MANAGING RISKS IN THE GHANAIAN COCOA SUPPLY CHAIN USING THE FUZZY AHP METHOD

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ABSTRACT

Cocoa is an essential economic tool for Ghana and as such the government has made a lot of initiatives to institutionalize a body Ghana cocoa board to ensure the cocoa industry rakes maximum gains. The supply chain of cocoa in Ghana is complex as it spans domestic and international engagements. Due to this complexity, the cocoa value chain faces a lot of risk and this study purposed to evaluate the risks that the cocoa chain face at the farmer level. The study identified risks at the farmer level and used questionnaires to solicit the opinions of top managers and workers in the cocoa chain on the risk level and risk situation. Thirty-one (31), consisting of eleven (11) top managers and twenty (20) high ranking employees participated in the study. Data was analyses using Analytical hierarchical process (AHP) and fuzzy models. AHP analytical tool was used to compare the importance of opinions and calculate the weight of each risk while the fuzzy model was employed to assess the importance of each risk and to calculate the risk distribution. The study revealed there exists plethora of risks at the farmer level such as quality risk, pest infestation, risk of theft, smuggling/robbery etc. The study based on findings to recommend supply chain risk management practices; advanced training for farmers, efficient warehousing systems, improved transport systems to help improve operations at the farmer level.

Keywords: Supply Chain Risk, Supply Chain Risk Management, Ghana Cocoa, Farmer, FUZZY AHP.

INTRODUCTION

The concept of risk management has increasingly gained popularity and competence in risk management is important in most supply chains, especially in those that function in very fierce competitive markets as one of the competitive tools now lies with how resilient a company's or nation's supply chain is (Flint and Golicic, 2009). In the context of food, risk management is proving to be a key concern for all players in the food supply chain. The Government of Ghana, for instance, has identified agriculture and cocoa in particular, as having the potential to make an important contribution to economic growth and to assist in meeting its goals for poverty reduction (Assuming-Brempong et al., 2008). To regulate and oversee the trade of its cocoa business, the Government of Ghana established an encapsulating body; cocoa board to oversee cocoa activities in the country. Historically, cocoa production has been the mainstay of the Ghanaian economy and today cocoa continues to be Ghana's main agriculture export commodity and an important contributor to Ghana's foreign exchange earnings and GDP. This study attempts a timely investigation into the risks that the cocoa supply chain may face to ensure sustainability with this great economic tool. The primary focus area of this research are cocoa farmers in Ghana who contribute greatly to the production of cocoa beans and represent a key chain member in the domestic cocoa supply chain of Ghana. The main objective of the study is to;

a. Identify the types of risks that may affect the cocoa supply chain at the farmer level and
b. the most important risks that may affect them

A model for risk evaluation in the cocoa supply chain is presented based on the analytic hierarchy process (AHP) and FUZZY. To improve the resilience of the cocoa chain, AHP is used to calculate the weight of set up risk system of evaluated data collected from expert opinions and stakeholders in the supply chain and Fuzzy model used to evaluate risk distribution in cocoa chain activities.

LITERATURE REVIEW
The Ghana Cocoa supply chain
The cocoa sector has always played a vital role economically and this led the Ghanaian colonial government to establish the Cocoa Marketing Board (CMB) in 1947 aimed at resolving problems in the industry related to market sharing, price fixing, and unstable domestic prices. CMB, which was renamed to Cocoa Board (COCOBOD) in 1984, and became responsible for every facet of the Ghanaian cocoa market, and was the single biggest employer in Ghana in the early 1980s, counting over 100,000 employees (Kolavalli et al. 2012). Presently, the overall supply chain of Ghana's cocoa is very complex and as a result the domestic chain is used for the purpose of this study. According to Dorcas (2015), the domestic value chain of the cocoa chain primarily entails farmer level, purchasing clerks (PC), license buyer company (LBC) and cocoa marketing company (CMC) and this study will consider only the farmer level chain member. The supply chain of Ghana's cocoa begins with thousands of small holder farmers across the cocoa regions in Ghana and is at the heart of producing the cocoa beans by planting, harvesting and drying the cocoa beans. Due to the large number of holder farmers spread across the country, the federal cocoa regulating body in its chain has the purchasing clerks (PC) who consolidates harvests and prepare purchasing orders on behalf other chain members (Karibu 2014). The diagram below is the basic supply chain structure of farmer level

