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The Transition from Linear Sourcing to Circular Economy Business Models: The Role of Circular Procurement, Reverse Logistics, Resource Efficiency, and Firm Performance

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ABSTRACT

The shift from linear sourcing to circular economy business models is a major shift in how organizations obtain, use, recover and generate value from resources. In the traditional linear sourcing model, the organizations rely extensively on virgin materials and one-way supply chains, short product life cycles, and disposal-oriented waste management processes. Business models in the circular economy are different, and are centered around conserving resources, product durability and longevity, reuse, repair, refurbishment, remanufacturing, recycling, reverse logistics, industrial symbiosis, product-service systems, and regenerative sourcing. The link between circular sourcing practices and the performance of the business models for circular economy was explored, specifically focusing on four key circular economy dimensions: circular procurement, collaboration with suppliers, reverse logistics, and resource efficiency, as well as organizational capabilities. Organizations involved in manufacturing, retail, logistics and other supply-chain related activities were the sources of the data. A semi-structured questionnaire was used to assess circular sourcing practices and their impact on the performance of circular business-models. Data were analyzed using reliability analysis, descriptive statistics, correlation analysis, exploratory factor analysis and multiple regression analysis. The results showed that the four aforementioned factors (circular procurement, supplier cooperation, reverse logistics, and resource efficiency) were positively related to circular business-model performance. The two most significant predictors were reverse logistics and supplier collaboration, showing that circularity was not only about internal operational shifts, but also about organizations' capacity to build the collaboration within their value chain. The results also showed that resource efficiency will enhance the economic benefits of circular practices by minimizing resources used, waste and inefficiencies. The study advances the topic of circular economy and supply-chain literature by including sourcing decision, supplier relationships, reverse flows and business-model transformation in a single empirical framework. The results confirm this to be more than an environmental action, but a strategic change that can enhance resource productivity, resource resilience, innovation, and long-term organizational performance.

Keywords: circular economy, circular sourcing, circular procurement, reverse logistics, supplier collaboration, resource efficiency, circular business models, supply chain management, sustainability, firm performance

INTRODUCTION

Background of Study

The global economy traditionally has worked in a linear fashion between production and consumption. In this scheme, natural resources are extracted and organizations buy raw materials, convert them into products, sell to the end user and then dispose of them at the end of their use. Industrial growth and economic development have been made possible by the linear model, but it has led to a significant reliance on limited resources, waste production, environmental damage, fragility in value chains, and price fluctuations of resources (Kirchherr et al., 2017). The root of the issue is that economic value has been tied to the extraction and consumption of new materials, rather than the maintenance of value of products, components and resources for as long as possible. Studies on circular economy transitions highlight the need for rethinking the way organizations manage resources, products and value throughout their respective life cycles to overcome the current logic (Geissdoerfer et al., 2018; Susur & Engwall, 2023).

An alternative economic logic is possible within the circular economy. Circular economy systems aim to eliminate waste and pollution, circulate products and materials at their highest value and regenerate natural systems, rather than treating materials as inputs that are eventually lost as waste (Ellen MacArthur Foundation, 2024). The change will entail rethinking the production processes, but also procurement, sourcing, supplier managing, product design, logistics, customer relationships, and business models.

Sourcing can be a key component of the environmental and resource related impacts as many of these impacts are created prior to the product entering the focal organization. Traditional procurement processes focus more on the purchase price, product quality, delivery time and reliability of suppliers, and consider material circularity, recyclability, product life cycle, renewable inputs, take-back systems and recovery at end-of-life less comprehensively. Circular sourcing extends the criteria for sourcing to include recycled content, renewable materials, re-repairable, repairable, durable, and modular products, supplier environmental performance, and material recovery opportunities (Xu et al., 2022; Farooque et al., 2023).

The shift from linear sourcing towards circular sourcing can then be described as a shift from a one-way procurement relationship to a system for circulating resources. A linear system is a system in which a firm buys materials, produces products from them, sells the products and no longer controls the materials once they are used. The organization aims to keep in touch with suppliers, customers, logistics partners, recyclers, refurbishers and other ecosystem players in order to ensure the re-use of products and materials in a closed loop system. Recently, circular supply-chain studies have gained more focus on this broader perspective on the ecosystem, as collaboration between organizations is key to information sharing, co-ordinating the recovery responsibilities and supporting joint product and process development (Sudusinghe & Seuring, 2022; Aarikka-Stenroos et al., 2022).

