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# Information technology deployment and supply chain performance: Evidence from emerging economy

*Edward S Fekpe, Ghana Institute of Management and Public Administration, Ghana*
*Michelle E Fiagbey, Ghana Institute of Management and Public Administration, Ghana*
*Corresponding author: efekpe@gimpa.edu.gh

This study used empirical data to investigate the relationship between IT deployment and supply chain performance of manufacturing firms in a developing economy. A survey research method and purposive sampling were employed to gather data from 85 companies. A quantitative research approach was adopted to analyze data using Partial Least Squares-Structural Equation Modelling (PLS-SEM) to explore the relationships among the constructs. It is found that there is a statistically significant positive relationship between IT-Use and supply chain performance. Furthermore, collaboration acts as a mediating variable that significantly impacts the IT-Use and supply chain performance relationship. The research emphasizes the importance of collaboration among supply chain partners and IT deployment in improving supply chain performance of manufacturing firms in less developed countries especially where some of the partners are located in foreign countries. Effective IT-Use is expected to address some of the challenges of collaboration and uncertainties regarding delivery of supplies through more effective and efficient information flow.

*Keywords:* developing country, information technology, manufacturing industry, supply chain performance

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## Introduction

Information flow is potentially the biggest driver of supply chain performance and it provides the foundation for other supply chain processes, transactions, and decisions. Information acquisition and sharing do not only allow firms to reduce costs, increase responsiveness and gain competitive advantage, but they also prevent supply chain disruptions by allowing potential supply chain risks and interruptions to be identified, assessed and quantified (Wakolbinger & Cruz 2011). Information flow can be managed and facilitated through the use of information technology (IT). The role of IT is to facilitate coordination and integration of supply chain capabilities efficiently and effectively by securing and analyzing information essential to decision making at all stages of a supply chain (Chandler & Munday 2016, Chopra & Meindl 2016). In addition, the quality of information is equally important in assessing the effectiveness of information sharing on supply chain decision making (Marinagia et al. 2015).

The systematic process of measuring the effectiveness and efficiency of supply chain operations and ensuring continuous improvement in supply chain processes is termed supply chain performance (Sundram et al. 2016). IT plays the important role of promoting integration and coordination among

supply chain partners such that customer demands are successfully met. Although studies have been conducted on the impact of IT-Use on the performance of firms and supply chains, there have been mixed arguments regarding its impacts. Some researchers (e.g. Campo et al. 2010, Sanders 2007, Yang 2014) found a positive relationship between IT deployment and supply chain performance (SCP) while others (e.g. Ghobakhloo et al. 2014, Kim et al. 2015) noted that IT implementation has no effect on SC performance. Some studies (e.g. Campo et al. 2010, Devaraj et al. 2007, Sanders 2007) suggest that though there may be no direct benefits of IT-Use on performance, there exists an indirect relationship between IT-Use and supply chain performance. Most of these studies were conducted on operating environments in developed economies which tend to be more advanced in their appreciation and deployment of IT.

Implementing IT is known to contribute to effective and efficient information flow in any supply chain. There is also evidence that different types of IT have been implemented to various supply chain processes including planning, sourcing, making, delivering, and return. However, quantitative assessment of the relationships between the use of IT and SCP especially in emerging economies has not been explored and documented in the literature. Supply chains in emerging economies typically have global partners where lack of interoperability of technologies can be information flow or communication barriers to local partners with low end technology applications. This study examines the impact of IT-Use on supply chain performance of manufacturing companies in an emerging economy where manufacturing is not the backbone of the economy. The study investigates the direct and indirect relationships between IT-Use and supply chain performance and the mediating effect of collaboration, a factor that enhances the relationship.

## Literature Review

There are several definitions for supply chain in the literature. Chopra and Meindl (2016) defined a supply chain as consisting of all parties directly or indirectly involved in fulfilling customer requests and includes the manufacturer, suppliers, transporters, warehouses, retailers and customers. Supply chain integration is a performance improvement approach that develops seamless linkages between the various levels and functions within a supply chain to optimize customer service. Information is the most important flow in supply chain management and it is facilitated by information technology.

