Quantification of Risk Mitigation in Ghanaian Pharmaceutical Industry Supply Chain

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Global pharmaceutical supply chain risk mitigation has become an important issue in the corporate board room. This paper reports on the empirical findings of the quantification of risks that decision makers consider most important when deciding on risk portfolio to mitigate and the manner in which risks are prioritized according to their importance. Based on reviewed literature, five objectives and four alternative risk mitigation treatments were identified. The empirical findings suggest that decision makers attach great importance to counterfeit, Food and Drugs Board, and exchange rate fluctuations. For currency and supplier failure, they are less important to the decision makers. With respect to risk mitigation strategies, risk reduction is considered most important followed by risk avoidance. Dynamic sensitivity analysis with respect to change (increase) in Food and Drugs Board did not result in any change in the ranking of risk mitigation strategies, while change (increase) in counterfeit resulted in a change in the ranking between risk reduction and risk avoidance. Risk reduction ranked number one followed by risk reduction. Implications distilled from this paper are far reaching for the Ghanaian pharmaceutical C-level executives.

INTRODUCTION

The spate in the pharmaceutical supply chain risks and the accompanying pressure from regulatory bodies, changing legislation, customers, and cut-throat competition are forcing many forwarding looking pharmaceutical organizations to implement supply chain risk management. Some of the merits associated with supply chain risk management are gaining sustainable competitive advantage (Enyinda, et al., 2008), fewer surprises, better decision making, achieving an improved balanced between opportunity and threat, enhanced competitive position, and manage suppliers more effectively (O'Brien and Joyce, 2007). However, it has been acknowledged that the most challenging aspect of supply chain risk management is the identification of risk factors for mitigation. Therefore, to ensure pharmaceutical supply chain resiliency and continuity, it is imperative to effectively assess risks and develop a comprehensive mitigation approach (Srividhya and Jayaranman, 2007). Breen (2008) asserts that "at every basic level, risks in the pharmaceutical supply chain are associated with product discontinuity, product shortages, poor performance, patient safety/dispensing errors, and technological errors…all of which incur risk through disruption to the system." Lack of appropriate risk mitigation can erode public health confidence and reputation, patients' health and safety, and reduction in profit margin and shareholder value. Although the pharmaceutical firms cannot entirely eliminate risk portfolio they face in their daily operations, they can enable an environment conducive for responsive risk mitigation. Thus, for the Ghanaian pharmaceutical firms to prosper and flourish in today's risky global business environment, they must seek ways to manage and mitigate their drug supply chain risks.

Just as costs containment and growing revenue are important objectives, risk management has become another vital discipline for organizations (Kuhn, 2008). Kleindorfer (2000) argues that to mitigate risks in supply chain one must identify the underlying sources of risks and their quantification. Risk quantification represents the conversion of the qualitative risk description derived from the experts' judgments into a quantitative assessment. Miller (1992) suggests that risk mitigation is one of those strategic actions organizations must pursue to thwart the uncertainties identified from variety of sources. Bandyopadhyay et al. (1999) reported that key components of risk management include 1) risk identification, 2) risk analysis, 3) risk reduction, transfer and acceptance, and 4) risk monitoring. Pharmaceutical supply chain risk mitigation strategies considered in this paper includes avoiding, reducing, accepting, transferring (sharing) risk. The intent of this paper is to identify and mitigate the Ghanaian pharmaceutical supply chain risks. Specifically, this paper leverages analytic hierarchy process (AHP) to quantify risk mitigation. For organization to mitigate risks, it is imperative to identify and quantify them. Kuhn (2008) asserts that "risk quantification can help to improve business such as implementation of risk appetite or bounding losses which results in more stable earnings or attenuates extreme events." The result of this research will help supply chain managers with a step-by-step approach to identify, assess, manage and mitigate risks in their pharmaceutical supply chains.

The rest of the paper is organized as follows. Section 2 presents the literature review. Section 3 briefly discusses the research methodology. Section 4 describes the data collection and analysis. Section 5 discusses the research findings. Finally, section 6 presents the conclusions and managerial implications.

