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The effect of data driven culture on customer development and firm performance: the role of supply chain information sharing and supply chain information quality

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Abstract. Firms seeking to maximize the benefits of data analytics have begun adopting data driven culture. Data driven culture is expected to enhance firm performance outcomes. However, the mechanism through which data driven culture enhances firm performance has received little empirical attention and is little understood. This study proposes that data driven culture first enhances the supply chain information sharing and supply chain information quality capabilities of firms, which subsequently help firms to maximize their customer development and firm performance outcomes. A research model examining these relationships was developed and tested using data from 123 firms operating in Ghana. The results confirmed that data driven culture enhanced the supply chain information sharing and supply chain information quality, which subsequently enhance customer development and firm performance.

Keywords: Data Driven Culture, Supply Chain Information Management, Customer Development.

1 Introduction

In recent times, many organizations have turned to data analytics as a means to stay competitive amidst high levels of uncertainties in the current age of big data. But for organizations to be able to fully exploit the potential of advanced analytics, there is the need for an enterprise-wide data-driven culture [1]. It is therefore not surprising that becoming data-driven has become a top priority in many organizations [2]. “Data-drivenness” is all about developing tools, abilities and a culture that acts on data [1]. Data driven culture has been defined as a pattern of behaviors and practices by a group of people which share a belief that having, understanding and using certain kinds of data and information plays a critical role in the success of an organization

[3]. Organizations develop a data driven culture in order to gain new insights into their operations, business environments and customers, with the hope of being better able to achieve higher customer development – the ability to attract, satisfy and retain customers – and enhance their bottom line [4, 5]. Previous studies have indeed indicated that firms with high data driven culture obtain better customer results [6] and achieve higher firm performance [7, 8].

Whilst it is hoped that data driven culture would result in higher customer outcomes and firm performance, the mechanism through which data driven culture enhances these outcomes has been little explored and is little understood. In the light of this paucity, this study examines the mechanisms through which data driven culture enhances customer development and firm performance by shedding light on the important role of supply chain information management. Information has been identified as a key resource that must be well managed to enhance performance of firms. There is the need for firms to go beyond effectively managing information within the firm and aim at effectively managing relevant supply chain information with key supply chain partners [9]. Supply chain information management refers to how well an organization manages supply chain information, and it has been explored in two ways in the literature: volume of information shared and quality of information shared [10]. Supply chain information sharing relates to the volume of information shared between organizations and its trading partners whilst supply chain information quality refers to the accuracy, timeliness, adequacy and credibility of the supply chain information exchanged [4]. The study articulates that supply chain information sharing and supply chain information quality help further our understanding of how data driven culture enhances customer development and firm financial performance.

The study is relevant in a number of ways. First, the study fosters a deeper understanding of how data driven culture enhances the ability of firms to attract, satisfy and retain customers, as well as how data driven culture enhances the financial performance of firms. Supply chain information sharing and supply chain quality are confirmed to be initial benefits that firms obtain, which subsequently enable higher customer development and firm performance. The study also provides insights into the outcomes of “data-drivenness” from the context of a developing African country, a context that has been little explored in the existing literature [11]. The study also provides insights that can guide managers and practitioners in how to achieve higher customer development and firm performance outcomes from their data driven culture initiatives.

The rest of the paper is organized as follows. The theoretical background is presented next, followed by the research model and hypotheses. Next the methodology of the study is elaborated on, followed by a discussion of the results of the study. The study then concludes by discussing the implications of the study and recommendations for future research.

2 Theoretical Background

This study is grounded on the absorptive capacity theory and the dynamic capability theory. The absorptive capacity theory explains a firm's ability to recognize the value of new information, assimilate it and incorporate them into organizational processes [12]. The theory expounds that the ability of firms to extract valuable information from different sources is contingent upon their absorptive capacity. Drawing from the absorptive theory, we argue that data driven culture serves as an absorptive capacity, and allows organizations to share and have access to quality information [13].

Rooted in the resource-based view, dynamic capabilities refer to the ability of an organization to build and reconfigure the internal and external resources and competences required to sense and seize opportunities in rapidly changing environment [14]. The dynamic capability theory expounds that, the competitive benefits obtained by an organization are a result of capabilities built in reaction to environmental responsiveness strategies [15]. Correspondingly, this study draws on the dynamic capability theory to propose that information sharing and information quality are positively related to customer development and firm performance. Additionally, we draw on the same theory to propose a positive relationship between customer development and firm performance.

