

# **MODERATING EFFECT OF ICT ON SUPPLY CHAIN MATERIAL FLOW RISK AND PERFORMANCE OF MANUFACTURING FIRMS IN KENYA**

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## **Abstract**

*The manufacturing firms in Kenya contribute greatly to the economic development of the country. Developments in ICT are creating possibilities for moderating risks along the supply chain by creating platforms for effective decision support tools. However, the performance of the manufacturing firms has been decreasing in the past few years due to material flow risks that affect their supply chain, thereby undermining the sectors ability to contribute to the Gross Domestic Product (GDP) and attainment of Kenya's vision 2030. This study sought to investigate the moderating effect of ICT on material flow risks and performance among manufacturing firms in Kenya. Cross-sectional survey design was adopted as the research design for this study using both qualitative and quantitative approaches. The target population was 94 firms in Kiambu County, Kenya who were both members and potential members of the Kenya Association of Manufacturers (KAM). The study used stratified random sampling to pick a sample size of 76 manufacturing firms which represented 12 industrial sectors in manufacturing firms. Data was collected using questionnaires. Descriptive statistics was used aided by Statistical Packages for Social Sciences version 21 to compute percentages of respondents' answers. Inferential statistics using linear regression and correlation analysis was applied to assist examining relationship between the research variables. It was established that ICT used did not moderate the relationship between Information flow risks. Therefore, the study recommends that manufacturing firms should leverage on the existing infrastructure and skills to reduce material flow risk and improve the performance of their firms.*

**Keywords:** Supply Chain, Material Flow, Risk, ICT, Performance, Kenya

## INTRODUCTION

In today's competitive environment, companies are striving to get a competitive advantage over their competitors (Waqas, Yasir, Nauman & Hassan, 2010). Companies have also realized that the supply chain is one of the areas that they can leverage on to secure a competitive advantage and gain higher profits (Waqas et al, 2010; Elahi, 2010). A supply chain is said to be superior if it provides on time deliveries, low cost products and manufacturing flexibility compared to that of the competitors (Waqas, et al, 2010).

Competition is taking place between the company's supply chain and not between the single companies. To enhance value creation to the customers, supply chains are now focusing on increasing efficiency (Lamber & Cooper, 2000). The focus on efficiency makes the supply chains vulnerable especially when they engage in modern supply chain trends such as global sourcing, outsourcing and Just in Time strategies (Kalawsky, 2013). These trends have led to an increase in the areas which expose the supply chain to vulnerabilities. To identify these disruptions along the supply chain, Dani, Chester and Kalawsky, (2013) explains that there is need for organizations to adopt proactive approaches to manage risks on both the upstream and downstream sides of the supply chain. Complexity of supply chains and potential vulnerability is continuously increasing due to increase in globalization (Rajesh & Ravi, 2015). These vulnerabilities lead to uncertainties in the organizations operations and jeopardize the creation of value to the customer (Klibi, Martel & Guitoni, 2007).

Supply chain risks exists when the behavior of the supply market and an organizations dealings with its suppliers results in outcomes that harm the reputation of the company, capability, integrity of its operations as well as financial viability (Russill, 2008). These supply chain risks are identified by Accenture (2010) as materials flow risk, financial flow risk and information flow risks.

ICT solutions enhance the flow of information along the supply chain. For example, supply chain management solutions such as Electronic data interchange and internet allows the partners in the supply chain to use common data. Enterprise Resource planning (ERP) helps in the integration of all the departments and functions in the entire company into a single computer system that is able to serve all the needs of the different departments. Extended Enterprise solutions (XES) allows the collaborative sharing of information and processes among the supply chain partners using the technology that underpins ERP (Sweeney, 2006).

### Statement of the Problem

ICT is recognized by Kenya Vision 2030 as a major player in enhancing the competitiveness of Kenyan Manufacturing firms (Kenya-Vision2030, 2007). Information and Communication

Technology (ICT) developments according to Rasmussen et al (2000) are creating possibilities in the management of risks along the supply chain by creating platforms for effective decision support tools. The trend today is on the increasingly complexity of the supply chains which makes them vulnerable to risks. To moderate this, firms have introduced ICT and supply chain management ICT tools to maintain profits and competitiveness. Technology, particularly information technology (IT), is also an important issue which is considered by The World Economic Forum (2013) as one of the ways to create supply chain resilience.

## **Objectives of the Study**

### ***General Objective***

The main objective of this study is to examine the moderating effect of ICT on supply chain material flow risks and firm performance among the manufacturing firms in Kenya

### ***Specific Objectives***

The specific objectives of this study are:

1. To explore the moderating effect of ICT on material flow risk and firm performance among the manufacturing firms in Kenya.