Figure 1.1: Farmer level supply chain (source: researchers construct)
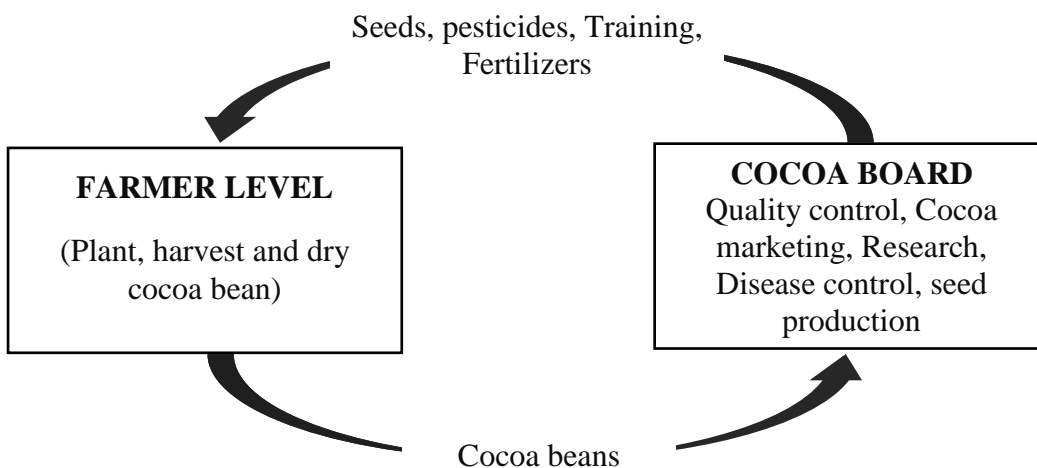
SUPPLY CHAIN RISK
Holton (2004) defined risk as a situation, having exposure to an event and event has possibility of uncertain outcomes. With the complex nature of the cocoa supply chain in Ghana, the concept of risk cannot be over looked. Dorcas (2015) states that the Farmer level, primarily comprise thousands of small holder farmers who face enormous risks. These risks or supply chain failures can be costly and lead to significant delays in consumer deliveries.

This paper will further discuss the risks associated with in farmer level with reference to some basic supply chain function that may apply to the operations of cocoa farmers such as purchasing, internal operation, warehousing, and transportation. The concept of risk identification is used to enumerate all types of risk systems in the supply chain. Common risk identification methods include, scenario analysis, Delphi method, checklists, module decomposition (Niu and Tian, 2007). This paper identified risk factors and subcategories based on interviews with cocoa experts in Ghana and extensive literature review. For the purpose of this study, the researcher focused on a domestic key player in the cocoa chain, that is, cocoa farmers to be precise, the various category of risks that affect them and measure how risks affect their activities.

Table 1. Farmer Level Risk System (source: researchers construct)

A1 PURCHASING RISK	A11 Stock out risk	Stock out risk refers to the exposure to loss resulting from running out of one or more inventory items. Although farmers prefer buying seedlings from the Agric Division of COCOBOD, they are unable to due to stock-out at the Division.
	A12 Risk of Spoilage	This includes risk that a pod that may be purchased is spoilt and farmers usually only realized during the nursery process.
	A13 Risk of Fraud	Fraud often occur when there is stock out of cocoa beans at cocoa board and they seek seeds from different source.
	A13 Quality Risk	Quality to the farmer means when farmers do not get the quality of cocoa beans to plant.
A2 INTERNAL OPERATIONAL RISK	A21 Environmental Risk (weather)	This is threats of adverse effects on living organisms and environment by effluents, emissions, wastes, resource depletion, etc.,
	A22 Risk of pest infestation	Risk that may occur during the cultivation period which easily destroys cocoa plantation of farmers and the internal activities
	A23 Health Risk	Chemicals used to control pest infestations, fumigations etc. may result in health risks
A3 WAREHOUSING/INVENTORY RISK	A31 Risk of spoilage	Refers to the likelihood of stored cocoa beans getting spoilt
	A32 Risk of theft	This is the likelihood that cocoa beans stored temporarily taken without consent
	A33 Risk of pest infestation	Risk that may occur during the storage which easily destroys cocoa plantation of farmers and the internal activities
	A34 Environmental risk (Humidity)	How environmental factors may affect stored cocoa beans
A4 TRANSPORTATION RISK	A41 Risk of injury (due to transport via foot)	Risks that may result from transporting cocoa beans via foot
	A42 Cost (via hired trucks)	The risk of cost in transportation via truck
	A43 Risk of accident	The likelihood of accidents due to various factors such as bad roads

ANALYTICAL HIERARCHICAL PROCESS (AHP)

The AHP was initially developed by Saaty in the 1970's, to solve the allocation of scarce resources and the planning needs of the military. Saaty's AHP theory explains an experts opinion alternative preferences based on peculiar criteria by a comparison scale to show the relative importance of one over another. The calculation of weights relies on an iterative

process in which matrixes are successively multiplied by itself, resulting in normalized weights (wi), and these weights represent the importance of alternatives relative to all other alternatives. The pairwise comparisons by the decision maker may result in inconsistencies given that all alternatives are taken into consideration (César Á. P et al 2017). With the AHP method, consistency ratio (CR), testing can be done to find out how consistent decision makers are.

