



STUDY ORIENTED PROJECT

**Supply Chain Sustainability Issues
associated with the Food Industry using
Mediation Theory**

**Under the able guidance of:
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Submitted by:

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ABSTRACT

This paper in the purview of the mediation equation theory uses secondary datasets and primary data from surveys conducted to form path coefficients between different variables using the PLS-SEM method. We then add variables as mediator variables to see if it causes a partial or a full mediation and if there is a link between the immediate supplier collaboration (acting as the constant exogenous variable) and the endogenous variables that we keep changing. The paper aims to draw relevant conclusions based on this and suggest practices to food industry focal companies, suppliers, and sub-suppliers specifically to help better the whole process.

LITERATURE REVIEW

1) Supplier Collaboration for Sustainability: A Study of UK Food Supply Chain

(By Dr. Abdul Ali, 2018)

While there are a few studies that focus on collaboration for sustainability in food supply chains, only a few consider sustainable (i.e. environmental, cost, and social) or Triple Bottom Line (TBL) performance, and there is scarcely any research in the context of the UK food sector. This thesis addressed these concerns both conceptually and empirically by a) examining supplier collaboration for sustainable performance; b) assessing supplier collaboration for environmentally friendly and socially responsible practices; c) measuring environmentally friendly and socially responsible practices for sustainable performance; and d) measuring environmental friendly and socially responsible practices for sustainable performance.

2) Supplier collaboration and speed to market of new products: the mediation and moderating effects

(By Dr. Ying Zhang. Lihua Wang. Jie Gao, 2015)

In a tumultuous market economy, the role of suppliers in new product creation by manufacturers has gotten a lot of attention from practitioners and scholars. The contribution of suppliers in tackling difficulties such as shorter product life, faster reaction, and faster information flows has been given with substantial empirical data. The goal of this study is to see which supplier cooperation (SC) methods are directly or indirectly connected to new product speed-to-market (STM) across different company sizes.

3) Synergy analysis of collaborative supply chain management in energy systems using multi-period MILP

(By Dr. Ahu Soylu. Cihan Oruc. ,2005)

Fossil fuels are typically used as the major raw material in the production of energy, which is a vital component of contemporary life. The release of ecologically hazardous compounds is a result of burning fossil fuels. Energy production systems create steam and electricity, which are then distributed to various clients to meet their energy needs. Due to the important importance of energy in all industrial activities, improving the economic and environmental performance of energy production systems is a crucial concern. This research takes a systematic method to identify synergy across various energy systems.

4) A social-ecological systems framework for food systems research: accommodating transformation systems and their products

(By Dr. Graham R Marshall)

The SES framework was created to facilitate communication across the many disciplines dealing with the long-term provision and/or appropriation of common-pool resources (CPRs). Transformation activities (e.g., processing, distribution, and retailing) that add value to resource units taken from CPRs were believed to be external to the SES of main concern while building the framework.

5) Supply Chain Collaboration for Transparency

(By Dr Alessandro Brun, Hakan Karaosman)

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6) Supply Chain collaboration for sustainability: A literature review and future research agenda

(By Dr. Lujie Chen, Xiande Zhao)

Business strategies and innovation skills are changing as a result of new technology, which is expanding the possibilities for production and process innovation. This process of transformation is presently being accelerated by supply chain collaboration for the sake of sustainability; a growing body of research is examining the relationships between sustainability collaboration and firm success on economic, environmental, and social criteria.

INTRODUCTION

Since the food industry is an industry of perishable goods, speed-to-market becomes of utmost importance, with the need to use Just-in-Time practices to prevent wastage of food. With such a commodity at hand, collaboration within the supply chain becomes of the utmost importance. There is enough literature to broadly suggest that collaboration does indeed help every party involved in the supply chain. In this paper we aim to firstly identify the critical variables which affect the supply chain and then add exogenous variables to the path previously laid out to see if the variable added causes partial or full mediation (more on this in the methodology).

There have been studies which have used the PLS technique with SEM to find path coefficients, which we use in the mediation technique to estimate the overall contribution of a particular variable.