## **Research Questions**

1. What is the moderating effect of ICT on material flow risk and firm performance among the manufacturing firms in Kenya?

## **Research Hypothesis**

H<sub>0</sub>: ICT use does not moderate the relationship between material flow risk and firm performance among the manufacturing firms in Kenya.

## **LITERATURE REVIEW**

### **Theoretical Review**

#### ***Normal Accident Theory (NAT)***

The Normal accident Theory (NAT) was propagated by Charles Perrow whose objective was to explain the reasons that lead to the failure of social-technical systems based on the nuclear power plant near-disaster analysis of the US (Perrow, 1984). The theory suggested that the probability of systems accident occurrence and the severity of the systems accidents are determined by two characteristics of the system:

Interactive complexity of the system is the first characteristic, a supply chain is a system which is social-technical, that is, it is a complex system since there are many elements that interact in a non-simple way as explained by Simon (1962), this makes it more difficult to control and manage. The complexity according to NAT becomes more dangerous when the components in the system interact in a non linear. This is because non linear interactions lead to event consequences that are unpredictable. When many small failures interact, they produce unfamiliar and unexpected events.

Tight coupling of the elements in the system is the second characteristic; the system is a tightly coupled system and as Galbraith (1973) and Perrow (1984) puts it, the system contains interrelated components that have processes that are time dependent, have possible substitutions and minimal slack or buffer. While systems that have tight coupling are able to have high efficiency and performance levels, supply chains that are loosely coupled are also able to absorb changes in the environment, failures or unexpected behaviors in the system. A system that is tightly coupled, a change in one component may trigger a strong and fast change in the other components in a domino kind of an effect. Therefore disruptions along the supply chain can rapidly spread through the system.

Based on these characteristics therefore, a system that has high levels of interactive complexity and high levels of tight coupling is vulnerable to accidents. This is because the combination of the two characteristics makes the prediction and the protection of the ways in which the system would fail impossible. The accidents in the system are therefore inevitable; one concludes therefore that in such systems, accidents are normal.

According to the NAT supply chains whose degree of interactive complexity is complex, and have tight coupling, the frequency of supply chain disruption is higher. Hopkins, (1999) and Wolf, (2001) as cited by Sammarco (2003) argue that it is difficult to subject the level of tight coupling to empirical test.

Vachon and Klassen, (2002) view information processing and technology as the two dimensions of supply chain complexity. Supply chain has three drivers according to Choi and Krause (2006); the quantity of suppliers, the diversity among the suppliers and the interrelationships among the suppliers. Daft (2006) on the other hand view complexity from the dimensions of vertical complexity, spatial and horizontal complexity. In the supply chain context, the vertical complexity can refer to the number of tiers in the upstream supply chain.

Spatial complexity can be seen as the geographical dispersion of the various supply base, while the horizontal complexity as Choi, Dooley and Rungtusanatham, (2001); Choi and Hong, (2002) and Vachon and Klassen, (2002) point out, refers to the number of suppliers that an organization has. In summary therefore, the three dimensions increase the supply chain

complexity, reduce transparency, increases uncertainty and this in turns leads to increased exposure to disruptions along the supply chain (Choi & Krause, 2006).

In the Kenyan manufacturing sector, this theory is very relevant. This is because the interactive complexity and tight coupling (inventory buffering) leads to disruptions along the supply chains which also is the case in safety accidents. According to Perrow (1999), an accident refers to a failure in a subsystem or the system as a whole that causes damage to more than one unit and in the process causes a disruption (missed shipment, drought, depreciation of the Kenyan shilling against the dollar) on the ongoing or even the future output of the supply chain (system). The manufacturing Sector in Kenya however, with the right information are able to detect when the disruptions are occurring or when they are about to occur. Manufacturing firms in Kenya have also experienced tight coupling (higher inventory levels) that has affected customer satisfaction.