The pairwise comparisons are considered to be adequately consistent if the corresponding consistency ratio (CR) is less than 10% (Saaty T. L., 1980). In this study, AHP is used to calculate the weight of set up risk system from data collected.

Table 2. Scale to use in making expert pairwise comparison Judgments
(Note: Element *a* and *b* are any two of the criteria)

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgment slightly favor one over the other
5	Much more important	Experience and judgment strongly favor one over the other
2, 4,	Intermediate values	When compromise is needed

FUZZY METHODOLOGY

In 1965 fuzzy logic by Professor Lotfi Zadeh, the Iranian-born professor at UC Berkeley, presented a paper known as fuzzy sets. This logic is used in conditions of uncertainty. It entails a representation and manipulation of 'fuzzy' terms and uses degrees of membership in sets rather than strict true or false membership' (Tah& Carr, 2000). The degree of membership can assume any value in the closed interval between 0 and 1, and this value defines the extent to which an element belongs to a fuzzy set (Tah& Carr, 2000; Kasirolvalad, Motlagh, &Shadmani, 2006). The Fuzzy model is applicable to the concept of risk and in this study it is used to evaluate risk distribution in the cocoa chain activities.

SUPPLY CHAIN RISK MANAGEMENT (SCRM)

Risk management began to be studied after world war 2. Several sources (Crockford, 1982; William and Heins, 1995; Harrington and Neihaus, 2003;) date the origin of risk management to 1955-1964. Risk management is essentially the process of responding to the existence of uncertainties through "controlling variability from an objective, target specification or standard" (Hutchins & Gould, 2004). Risk analysis could be undertaken by quantitative technique which is subject to or based on people's perception, and qualitative technique which is objective and uses analysis such as FUZZY and AHP methodologies.

FUZZY and AHP methodologies are applicable analytical tools in risk management because it can evaluate the various dimensions of products or organizational risks and their weight of importance in a comprehensive framework. As a valuable tool for prioritizing and consolidating performance metrics based on multiple criteria, AHP is a promising mechanism to help overcome and anticipate the likelihood of risk. Regardless of the fact that FUZZY and AHP models has been used widely in various aspects of business, there is very little or no literature with regards to cocoa supply chain in Ghana. Thus, this study proposes the use of the aforementioned in the risk evaluation of farmer level supply chain.

RESEARCH DESIGN, METHODOLOGY AND MODEL
Methodology
This research is intended to be applied in the real world, the Ghanaian cocoa chain to be precise. For this purpose, the research focuses on a methodology that can to a large extent used to solve problems which as a results can be applied in real life decision-making situations.

Using the risk systems identify and setup above in table 1, interview questions are prepared for stakeholders in the cocoa chain (Ghana). The researcher sought cocoa chain managers and employees opinion by an AHP structured questionnaire designed for pairwise comparisons of the various risks that may affect their operations. Finally, AHP was applied to obtain the weights of the various risks.

These are the procedure used to achieve this purpose;
  a. Analyze to identify the various risk systems
  b. Prepare a questionnaire in AHP format based on the identified risk systems to obtain the opinions of experts such as employers and employees in the cocoa supply chain.
  c. Prepare the answers obtained from the experts and employees, organize and make ready to be inputted into Microsoft excel (to calculate the various AHP components)
  d. Calculate the weights of all the various major categories and subcategories of risk of the collected data.
  e. Use FUZZY to evaluate risk distribution at the farmer level of cocoa chain activities.
  f. Show the results and analyze them to discuss the result, obtain conclusions and recommendations

Data Collection
Based on the risk system set up, questionnaires are designed to ascertain the judgments of experts from the cocoa chain with a conventional AHP questionnaire appropriate format. This was sent to two groups of people in the cocoa chain of Ghana which includes top managers (employers) and senior staff members (employees) of the cocoa chain major cocoa farming communities.

Table 3. Top managers/employer questionnaire feedback

Position	Function	Number
MANAGER 1	Quantity and quality of stock and verifying stock with losses.	3
MANAGER 2	Company policy making.	1
MANAGER 3	Oversee the activities of all cocoa production processes in the region.	2
MANAGER 4	Planning and supervising all operational functions in the cocoa chain activities.	5
Total		11

Employee questionnaire feedback
To calculate the risk situation, questionnaires were sent to employees who consisted of farmer union executives and small holder farmers.