This paper other than telling which factor's addition really affects the supply chain also aims to then classify those factors into three stratas, based on at which level can the most change be brought about:

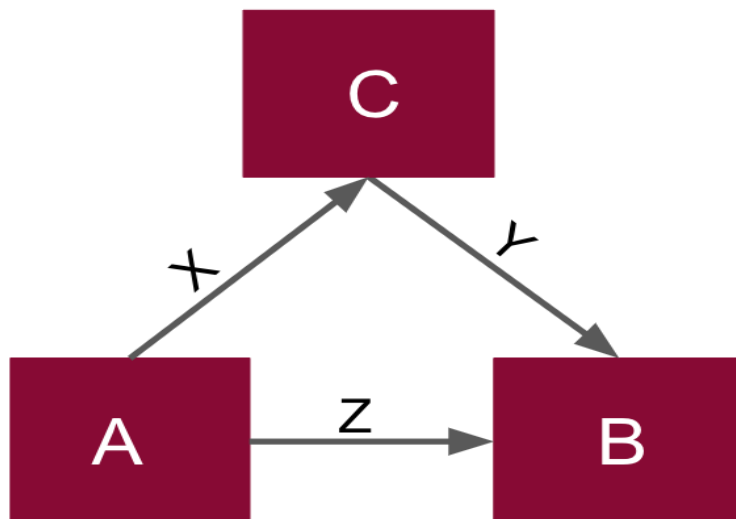
- 1) focal company level
- 2) relationship related
- 3) supply chain partner level

At every level there are different factors and different outside pressures. For example, companies being put under scrutiny by customers, regulators, or NGO's, to establish a sustainable chain of supply. Usually in this case the focal company ends up having to take maximum responsibility. Most of the stakeholders also do not care to differentiate between the supplier or the focal company, or care to see where the real issue is, leading to corporate blame games, not leading anywhere. Nike, and Nestle are great examples of non-compliant suppliers, because of which the customers blamed the company and led to their lawsuit.

METHODOLOGY

The crux of this paper is based on the mediation formula as proposed by (Iacobucci et al., 2007, Preacher and Hayes, 2008). A rudimentary model is as follows with A as the starting (independent) variable, B as the direct path end (dependent variable), and C as the indirect path (mediating variable) with respective path coefficients as X, Y and Z.

The path coefficients denote the relationship between the two connected variables, calculated using the PLS-SEM method. The coefficients give an indication of the correlation between the variables and range between -1 and +1. Values on the 2 extremities denote strong positive relationships whereas values closer to 0 indicate a weaker relationship.



According to Iacobucci et al. (2007), the mediation indicates the comparative size of indirect vs direct channels by relating the scale of indirect to total effects (direct + indirect effects). He gave the following equation for mediation:

$$\text{Mediation} = X * Y / (X * Y) + Z$$

In purview of the mediation equation, we try to see if there is a link between the immediate supplier collaboration (acting as the constant exogenous variable) and the endogenous variables:

- 1) Environmentally friendly practices
- 2) Social Responsible Practices
- 3) Cost performance
- 4) Social Performance

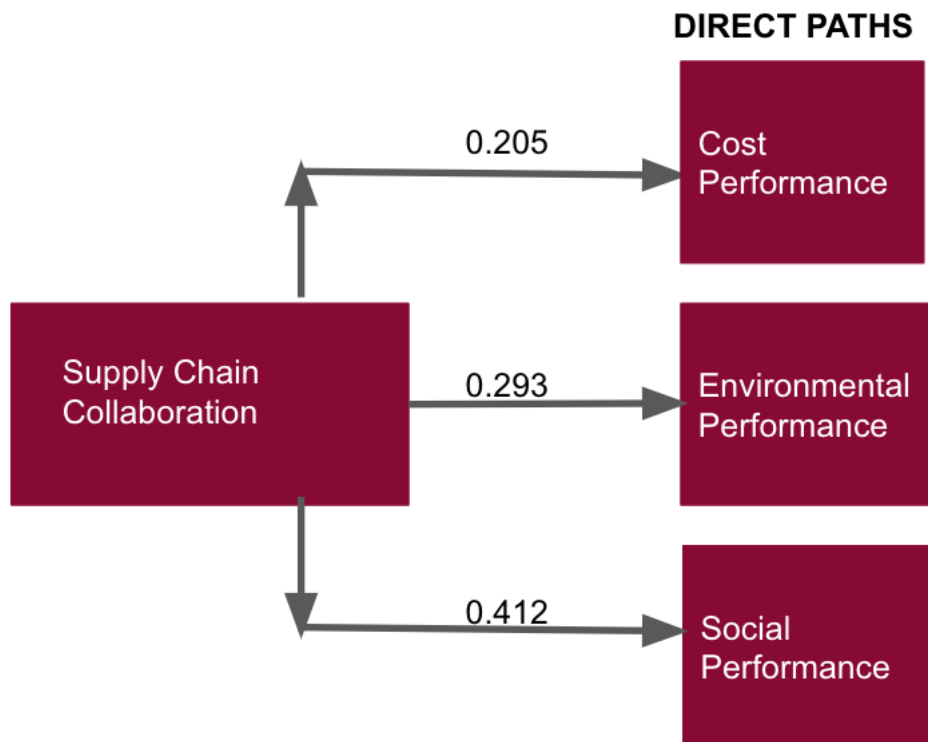
We go variable by variable and see if adding those variables as a direct variable or indirect variable makes any difference in our exogenous variable.