### **Material Flow Risk**

Musa, (2012) defines materials flow as the physical flow of goods and services between and within the elements of a supply chain. Certain risk factors of materials flow such as rare raw materials, mistakes in production and logistics barriers in trade routes as well as language and cultural difficulties may affect the smooth flow of materials through the chain (Ruriani, 2013). According to Kerstern and Blecker (2006), these risk factors can disrupt the flow of the materials and cause significant delays and customers orders will not be finished on time. Risks in information flow, financial flow and materials flow have some reciprocity in the sense that lack of efficient information may lead to delays in the materials and consequently affect the financial position of an organization due to lost sales. It is therefore important to link the flow of the materials risk to the performance of an enterprise (Kerstern&Blecker, 2006). Supply chains are aimed at realizing a win-win situation for all the participants. The supply chain is viewed as a simple pipe line where risks can affect the smooth flow of materials in an enterprise according to Waters (2011). There risks can be managed through increasing visibility which increases efficient flow of materials and allows better controls (waters, 2011). Li and wang (2011) are of the view that fluctuations in demand and disruptions in supply are the two primary uncertainties in a supply chain materials flow, for example, the uncertainties of the purchasing costs, selling prices and the purchasing parameters. They further classify materials flow risk into demand risk and supply risk. However, Jamil et al (2016) notes that firms can only leverage on ICT to reduce material flow risk when the management appreciates the use of automated system for agile decision making and also fuse ICT to allow agile changes in the production systems to meet the customer requirements.

## **Sourcing**

Sourcing risks signify the probability of loss to an organization that results from events that originate from the upstream side of the supply chain (Harland, Brenchley, & Walker, 2003). These losses may be caused by natural disasters, supplier bankruptcy, supplier flexibility, lack of capacity and exchange rate risks. One of the key issues of Supply Chain Management (SCM) according to Goffin, Lemke and Szwejczewski (2006) is the management of the suppliers because the cost of the raw materials and components procured constitute the highest percentage of the costs of a product and most firms spend a considerable amount of the revenues that they obtain from sales in purchasing, therefore, selecting the suppliers is one of the most important problems when making decisions. Dey and Lockstrom (2011) also agree that selection of the right supplier reduces the costs of purchasing and increases the competitive advantage of an enterprise. Therefore, selecting the suppliers appropriately increases the performance of the supply chain and the organization as a whole (Dey&Lockstrom, 2011). To effectively manage risks associated with the sources of a product, the organization needs to have knowledge on the events that lead to the losses, the probability of those events occurring and the effect to the organization in the event they occur (Ellegaard, 2008).

Fischl, Scherrer and Friedli (2014) agree that some of the risks that are facing manufacturing firms today as far as sourcing is concerned are the price volatility especially of critical supplies such as oil. Some of the strategies that manufacturers can adopt in order to prevent the increases in prices is through vertical integration and strategic alliances with suppliers so as to secure their sources of supply and also stability of the prices (Fischl, Scherrer&Friedli 2014). Sourcing risks can also be mitigated through undertaking category management (strategic, leverage, non-critical, bottleneck) and then implementing sourcing strategies based on each category of the items (Cox, 2014).

Global sourcing which influences the financial success of a company and is viewed as a low cost strategy raises major concerns for managers due to the risks involved (Ellegaard&Vedel 2013). The large distances increase the probability of severe losses in the event damages occur along the supply chain (Juttner, Peck & Christopher, 2003). The distance also increases the information asymmetry thereby reducing the probability of creating a knowledge base for managing the risks. Other risks associated with global sourcing according to Nelson (2013) include; capacity risk (output availability and lead time variability), catastrophic risks (natural disasters, wars, and terrorism), quality risk (specification, non compliance), contractual risk (intellectual property risk) and management risks (embezzlement, fraud). Traditionally, intermediaries such as agents and trading houses have played a vital role in mitigating risks associated with global sourcing as they improved the flow of information,

physical flows and also were responsible for supply base inventories. However, intermediaries have been criticized as emphasizing more on the profits as compared to the services rendered (Ellegaard&Vedel 2013). Nelson (2013) explains that other sourcing strategies such as single sourcing strategies reduces the cost of quality to the procuring entity, it also increases the costs of supplier failure and increases the supplier power. Outsourced manufacturing initiatives are also effective in an environment that is stable but they make the supply chain more vulnerable to disruptions caused mainly by uncertain economic cycles, consumer demands as well as natural and man-made disasters (Tang, 2006).

### ***Sourcing Flexibility***

Flexibility in sourcing enables a firm to adapt to changing business requirements and allow them to respond to the new conditions in the market (Byrd & Turner, 2000). Benefits that accrue from a flexible supply chain are reflected in terms of postponement in the processing of orders, reacting to variations in demand distributions across the nodes of the supply chain, responding to forecasting errors in a rapid manner, increased efficiency in order filling and managing of the suppliers (Christopher et al., 2006). Results of a study carried out by Khan and Pillania (2008) shows that sourcing flexibility is the strongest area of strategic sourcing to consider when organizations are planning for capabilities that are geared towards making their manufacturing processes more agile. Sourcing flexibility also increases the agility of the supply chain and the performance of a firm. According to Kidd (2000), Agility is related to quickness while flexibility is refers to adaptability and versatility.