Table 4. Employee questionnaire Information

Position	Function	Number
Farmer	Planting, harvesting and drying	9
Purchasing clerk	Buying cocoa beans from farmers	9
Warehousing staff	Processing storage of harvested of cocoa beans	2
Total		**20**

DATA ANALYSIS, RESULTS AND DISCUSSION

After the first category of data collection from the top managers, three professors (from Nanjing University of Posts and telecommunication) were invited to do a pairwise comparison matrices on the importance of the various positions of the top managers who filled the questionnaire, thus selected a scale from 1 to 5. The top managers who filled the questionnaire spans senior officers in the cocoa industry, cocoa committee members, Regional level managers, and a variety of managers of different departments in the cocoa chain. The table below shows professors view on the importance of top managers opinions.

Table 5. Pair wise comparison of the importance of top managers opinion

	MANAGER 1	MANAGER 2	MANAGER 3	MANAGER 4
MANAGER 1	1	1/5	1/3	1/2
MANAGER 2	5	1	2	3
MANAGER 3	3	1/2	1	2
MANAGER 4	2	1/3	1/2	1

Calculating the importance of different opinions
The product of each criteria is calculated using the formula below. The researcher uses Microsoft excel to calculate the product (M) as follows.
$M = \prod a$
Manager 1: (1.00 x 0.20 x 0.33 x 0.50) = 0.033;
Manager 2: (5.00 x 1.00 x 2.00 x 3.00) = 30.000;
Manager 3: (3.00 x 0.50 x 1.00 x 2.00) = 3.00;
Manager 4: (2.00 x 0.33 x 0.50 x 1.00) = 0.333

Calculating the root of the said product
The root of the product is calculated by the formula $W_i = \sqrt[n]{M}$, where n=1/4
From the above matrix we can calculate the forth root of product values in each row. The forth root of product is calculated because there are four (4) criteria. The forth root of product in each row criteria is calculated in Microsoft excel as follows.

$W_i = \sqrt[n]{M}$
Manager 1: $(1.00 \text{ x } 0.20 \text{ x } 0.33 \text{ x } 0.50)^{(1/4)} = 0.4273;$
Manager 2: $(5.00 \text{ x } 1.00 \text{ x } 2.00 \text{ x } 3.00)^{(1/4)} = 2.3403;$
Manager 3: $(3.00 \text{ x } 0.50 \text{ x } 1.00 \text{ x } 2.00)^{(1/4)} = 1.3161;$
Manager 4: $(2.00 \text{ x } 0.33 \text{ x } 0.50 \text{ x } 1.00)^{(1/4)} = 0.7598;$
Lastly, each of the above mentioned forth root product values are then added together;
0.4273 + 2.3403 +1.3161 + 0.7598 = **4.8435**

Normalizing the aforementioned nth root of products to get the appropriate weight $\overline{W_i}$

The forth root product values (and total) from the previous step will be normalized to get the appropriate weights for each criteria. The weights of each criterion are calculated in excel as follows.

$$\overline{W_i} = W_i / \sum_{1}^{n} W_i$$

Manager 1: (0.4273/4.8435) = 0.0882;
Manager 2: (2.3403/4.8435) = 0.4832;
Manager 3: (1.3161/4.8435) = 0.2717;
Manager 4: (0.7598/4.8435) = 0.1569;
The above weight calculated correctly sums up to 1;
0.0882 + 0.4832 + 0.2717 + 0.1569= 1.0000

Table 6. Weight of the opinions

	MANAGER 1	MANAGER 2	MANAGER 3	MANAGER 4	M	$\overline{W_i}$	Weight (Wi)
MANAGER 1	1	1/5	1/3	1/2	0.033	0.4273	0.0882
MANAGER 2	5	1	2	3	30	2.3403	0.4832
MANAGER 3	3	1/2	1	2	3	1.3161	0.2717
MANAGER 4	2	1/3	1/2	1	0.333	0.7598	0.1569
						4.8435	1

Calculating and checking the consistency ratio (CR)

The consistency Ratio (CR) tells the decision maker on how consistent he or she has been when making the pairwise comparisons. In calculating the Consistency ratio for this study included a four step process.

First, the pairwise comparison values in each column are added together (as the "Sum" values) and each is multiplied by the respective weight (from the $\overline{W_i}$ column) for that criteria. Specifically,

Manager 1: (1.00 + 5.00 + 3.00 + 2.00) = 11.00 x 0.0882 = 0.9704;
Manager 2: (0.20 + 1.00 + 0.50 + 0.33) = 2.03 x 0.4832 = 0.9825;
Manager 3: (0.33 + 2.00 + 1.00 + 0.50) = 3.83 x 0.2717 = 1.0416;
Manager 4: (0.50 + 3.00 + 2.00 + 1.0) = 6.50 x 0.1569 = 1.0197;

Secondly, the aforementioned values are summed to yield a total of 4.0142
(i.e. 0.9704+ 0.9825 + 1.0416 + 1.0197). The value 4.0145 which is known as Lambda-max.