In response to the conflicting arguments regarding the impacts of IT deployment on SCP, attempts have been made to establish direct and indirect relationships between some IT variables and SCP. For example, Campo et al. (2010) provided evidence of a positive indirect relationship between specific use of IT and a firm's perceived performance through information sharing and satisfaction obtained from the relationship with the provider. Using path analysis, Yang (2014) observed that strong associations exist between the IT capability of manufacturing firms and their operational collaboration with suppliers and their supply chain agility and performance.

### Importance of Information Technology (IT) in Supply Chains

IT has become a unique tool for improving the effectiveness of supply chains especially because every supply chain activity thrives on information. Given the complexity of supply chains especially global supply chains with multiple partners, IT facilitates the development and management of these relationships and interfaces. IT implementation offers benefits such as increased productivity and efficiency, increased performance, quick movement of information between supply chain partners, visibility through more timely and accurate information, cost reduction, amongst others (e.g. Davis-Sramek et al. 2010, Sabherwal & Jeyaraj 2015, Tang & Zimmerman 2013).

Complexities associated with globalization and the need to improve supply chain visibility to remain competitive and profitable require end-to-end supply chain visibility capabilities among supply chain partners. Supply chain visibility is the key enabler that requires the need to implement advanced and

innovative IT. The supply chain control tower is one such concept that is an agile cloud platform focusing on providing end-to-end supply chain visibility and control by integrating and extending existing Enterprise Resource Planning (ERP), Warehouse Management System (WMS), and Transportation Management System (TMS with suppliers, manufacturers, 3PLs, and other partners. The concept of the "control tower" is increasingly becoming prevalent in supply chain management and that means having the ability to track deliveries in real time, which in return helps make the delivery process more efficient (Bhosle et al. 2011).

**Supply Chain Performance (SCP)**

Chang et al. (2013) defined supply chain performance as the evaluation of supply chain management using both tangible and intangible factors. It has been shown that productivity and performance of supply chains are increased with the use of IT. This is because IT enables supply chains to share large quantities of quality information on both tactical and strategic operations thereby affecting inventory velocity, delivery time, responsiveness, costs and product development cycle time in a positive way (Ramayah et al. 2008).

Collaboration in a supply chain optimizes SCP through improved production planning and demand forecasts and ensures the delivery of the right product at the right time to the right location with reduced inventories, avoidance of stock-outs, and improved customer service (Li et al. 2014). Firms such as Nokia, Procter and Gamble, Toyota and Zara have been able to achieve competitive advantages over rival firms through collaboration (Kim & Lee 2010). Through IT enabled collaboration, supply chains can achieve improvements in cost efficiencies such as lower inventory costs, accuracy in ordering, shipping and receiving, and reduction in labor costs (Collins et al. 2010). Information sharing is vital in linking supply chain partners hence for supply chains to be successful, it is important for partner firms to share timely and quality information to coordinate intra- and inter-organizational business activities (Wong et al. 2012).

## Theoretical Foundation and Conceptual Framework

**Theoretical Foundation**

A supply chain can be considered as a network of autonomous firms that are linked together for the purposes of creating products and services (Hearnshaw & Wilson 2013). Supply chain network is thus defined as a supply-product-distribution network where suppliers, manufacturers and distributors are dependent on each other in the areas of strategy, resources, capacity and information (Zeng & Xiao 2014). As a result of this interdependence, firms no longer compete individually but in the form of supply chain networks and the most successful firms are those which better coordinate their cooperative or collaborative partnerships in order to provide better, faster and closer service to end users (Xu et al. 2016).

The network theory is one of the grand theories for purchasing and supply management. The theory describes the relationships between companies in the same supply chain i.e., suppliers, manufacturers, customers or buyers (Wellenbrock 2013). The theory contributes to an understanding of the dynamics of how interacting firms in a supply chain or network adapt their processes and systems to each other through exchange processes and how they can establish mutual and strong relations through close and long-term cooperation or collaboration (Halldorsson et al. 2007). The network theory provides techniques for analyzing structure in a system of interacting agents or partners, represented as a network. Jao-Hong and Chih-Huei (2014) suggest that in order to increase performance for the firm and its entire supply chain, partners in supply chain must maintain collaborative relationships with each other. IT use enhances cooperative relationships and potentially increases the level of collaboration and degree of interaction among firms (Carr 2016).

**Hypotheses Development**

As noted earlier, there are conflicting arguments regarding the impacts of IT implementation on supply chain performance. This study examines the direct and indirect effects of IT-Use on supply chain performance. Based on the literature review and theoretical background the following hypotheses emerge.