Agility is concerned with the abilities of the organization while flexibility is related to the operational abilities in the case of manufacturing processes (D'Souza & Williams, 2000). An agile supply chain increases the competitiveness of an enterprise. Supplier sources which are flexible provide the buying firms with alternatives in case of capacity constraints or when they are faced with other disruptions which are hazardous (Musa, 2012). However, switching from one source of supplier to another suscept the organization to other hidden costs as pointed out by Kamrad and Siddique (2004). The costs incurred by a buying organization when switching from one supplier to the other may be attributed to the establishment of relationships among the various partners along the supply chain (Musa, 2012).

### ***Supplier Capacity***

Capacity constraint according to Zsidisin (2003) is the inability of the supplier organizations production systems to produce the quantity that is demanded by the customers. Fluctuations in demand tax a supplier beyond his capabilities as the equipments are depreciating and the labor

is idle. Capacity constraint can be caused by poor technology, that is, if the supplier is not able to adjust to changing technologies in the long term, the supplier may not be able to meet increased rates in demand. Johnson (2001) asserts that capacity limitation is one of the major risks that disrupt the supply chain. Resilinc (2015) point out that supplier capacity risk is one of the factors that a supply chain manager should evaluate in order to ensure uninterrupted flow of products and services that are required in the events of fluctuating demands. Lack of visibility to the supplier capacity constraints can lead to loss of revenues, market share and customer dissatisfaction and especially if a firm cannot respond to shortages in supply and surges in demand (Johnson 2001; Resilinc, 2005).

Companies can reduce idle capacity risks by ensuring that each plant is flexible (Chopra & Sodhi, 2004). Market capacity risks occur when there are few available suppliers in the market (Zsidisin, 2003). Companies can implement collaborative strategies with both the suppliers and customers such as vertical and horizontal integration to mitigate supplier capacity risks (Guillaume, Thierry & Grabot, 2014). This is because for a company to be competitive, it must compete as part of the entire supply chain process as opposed to a standalone entity.

## **RESEARCH METHODOLOGY**

The study applied Cross-sectional survey design was adopted as the research design for this study using both qualitative and quantitative approaches. The target population was 94 firms in Kiambu County who were both members and potential members of the Kenya Association of Manufacturers (KAM). The study used stratified random sampling to pick a sample size of 76 manufacturing firms which represented 12 industrial sectors in manufacturing firms. Data was collected using questionnaires. Descriptive statistics was used aided by Statistical Packages for Social Sciences version 21 to compute percentages of respondents' answers.

## **ANALYSIS AND RESULTS**

### **Descriptive Analysis of Material Flow Risk**

The researcher observed that 37.9% of the respondents disagreed that they frequently experience logistical barriers in trade routes, language and cultural difficulties as materials flow along the supply chain, 22.7% agreed, 19.7% strongly agreed, 15.2% were neutral while 4.5% strongly agreed (Mean = 2.55, SD =1.179). A large number (34.8%) also disagreed that the flow of materials is often disrupted due to lack of information and finances (Mean = 2.39, SD =1.051) as shown in table 1.

Table 1: Measurement of material flow risk

	SD %	D %	N %I	A %	SA %	M	SD
a) We frequently experience logistical, barriers in trade routes, language and cultural difficulties as materials flow along the supply chain	19.7	37.9	15.2	22.7	4.5	2.55	1.179
b) The flow of materials is often disrupted due to lack of information and finances	22.7	34.8	22.7	19.7		2.39	1.051

From the results of the study, it was found that manufacturing firms in Kenya do not frequently experience logistical barriers in trade routes, language and cultural difficulties as materials flow along the supply chain. These findings are in agreement with Ruriani (2013); Kerstern and Blecker (2006) that certain risk factors of material flow such as rare raw materials, mistakes in production and logistical barriers in trade routes as well as language and cultural difficulties may affect the smooth flow of materials throughout the chain, may cause delays and disrupt customer orders. The study also found out that the flow of materials is also not disrupted due to lack of information and finances. This is in line with Kerstern and Blecker (2006) that risk in information flow; financial flow and material flow have some reciprocity in that lack of efficient information may lead to delays in materials and consequently affect the financial position of an organization due to lost sales. Therefore, manufacturing firms in Kenya should mitigate risks that may hinder the smooth flow of materials as these may affect the financial flow of the firm and consequently performance.