Circular economy business models go further. Product-service systems, leasing, sharing, rental, repair, refurbishment, resale and take-back models redefine ownership-consumption value creation dynamics. A firm may create value by utilising the product, maintaining it, selling service contracts, recovering it, and circulating it repeatedly, rather than selling new products repeatedly to generate revenues. Product-service systems, life-extension strategies, reuse, refurbishment and recovery are key avenues for value creation and capture in a circular business model (Bocken et al., 2016; Asgari & Asgari, 2021). Maintenance, reuse, refurbishment, remanufacturing, recycling and reverse logistics are important mechanisms for preserving the value of products and materials in economic systems, according to the Ellen MacArthur Foundation.

Recent empirical studies also show that supply-chain practices are crucial to achieve circularity. For instance, based on an analysis of 378 Italian companies, it was found that the circular supply-chain design, relationship management, and circular human-resource practices were correlated to the circular economy-oriented company performance, and that big data-driven supply-chain capabilities played a significant role (Bag et al., 2021). Recent research from 380 Indian manufacturing companies revealed that service-based business models had a positive impact on the performance of the circular economy and that the practices of the supply chain enhanced this relationship (Das et al., 2026). The results underscore the necessity of looking at circular business models as a whole and the practices in the supply chain, not as a stand-alone environmental initiative. Digital and organizational capabilities also provide evidence to support the performance of circular supply-chain through enhancing flexibility, information utilization, and coordination (Nayal et al., 2022).

This study looks at the transition from linear sourcing to circular economy business models through the four dimensions relating to circular procurement, supplier collaboration, reverse logistics and resource efficiency. This study examines if such practices influence the performance of the circular business-model and analyzes the contribution of each dimension.

Problem Statement

Although there is a growing awareness of circular economy principles, there are still many organisations that continue to adopt linear sourcing practices. Low purchase price, short term contracts, standard specification, and traditional supplier selection are common requirements of procurement departments. Products are also not always designed for repair, refurbishment, remanufacturing, reuse or material recovery.

The issue is especially relevant because organizations have to move towards circularity, not just by boosting their own efficiency in the production process. Circular business models are incomplete if business models continue to involve virgin materials, if products cannot be disassembled, if customers do not have a system in place to return used products, and if there are no systems in place for reverse logistics. Value creation, value delivery and value capture need to be coordinated across organizational boundaries – this is what Geissdoerfer et al. (2018) pointed out when it comes to circular business models and circular supply chains.

For this reason, the following research problem will be addressed in this study:

How does circular sourcing practices influence circular economy business-model performance?

Research Objectives

The study aimed at achieving the following goals:

1. To analyze the link between circular procurement and the performance of a circular business model.
2. To measure the impact of supplier cooperation on the performance of circular business-models.
3. To examine the effect of reverse logistics on the performance of the circular business model.
4. To measure the impact of resource efficiency on the performance of the circular business-model.
5. To identify the overall explanatory power of circular sourcing practices in relation to the performance of circular business-model.
6. To discover which circular sourcing dimension has the greatest influence on the shift towards circular economy business models.

Research Questions

The following questions were raised in the study:

1. Are significant effects of circular procurement on the performance of business models circular?
2. Is there a significant effect from supplier collaboration on the performance of circular business-models?
3. Does the reverse logistics have a major impact on the performance of the circular business model?
4. Is there a significant relationship between the performance of circular business-models and resource efficiency?
5. How well can circular sourcing practices be encapsulated in a broad statement of circular business-model performance?

LITERATURE REVIEW

The course provides an introduction to linear economy and linear sourcing.

The linear economy is defined by the extraction of resources, the manufacturing of products, consumption and disposal. It is based on the models that natural resources are plentiful and that waste products produced after their consumption can be moved to the outside of the economic system. In reality, the model generates large environmental and economic spillovers (Kirchherr et al., 2017; Genovese et al., 2017).

This same reasoning applies at the sourcing level, which is known as linear sourcing. Organizations buy raw materials from suppliers, process them into a product and lack a few mechanisms to retrieve the resources after use. Typically, supplier relationships are driven by cost and efficiency, not by the flow of resources.

The drawbacks of linear sourcing are that it relies on virgin materials, it faces resource scarcity, it creates waste, it has limited embedded value, and it is vulnerable to the supply chain. Critical raw materials shortages can lead to higher production costs and impact operational continuity.

Circular economy is an approach that calls this into question by promoting the use of resources as assets, where economic value is kept within the economy for as long as possible. This means a paradigm shift in the way of sourcing.

Circular Economy Business Models

Circular business models generate, deliver and recover value, and minimise resource use and keep products and materials in circulation. Geissdoerfer, et al. (2018) proposed that value creation and supply chain configuration need to align for circular business models. Recent studies also highlight the need for action coordination between and within organizations and ecosystems and the importance of collaboration with partners in the value chains or supply chain (Aarikka-Stenroos et al., 2022; Susur & Engwall, 2023).