LITERATURE REVIEW

March and Shapira (1987) and Buehler and Pritsch (2003) contend that risk assumption is ultimately a fact of business and management life. Hence it is the ability to assume and manage risks is what organizations must do to produce profits and shareholder value (Buehler and Pritsch, 2003). Lowrance (1976) described risk as a measure of the probability and severity of adverse impacts. Haimes (1998) attributes the difficulty in understanding risk to two constructs 1) real (potential damage and consequences, or unfavorable adverse effects) and 2) an imagined, mathematical human construct called probability. Holton (2004) described risk as composed of exposure and uncertainty. Indeed, in recent years, the relevance of uncertainty and risk in supply chain has received an avalanche of attention from academics, practitioners (Hendricks and Singhal, 2005; Cavinato, 2004; Kleindorfer and Saad, 2005; Towill, 2005; Barry, 2004; Christopher and Lee, 2004; Harland and Brenchley; 2001, Zsidisin et al., 2004; Spekman and Davis; 2004) C-Level executives, Wall-street, regulatory and rating agencies, and governments. All types of risks exist within supply chains (Lee et al., 1997) and organizations face them whenever they seek goods and services to meet their goals and objectives (Zsidisin et al., 2004) and when there is a high propensity that an event can take place and result in a significant disruption (Hallikas et al., 2002).

Based on the review of relevant literature, counterfeit, regulatory agencies, intellectual property infringement, strategic risk, natural disaster, currency fluctuation, exchange rate, supplier failure, legislation, underdeveloped product pipeline, and legal liability can have impact on pharmaceutical supply chain performance (Enyinda, 2008; Enyinda et al., 2009; Hillman and Keltz, 2007; Enyinda, and Tolliver, 2007; Enyinda and Szmerekovsky, 2007; Chan et al., 2002; KPMG, 2005; WHO, 1998).

RESEARCH METHODOLOGY

A decision-making environment can entail multiple objectives called multi-criteria decision making. Evaluation and risk management in the pharmaceutical industry supply chain is a typical MCDM problem that entails multiple criteria that can be both qualitative and quantitative. An example of MCDM selected to model risk management in pharmaceutical supply chain is AHP developed by Saaty (1980). It is selected because it allows decision-makers to model a complex problem in a hierarchical structure portraying the relationships of the overall goal, criteria (objectives), sub-criteria (sub-objectives), and

alternatives. Research that have used AHP include supplier selection (Lee et al., 2001); international business management (Atthirawong and MacCarthy, 2005), operations and logistics/supply chain management (Enyinda, 2008; Enyinda et al., 2009; Min, 1992), marketing (Dyer and Forman, 1992), pharmaceutical marketing and management (Ross and Nydick, 1994).

For the present study, a total of five objectives (risks) were identified. Based on the five objectives and four decision alternatives, the decision hierarchy for the Ghanaian pharmaceutical industry supply chain risk mitigation is depicted in Figure 1.

DATA COLLECTION AND ANALYSIS

Data were obtained via the use of survey questionnaires. The survey questionnaire was derived from the information obtained from the literature review. The survey questionnaire was bifurcated into three major categories. The first category solicited logistics and supply chain management experts to make pairwise comparisons of the five decision objectives. The second category elicited experts to make pairwise comparisons of the decision alternatives (risk reduction/control, risk avoidance, risk acceptance/retaining, and risk transfer/funding) with respect to each of the five objectives (i.e., FDB, counterfeit, currency, exchange rate, and supplier failure). For the pairwise comparisons, Table 1 portrays the nine-point scale used (Saaty and Vargas, 1994).

For this study, a total of six questionnaires were sent to experts who work for the six major pharmaceutical firms in Ghana. Of this number, two questionnaires were returned. The analysis was conducted using the Expert Choice Software (11.5) developed by Expert Choice, Inc.