*Information Technology (IT) Use*

Supply chain performance is substantially improved through the exchange of timely and accurate information among supply chain partners. Through this exchange, manufacturers are better able to align demand with production, suppliers have better visibility and flexibility, and distributors have better accuracy in establishing transportation plans while retailers can increase sales (Yee 2005). IT makes this exchange possible by linking supply chains and making operations easier and faster.

Hall and Saygin (2012) suggest that the performance of any firm or supply chain is dependent on the ability to coordinate activities within the supply chain and IT facilitates the necessary communication, coordination, and collaboration among supply chain partners. The adoption and use of IT is regarded as a source of competitive advantage that can result in superior market performance in terms of sales growth, market development and market share – all of which contribute to the performance of the entire supply chain (Kim & Lee 2010). Campo et al. (2010), Sanders (2007) and Yang (2014) found a positive relationship between IT deployment and SCP. It is therefore hypothesized as follows:

*H1. IT-Use has a statistically positive direct relationship with supply chain performance.*

*Collaboration*

Collaboration can be defined as a process by which tasks are jointly performed by two or more organizations in order to obtain collective results (Carneiro et al. 2013). It is an inter-organizational relationship in which supply chain partners share information and responsibilities to achieve common goals and objectives in order to create competitive advantage (Montoya-Torres & Ortiz-Vargas 2014). Collaboration offers many benefits including improved demand forecasts and inventory management (Li 2012). IT has been identified as an essential factor for facilitating the flow of information to enable collaboration among supply chain partners (Aparecida de Mattos & Laurindo 2015). Collins et al. (2010) and Wong et al. (2012) noted that IT enables collaboration among supply chain partners. IT-enabled collaboration enhances strategic partnership that often results in increased SCP. It is therefore hypothesized as follows:

*H2. IT-Use positively influences collaboration among supply chain partners.*

*Supply Chain Performance*

Performance measurement is necessary in providing feedback regarding customer requirements, company and supplier capabilities, and probable success of collaboration. The performance of supply chains is multi-dimensional and selecting the appropriate performance measures for a given supply chain presents challenges. A number of frameworks and models for measuring supply chain performance such as by Gunasekaran et al. (2004) and Shepherd and Gunter (2006) have been proposed. One particular performance model that has become increasingly popular is the Supply Chain Operations and Reference (SCOR) model. The model identifies five major metrics for measuring supply chain performance namely (1) reliability, (2) responsiveness, (3) flexibility, (4) cost, and (5) asset management factors (Coyle et al. 2013). This research uses the SCOR model to develop indicators that measure SC performance. It is therefore hypothesized as follows:

*H3. The direct relationship between IT-Use and supply chain performance is mediated by supply chain*

*collaboration.*

*Conceptual Framework*

The conceptual framework shown in Figure 1 is thus grounded on the network theory. In this framework, collaboration acts as a mediating variable to explain how and why there is a relationship between the dependent (supply chain performance) and independent (IT use) variables. The mediating analysis helps understand the degree to which the mediating variable influences the relationship between the independent and dependent variables.

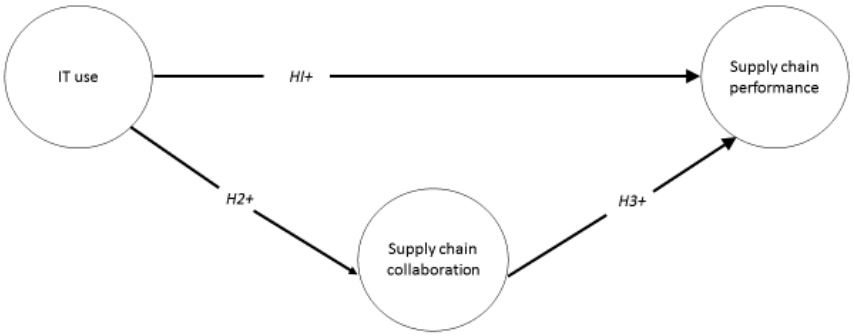


**Figure 1. Conceptual Framework**
*Source: Adapted from Camo et al. (2010)*

**Variables**

Based on the conceptual model, the following variables are defined:

*Independent Variable (IT-Use)*- this variable measures IT-Use i.e. types of technologies, the extent of use, and use for supply chain activities including procurement, placing and receiving orders, checking order status, responding to request for prices and tariffs, billing and paying for orders.