#### a) Sourcing

The study showed 42.0% of the respondents agreed and also strongly agreed that they always select their supplier competitively, 2.9% strongly disagreed and also disagreed while 10.1% were neutral (Mean = 4.17, SD =0.939). Also, 35.4% of the respondents were neutral on whether their firms experience disruptions in material flows due to long lead times, terrorism, quality risk (noncompliance) when sourcing goods internationally, 26.2% disagreed, 16.9% strongly disagreed, 13.8% agreed while 7.7% strongly agreed (Mean = 2.69, SD =1.145) as shown in table 2.

Table 2: Measurement of sourcing

	SD %	D %	N %	A %	SA %	M	SD
a) We always select our suppliers competitively	2.9	2.9	10.1	42.0	42.0	4.17	.939
b) When sourcing internationally, we experience disruptions in material flows due to long lead times, terrorism, quality risk (noncompliance)	16.9	26.2	35.4	13.8	7.7	2.69	1.145

In terms of sourcing, it was clear from the study that the manufacturing firms in Kenya select their suppliers competitively. This is in agreement with Dey and Lockstrom (2011) that the selection of the right suppliers reduces the cost of purchasing and increases the competitive advantage and the performance of a firm. In addition one of the key issues of supply chain management according to Goffin, Lemke and Szejewski (2006) is the cost of the raw materials and components procured as they constitute the highest percentage of the total spend of the revenues that the firm obtains from sales. Likewise, manufacturing firms in Kenya do not experience disruptions in material flows due to long lead times, terrorism, quality risk (noncompliance) when sourcing goods internationally. This is in line with Juttner, Peck and Christopher (2003) that large distances associated with international sourcing increases the risks along the supply chain and the probability of severe losses incase damages occur. Large distances also create information asymmetric thereby reducing the probability of creating a knowledge base for managing the risks. Therefore, selecting the right suppliers is key to the performance of the manufacturing firms in Kenya as it reduces the risks associated with the sources of the products, high prices and prevents the firms from incurring losses (Ellegaard, 2008).

### b) Sourcing flexibility

The study showed that 32.8% of the respondents agreed that their suppliers postpone processing of orders in case of changes in demand, 28.4% disagreed, 23.9% were neutral, 11.9% strongly disagreed while 3.0% strongly agreed (Mean = 2.87, SD = 1.100). On the other hand, 63.2% of the respondents disagreed that their firms consider flexibility of the suppliers when selecting them to ensure that the manufacturing processes are agile (Mean = 1.94, SD = 0.710) as shown in table 3.

Table 3: Measurement of sourcing flexibility

	SD %	D %	N %	A %	SA %	M	SD
c) Our suppliers postpone processing of our orders in case of changes in demand	11.9	28.4	23.9	32.8	3.0	2.87	1.100
d) We consider the flexibility of the suppliers when selecting them to ensure that the manufacturing processes are agile	23.5	63.2	8.8	4.4		1.94	.710

In terms of sourcing flexibility, the study found out that suppliers of the manufacturing firms are flexible and postpone the processing of orders in case of changes in demand. This is in agreement with Byrd and Turner (2000) that flexibility in sourcing enables a firm to adapt to the changing business environment and also allows them to respond to the new conditions in the market. However, manufacturing firms in Kenya do not consider the flexibility of the suppliers when selecting them to ensure that their manufacturing processes are agile. A study carried out by Khan and Pillania (2008) showed that sourcing flexibility is the strongest area of strategic sourcing to consider when organizations are planning for capabilities that are geared towards the agility of their manufacturing firms. Therefore, manufacturing firms in Kenya should consider the flexibility of the suppliers prior to awarding them a supplies contract in order to increase the supply chain and firm performance.

### c) Supplier capacity

The study showed that majority of the respondents 34.8% (Mean = 2.58, SD =1.151) disagreed that they are not able to keep pace with new products in the market because their suppliers do not adjust easily. Likewise, a large number of the respondents 42.2% (Mean = 3.58, SD =1.081) agreed that they maintain economic Order Quantities (EOQ) monitored by their system.

## Relationship between material flow risk and firm performance of manufacturing firms in Kenya

Objective 1: To explore the moderating effect of ICT on material flow risk and firm performance among the manufacturing firms in Kenya

The regression analysis was conducted to determine empirically whether material flow risk is a significant determinant of firm performance. The linear regression model for material flow risk was found to be statistically insignificant ( $F=1, 66= 0.062, p= 0.804$ ). Therefore, material flow risk is not a significant predictor of performance because  $p$  is larger than 5% that is, it is 80.4% as shown in table 4 below.