The Path Coefficients have been taken directly from (Ali, 2018), calculated using the PLS-SEM method using data from secondary datasets and primary data from questionnaires sent out to officials from leading food industry companies.

The Path coefficients represent the correlation and the contribution of that path is leading to the destination.

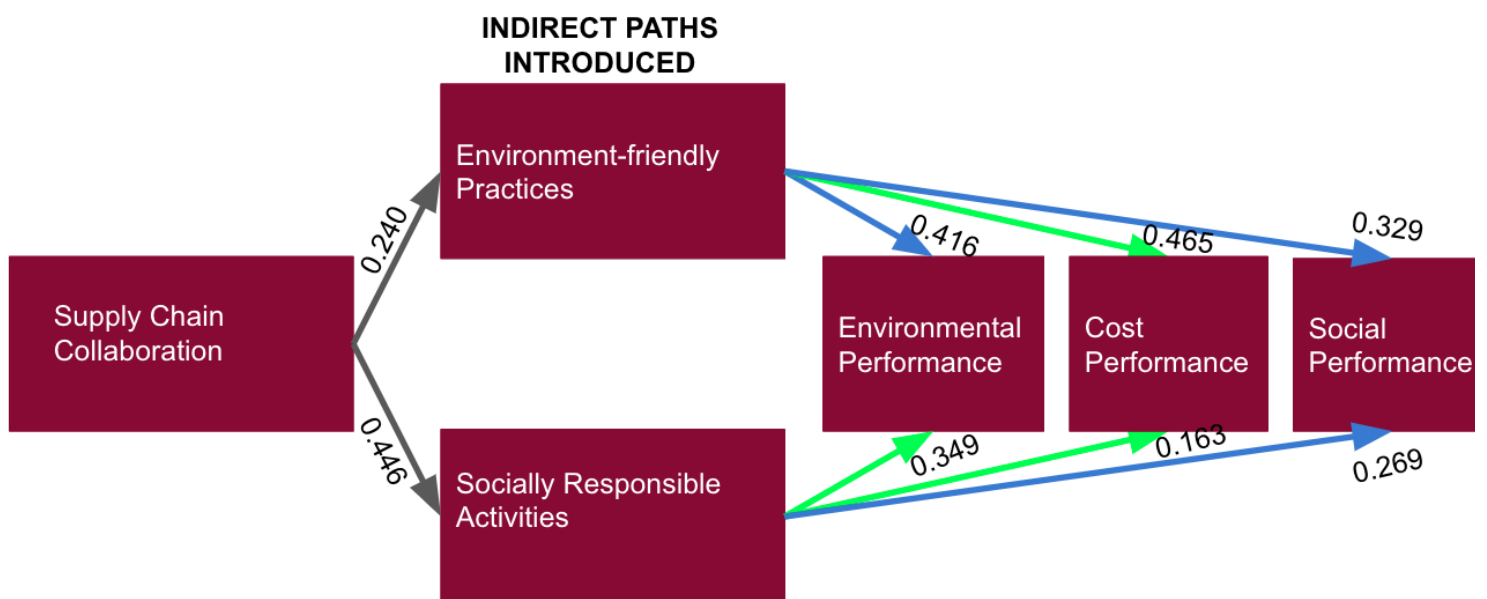
Exogenous Variables	Endogenous Variable	Path Coefficients	Inference
Supply Chain Collab	Environmental Performance	0.293***	Supported
Supply Chain Collab	Cost Performance	0.205***	Supported
Supply Chain Collab	Social Performance	0.412***	Supported

All path coefficients are positive and non-zero and all values are far from 0, and so these coefficients are also significant.