Thirdly, the consistency index (CI) is calculated with the formula;
CI = (λ max - n) / (n-1); where n=4 for the four different criteria being compared.
CI = (4.0145 − 4) / (4-1) = **0.0048**

Lastly, the consistency Ration (CR) is calculated by dividing the consistency index (CI) by a Random index (RI). For this research, the following Random index (RI) was set up in relation to direct function of the number of criteria being considered. The table of Random indices (RI) is shown below;

Table 7. Random Consistency Index (*RI*)

Number	1	2	3	4	5
Random Index	0	0	0.58	0.9	1.12

$CR = {CI}/{CR}$ where (CI) = **0.0048**, and (RI) chosen is **0.90**

CR = $0.0048/0.90$ = **0.0054**

If the consistency ratio (CR) is less or equal ($\leq$) to 0.1, then it means calculations are consistent on the other hand if it is greater than (>) 0.1 then serious reconsideration needs to be done. For the purpose of this research at this point, calculations shows that the consistency ratio (CR) is 0.0054 meaning all calculations so far is consistent and no corrective measure is needed.

Assessing The Importance of Each Risk Based On Fuzzy Model

Data entry of opinions of all top manager and calculating risk importance score

The data of all opinions of the top managers who filled the questionnaires are inputted as seen in table 8.

Risk importance score of the top managers opinion is calculated in Microsoft excel by;

Manager 1(W_i) X Manager 1 (A1) + Manager 2 (W_i) X Manager 2 (A1) + Manager 3 (W_i) X Manager 3 (A1) + Manager 4 (W_i) X Manager 4 (A1)

0.0882 *X* 2.67 + 0.4832 *X* 2 + 0.2717 *X* 3 + 0.1569 *X* 2.40 = **2.3933**

The result of **2.3933** represent the Risk importance score of A1, that is Purchasing risk. The calculation is repeated for all other features including the subcategory of risks in each section. The table below shows a full description of the total outcome of the questionnaire filled by the top managers with corresponding risk importance.

Table 8: Data entry of opinions of all top management and Calculating the importance of risk features

	Manager 1	Manager 2	Manager 3	Manager 4	Risk Importance score
A1	2.67	2.00	3.00	2.40	2.3933
A2	3.67	3.00	4.00	3.40	3.3933
A3	4.33	3.00	5.00	4.60	3.9121
A4	4.67	3.00	4.00	4.20	3.6070
					13.3057
A11	2.00	2.00	2.00	2.00	2.0000
A12	3.00	4.00	4.00	3.60	3.8490
A13	3.67	4.00	4.00	3.00	3.8137
A14	4.67	4.00	4.00	4.20	4.0902
A15	4.00	3.00	2.00	3.60	2.9106
					16.6636
A21	1.67	3.00	2.00	2.20	2.4852
A22	3.67	4.00	4.00	4.00	3.9706
A23	3.67	3.00	4.00	3.80	3.4560
A24	2.00	1.00	1.00	2.40	1.3078
					11.2196
A31	3.00	3.00	4.00	2.80	3.2403
A32	4.00	4.00	4.00	3.60	3.9372
A33	4.00	4.00	5.00	3.80	4.2403
A34	3.67	3.00	3.00	3.40	3.1216
					14.5395
A41	2.00	2.00	1.00	1.40	1.6342
A42	3.67	3.00	3.00	3.40	3.1216
A43	4.00	2.00	4.00	3.40	2.9395
A44	3.33	4.00	3.00	3.80	3.6381
					11.3333

Description of the Importance of Risk Features
From the above analysis and calculation, the risk importance calculated based on the experts opinion will be used comparatively with the risks scale of 1 to 5 (with 1 as least and 5 very important) indicated by the respondents. This is done to relate the risk importance to the risk levels of each risk to understand clearly if the risks identified corresponds with its importance and frequency.

In this part we discuss the importance of the risk features. Overall for farmers in the cocoa chain, the most important risks is warehouse/inventory and transportation with a risk importance score of 3.9121, 3.6070 respectively. According to the study's risk scale (1-5), the aforementioned is close to 4, meaning; important risk and thus, represent the most important risk at the farmer level of the cocoa supply chain. The least important risk for farmers is purchasing risk with 2.3933 risk importance score. On the risk scale from 1 to 3, it is slightly important and thus must be closely monitored.