3 Research model and hypotheses

The research model of the study proposes that data driven culture initially enhances the supply chain information sharing and supply chain information quality of firms. These subsequently result in customer development and firm financial performance benefits for firms. All constructs were conceptualized at the first order level. The research model is presented in Figure 1 below. The hypotheses of the study are discussed next.

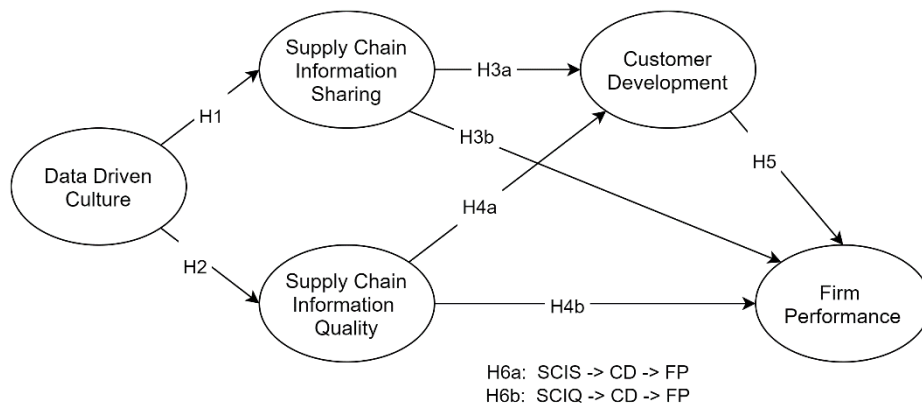


Fig. 1. Research model

3.1 Data Driven Culture, Supply Chain Information Sharing and Supply Chain Information Quality

Recent IT developments have enhanced the absorptive capacities of firms and empowered them to access, manage and analyze data for more effective decision making [16]. Sanders [17] emphasizes that the benefits of information are maximized through enabling information sharing within and outside the organization. It has been noted that data driven culture enables organization to collaborate closely with supply chain partners [18]. Firms with a strong data driven culture are more likely to aim to share sound supply chain data to a high level. Again, data driven organizations invest in big data analytics capabilities which maximizes their absorptive capacities for obtaining and leveraging quality supply chain information. Based on the discussions above, the study proposes that:

H1: There is a positive relationship between data driven culture and supply chain information sharing.

H2: Data driven culture is positively related to supply chain information quality.

3.2 Supply Chain Information Sharing, Customer Development and Organizational Performance

Supply chain information sharing enables visibility throughout the value chain, which helps firms to better understand customer and market demand, positioning them to be better able to meet customer demand [19]. Supply chain information sharing also allows firms to more efficiently and effectively fulfill supply chain operations, which culminates in higher firm performance [20]. Again, information sharing allows key supply chain actors such as suppliers, manufacturers, and retailers to forecast, synchronize, and improve production and delivery related decisions [21]. Effective supply chain information sharing helps firms to capture external knowledge to strategize to meet customers requirement in an everchanging business environment [22]. Accordingly, we propose that:

H3a: There is a positive relationship between supply chain information sharing and customer development.

H3b: There is a positive relationship between supply chain information sharing and firm performance.

3.3 Supply Chain Information Quality, Customer Development and Firm Performance

Having access to accurate and timely supply chain information is important for firms to meet dynamic customer demand and market changes for improved performance. A number of studies assert that information quality has an influence on the soundness of organizational decisions [23]. Poor supply chain information quality may cause organizational losses such as missed opportunities, making incorrect decisions and loss of customers [24]. The efficiency and effectiveness of a supply chain is largely influenced by the timeliness and accuracy of information used for decision making. The

use of quality information reduces risks associated with demand uncertainties. It has been argued that information quality is a key determinant of customer service capabilities [25]. It has also been observed that information quality has an effect on firm performance [20]. Based on the discussions above we postulate that:

H4a: There is a positive relationship between supply chain information quality and customer development.

H4b: there is a positive relationship between supply chain information quality and firm performance.

3.4 Customer Development and Organizational Performance

The main goal of any organization and supply chain is to create or improve the value offered to customers [26]. Fawcett et al. [27] maintains that customers are the main source of revenue in the supply chain. Thus, customer acquisition, satisfaction and retention are very key to the survival of organizations [4, 28]. However, customers have become increasingly demanding and their preferences can change rapidly over a short period of time [5]. It is firms that are able to meet dynamic needs of customers that will achieve high firm performance outcomes. This assertion is confirmed by the study of Amedofu et al. [4] who found that customer development has a positive impact on the performance of start-up firms. Based on the discussions above, this study postulates that:

H5: Customer development has a positive impact on firm performance.