Now we proceed to add pathways in between the source and the destination and use the

Mediation formula, $\text{Mediation} = X * Y / (X * Y) + Z'$, on the newly added indirect pathways to see if these routes are more or less significant than the previous routes.



The **green** arrow means full mediation, meaning that the addition of the indirect path overpowers the previous direct relationship and now only the mediating variable plays the major role in influencing the relationship, and the preexisting path coefficients become 0.

The **blue** arrow means partial mediation, meaning that the addition of the indirect path is not playing any role in improving the preexisting relationship and that the preexisting relationship still persists.

ANALYSIS OF RESULTS FROM MEDIATION THEORY

We will make sense of this using either of the following set of interpretations (Aglar, Robert, and Paul De Boeck) :

1. Specific Effects vs. Global Model

According to the view of specialized interests, a global model for all relationships is less relevant, and one should instead focus on tests of interest effects.

Because no one statistical model can be employed to estimate the effects in the case of a global model interpretation, the global model becomes largely a conceptual one.

And in the case of the global model, it is seen as too broad, and direct relationships on the other hand imply a concrete route to attaining something. Since our study is non-statistical, most of our interpretations can come from this way of thinking.

2. Directness v/s Indirectness

Another set of viewpoints is based on the semantics of causation. Directness is an enhancer of causal interpretation in both languages (e.g., Shibatani, 2001) and law (e.g., Hart and Honore, 1985), while a distant cause is deemed less of

a cause or even no cause at all.

Listing out the partial and full mediation results separately from our study, and drawing conclusions from it:

Partial Mediation:

1. Supply Chain Collaboration - Environment-Friendly Practices - Environmental Performance
2. Supply Chain Collaboration - Environment-Friendly Practices - Social Performance
3. Supply Chain Collaboration - Socially Responsible Activities - Social Performance

These three relations with the addition of the mediation variable have not changed drastically, but are supplementing each other, and are making a significant change in variable B, so it should be promoted.

So we can also think of it like that to achieve supply chain collaboration, we can use environment-friendly practices and socially responsible behavior to reach the aim.

Full Mediation:

1. Supply Chain Collaboration - Environment-Friendly Practices - Cost Performance
2. Socially Responsible Activities - Socially Responsible Activities - Environmental Performance
3. Socially Responsible Activities - Socially Responsible Activities - Cost Performance

With full mediation the path Z attains a path coefficient of 0, implying that the mediation variable completely overpowers variable A. So here we can see that Environment-Friendly Practices will lead to massive Cost Performance improvement

and similarly, Socially Responsible Activities will lead to improved Environmental Performance and Cost Performance.

There is a direct causal relationship between the two variables and this makes it easier to point out where an improvement is required in the supply chain. According to the “Specific effects / Global Model” too, the direct relationships are like a tree to the indirect effects acting like a forest in this analogy. Once you know which factors exactly affect the supply chain collaboration, you can make better decisions on how you want to go about making that change.

SUGGESTIONS BASED ON THE STUDY

Some critical success factors can be incorporated into the current paradigm. Keeping in mind the findings from mediation theory:

1. If the buying power of the focal firm is large, more so than the direct supplier, then it provides a substantial bump in the respect the supplier receives. Since Socially Responsible Activities lead directly to environmental and cost performance, an initiative has to come from the focal company's side.
2. Long-term relations between the direct and sub-supplier also foster a more open relationship between the two, according to SSCM literature, even increasing the likelihood of more effort inputted when engaging in such a relationship, along with an agreement that both parties mutually collude in healthy Socially Responsible Activities.
3. Knowledge of the supply know-how of the focal firm being capable of improving the firm's financial and operational capabilities is also highlighted in the literature review, and it is now backed by this study that improvement in the socially responsible activities and environment-friendly practices will lead to direct benefit in cost performance.
4. The risk of direct suppliers going around the sub-supplier, when they feel their initiatives would threaten their business, should be low. This is essentially a lack of trust and may be caused because the focal firm can directly source from the sub-supplier or if both the focal firm and sub-supplier don't have much

commitment to the business relationship with the direct supplier.

5. Considering the different factors of sub-supplier management and how it is affected by it, the bottom line is that there must be trust between the focal firm and direct supplier, as well as trust between direct supplier and sub-supplier

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