Table 4: Regression results of Material Flow risk and firm performance

<b>Model summary</b>					
Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate	
	.031 <sup>a</sup>	.001	-.014	.542	
<b>ANOVA</b>					
Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	.018	1	.018	.062	.804 <sup>b</sup>
Residual	19.400	66	.294		
Total	19.418	67			
<b>Coefficients</b>					
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	3.511	.241		14.574	.000
Material flow risk	-.023	.092	-.031	-.249	.804

### **Moderating effect of ICT use on the relationship between material flow risk and firm performance**

The third specific objective of this study was to explore the moderating effect of ICT on information flow risk and firm performance among the manufacturing firms in Kenya. The hypothesis to test for this specific objective was:  $H_0$  – ICT use has no significant moderating effect the relationship between material flow risk and firm performance among the manufacturing firms in Kenya. To determine if ICT use moderates the relationship between financial flow risk and firm performance among the manufacturing firms in Kenya, three models were fitted hierarchically with;

- 1) Model 1 having  $X_3$  as the predictor.
- 2) Model 2 having  $X_3$  and the moderation variable as a predictor.
- 3) Model 3 is model 2 with interaction term between  $X_1$  and the moderating variable.

The three models were found to be statistically insignificant, that is, in all cases p was bigger than 0.05 (see table 5).

Table 5: Moderated Multiple Regression for material flow risk

<b>Model Summary</b>									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		Change Statistics		
					R Square Change	F Change	df1	df2	Sig. F Change
1	.036 <sup>a</sup>	.001	-.014	.541	.001	.083	1	65	.774
2	.266 <sup>b</sup>	.071	.042	.526	.069	4.783	1	64	.032
3	.267 <sup>c</sup>	.071	.027	.530	.000	.021	1	63	.886
<b>ANOVA<sup>a</sup></b>									
Model		Sum of Squares	Df	Mean Square	F	Sig.			
1	Regression	.024	1	.024	.083	.774 <sup>b</sup>			
	Residual	19.004	65	.292					
	Total	19.028	66						
2	Regression	1.346	2	.673	2.436	.096 <sup>c</sup>			
	Residual	17.682	64	.276					
	Total	19.028	66						
3	Regression	1.352	3	.451	1.606	.197 <sup>d</sup>			
	Residual	17.676	63	.281					
	Total	19.028	66						
<b>Coefficients<sup>a</sup></b>									
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics		
		B	Std. Error	Beta			Tolerance	VIF	
1	(Constant)	3.463	.066		52.405	.000			
	Material flow risk	-.026	.092	-.036	-.288	.774	1.000	1.000	
2	(Constant)	3.267	.110		29.596	.000			
	Material flow risk	-.002	.090	-.002	-.019	.985	.984	1.016	
	ICT use	.298	.136	.266	2.187	.032	.984	1.016	
	(Constant)	3.265	.112		29.097	.000			
3	Material flow risk	.013	.135	.017	.094	.925	.441	2.268	
	ICT use	.300	.138	.267	2.175	.033	.978	1.023	
	Material flow risk*ICT use	-.026	.182	-.026	-.144	.886	.447	2.236	
	(Constant)								

The model did not provide sufficient evidence of ICT use moderation on the relationship between material flow risk and performance of manufacturing firms in Kenya. Moreover, further investigations using scatterplot revealed no form of moderation as shown in the Figure 1.