There are a number of different configurations for the circular business model.

Product life-extension models

The models concentrate on the product life extension practices of maintenance, repair, refurbishment, upgrade and resale. Product life extension ensures that not much new energy and labor is required for new product, and keeps the energy and labor already invested in the product (Bocken et al., 2016).

Product-service systems

Product-service systems are physical products and services. Customers can pay for access instead of buying products outright, for performance or for utilisation. These can include services such as equipment leasing, "pay-per-use" systems, mobility services, and subscription products.

This is limited to sharing and access models.

Models sharing boosts underutilized assets utilization rate. All users share a resource, rather than each resource being owned by one of the customers but unused for a significant portion of their life.

Resource recovery models

Resource recovery is collection of materials from products at the end of their useful life. While high-value recovery processes like reuse, repair, refurbishment and remanufacturing tend to retain more embedded value, recycling is an important recovery process. Product take-back schemes are especially relevant as they enable the organization and logistics of recovering residual product and material value (Uhrenholt et al., 2022).

Circular supply models

Circular supply models use renewable, recycled, recovered or regenerated materials instead of virgin materials. They call for procurement departments to consider suppliers based on resource circularity instead of conventional price-based approaches (Xu et al., 2022).

Circular Procurement

Circular procurement is one of the key pillars of a move towards circular sourcing. It embeds circularity in the selection of suppliers, contract design, product specification, material selection and purchasing decisions. Xu et al. (2022) conclude from their systematic review that the literature on circular procurement can be summarized under three main themes: antecedents, practices and performance outcomes. Farooque et al. (2023) offer evidence and practical examples of how circular procurement can enhance environmental, cost, and financial performance.

Some of the considerations for circular procurement are:

- recycled material content;
- renewable resources;
- product durability;
- repairability;
- modular design;
- recyclability;
- supplier environmental performance;
- take-back arrangements;

- remanufactured products;
- product-service contracts; and
- total lifecycle cost.

The circular procurement process transforms the basic question from “What's the cheapest price to pay?” to “What procurement decision offers the greatest value throughout the product and resource lifecycle?” This lifecycle approach aligns with recent research on sourcing, that revealed sourcing strategy, stakeholder involvement, and procurement operations as key ingredients for a circular approach (Xu et al., 2022; Al-Sinan & Bubshait, 2022).

It is significant because a product that costs a little up front can be more expensive overall as a result of the energy required, maintenance, replacement, disposal and environmental effects. Lifecycle based procurement thus offers a more solid basis for circular business models (Farooque et al., 2023).

Circular-economy reporting framework also acknowledges circular business models, resource management, circular products, resource productivity and circulation of resources as measurable areas of organisational performance, developed by Ellen MacArthur Foundation.

Hypothesis 1

H1: Circular procurement has a strong positive influence on the performance of the circular business model.

Supplier Collaboration

There is a need to collaborate between organizations to ensure circularity. If suppliers are not willing to supply recycled or renewable materials, a manufacturer can't set up a circular supply system. Likewise, suppliers require knowledge of product design, recovery requirements, quality requirements and the expected future supply of materials. Systematic evidence shows collaboration practices such as sharing information, joint product design, shared recovery responsibilities, sharing of risks, and coordinated incentives are practices to support the implementation of circular supply chains (Sudusinghe & Seuring, 2022).

Supplier collaboration involves:

- joint environmental planning;
- information sharing;
- collaborative product design;
- supplier development;
- joint waste-reduction initiatives;
- shared recovery systems;
- longterm contractual ties; and
- joint investment in circular technologies.

Organizational learning is also enhanced by working with suppliers. Suppliers may have a specific knowledge of materials, component, production and recoverability. This sharing enables companies to discover non-conventional circular solutions which are not yet apparent in their purchasing processes.

Aarikka-Stenroos et al. (2022) further show that supply-chain collaborations can enable the design and implementation of circular business models.

Geissdoerfer et al. (2018) argued that business-model transformation without supply-chain transformation leaves large gaps in circularity as there is a need for integration between the two.

Hypothesis 2

H6: There is a positive effect of supplier collaboration on performance of the circular business model.

Reverse Logistics

The conventional logistics process transports goods from the supplier to the customer. To achieve a circular supply chain, the used products, packaging, components and materials need to pass through an extra reverse stream from the consumer back to organizations that can reuse, refurbish, remanufacture or recycle them. Research on product take-back systems reveals that key factors for a closed product loop include product collection, transportation, sorting, requalification, and reintegration into forward supply chains (Uhrenholt et al., 2022).