3.5 Mediating role of Customer Development

The study finally proposes that the supply chain information management capabilities obtained by data driven firms enhance their performance by first enhancing their ability to attract, satisfy and retain customers. The ability of firms to obtain benefits from enhanced supply chain information management lies in how well they are able to leverage the supply chain information to respond to varying customer demand. This assertion is confirmed by Amedofu et al. [4] who observed that supply chain management practices such as supply chain information sharing and supply chain information quality first enhanced customer development, which subsequently enhanced performance of start-ups. This suggests that customer development plays an important intervening role in the relationship between supply chain information sharing and firm performance. This leads us to hypothesize that:

H6a: Customer development mediates the relationship between information sharing and firm performance.

H6b: Customer development mediates the relationship between information quality and firm performance.

4 Methodology

4.1 Measurement items development

The measurement instruments used to measure the constructs explored in this study were initially sourced from previous studies, with measurement items for data driven culture sourced from [11]. Measures for supply chain information sharing and supply chain information quality were sourced from [29] and [10]. Measurement items for customer development were adapted from [4] and firm performance from [10] and [28]. After carefully selecting the various measurement items from literature, the resultant questionnaire items were sent to various managers of different industries to assess whether the items were applicable within their respective domains. Some of the items for the constructs were modified to suit the context of the study based on the feedback received. The instruments were then administered to three experts for review. Their response and input further helped to refine the measurement instruments and ensured that the questionnaire was readable, understandable, and relevant to the study. The measurement items used in this study are presented in the Appendix.

4.2 Data collection

To obtain data to test the research model, a survey of manufacturing and service firms operating in Ghana was conducted. A list of 5,000 firms operating in Ghana was obtained from the Registrar General's Department, out of which a sample of 500 firms were randomly selected for this study. The firms were contacted and permission was sought for data collection. In all, 58 firms declined to participate in the study. These were removed from the sample. For the remaining firms, questionnaires were sent to email, courier or in-person, depending on which option the firms preferred. After a week, follow up calls were made, with a second wave of reminders sent in the next week. In all, 123 usable responses were successfully retrieved, which accounted for a response rate of 24.6%. Power analysis was conducted using a recommended medium effect size of 0.3, a minimum statistical power of 0.8, and a probability of error of 0.05 [30], with the results revealing that a minimum sample size of 82 responses will be required for the results to attain statistical power. Therefore the 123 responses were sufficient for the study.

5 Results

5.1 Demographic results

The demographic data revealed that cumulatively, 57.8% of the organizations who responded had employed less than 19 people, falling under the classification of micro enterprise businesses. Also, 26.8% of firms surveyed had more than 99 employees. With regards to how long the firms have been in operation, 54.5% had been in operation from 5 years or less. In terms of estimated annual revenues, 30.9% of responding firms had revenue levels of less than \$10,000.

5.2 Measurement model results

The analysis was conducted using the partial least squares structural equation modeling (PLS-SEM) approach. The measurement model was analyzed by assessing the convergent validity and discriminant validity of the model. Convergent validity can be assessed by measuring the composite reliability of constructs, average variance extracted (AVE) and factor analysis [31]. Items with loadings below 0.708 and items with high cross loadings were dropped. The attributes of the constructs were then tested by measuring the psychometric properties of the constructs and comparing them against acceptable benchmarks. Composite reliability values were high and comfortably exceeded the suggested 0.7 threshold and the AVEs of all the constructs are higher than 0.5 as required [31]. The summary of the psychometric properties of the constructs are presented in Table 1.

Table 1. Psychometric properties of constructs

Construct	Composite Reliability	AVE
Data Driven Culture	0.906	0.707
Supply Chain Information Quality	0.959	0.825
Supply Chain Information Sharing	0.923	0.665
Customer Development	0.937	0.682
Firm Performance	0.937	0.714

The items were next tested for sufficient discriminant validity. Discriminant validity examines the extent to which a measure correlates with measures of constructs that are different from the construct they intended to assess [31]. Discriminant validity can be assessed by comparing the AVE for each factor against the squared correlation of each constructs, with the former required to be higher than the latter [31]. In Table 2, the bold diagonal numbers represent squared AVEs whilst the off-diagonal numbers represent correlation among constructs. It can be seen that the bold diagonal values are all greater than the off-diagonal ones, confirming adequate discriminant validity.