*Dependent Variable (Supply Chain Performance)* – supply chain performance is measured based on the SCOR model and in terms of cash-to-cash cycle time, return on supply chain fixed assets, return on working capital, customer complaints and compliance with regulations.

*Mediating Variable (Supply Chain Collaboration)* – this variable measures supply chain collaboration in terms of the use of IT in performing collaborative activities, developing demand and sales forecast through supply chain coordination, sharing planning information and data with supply chain members, fostering communication and cooperation among supply chain partners and sharing risks with supply chain partners (Kim & Lee 2010, Li et al. 2014).

The hypotheses are tested to investigate the following relationships:

$$SCP = \alpha_0 + \alpha_1 * SCCOL + \alpha_2 * ITUSE + \varepsilon$$

$$SCCOL = \beta_0 + \beta_1 * ITUSE + \varepsilon$$

where SCP is supply chain performance; SCCOL is supply chain collaboration; ITUSE is IT use or deployment; $\alpha_0$, and $\beta_0$ are the intercepts; $\alpha_1$, $\alpha_2$, $\beta_1$ and $\beta_2$ are the regression coefficients for the latent variables; $\varepsilon$ is the residual error.

## Methodology

### Research Design and Data Collection

A quantitative research approach was employed where a structural equation model was used. This approach is suitable because this an emprical research where numerical data and statistical procedures were used to measure, analyse and examine the relationships among variables. A survey method was used in collecting primary data. The sample population comprised small and medium sized manufacturing companies in the capital region of Ghana (GSS 2015), which is assumed to be representative of the situation in the country. Small and Medium Sized enterprises (SMEs) is the focus of this study because they provide about 85 per cent of manufacturing employment, contribute about 70 percent to Ghana's GDP, and therefore have catalytic impacts on economic growth, income, and employment (GSS 2015). Undoubtedly, SMEs have contributed immensely to income, employment generation and, ultimately, economic growth of the country.

Purposive sampling was used in selecting the companies to be surveyed. With this sampling approach, it was possible to obtain information from samples that are more readily accessible and willing to respond to the questionnaire. A total of 85 companies were surveyed. The data collection instrument was a semi-structured questionnaire divided into four sections: (1) IT-Use, (2) information sharing, (3) collaboration, and (4) supply chain performance. The data collection instrument was self-administered after pre-testing with a few firms to ensure validity, clarity, and ease of comprehension of the questions. Respondents comprised employees in supply chain management positions as well as other departments with adequate knowledge on the use of IT in firm's operations. Out of the 85 firms surveyed only 65 valid responses were retrieved and analyzed, representing about 77 percent response rate.

Table 1 presents the extent of use of various information technologies by the firms surveyed. It would be noted that information technologies that are used by all firms surveyed to varying degrees for communication and exchange of information among supply chain partners are the internet, email and computer networks. Telephone and fax machines are also used by almost all firms surveyed (about 95 percent). However, a high percentage, 25 to 52 percent of firms rarely use advanced IT tools such as ERP, GPS tracker, bar codes, and TMS.

**Table 1. Extent of IT Use among Manufacturing Firms**

| Information Technology | Used (%) | | | |
|---|---|---|---|---|
| | Not | Moderately | Frequently | Always |
| Internet | 0 | 7 | 20 | 73 |
| Email and Computer Networks | 0 | 5 | 24 | 69 |
| Telephone and Fax Machines | 4 | 18 | 27 | 51 |
| Inventory Management System (IMS) | 15 | 15 | 27 | 40 |
| Transportation Management System (TMS) | 25 | 16 | 16 | 38 |
| Warehouse Management System (WMS) | 18 | 20 | 20 | 36 |
| Enterprise Resource Planning (ERP) | 33 | 20 | 11 | 27 |
| Electronic Data Interchange (EDI) | 24 | 31 | 13 | 18 |
| GPS Tracker | 38 | 16 | 18 | 15 |
| Bar Codes | 49 | 9 | 22 | 7 |
| RFID | 51 | 18 | 4 | 4 |
| Other (unspecified) | 27 | 2 | 4 | 9 |