At the purchasing level of farmers, the most important risk that affects them is quality risk with 4.0902 risk importance score out of 5 (very important). The moderately important risk to the farmer are risk of spoilage and risk of fraud with score of 3.8490 and 3.8137 respectively. Considering the results at the internal operation level of the cocoa chain for farmers, the result shows moderate risk importance for both risk of pest infestation and risk of theft; that is 3.9706 and 3.4560 risk importance scores respectively. However since the score of risk of pest infestation on a scale from 1 to 4 is close to 4, it is the most important risk for farmers at the internal operation level.

The warehouse/inventory level shows an interesting results of which the most outstanding important risk is the risk of pest infestation 4.2403 on a scale from 1 to 5. The remaining risks in this level; that is risk of spoilage (3.2403), risk of theft (3.9372) and environmental risk (3.1216) are moderately important from a scale 1 to 4.

Transportation is key at all levels of the cocoa chain and as such the results from the calculated data only show moderate importance for both risk of smuggling/robbery (3.6381) and cost via hired trucks (3.1216) on a risk importance scale from 1 to 4. On the other hand, risk of accident (2.9395) risk of injury (1.6342) revealed slightly important and least important respectively.

Figure 2: Risk importance
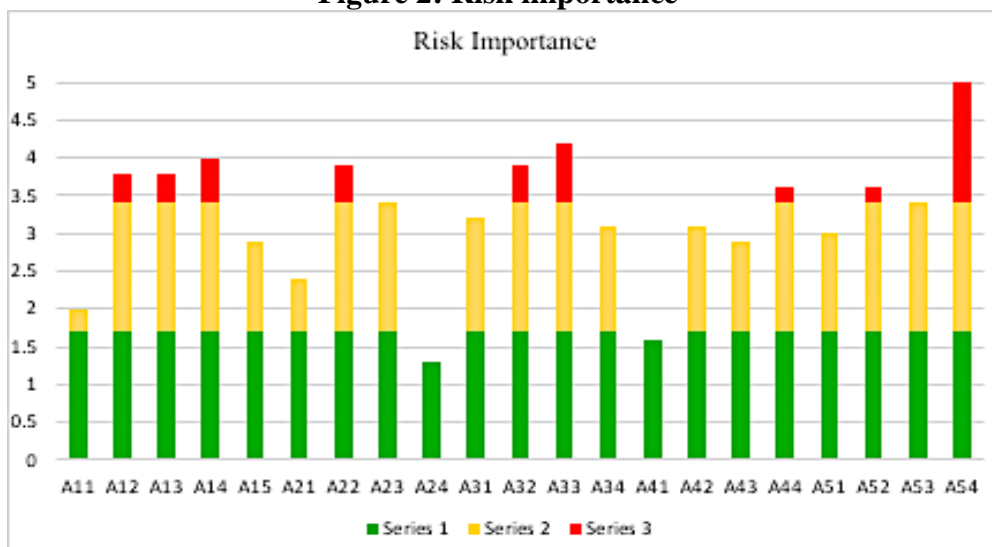
Assessing the risk level

For the purpose of analyzing the risk levels by comparing to the risk importance, questionnaires were designed and given out to supply chain members consisting of farmers, license buying cocoa companies (LBC) and cocoa marketing companies (CMC). The LBC, PC and CMC were considered since they work closely with farmers. The aforementioned constitute employees from different cocoa chain levels and this was to get risk levels from the employees in the cocoa chain of Ghana, indicating risks as being low, medium and high based on respondents personal experience.

Table 9: Farmer risk level and risk importance tabulation

FARMER LEVEL RISK					
		LOW	MEDIUM	HIGH	RISK IMPORTANCE
PURCHASING RISK	Risk of stock out	60%	40%	0%	2.0000
	Risk of Spoilage	10%	30%	60%	3.8490
	Risk of Fraud	60%	10%	30%	3.8137
	Quality Risk	10%	50%	40%	4.0902
		LOW	MEDIUM	HIGH	
INTERNAL OPERATIONAL RISK	Environmental Risk (weather)	20%	40%	40%	2.4852
	Risk of pest infestation	30%	30%	40%	3.9706
	Risk of theft	50%	40%	10%	3.4560
	Health Risk	10%	30%	60%	1.3078
		LOW	MEDIUM	HIGH	
WAREHOUSING RISK	Risk of spoilage	80%	10%	10%	3.2403
	Risk of theft	90%	10%	0%	3.9372
	Risk of pest infestation	70%	20%	10%	4.2403
	Environmental risk (Humidity)	60%	40%	0%	3.1216
		LOW	MEDIUM	HIGH	
TRANSPORTION RISK	Risk of injury (due to transport via foot)	20%	30%	50%	1.6342
	Cost (via hired trucks)	0%	60%	40%	3.1216
	Risk of accident	0%	70%	30%	2.9395
	Risk of smuggling/Robbery	20%	70%	10%	3.6381