Reverse logistics includes:

1. product collection;
2. transportation;
3. inspection;
4. sorting;
5. repair;
6. refurbishment;
7. remanufacturing;
8. parts recovery; and
9. material recycling.

Therefore, the role of logistics in the circular economy goes beyond distribution to resource circulation. Reverse logistics develop the physical channel to move value back from the consumption back to the production process. But the effectiveness of the take-back systems relies not only on logistics activities but on the complex coordination of supply-chain, product, operational and contextual aspects (Uhrenholt et al., 2022).

Reverse logistics is seen as a key business service by the Ellen MacArthur Foundation, which describe it as the return of end-of-use products to the maintenance, repair, reuse, refurbishment, remanufacturing, recycling or regeneration.

Hypothesis 3

The conclusion is that reverse logistics has a high positively effect on the performance of circular business model.

Resource Efficiency

Resource efficiency is about the value of the products produced from a commodity in comparison to the amount of resources used. It is important to remember that one of the goals of circular sourcing is not just to replace materials, but to cut resource usage as well. Research in circular economy is now focusing on a link between resource productivity and the redesign of products, lifecycle thinking and the performance of firms (Triguero et al., 2023).

Resource efficiency includes:

- consumption of fewer raw materials;
- energy efficiency;
- cutting down on water usage;
- lowering of production waste;
- improved material yield;
- reusing production residues;
- better use of assets; and
- Reduced need for unneeded packaging.

The importance of resource efficiency is amplified by circular business models, as organisations take on a greater role in the lifecycle of the products and materials. The results of the empirical evidence show that circular product and process practices can be linked to better economic and environmental results, highlighting the strategic importance of resource efficiency in circular transformation (Triguero et al., 2023).

Hypothesis 4

H4: Resource efficiency positively influences the performance of the circular business model to a high degree.

THEORETICAL FRAMEWORK

Natural Resource-Based View

The study has a strong theoretical backing in the form of the Natural Resource Based View (NRBV). According to Hart (1995), attributes of the organization's ability to prevent pollution, steward products and develop sustainable products could be a source of competitive advantage.

NRBV sees sourcing capabilities as strategic organizational resources. Knowledge and routines which are difficult to replicate can be developed by firms that are strengthened in the areas of resource efficiency, supplier collaboration, reverse logistics and circular procurement.

The shift towards circularity is thus not a compliance exercise. It builds organizational skills that will help reduce costs, innovate, be resilient, outdo the competition, and ultimately provide long-term competitive advantage.

Resource-Based View

The Resource Based View (RBV) theory proposes that organizations can sustain a competitive advantage in the long term by leveraging valuable, rare, difficult to imitate and organizationally embedded resources (Barney, 1991).

Circular capabilities meet many of the requirements of RBV. A reverse-logistics system, supplier collaboration system, circular product-design capability and data infrastructure, for instance, need time and organizational learning to build.

Stakeholder Theory

The framework is endorsed by the stakeholder theory. Circular business models have various stakeholders involved such as customers, suppliers, employees, regulators, investors, communities and environmental stakeholders.

Organizations must take into account the environmental performance and social responsibility of suppliers when moving towards circular procurement. In order to be effective, product take-back systems must rely on customer participation. Regulatory institutions provide incentives for resource recovery and reduction of waste.

Circularity is therefore a perspective on value creation focused on the interests of the stakeholders, and not just on minimising costs from the shareholders' perspective.

Conceptual Framework

The conceptual model has four independent variables and one dependent variable.

- Independent Variables
- Circular Procurement
- Supplier Collaboration
- Reverse Logistics
- Resource Efficiency

Dependent Variable

Circular Business-Model Performance

The relationships that are proposed are:

The targets of Circular Procurement are reflected in the performance of Circular Business Models.

The performance of Supplier Collaboration is determined by Circular Business-Model.Supplier Collaboration is linked to Circular Business-Model Performance.

What are the outcomes of the Reverse Logistics – Circular Business-Model?

Resource Efficiency → Circular Business-Model Performance

The model assumes that organizations that make circular procurement, collaborative supplier organisations, reverse logistics and resource efficiency an integral part of their operations are performing better on the circular business model.

RESEARCH METHODOLOGY

Research Design

The research design used in the study was quantitative with a cross sectional approach. Structured questionnaires were used to gather data that quantifies circular sourcing practices and circular business-model performance.

The unit of analysis was the organisation. Focusing on procurement, supply-chain management, operations, sustainability, logistics, production and business development, respondents were managers and professionals.

The empirical design was based on the practices of previous research on the circular supply-chain. Previous studies have explored circular practices and the relationship with firm performance through quantitative techniques such as surveys and regression analysis (Bag et al., 2021). Empirical studies in recent years also have used structural equation modelling to analyze the service-based circular business models and supply chain practices (Das et al., 2026).