SAATY'S AHP

For AHP application, Saaty (1980) suggested the following steps: 1) define the problem and determine its goal. The goal is the decision to mitigate risk in the Ghanaian pharmaceutical supply chain; 2) structure the hierarchy (see Figure 1) from the top (decision-maker's objectives) to the bottom level (decision alternatives); 3) construct a set of pairwise comparison matrices (n x n) for each of the lower level with one matrix for each factor in the level immediately above by employing the fundamental scale measurement presented in Table 1. The pairwise comparisons are accomplished with respect to which factor dominates; 4) n(n – 1)/ judgments are needed to develop a set of matrices in step 3. And reciprocals are assigned in each pairwise comparison automatically; 5) hierarchical synthesis is utilized to weight the eigenvectors by the weights of the objectives and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy; 6) After completing all the pair-wise comparisons, the consistency can be evaluated using the eigenvalue (λ_{max}), to derive the consistent index (CI). Specifically, CI for each matrix order *n* is determined by CI = (λ_{max} – n)/n – 1, where n is the matrix size. Expert judgment consistency can be examined by determining the consistency ratio (CR). Specifically, CR = CI/RI = [(λ_{max} – n)/n – 1]/RI, where RI is random index. CR is acceptable, if its value is less than or equal to 0.10. However, if it is greater than 0.10, the judgment matrix will be considered inconsistent. To rectify the judgment matrix that is inconsistent, decision-makers' judgments should be reviewed and improved.

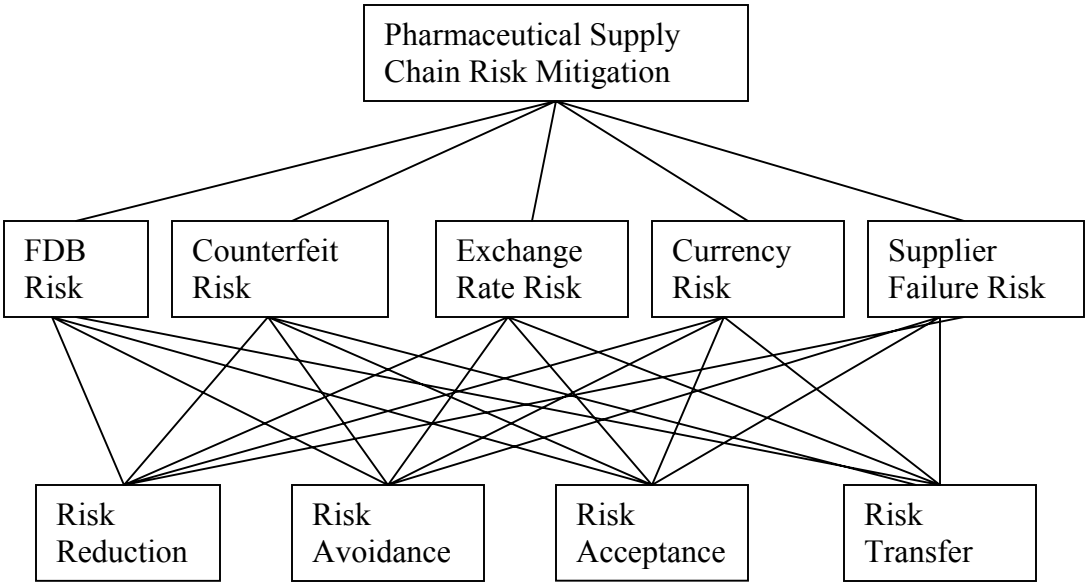

Figure 1: Decision Hierarchy to Mitigate Pharmaceutical Supply Chain Risk

Table 1. The AHP Preference between two Elements

Level of importance	Definition	Explanation
1	Equally important/preferred	Two activities or elements contribute equally to the objective
2	Equally to moderately important/preferred	
3	Moderately important/preferred	Experience and judgment slightly favor activity or element over another
4	Strongly important/preferred	
5	Strongly important/preferred	Experience and judgment strongly or essentially favor one activity over another
6	Strongly to very strongly important/preferred	
7	Very strongly important/preferred	An activity is strongly favored over another and its dominance demonstrated in practice
8	Very strongly to extremely important/preferred	
9	Extremely important/preferred	The evidence favoring one activity over another is of the highest degree possible of affirmation

RESEARCH FINDINGS

Table 2 reports on the criteria and their corresponding risk mitigation strategy priorities. The consistency ratio for the four criteria is less than 0.10. Similarly, the consistency ratio for each of the criterion with respect to risk mitigation strategies is less than 0.10. Thus, suggesting that the experts' judgments or

opinions are reliable. The empirical findings also indicate that counterfeit risk (0.453) is considered more important followed by FDB (0.264), exchange rate (0.112), and so forth.