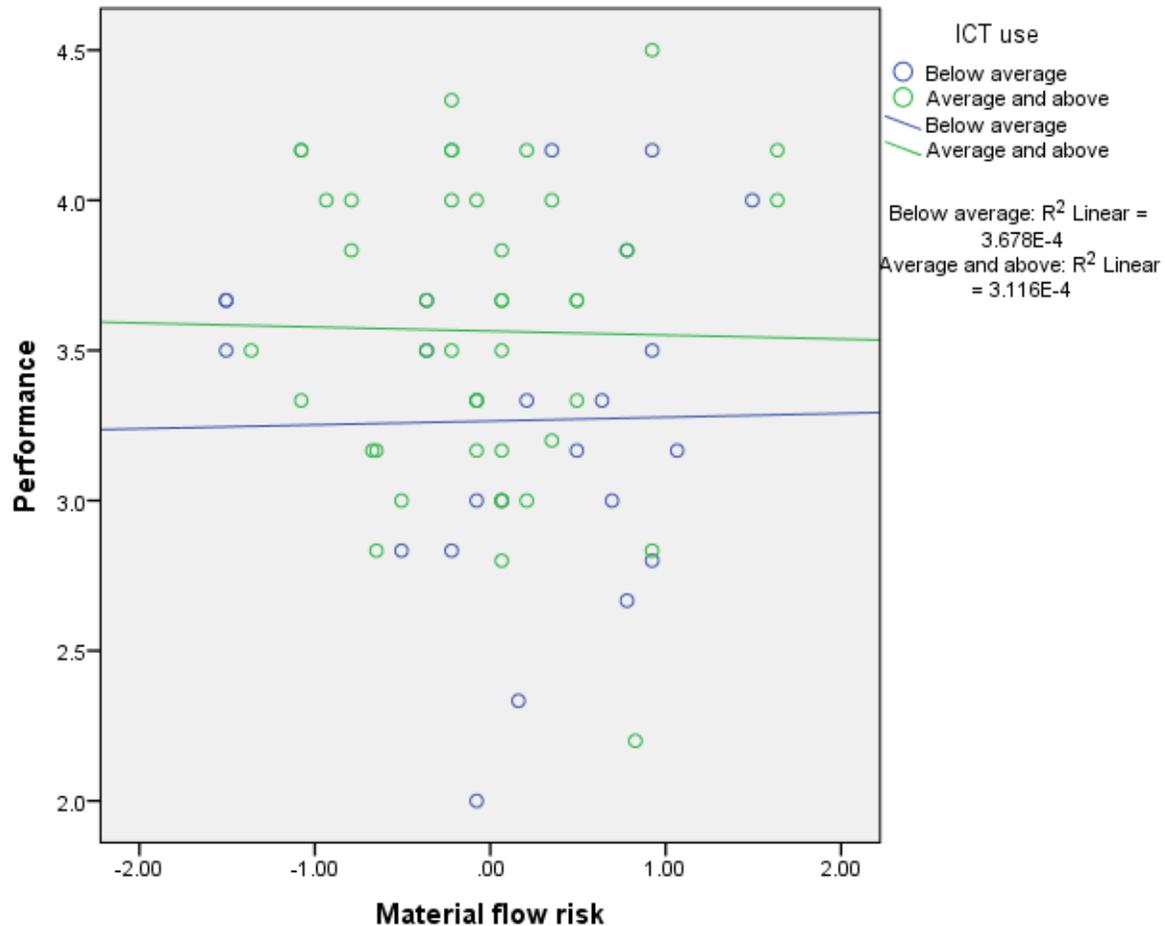


Figure 1: Material flow risk

## DISCUSSION

From the qualitative results, it is evident that there is no presence of material flow risk among the manufacturing firms in Kenya. This means that the sourcing, the sourcing flexibility and supplier capacity do not pose a risk to the supply chains of the manufacturing firms. These findings disagree with the studies carried out by Ruriani, (2013) that poor sourcing strategies, lack of competitive and agile suppliers as well as lack of supplier capacity disrupt the flow of materials along the supply chain. Material flow risk did not affect the performance of the manufacturing firms in Kenya. This could be explained by the earlier results on financial flow risk. Both qualitative and quantitative analysis on financial flow risk indicated that manufacturing

firms in Kenya pay their suppliers on time. This therefore means that materials also flow because suppliers withhold the materials due to lack of timely payment (Hausman, 2004).

On the moderating effect of ICT use on the relationship between material flow risks and the performance of the manufacturing firms in Kenya, ICT use did not moderate the relationship. This means that there was no difference in terms of performance among firms that had leveraged on ICT use and those that had not. This findings can be explained by the qualitative findings on ICT use where the majority of the manufacturing firms (74.2%) failed to leverage on ICT to conduct their market research on possible competitive material sources, flexible supplier as well as analyze supplier capacity prior to the engagement of the suppliers with the firm. Jamil *et al*, (2016) points out that having ICT infrastructure and skills is not enough, firms must leverage on the same to experience improved firm performance.

## SUMMARY

Material flow risk is defined as disruptions that may affect the smooth flow of materials through the supply chain. In this study, material flow risk was operationalized using sourcing, sourcing flexibility and supplier capacity. The study found out that manufacturing firms in Kenya do not frequently experience logistical barriers in trade routes, language and cultural difficulties as materials flow along the supply chain. Also, lack of information and finances does not affect the flow of materials. In addition, manufacturing firms in Kenya select their suppliers competitively. Likewise, long lead times, terrorism, quality risk (noncompliance) do not disrupt the flow of materials among the manufacturing firms in Kenya when sourcing goods internationally. In case of changes in demand, suppliers of the manufacturing firms in Kenya are flexible and are able to postpone the order processing.