Description of the Data entry for farmer level and risk importance tabulation

Overall, at the farmer level it can be deduced that, at the purchasing stage, quality risk is very

important with risk importance score of 4.0902 and percentage risk level scores ranging between 40 percent (high) and 50 percent (medium) respectively showing a 50 percent chance of occurrence given its high importance of 4 which is close to 5. This means quality risk is the risk with the most likely risk that may occur at this stage and calls for measures to control this risk. Also, risk of spoilage is shown to be predominant as its risk importance score is 3.8490 but is about 60 percent high level risk.

At the internal operation stage of the farmer level, the risk importance shows that health risk has the least risk importance (1.3078) but with high risk level score of 60 percent. This indicates a possible frequent occurrence which may compound over a period to disrupt the cocoa chain and as such attention has to be given to this risk feature. Also more efforts and attention must be given to risk of pest infestation as its risk importance shows the highest (3.9706) with 40 percent risk level in this stage.

Regarding farmers warehouse, the most important risk is risk of pest infestation due to a 4.2403 risk importance score but information gathered shows that the majority of the risk levels is low and thus, measures put in place is to a large extent are quiet effective or risks at the warehouse are being controlled well together with risks such as risk of theft, spoilage and environment given its risks levels between 0 and 10 percent.

At the transportation stage of farmers, risk of injury is seen as the least importance 1.6342 but its occurrence may be 50 percent likely and may disrupt the supply chain activities in the long run. Regardless, other risk (cost via hired truck 3.1216, risk of accident 2.9395 and risk of smuggling 3.6381 show medium level risk of 60, 70, 70 percent respectively) indicating the ability for such risks being controlled and monitored well.
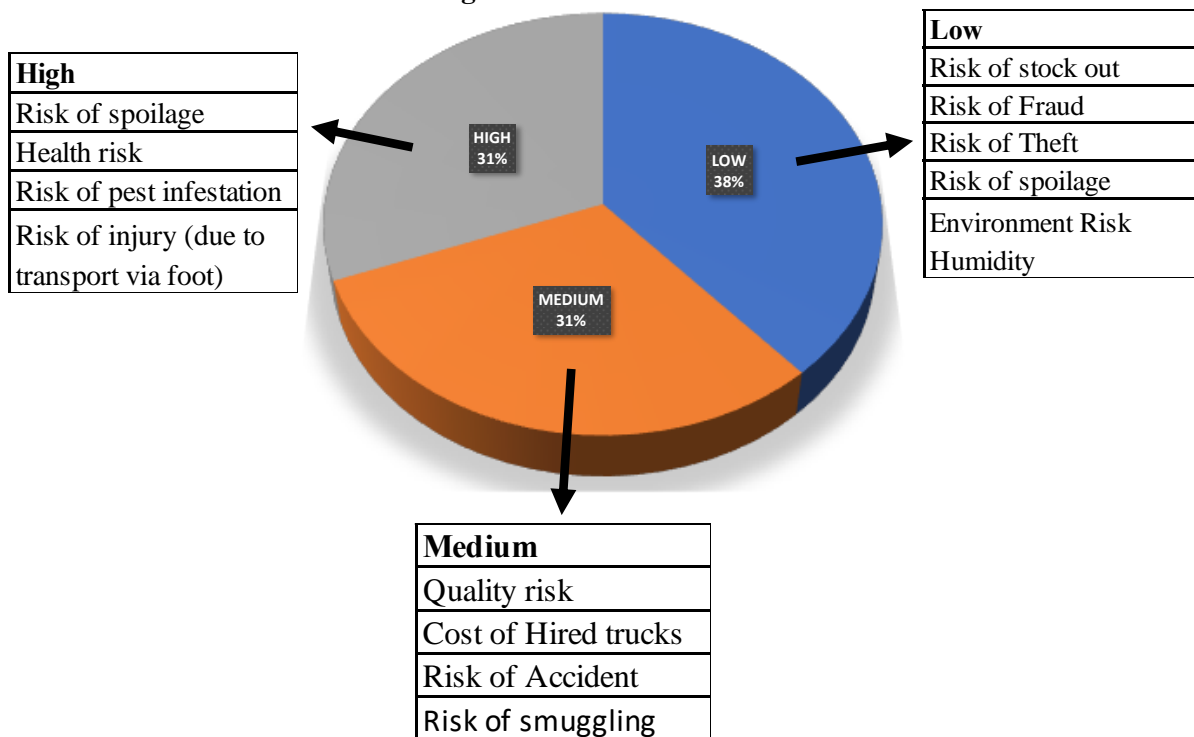
Figure 2: Famer level risk