Table 2. Major Criteria (CR: 0.05 <0.10) and Risk Mitigation Strategies Priorities

	Counterfeit (0.453)	FDB (0.264)	Exchange Rate (0.112)	Currency (0.089)	Supplier Failure (0.082)
Reduce Risk	0.406	0.462	0.202	0.333	0.440
Avoid Risk	0.477	0.301	0.255	0.306	0.325
Transfer Risk	0.073	0.103	0.474	0.235	0.146
Accept Risk	0.044	0.134	0.069	0.125	0.088

CR: 0.02<0.10; CR: 0.05<0.10; CR: 0.03<0.10; CR: 03<0.10; CR: 02<0.10

With respect to risk mitigation, risk avoidance (0.477) is considered more important for counterfeit followed by risk reduction (0.406); risk reduction/control (0.462) is more important for FDB followed by risk avoidance (0.301). Table 3 which shows the composite or overall priority indicates that risk reduction (0.394) is overall considered more important followed by risk reduction (0.378).

Table 3. Composite or Overall Priority With Respect To Risk Mitigation Strategies

	Counterfeit	FDB	Exchange Rate	Currency	Supplier Failure	Overall Priority
Reduce Risk	0.183918	0.121968	0.053088	0.029637	0.036080	0.394227
Avoid Risk	0.216081	0.079464	0.028560	0.027234	0.026650	0.377989
Transfer Risk	0.033069	0.035376	0.022624	0.020915	0.011972	0.146236
Accept Risk	0.019932	0.027192	0.007728	0.011125	0.007216	0.081377

SENSITIVITY ANALYSIS

To perform a sensitivity analysis, a decision maker can vary weights or priorities of the objectives in order to assess how the priorities of the alternative risk mitigation strategies on the right-hand side would change. The dynamic sensitivity analysis in Figure 2 is employed to dynamically change the priorities of the objective to evaluate how these changes can influence the priorities of the alternative risk mitigation strategies.