Table 2. Fornell-Larcker test

	I	II	III	IV	V
Data Driven Culture (I)	0.841				
Supply Chain Information Quality (II)	0.528	0.908			
Supply Chain Information Sharing (III)	0.668	0.685	0.816		
Customer Development (IV)	0.563	0.622	0.586	0.826	
Firm Performance (V)	0.441	0.488	0.507	0.552	0.845

Discriminant validity was further assessed using the HTMT test. HTMT is the average of the heterotrait-heteromethod correlations and is a more stringent alternative measure of discriminant validity [31]. HTMT test approach indicates that HTMT values must be significantly less than 1, with a value of less than 0.85 ideal [31]. Table 3 indicates that the highest HTMT value is 0.758, confirming the model possesses adequate discriminant validity.

Table 3. HTMT test

	I	II	III	IV	V
Data Driven Culture (I)					
Supply Chain Information Quality (II)	0.583				
Supply Chain Information Sharing (III)	0.758	0.738			
Customer Development (IV)	0.631	0.662	0.634		
Firm Performance (V)	0.487	0.519	0.555	0.579	

5.3 Structural model results

After confirming the soundness of the measurement model, the structural model and hypothesized relationships were examined. PLS-SEM provides the coefficient of determination value (R^2), as well as the magnitude, direction and significance of the hypothesized causal relationships as standardized path coefficients. We first assessed the model's in-sample explanatory power by investigating the R^2 values of the endogenous variables. As a guideline, R^2 values of 0.75, 0.50 and 0.25 can be considered substantial, moderate and weak respectively [31]. The co-efficient of determination (R^2) of the constructs ranged from 0.278 to 0.450, which represent moderate levels of determination. Examining the predictive relevance of the model revealed Q^2 values ranging from 0.223 to 0.286, confirming the predictive relevance of the model [31].

Assessing the hypotheses results revealed that all hypothesized relationships in the study were positive and significant except the direct relationship between the supply chain information quality and firm performance. The findings revealed that data driven culture significantly enhances the supply chain information sharing and supply chain information quality capabilities of firms as hypothesized. Supply chain information sharing then directly enhances customer development and firm performance. Supply chain information quality on the other hand directly enhanced customer development, but not firm performance. Customer development was also found to significantly enhance firm performance. Examining the mediating role of customer development in the relationship between supply chain information sharing and firm performance revealed that customer development partially mediated the effect of supply chain information sharing on firm performance. On the other hand, the relationship between supply chain information quality and firm performance was fully mediated by customer development. The structural model results are summarized in Figure 2 below.

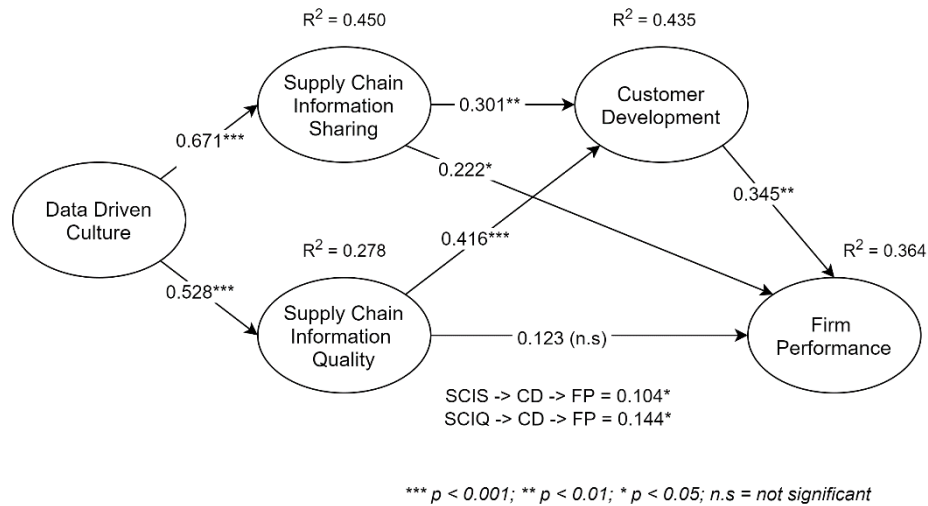


Fig. 2. Structural model results

5.4 Discussions

The findings of the study confirm that the initial manifestation of outcomes of a sound data driven culture is an increase in the volume and quality of important supply chain information that is shared with key partners, which is in line with previous studies [16].