However, manufacturing firms in Kenya do not consider the flexibility of the suppliers when selecting them to ensure that their manufacturing processes are agile. Suppliers are also able to adjust easily and this enables the Kenyan manufacturing firms to keep up with the technological changes. Adoption of strong materials flow management, strategically leveraging on supplier relationship as well as strategic sourcing, use of supplier collaboration to enhance security of supplies and modern vehicles that are faster in delivery are some of the strategies that the Kenyan manufacturing firms indicated would help reduce the risk of materials flow and improve the performance of the firm.

On the Use of ICT in managing material flow, manufacturing firms in Kenya used ICT to improve the flow of materials, in selecting their suppliers, in monitoring price volatility, supplier capacity management and in collaborating with the suppliers or customers. However majority of

the respondents did not use ICT to conduct market research for goods and services in their firms.

In addition, material flow risk was not a significant predictor of firm performance. When ICT use was not a significant moderator of the relationship between material flow risk and performance of the manufacturing firm in Kenya. Moreover, the scatter plot supported the findings with two parallel lines. The two parallel lines were suggesting that manufacturing firms that had leveraged on ICT use and those that had not leveraged on ICT use had recorded equal performance. That is, there was no difference in term of performance among firms that used ICT in managing the material flow risk and those which did not. These findings agree with Jamil et al, (2016) that manufacturing firms can only benefit form ICT use when they leverage on the same to make decisions faster that will enable material to flow along the supply chain. This findings are also supported by the descriptive results which revealed that manufacturing firms in Kenya do not use ICT in making supply chain decisions.

## **CONCLUSION**

The study concluded that material flow risk does not significantly affect the performance of the manufacturing firms in Kenya. This is explained by the fact that manufacturing firms in Kenya are not aware of supply chain issues that may pose risks to their supply chains. For example, supplier flexibility can pose a major risk to the flows of the materials yet the majority of the manufacturing firms in Kenya do not see it as a risk (86.7%). Flexibility of the suppliers is a very strong area that contribute significantly to the competitiveness of a firm. This is because, when suppliers are flexible, they are able to respond to the increasing changes in customer demands and this improves the agility of the supply chain (Khan & Pillania, 2008). This is because ICT use also does not moderate the relationship between material flow risk and performance among manufacturing firms in Kenya.

ICT use is also not a significant moderator of the relationship between material flow risk and performance of the manufacturing firms in Kenya. The study can therefore conclude that although manufacturing firms in Kenya have adequate ICT infrastructure and training, they are not leveraging on the same to improve the flow of materials along the supply chain. This evident by because only (25.8%) of the manufacturing firms in Kenya are using ICT to conduct market research for goods and services. This means that the firms are not able to monitor the price volatility which can increase the risks of material flows because of the high risks involved (Fischl, Scherrer&Friedli, 2014). Market research also helps in identifying better quality of materials sourced by a firm. This reduces risks associated with materials returns which are also

costly to a firm because a firm has to incur the costs to enhance customer satisfaction Wagner & Neshat, 2012

## RECOMMENDATIONS

Supplier flexibility is key to monitoring the risk of material flow along the supply chain. Lack of supplier flexibility reduces the responsiveness and agility of a supply chain. This has a negative impact on performance in terms of customer satisfaction. Therefore, in order for the manufacturing firms in Kenya to reduce the risk of material flow, they must monitor the flexibility of their suppliers. This can be done at the supplier evaluating stage. This is where the supplier who are not flexible will not be engaged by a firm. This is because flexible supply chains will provide the manufacturing firms with alternatives in the event their suppliers are constrained in terms of capacity or when their suppliers are faced with hazards such as fire that can lead to their closures (Musa, 2012). On ICT use, this study recommends that manufacturing firms should leverage on their ICT infrastructure and employee skills to conduct market research on sourcing strategies, supplier flexibility and supplier capacity. Manufacturing firms may not reduce the risks of material flow if the existing ICT is not properly utilized in their supply chain management practices.

## AREAS FOR FURTHER RESEARCH

The study limited itself to the material flow risks, from the literature that affect the performance of manufacturing firms in Kenya. This therefore meant that the empirical review that supports material flow risk and the moderating effect of ICT on these risks among the manufacturing firms in Kiambu County Kenya was only limited to this variable identified in the study. Therefore, similar study should be conducted with other variables that affect the risk of the supply chains and the performance of the firms observed.

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