**Data Analysis**

The Structural Equation Model (SEM) was employed to investigate the relationship and impact of IT-Use on supply chain performance. Structural equation modelling is a combination of path analysis, factor analysis, and regression modelling (McQuitty & Wolf 2013). Partial Least Squares - Structural Equation Modeling (PLS-SEM) approach was employed. The choice of the PLS-SEM analytical tool is based on the recognition that PLS is a soft modeling approach to SEM with no assumptions about data distribution, and flexible on sample size even when models are highly complex (Vinzi et al. 2010). According to Hair et al. (2014a) PLS-SEM is an OLS regression-based method and it operates much like the multiple regression analyses. Hair et al. (2014b) noted that increasing popularity of PLS-SEM in recent years can be attributed to the method's ability to handle problematic modeling issues encountered in social sciences research such as unusual data characteristics (e.g. non-normal data), small sample sizes, and highly complex models. This research applied the PLS-SEM approach to a supply chain management issue. The SmartPLS 3.0 software application was used in this research.

## Findings

Analysis of the PLS-SEM outputs involves two steps: (1) evaluation of the measurement model, and (2) evaluation of the structural model - These are discussed in the following sections.

**Evaluation of Measurement Model**

Evaluating the measurement model involves determining the convergent validities of the indicator variables, their constructs as well as the internal consistency reliability. Internal reliabilities are indicated by the outer loadings of the indicators. This characteristic, also known as indicator reliability (Hair et al. 2014a), identifies indicators that are important to characterizing the various constructs. Figure 2 is a schematic presentation of the output of the PLS algorithm. The figure shows indicators with outer loadings of at least .70 i.e. the associated indicators have much in common (Fornell & Larcker 1981). Each question on the data collection form represents an indicator. Therefore, indicators with outer loadings of at least .70 are questions that are relevant to characterize the variables in the model.

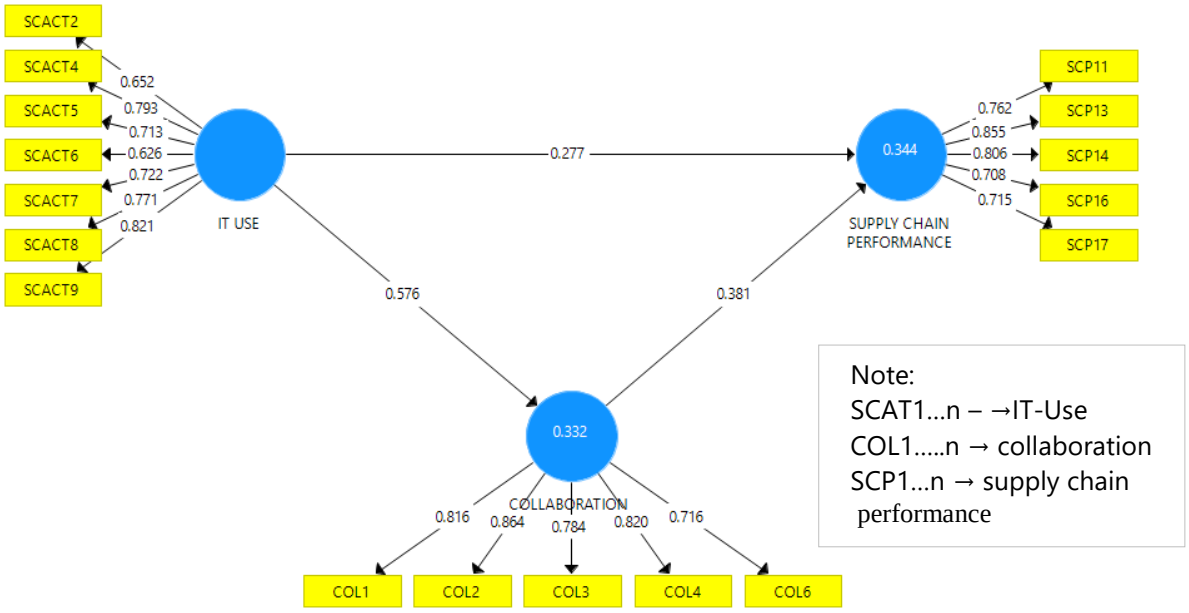


**FIGURE 2. PLS-SEM MODEL OUTPUT (PLS ALGORITHM)**

*Internal Consistency Reliability*

Internal consistency reliability measured using Cronbach's alpha (CA), provides an estimate of the reliability of the measurement models based on the inter-correlations of the observed indicator variables (Henseler et al. 2009). According to Nunally and Bernstein (1994), composite reliability (CR) values between .70 and 0.90 are considered satisfactory. As shown in Table 2, the CA and CR values are within the .70 to .90 acceptable range and are indicative of sufficient internal consistency. These values confirm that the indicators of the constructs used in the survey instrument are consistent and produced reliable data.