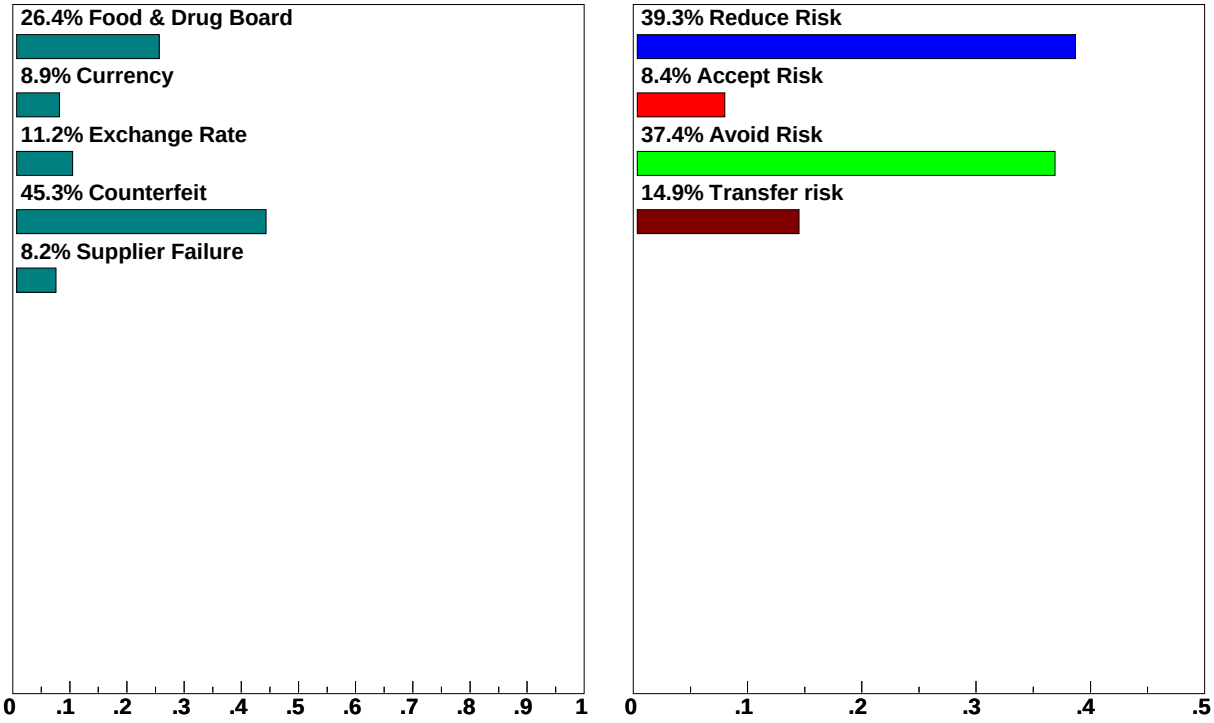

Figure 2: Dynamic Sensitivity Analysis for Nodes Below: Goal – Mitigation of Pharmaceutical Supply Chain Risk

A decision-maker can utilize sensitivity analysis to compare a "what-if" scenario by increasing or decreasing the criterion's priorities in the left column to observe if there will be changes in the priorities of the decision alternatives on the right-hand side column as shown in Figure 2. Because of limitation of space only dynamic sensitivity analysis was considered for Food and Drugs Board and counterfeit risks. Figures 3-4 shows two sensitivity scenarios. As shown in Figure 3 (scenario 1), when the relative importance of FDB risk increased from .264 (26.4%) to .530 (53.0%), the risk mitigation strategies' (alternatives') ratings or rankings were insensitive. Risk reduction remained the best risk mitigation strategy. In Figure 4 (scenario 2), when the relative importance of counterfeit risk increased from .453 (45.3%) to .702 (70.2%), the risk mitigation responses were sensitive. Risk avoidance previously ranked as number two now ranked number followed by risk reduction. This means that decision makers must exercise due diligence to avoid counterfeit.