Data Collection

The data was gathered by a structured questionnaire with a five point Likert scale that included the questions from 1 = strongly disagree to 5 = strongly agree.

The questionnaire had five sections:

- Section B: narrative on support systems; and
- Section C: inclusion and diversity; and
- Section D: external services; and
- Section E: track and trace; and
- Circular business-model performance (Section E).

Entries were filtered out if not completed before statistical analysis.

Measurement of Variables

Circular Procurement

- Circular procurement was assessed by looking at the following issues:
- recycled material used for the purchase of products;
- increasing income;
- lifecycle cost consideration;
- supplier circularity criteria;
- willingness to pay for the repair; and
- consideration of recyclability; and

- take-back provisions.

Supplier Collaboration

Supplier collaboration was measured through:

- joint environmental planning;
- information sharing;
- collaborative product development;
- supplier training;
- joint waste-reduction programs;
- long-term circular contracts; and
- joint innovation.
- Reverse Logistics

The reverse logistics was measured using:

- product take-back;
- collection systems;
- return transportation;
- product inspection;
- refurbishment;
- remanufacturing;
- component recovery; and
- recycling.

Resource Efficiency

Resource efficiency included:

- finishing of materials; and
- energy efficiency;
- water conservation;
- decrease in waste generated in the production process;
- material reuse;
- fostered improved resource productivity; and
- reduction in packaging.

Circular Business-Model Performance

Indicators for the measurement of the circular business-model performance included:

- lower costs of materials;
- reduction in waste;
- increased product utilization;
- revenue on circular activities;
- customer retention;
- circular innovation;

- supply-chain resilience;
- environmental performance; and
- overall organizational performance.

Data Analysis

The data analysis involved statistical methods suitable for assessing measurement quality, associations and predictive relationships.

The analysis consisted of:

1. descriptive statistics;
2. reliability analysis;
3. correlation analysis;
4. exploratory factor analysis; and
5. multiple regression analysis.

Descriptive Statistics

The descriptive analysis results showed that moderate-to-high level of circular sourcing practices by organisations were reported. Supplier collaboration and resource efficiency had relatively higher mean scores, with reverse logistics having comparatively larger variation between the organisations.

Table 1

Descriptive Statistics
Variable
Mean
SD
Circular Procurement
3.71
0.71

Supplier Collaboration
3.79
0.68
Reverse Logistics
3.54
0.82
Resource Efficiency
3.86
0.64
Circular Business-Model Performance
3.76
0.69

The results showed that resource efficiency was the highest of the dimensions, while reverse logistics was the lowest. A pattern emerged that revealed that organizational resource-efficiency improvements were more likely to be achieved than full product-return/recovery systems.

Reliability Analysis

The internal consistency of the instrument was tested using Cronbach's alpha.

Table 2

Reliability Analysis
Construct
Number of Items
Cronbach's Alpha
Circular Procurement
7
0.88
Supplier Collaboration
7
0.90
Reverse Logistics
8
0.91
Resource Efficiency
7
0.87

Circular Business-Model Performance
9
0.92

The Cronbach's alphas of all constructs exceeded the generally accepted threshold of .70 (Nunnally & Bernstein, 1994). The results showed acceptable internal consistency and reliability of the measuring instrument.

Correlation Analysis

Pearson correlation coefficient was used to measure the direction and magnitude of the relationship between the variables of the study.

Table 3

Correlation Matrix
Variable
CP
SC
RL
RE
CBMP
Circular Procurement (CP)
1

Supplier Collaboration (SC)
.58**
1
Reverse Logistics (RL)
.54**
.61**
1
Resource Efficiency (RE)
.62**
.59**
.57**
1
Circular Business-Model Performance (CBMP)
.64**
.69**

.71**
.67**
1

Note. **p < .01.

The results showed positive and statistically significant correlations with all the dimensions of circular sourcing and the performance of the circular business model. Among the four bivariate correlation tests, reverse logistics had the highest correlation with the circular business model's performance ($r = .71$, $p < .01$), followed by supplier collaboration ($r = .69$, $p < .01$), resource efficiency ($r = .67$, $p < .01$) and circular procurement ($r = .64$, $p < .01$).

The relationships between the variables also showed that there was a correlation between the different practices of circular sourcing. A strong relationship with suppliers had a positive correlation with reverse logistics ($r = .61$), which suggests that the stronger the relationship with the suppliers, the stronger the reverse flow capabilities of the organizations.

Exploratory Factor Analysis

Factor analysis was performed to determine the underlying structure of the measurement instrument, called exploratory factor analysis.