*Convergent Validity*

Convergent validity is the extent to which a measure correlates positively with alternative measures of the same construct. This characteristic is known as indicator reliability and requires that all outer loadings of indicators should be statistically significant at a minimum (Hair et al. 2014a). This is measured by the Average Variance Extracted (AVE), which is the portion of the data that is explained by each one of the constructs, respective to their groups of variables or how much, on average the variables correlate positively with their respective constructs. An AVE>.50 indicates that on average, the construct explains more than half of the variance of its indicators (Hair et al. 2014a, Henseler et al. 2009, Vinzi et al. 2010). The results indicate that the observed values are all greater than the threshold of .50 (Table 2). This means the constructs explain more than half of the variance of their indicators. Therefore, the model converges to a satisfactory result and the convergent validity has been achieved.

**Table 2. Convergence and Consistency Reliability**

| Construct | Average Variance Extracted (AVE) | Composite Reliability (CR) | Cronbach's Alpha (CA) | $R^2$ |
|---|---|---|---|---|
| Collaboration | .64 | .89 | .86 | .33 |
| IT-Use | .53 | .88 | .85 | |
| Supply Chain Performance | .59 | .88 | .83 | .34 |

*Discriminant Validity*

Discriminant validity measures the extent to which a construct is truly distinct from other constructs and implies that a construct is unique and captures phenomena not represented by other constructs in the model (Hair et al. 2014a). This is measured by the cross loadings (Henseler et al. 2009) or by the Fornell-Larcker criterion. The square root of each construct's AVE should be greater than its highest correlation with other constructs (Fornell-Larcker 1981). The results presented in Table 3 show that this criterion has been met.

**Table 3. Fornell-Larcker Criterion**

| Fornell-Larcker Criterion | Collaboration | IT-Use | Supply Chain Performance |
|---|---|---|---|
| Collaboration | **.80** | | |
| IT-Use | .58 | **.73** | |
| Supply Chain Performance | .54 | .49 | **.77** |

*Note: Numbers on diagonal are square roots of AVEs; off-diagonal numbers are inter-construct correlations.*

In summary, the variables in the adjusted model are valid and consistent in characterizing the constructs they represent. Having determined that the measurement model meets the evaluation criteria, the next step is to evaluate the structural model to determine its accuracy and predictive capability.

**Evaluation of Structural Model**

The first metric for evaluating the structural model is the Pearson coefficients ($R^2$). The $R^2$ measures the variance in the endogenous variables that is explained by the structural model. According to Chin (1998), $R^2$=.19 shows a weak effect; $R^2$=.33 shows a moderate effect and $R^2$=.67 shows a substantial effect. The $R^2$ values for the two models are .33 and .34 respectively. These values are within the moderate bracket. According to Cohen (1988), $R^2$=.02 is considered to be having a little effect, $R^2$=.13 as a medium effect, and $R^2$=.26 as having a large effect. The LVs have large effects using Cohen (1998) criteria.

The predictive capabilities of the adjusted models were also evaluated by examining the change in $R^2$ using Cohen's indicator or the effect size ($f^2$) and Cross-validated Redundancy or Stone-Geisser indicator ($Q^2$). The effect size measures the impact of each predictor variable on the dependent variable. The Stone-Geisser indicator also measures a model's predictive relevance. It shows whether the model accurately predicts the data points of indicators in reflective measurement models of endogenous constructs (Hair et al., 2014a). According to Hair et al. (2014a), $f^2$ and $Q^2$ values for dependent variables should be greater than 0 and values of .02, .15, and .35 are considered as small, medium or large predictive relevance respectively. The results indicate that $f^2$ values range from .07 to .49 implying that the independent variables have small to large impact and are useful in predicting the dependent variables. The results also show $Q^2$ values of .17 and .18 respectively. Based on the $Q^2$ and $f^2$ values, it can be concluded that the models have accurate predictive capabilities. The direct impact of IT-Use on SCP is less than the indirect impact through Collaboration. Both models do have acceptable predictive capabilities.

