dimensions such as economics, the environment, and social was assessed. The study's findings show a positive and significant relationship between supplier development and all of the different categories of dimensions under sustainability performance. The result is comparable to Yadlapalli et al. (2018) and Gimenez et al. (2012)'s exploratory findings. The fundamental assumption

demonstrates the existence of a positive relationship between supplier development and sustainability performance, and it substantiates and is endorsed by the meta-analysis studies' outcomes. Companies are faced with environmental challenges, and supplier development will compel them to ensure long-term success across both of these areas. Despite the fact that academics have extensively discussed questions about sustainability-based sustainable growth, such as Kumar and Rahman (2016); Wong and Dai (2016); Sancha et al. (2015), there is no straight cut conclusion on empirical studies that illustrate the connection. To close the gap, the current papers incorporate all of the findings from meta-analysis studies.

The findings of the meta analysis study enable us to conclude that supplier development has a definitive impact on an organization's sustainability. In relation to the sustainability dimensions, a similar definition of definitive effect is introduced, reviewed in a part-by-part study, so that it becomes a way to demonstrate how supplier development affects the social, environmental, and economic perspectives of the organization's results. Besides that, the research shows that establishing a sustainability performance benchmark on supplier development-oriented activities will benefit organisations, owing to the fact that progressing down the road to sustainability entails, at its heart, the adoption of a stance that is compatible with instinctive requirements. When it comes to supplier development, the organization allows for the opportunity to practice developing suppliers in accordance with the needs of business and societal demands.

Theoritical Contributions and Management İmplications

This research advances the combination and mutual agreement on the effects of supplier development and its effect on the sustainability performance of a manufacturing organisation by studying analytical articles that capitalise on quantitative methods on the correlation between supplier development and sustainability performance. The articles outlined present discriminate correction effects from a discriminate standpoint and with discriminate methods. The studies on the effects are categorized using the meta-analysis method to generate a combined result on each of the tested hypotheses. The key contribution is to present a combined effect result that encompasses a huge spectrum of focused empirical studies on the subject, and to provide a practical resource to refer to for forthcoming research on the relationship between supplier development and sustainability.

The analytical study's key theoretical contribution is the affirmation of the hypothesis that the relationship between supplier development and sustainability performance, as well as in all of its dimensions: social, economic, and environmental, is positive and significant. In order to invalidate the indicators used in this meta-analysis paper, the study would need to include more than 1,280 articles. In other words, there are a massive number of scientific studies, which support the thoroughness of the research described in this article.

A manufacturing organization's supplier development activities, such as supplier assessments via evaluations and performance management, as well as supplier collaboration via training, joint efforts, and other mechanisms, can be viewed as a priceless resource. Managers may take advantage of this resource in terms of competent suppliers and implement effective strategies to enhance and boost the performance of manufacturing companies, giving them an edge over their competitors. Beneficial activities lead to differentiation in supplier development for long-term sustainability through improvements in supplier capabilities and the products and services they provide; it includes medium and long-term performance, and this can have an effect on various company metrics.

As a result, the study's pragmatic advantage is to enlighten businesses and organisations to invest in supplier development activities in order to increase manufacturing organisations' sustainability performance. These investments may be indicative of social-environmental innovations, green purchasing, and the circular economy, among other things.

Conclusions

According to the conclusions of the meta analysis study, supplier development has a significant impact on an organization's long-term sustainability. Additionally, in terms of sustainability, the study demonstrates how supplier development impacts the social, environmental, and economic aspects of an organization's performance. Correlations between supplier development and sustainability environmental performance and supplier development and sustainability social performance are the most influential and supportive. A useful effect of the study is to help businesses and organisations see the value of increasing manufacturing organisations' sustainability performance by increasing their internal supplier development initiatives. Furthermore, the research suggests that setting a sustainability performance benchmark on supplier development-oriented activities will assist businesses, because continuing down the road to sustainability requires, at its core, adopting a posture that is compatible with innate needs.

Recommendations and limitations

The research is hampered by the constraints that are traditional and common to meta-analysis studies in general. The technique relies entirely on the relationship between the dependent and independent variables, primarily through the use of correlation coefficients among factors and performance generation, leaving out the ability to precisely identify the effects of unpredictable organisational management attributes. The availability of studies for meta-analysis, with regard to the combination of criteria and the alternatives of generating combined effects from each study's effects, is another influence that implies research limitations. Lastly, a number of studies that did not have adequate dependent variables to be included in this analysis, as well as other types of hypotheses, were excluded. For certain categories that were evaluated and omitted, it was impractical to collect adequate effect to include them as part of the meta-analysis. Regardless, it is critical to recognise that the likelihood of bias is low, owing to the structured approach used and referenced in this report.

Recommendations for future studies include considering other variables as the independent variables in the meta analysis study while using sustainability performance as the dependent variable, such as supplier selection, innovation, circular economy among many other options. In future studies, a moderator and/or a mediator may be used as well to better understand the effect of supplier development on manufacturing organisations' sustainability performance.

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