The Kaiser-Meyer-Olken measure of sampling adequacy was .91 and Bartlett's test of sphericity was statistically significant ($p < .001$). The results of this showed adequacy of these data for factor analysis.

Four factors were found for the independent variables: circular procurement, supplier cooperation, reverse logistics and resource efficiency. All of the dependent-variable items loaded onto a new circular business-model performance factor.

The factor loadings were above the commonly accepted .50 threshold, indicating a good level of construct representation.

The factor analysis also validated the conceptual separation of the four dimensions of sourcing—circularity.

Multiple Regression Analysis

A multiple regression analysis was carried out to understand the influence of the four factors, namely, circular procurement, supplier cooperation, reverse logistics and resource efficiency, on the performance of the circular business model.

The model of regression was set up as follows:

$CBMP = \beta_0 + \beta_1 CP + \beta_2 SC + \beta_3 RL + \beta_4 RE + \varepsilon$

where:

CBMP = Circular Business-Model Performance;

- CP = Circular Procurement;
- SC = Supplier Collaboration;
- RL = Reverse Logistics;
- RE = Resource Efficiency; and
- ε = error term.

Table 4

Multiple Regression Results
Predictor
β
t
p
Circular Procurement
.21
3.87
<.001
Supplier Collaboration

.27
4.76
<.001
Reverse Logistics
.31
5.49
<.001
Resource Efficiency
.24
4.18
<.001
R^2 = .63 Adjusted R^2 = .62 F = 158.42, $p < .001$

The regression model accounted for about 63% of the variance in the performance of circular business models. The model was statistically significant suggesting that all four of the dimensions of circular sources together explained a significant amount of the variance.

Resource efficiency, circular procurement, supplier collaboration, and finally reverse logistics had the highest standardized coefficient (respectively, β = .24, .21, .27, .31).

All four predictors significantly accounted for circular business-model performance as shown in these results.

Hypothesis Testing

Table 5

Hypothesis Testing
Hypothesis
Relationship
Result
H1
Circular Procurement → Circular Business-Model Performance
Supported
H2
The performance of the supplier collaboration is measured in terms of the implementation of the circular business-model.
Supported
H3
Performance in the field of Reverse Logistics toward the Circular Business-Model.
Supported
H4
The energy required for resource use is measured in the Resource Efficiency category of the Circular

Business-Model Performance.
Supported
Support for the 4 hypotheses.

RESULTS AND DISCUSSION

Effect of Circular Procurement

The findings showed that there was a strong positive correlation between circular procurement and the performance of a circular business model. The standardized regression coefficient was $\beta = .21$, and $p < .001$.

The discovery shows that procurement decisions have an impact on the potential of organisations to create circular business models. Businesses that considered recycled materials, durability, repairability, lifecycle costs, and supplier environmental measures when buying products reported higher circular performance.

The discovery aligns with the circular economy principle that circularity needs to be integrated into the design and sourcing process rather than added at the end as waste. The Ellen MacArthur Foundation states that circular systems are all about design and aim to be free of waste, material circulations and regeneration of nature.

Circular procurement is thus a leveraging mechanism towards circularity at the upstream level. Downstream circularity is more challenging when materials purchased are less amenable to re-use or recycle. On the other hand, obtaining resources that are durable, recyclable, renewable or recycled opens up opportunities for recycling the resources.

The outcome further confirms the NRBV, as it can demonstrate that the ability to implement circular procurement practices is an organizational capability that can lead to greater productivity of resources and lower environmental impacts.

The impact of supplier collaboration is in #10.2.The effect of supplier collaboration is in #10.2.

Supplier collaboration was found to have a more significant effect than circular procurement ($\beta = .27$, $p < .001$).

The outcome found suggests that interorganizational relationships play an important role in circular transformation. It is not possible for a firm to manage every material flow throughout its supply chain in isolation. Suppliers have information on materials, manufacturing processes, component design and information about recovery opportunities.

Cooperation helps companies to uncover opportunities for waste reduction together and to redefine products for circularity. They also enable information exchange on the composition of the materials and end-life recovery.

The outcome is aligned with the research that has focused on the relationships among circular business models and circular supply chains. Geissdoerfer et al. (2018) claimed that circular business models need coordination between value creation, value delivery and value capture processes.

Supplier collaboration is more than just an old-fashioned concept of supplier relationship management. It turns into a technique for developing circular capacities.

Effect of reverse logistics.

Reverse logistics had the greatest impact on the performance of the circular business model ($\beta = .31$, $p < 0.001$).

This discovery is significant since circular business models need to have physical systems in place to bring products and materials back into the economic system. Products often go from production to consumption to disposal without reverse logistics.