The final step in evaluating the structural model is to examine the significance of the relationships established based on sign, magnitude, and significance of the path coefficients generated from the PLS analysis. These coefficients represent the hypothesized relationships linking the constructs in the models. The path coefficients of the constructs were tested to determine if they are statistically significant using the p-values and Student's t-test. The analysis is based on 5 percent significance level (i.e. $p \leq .05$) therefore, the critical region for the t -test is between -1.96 and +1.96. Table 4 shows the values of the t-test as well as their corresponding p-values at 5 percent significance level.

**Table 4. Results of Hypotheses Testing**

| Construct | Original Sample | Sample Mean | Standard Deviation | *t*-statistics | *p*-values |
|---|---|---|---|---|---|
| Collaboration → SCP | .38 | .38 | .14 | 2.71 | .00 |
| IT-Use → Collaboration | .57 | .59 | .09 | 6.08 | .00 |
| IT-Use → SCP | .27 | .28 | .12 | 2.24 | .02 |

The path coefficients clearly show that IT-Use is positively related to SCP; IT-Use and Collaboration; and Collaboration and SCP, and statistically significant at 95 percent confidence level; i.e. $p \leq .05$. In relative terms however, the relationship between IT-Use and Collaboration is stronger than the direct relationship between IT-Use and SCP. Therefore, hypotheses *H1* and *H2* are accepted implying that, IT-Use directly impacts SCP and positively influences collaboration among supply chain partners.

**Mediation Analysis**

According to Hair et al. (2014a) in order to establish mediation, the direct effect must first be significant if the mediator variable is not included in the model. A significant relationship indicates that the mediator may absorb some of this effect or the entire effect. As noted earlier all three direct path relationships are statistically significant at 95 percent confidence level. In order to establish that Collaboration construct is indeed a mediating variable between IT-Use and SCP, a mediation analysis was necessary. The mediating

variable may absorb some or the entire effect be it an increase or a decrease. This was achieved through the Bootstrapping algorithm in Smart PLS 3.0 software.

For there to be a mediating effect, the mediator variable is included in the PLS path model and the significance of the indirect effect $P_a$*$P_b$ assessed. For the indirect effect to be significant each individual path $P_a$ and $P_b$ must be significant (Hair et al. 2014a). The following results were obtained:

- IT-Use is positively related to collaboration ($P_a = \beta_1 = .57$, t = 6.08, p = .00)
- Collaboration is positively related to SCP ($P_b = \beta_2 = .38$, t = 2.73, p = .00)
- IT-Use is positively related to SCP ($P_c = \beta_3 = .27$, t = 2.27, p = .02)

Hence, the indirect effect is also significant indicating that the mediator variable (collaboration) absorbs some of the direct effect. To determine how much the mediator variable absorbs, the variance accounted for (VAF) is determined. According to Hair et al. (2014a), VAF determines the size of the indirect effect in relation to the total effect and is calculated using the formula:

$$P_M = (P_a * P_b) \ / ((P_a * P_b) + P_c)$$

The results show a VAF of .44 or 44 percent suggesting partial mediation. According to Hair et al. (2014a), VAF value between 20 and 80 percent indicates a partial mediation and a value of over 80 percent indicates a full mediation.

## Discussion

The results from the PLS-SEM analysis established that there is a strong statistically significant positive relationship between IT-Use and SCP, supporting the first hypothesis (*H1*). This is consistent with earlier studies (e.g. Davis-Sramek et al. 2010, Kamaruddin & Udin 2009, Sabherwal & Jeyaraj 2015, Wakolbinger & Cruz 2011) which found that the IT-Use makes it possible to obtain and exchange accurate and timely information in the supply chain hence providing benefits in the form of better visibility, reduced costs, increased productivity, and increased performance of the supply chain.

It is also noted that IT-Use has a greater effect on collaboration than its direct effect on SCP as indicated by the higher path coefficient. Therefore, the second hypothesis (*H2*) which proposes a positive link between IT-Use and collaboration is supported. This clearly indicates that IT-Use among partners in a supply chain facilitates integration and collaboration. An integrated supply chain is known to enhance performance and collaboration is a necessary condition. In the manufacturing industry in particular, effectiveness of information flow with suppliers and customers greatly facilitates collaboration and reduces delays and costs which ultimately results in productivity and supply chain performance in general. The effective use of appropriate IT in all supply chain processes therefore improves collaboration and SCP. Aparecida de Mattos and Laurindo (2015) also identified IT as an essential factor for facilitating the flow of information to enable collaboration among supply chain partners.