High
Risk of spoilage
Health risk
Risk of pest infestation
Risk of injury (due to transport via foot)

Low
Risk of stock out
Risk of Fraud
Risk of Theft
Risk of spoilage
Environment Risk Humidity

Medium
Quality risk
Cost of Hired trucks
Risk of Accident
Risk of smuggling

Figure 2: Farmer level Risk Matrix

			Risk Level		
			LOW	**MEDIUM**	**HIGH**
Risk Importance	5	Very Important	None	- Quality risk	None
	4	Important	- Risk of pest infestation	None	None
	3	Moderately Important	- Risk of fraud - Risk of spoilage - Risk of theft - Environmental Risk (Humidity) - Policy risk	- Risk of theft - Risk of theft - Cost via hired truck - Risk of smuggling/robbery - Exchange rate - Lead time	- Risk of spoilage - Risk of infestation
	2	Slightly Important	- Risk of stock out	- Risk of accident	-Credit risk -Environmental risk (weather)
	1	Not Important	None	None	- Health risk - Risk of injury

CONCLUSION

In conclusion, this study contributes to the literature on supply chain risk management by providing evidence on some risks in the Ghanaian cocoa value chain. The study set out to research the flow process of cocoa beans in Ghana and to particularly investigate risks that surface at the farmer level. The study gathered that the domestic flow process of cocoa beans begins with the farmer, to purchasing clerks, license buying company and through to cocoa marketing companies. The study focused on the farmer level risk because farmers play a very important and critical role in the cocoa chain and is the most exposed chain member according to literature reviewed and based on the researchers prejudice. Generally, farmers face enormous risks at every facet of their supply chain operational activities of purchasing (of cocoa beans) through to transportation (of the beans) such as spoilage, health risks, pest infestation to mention but a few. The study explored to find out the most important risks for farmers and the risk levels. Evidence from the analysis highlights that warehousing or inventory, transportation and internal operations respectively show a significant level of risk importance. Further on the individualized risk under the aforementioned supply chain function, quality risk, pest infestation, risk of theft, smuggling/robbery and cost of hired trucks hierarchically among other risk are the most important risks that farmers may face. On the contrary, it also emerged that due to good supply chain risk management practices, risks such as stock out and lead time are well controlled.

RECOMMENDATION

Finally, recommendations are made based on supply chain risk management theories to help the case of farmers in the cocoa supply chain of Ghana. As established by the study, the most

important and prevalent risks farmers face include quality risk, pest infestation, risk of theft, smuggling/robbery and cost of hired trucks respectively. According to the analysis and results obtained, the following recommendations are made to help manage the risks farmers face.

Advanced Training of Farmers

The cocoa industry must invest more resources in training programs for farmers as farmers are key and the producers of cocoa beans. Farmers can be trained via their unions established and accountable to the mother company Ghana cocoa board. Training on practices such as mechanized farming will help to improve farming practices and mitigate or eliminate risks of injuries and pest infestation as farmers can mechanically and rapidly apply efficient and effective methods. Frequent training programs will further improve the social, environmental and economic gains of the cocoa chain and will adequately tackle risks that will result from farmer incompetence. With more improved and good training on best cocoa practices quality risk which accounted for the most important risk in at the purchasing stage of all the supply chain members will be dealt with. By so doing other important risks such as health risks, environmental risks, risk of spoilage and risk of pest infestation will be abated, thus ensuring the best cocoa beans handed down to other chain members of the company.

Efficient warehousing system

The study reiterated the essence of warehousing to farmers and it is only prudent to mention the improvement of warehouse systems. The research showed that the risk of pest infestation, risk of theft, risk of spoilage, and environmental risk respectively accounts for risk that are very important. An improvement on the efficiency of warehousing systems will enable farmers deal with the above mentioned risks. Efficient warehousing systems such as proper ventilation will mitigate bacteria and mold accumulation.

Improved transport systems

Transportation in Ghana is to some extent influenced negatively due to bad roads in farming and major highways and road networks. The researcher believes regardless that monitoring systems such as tracking devices can be incorporated into transportation systems to reduce the risks related to smuggling/robbery or theft. Farmers control of risk can be improved by increasing risk management efforts so as to gain more resilience in its supply chain, and make the maximum gains to help develop Ghana with such an amazing economic development tool called cocoa.

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