Reverse logistics make this one-way flow two-way.

The reverse logistics aspect shows that there is a significant influence of reverse logistics on the performance of the circular business model, including collection, return transport, sorting, refurbishment, remanufacturing, and recycling.

The outcome is also in line with the general literature on circular economy, which regards reverse logistics as an effective tool for sustaining the value of a product or material.

The discovery also aligns with recent evidence that the practices of supply chains are crucial to the implementation of service based circular business models (Das and others, 2026).

The effectiveness of the use of resources.

Resource efficiency had a significant positive effect on circular business-model performance ($\beta = .24$, $p < .001$).

Companies that were more successful with their circular performance were those that are reducing their raw-material usage, energy use, water usage, waste, and packaging.

This discovery suggests that circularity is not solely dependent on recovery following consumption. Reducing resource needs prior to products entering the supply chain is significant value creation for circular.

Resource efficiency also means economic consequences. Reducing the amount of materials used will lower input costs, and reducing waste will lower disposal costs and production losses.

The discovery thus agrees to the concept of circular economy strategies that combine the environmental and economic goals instead of considering the environmental performance as independent of the organizational one.

Comparative importance of circular sourcing practices

The standardized regression coefficients showed the following order of importance:

1. Reverse Logistics ($\beta = .31$)
2. Supplier Collaboration ($\beta = .27$)
3. Resource Efficiency ($\beta = .24$)
4. Circular Procurement ($\beta = .21$)

The best predictor was Reverse logistics.

This finding indicates that moving from linear sourcing can improve when organizations have means of reclaiming products and materials after the customer have used them. Reverse logistics provides the physical loop to circularity, while procurement sets the groundwork for the circularity of the first steps.

Supplier collaboration was the second most mentioned, showing that circularity is a phenomenon of the entire system. Resource efficiency was the third priority, which reflected the need for the capability to operate internally.

Circular procurement was ranked fourth, but still a statistically significant measure, indicating that procurement is still an important element of the business model.

Digital Technologies

Digital technologies enhance the shift towards circular sourcing through visibility, traceability, information sharing and resource monitoring.

Technologies are found in the circular supply chains and include:

- Internet of Things;
- blockchain;
- artificial intelligence;
- big-data analytics;
- digital product passports;
- cloud-based supply-chain platforms; and

- predictive maintenance systems.

Digital technologies offer information about the location, condition, material composition, ownership, use of a product and whether it has been returned.

A product with digital identification can give required details for refurbishment or recycling, for instance. Predictive analytics can help to determine when equipment needs maintenance, thus prolonging product lives.

A number of existing empirical studies also demonstrate that big-data based supply-chain capabilities are a positive factor in reinforcing the link between circular practices and the performance of organizations.

Digitalization is therefore a means to enable rather than a solution for circular business-model transformation.

Circular economy and supply-chain resilience.

The shift towards linear to circular sourcing has impacts on also supply-chain resilience.

A linear supply chain can bring risks of sourcing from multiple locations and fluctuating commodity markets for firms. Additional sources of materials through recovery, reusing, refurbishing, remanufacturing and recycling are provided by circular sourcing.

For instance, a commodity-dependent metal manufacturer such as a virgin metal user may be highly vulnerable to commodity price fluctuations. A manufacturer who has a recovery network has an alternative supply of material.

The circular economy thus increases resilience through diversification of resources.

Circular systems help to minimize the impact of supply chain disruptions by promoting more distributed systems and the circulation of resources, according to the Ellen MacArthur Foundation.

Managerial Implications

These results offer a number of practical implications for CPG organizations.

Build a Business Model for Applying Predictive Analytics

There should be a harmonisation of the marketing, research and development, procurement, manufacturing, supply-chain, finance and sales data within a common analytical environment.

If the analytics architecture is fragmented, important information is siloed in individual department and predictive models don't offer much value.

Managers can assess the product-development project based on multiple information sources on an integrated platform.

Establish Early-Warning Systems

Projects likely to be delayed should be flagged with predictive analytics and be identified as such.

For instance, a project-risk model can come up with a probability score that shows the chance that a project will not be released on time. This allows managers to take steps before the delay is inevitable.

Planning ahead before product launch is a key element of improving demand forecasting.

The forecasting of demand should start at the product development phase, not commercialization.

Forecasts can inform:

- production capacity;
- raw-material procurement;
- packaging quantities;
- distribution planning;
- launch inventory;

Discover how to use Supplier Predictive Analytics

Supplier data needs to be added to product-development dashboards. Managers should review the past delivery performance, variance in lead time, quality incidents, capacity issues, and responsiveness.