From the mediating analysis, hypothesis *H3* which examines the mediating role of collaboration on SCP is also supported. Even though there is a direct relationship between IT-Use and SCP, the effect of IT-Use on SCP is influenced by the degree of collaboration among the partners in the supply chain. Collaboration has been demonstrated to be a mediating variable and has partial impact on the IT-Use – supply chain performance relationship. SCP is enhanced by a high degree of collaboration among supply chain partners. The positive relationship between Collaboration and SCP could also be attributed in part to the fact that collaboration eliminates inefficiencies and boosts performance. This finding is particularly important for manufacturing firms in less developing economies some of which depend on foreign suppliers. In such supply chains, effective collaboration is a key to performance and survival in a market where local products compete with imported finished products. This is consistent with the study

conducted by Sanders (2007) which observed that the use of IT impacts performance directly and indirectly with the relationship being mediated by inter and intra-organizational collaboration.

Furthermore, the use of IT increases collaboration among supply chain partners which leads to improvement in SCP. This finding is consistent with those by other researchers. For example, Lockamy III and McCormack, (2004) noted that collaboration has a direct impact on SCP; García-Alcara et al. (2017) found that IT has a positive direct impact on the economic performance of supply chains; Zhang et al., (2016) also found that IT-Use among supply chain firms has a positive direct relationship with supply chain performance; Sanders (2005) showed that IT alignment between suppliers and buyers has a direct positive impact on both strategic and operational performance measures.

## Conclusion and Recommendations

This study investigated the impact of IT deployment on the supply chain performance of small and medium scale manufacturing firms in Ghana. The PLS-SEM approach was used to examine the direct relationship between IT and supply chain performance and an indirect relationship between both variables through the mediating role of collaboration. It is concluded that there is a statistically significant positive direct relationship between IT-Use and supply chain performance when measured in terms of SCOR performance attributes. An increase in IT-Use is expected to improve supply chain performance. Collaboration acts as a mediating variable where the effect of IT-Use on SCP is influenced by the degree of collaboration among the partners in the supply chain. The results indicate that IT-Use has more significant influence on collaboration than on SCP and collaboration has more significant influence on SCP than IT-Use.

It is concluded that the use of IT contributes to supply chain performance both directly and indirectly through collaboration between supply chain partners. It is further concluded that collaboration is a necessary condition for IT-Use to have marked SCP improvements. It is recommended that manufacturing firms, particularly in less developed economies, invest in some level of IT to facilitate the flow of timely and accurate information at every stage of the supply chain to develop their strategic alliances with their supply chain partners and ultimately improve performance of their supply chains.

## Contribution

This study contributes to existing literature by using empirical data to demonstrate the direct and indirect relationship between IT-Use and performance of manufacturing industry supply chains in the developing country. The study established that collaboration acts as a mediator variable in the IT-Use – supply chain performance relationship. Theoretically, the research demonstrates the application of PLS-SEM to analyze supply chain variables that cannot be directly measured. Practically, the research demonstrates the importance of collaboration among supply chain partners and IT deployment in improving supply chain performance of manufacturing firms in less developed countries especially where some of the partners are located in foreign countries.

## Limitations and Suggestions for Future Research

The study focused on the manufacturing industry in a developing economy. Extension of the findings to the service, retail and other industries and other operating environments may be limited. It is recommended that similar studies be conducted on other industries to validate the findings.

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## Authors

Professor Edward Fekpe holds a PhD in transportation engineering with over 39 years of professional experience, research, and education. He is currently an Associate Professor at the Ghana Institute of Management and Public Administration (GIMPA) where he teaches courses in Supply Chain Management, Advanced Project Management, Manufacturing Strategy, and Logistics Management.

Michelle Eyram Fiagbey holds a Master of Research (MRes) in Business Administration in Supply Chain Management with over 3 years of professional experience. She is currently an Operations Support Supervisor at Rocksters Roofing Systems Manufacturing Company where she manages the daily operations of the company.