The subsequent outcomes of these first level benefits provide more insight into how data driven culture enhances performance of organizations. Supply chain information sharing was found to directly enhance the ability of firms attract, satisfy and retain customers. This supports the findings of previous studies [4]. Additionally, supply chain information sharing directly enhanced the firm performance of firms, which is in congruence with the findings of previous researchers [10]. Delving further into the performance outcomes of supply chain information sharing by examining indirect effects reveals that some of the effect of supply chain information sharing on firm performance was mediated through customer development, which is indicative of complimentary partial mediation. Thus, supply chain information sharing enhances firm outcomes by directly enhancing customer development and firm performance, and indirectly enhancing firm performance through enhanced customer development.

Supply chain information quality enhances performance of organizations in a different way. Supply chain information quality directly enhances the ability of firms to attract, satisfy and retain customers, consistent with previous studies [25]. However, supply chain information quality did not directly enhance firm performance. Closer examination of the supply chain information quality – firm performance link however, reveals that there is a positive and significant indirect effect of supply chain information quality on firm performance. Given that the direct effect was not significant and the indirect effect through customer development was significant, it is concluded

that customer development fully mediates the effect of supply chain information quality on firm performance.

Put together, the findings shed much insights into how the capabilities delivered by data driven culture enhances the performance of firms. These findings should be of interest to both researchers and practitioners. For researchers, the study elucidates the important roles of supply chain information sharing and supply chain information quality in understanding how “data-drivenness” enhances the bottom line of firms. These can be viewed as the initial manifestation of the outcomes of data driven culture. The study additionally identifies the important role of customer development in explaining how supply chain information sharing and supply chain information quality enhance firm performance. For practice, the study provides an important guide for managers and owners of firms who want to see positive outcomes from their data driven culture. Business leaders can expect that “data-drivenness” will ultimately enhance their firms’ performance but important intermediary outcomes such as supply chain information management and customer development must be managed to ensure that financial firm performance gains are maintained.

6 Conclusion

The study was conducted to examine how data driven culture enhances performance outcomes of firms. The study proposed and empirically confirmed that data culture initially creates supply chain information sharing and supply chain information quality capabilities for firms, which are then leveraged to achieve higher customer development and firm performance. Additionally, customer development was found to play important mediation roles in understanding how supply chain information management enhances firm performance.

There were some limitations of the study. Data was collected only from Ghana and the results should be interpreted with this limitation in mind. Further research is needed to explore the effect of data culture on firm performance in developed countries and other regions as it is suggested that environmental conditions might play an important role in the outcome of information systems and supply chain initiatives [32, 33]. Further research can also examine the complementarity between supply chain information sharing and supply chain information quality in understanding the effects of data driven culture on performance outcomes.

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Appendix: Measurement items and their sources

Data driven culture [11]

Our organization has the data it needs to make decisions

Our organization depends on data to support its decision making

Our organization spends significant time analyzing data to support decision making

Our organization uses data rather than guess work to make decision

Supply Chain Information Sharing [10, 29]

Information sharing between our trading partners (suppliers and customers) and us is timely

Information sharing between our trading partners and us is accurate

Information sharing between our trading partners and us is complete

Information sharing between our trading partners and us is adequate

Information sharing between our trading partners and us is reliable

Supply Chain Information Quality [10, 29]

We inform trading partners (suppliers and customers) in advance of changing needs

Our trading partners share proprietary/exclusive information with us information with us.

Our trading partners keep us fully informed about issues that affect our business

Our trading partners share business knowledge of core business processes with us

We and our trading partners exchange information that helps in the drawing of business plans

We and our trading partners keep each other informed about events or changes that may affect the other partners

Customer Development [4]

Our firm is able to attract customers

Our firm has discovered our niche customer markets

Our firm has validated customer base

Our firm is able to acquire customers

Our firm is able to retain customers

Our firm's customer base is growing

Our firm has growing referred customers (dropped)

Overall, our customers are satisfied with us

Firm Performance [4, 28]

How well does your organization perform in terms of meeting its goals in terms of:

returns on assets

revenue

return on investment

profit margins on sales

growth in sales market share