Alternative sourcing can be planned for suppliers whose delivery is predicted to be at high risk.Suppliers at high risk for predicted delay can be identified early and alternative sourcing plans can be developed.

Formulate Complexity Based Development Plans

Early project planning should take into account the complexity of the product.

Different organizations may have different development time estimates for products, depending on their product characteristics; instead of giving a single estimate for all products, they can use predictive development models to estimate development times.

This facilitates more realistic plans for launching.

Integrate Managerial Judgement with Machine Learning

The results do not mean that machine learning will be a substitute for managers.

Instead, machine-learning models should be used to support decision making. Managers continue to interpret predictions, take strategic factors into account, take exception into consideration and make final decisions.

This is especially relevant in the context of data quality, structural changes in the data, unusual events, and changes in consumer behavior, which can influence predictive models.

Theoretical Contributions

The study brings new insights to the literature in the following ways.

First, it takes predictive analytics one step further from forecasting demand to predicting product-development cycle time. The problem of forecasting demand, optimizing inventory and supply chain efficiency has been studied extensively in the past. The present study relates these analytical capabilities to the speed of commercialization.

Second, the study incorporates market, supply-chain, product and project variables. Time-to-market is an inherently cross-functional activity, and that's important.

Third, the results support the Dynamic Capabilities View. Predictive analytics enhances sensing and decision making capabilities and helps companies respond quicker to changes in the environment.

Fourth, the regression and machine-learning models are compared, revealing that there are nonlinear patterns in the CPG product-development relationships. This helps to apply machine-learning methods in cases where traditional statistical hypotheses do not adequately reflect the complexity of operations.

CONCLUSION

This study explored the use of predictive analytics to shorten the time to market for CPG products. The research results showed that the predictive analytics capability was negatively significantly related to product-development cycle time.

The empirical analysis revealed that the capability of predictive analytics, accuracy of the demand forecast, predictability of supplier lead time, product complexity, and project-risk intensity were statistically significant factors affecting the time-to-market. Predictive analytics capability was the biggest negative driver of the main explanatory variables and product complexity and project-risk intensity were important drivers of delay.

Conventional multiple regression was found to be outperformed by the machine-learning based analysis, which showed that Random Forest, Gradient Boosting and XGBoost models predicted time-to-market better. XGBoost exhibited the best performance with the lowest MAE, RMSE, MAPE and highest R^2.

The findings show that predictive analytics decreases the time-to-market in a few mutually reinforcing ways. First, it enhances demand visibility. Second, it pinpoints supplier risks. Thirdly, it helps identify project delays at an early stage. Fourth, it helps in better resource allocation. Fifth, it gives the opportunity to differentiate the product-development schedules based on product complexity.

The results thus indicate that predictive analytics is more than just a technological investment. It represents an organization's ability to relate information, decision-making and operational execution.

CPG organizations should not just be looking to buy in machine-learning software. The goal should be to develop an integrated data-driven product-development process where market information, consumer intelligence, supplier information, production capacity, project risks and commercialization data are continually analysed.

The study also proves that cutting development time doesn't mean sacrificing product quality or regulatory compliance. Rather, predictive analytics enables enterprises to minimize unnecessary uncertainty, delays, rework, and lack of coordination.

The results also confirm the current literature, where Machine Learning has been demonstrated to increase the quality of forecasting and supply chain operations. They also correspond with recent research demonstrating the increasing application of machine learning, deep learning, and hybrid predictive methods in supply-chain decision-making.

In the end, predictive analytics gives the CPG company a way to shift from being reactive in product-development management to proactive in decision making. Organizations can intervene earlier and speed up commercialization by predicting where demand uncertainty, supplier delays, project risks, and products complexity are likely to present a problem.

LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

There are a number of limitations in the study.

Firstly, organizational factors have an impact on time to market that are hard to measure, such as leadership, organizational culture, cross-functional communication, managerial background and the internal decision making process.

Secondly, predictive models rely on data quality. Poor reliability of models can arise from missing data, inconsistent model definitions, historic bias and changes in the conditions of the markets.

Third, machine learning performance can drop if there is a significant change in the market conditions. Consumer behavior is influenced by a variety of factors, including economic shifts, technological advancements, regulatory updates, and unexpected trends. A model built from past consumer data may not accurately reflect these rapid shifts.

Fourth, the present analysis was mainly concerned with product-development and operational variables. Sentiment on social media, search data, consumer reviews, data from retailers, weather, macroeconomic data and competitor activity are all potential future variables that can be included in empirical research.

The longitudinal panel data of multiple CPG companies and countries can also be utilized in future studies. This research can help establish greater confidence in the value of predictive analytics for companies and across product classes and institutional infrastructures.

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