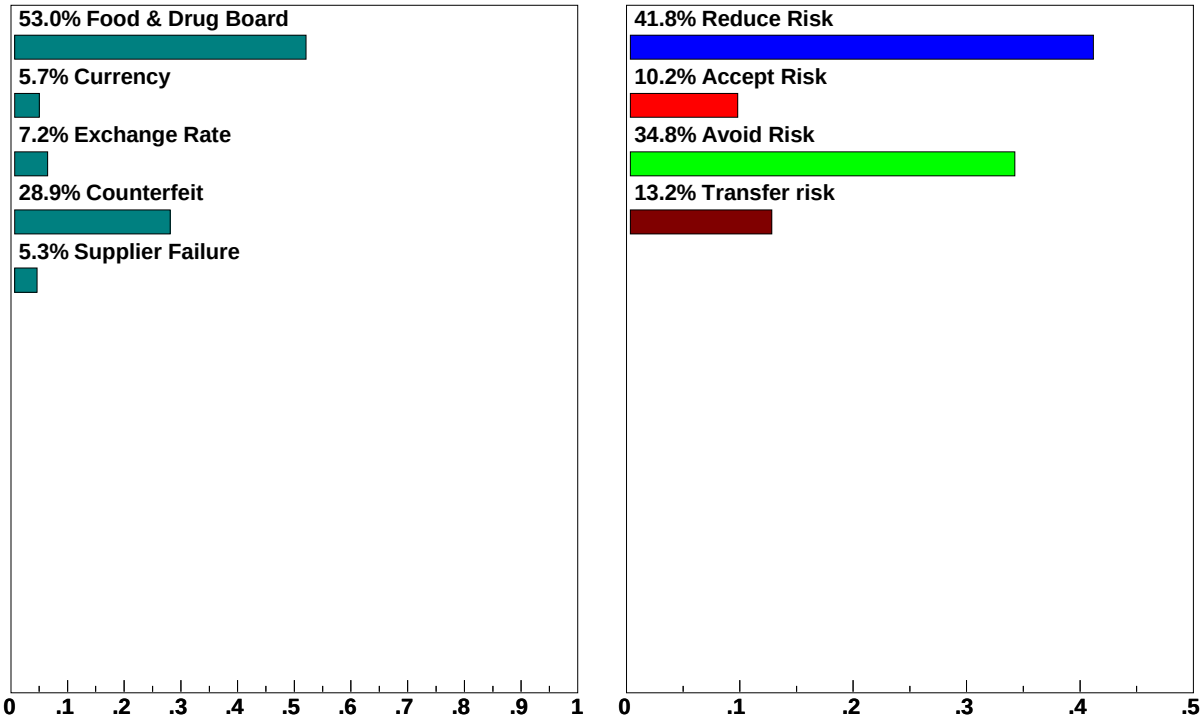

Figure 3. Scenario 1- Dynamic Sensitivity of Analysis for FDB Risk

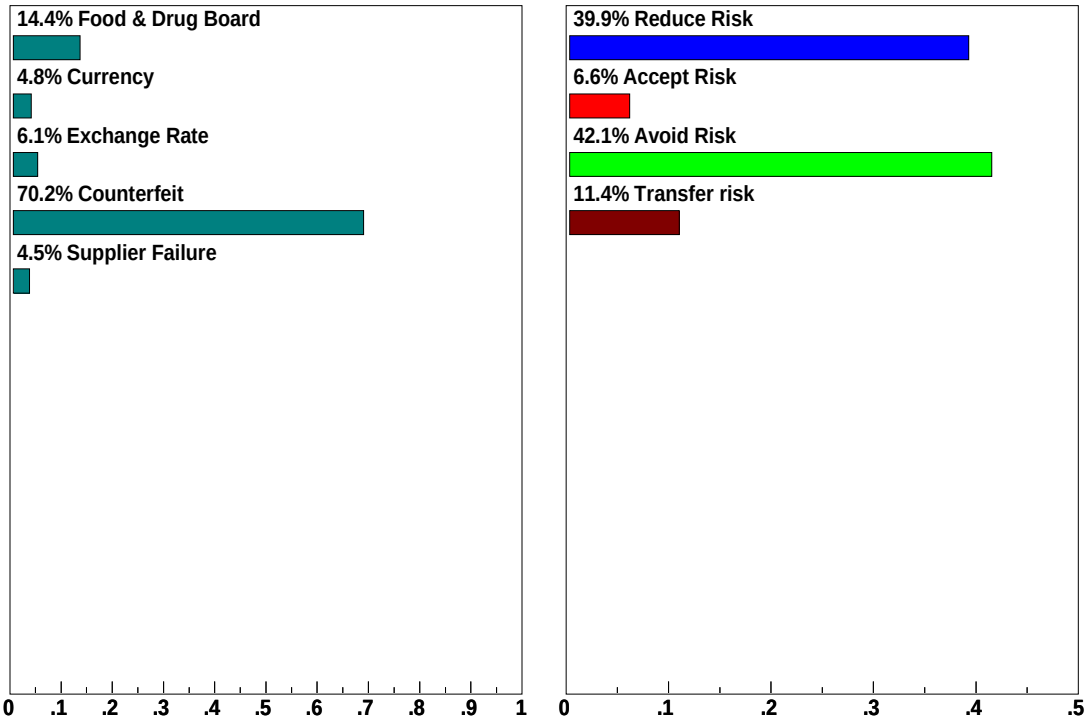

Figure 4. Scenario 2 -Dynamic Sensitivity Analysis for Counterfeit Risk

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

Risk is the quintessential of doing business. However, given the spate in global supply chain risk, risk management has been catapulted to the top of many organizations' agendas. Because risk management can mean the difference between success and failure, it deserves the undivided focus of any organization. The Ghanaian pharmaceutical industry can benefit from risk management. Pharmaceutical manufacturing supply chain operations which are global in nature encompasses relay of entities that are geographically dispersed across different countries and cultures. Pharmaceutical supply chain risks are risks due to deviations in the physical and information flows of drugs from the upstream to the downstream. Improved knowledge of the existence of pharmaceutical supply chain risks and their sources can enable decision makers position appropriate mitigation treatments for the identified risk portfolio. Indeed, supply chain managers must be able to understand pharmaceutical risk portfolio completely in order to handle or prevent them. Although pharmaceutical supply chains worldwide more than ever are facing growing number of risks, counterfeit risk has become more prevalent. The World Health Organization reports that 10 percent of all drugs distributed worldwide are counterfeit. Most importantly, the number catapults as high as 60 percent in developing countries. For example, Ghanaian pharmaceutical firms import 70% of their pharmaceuticals from China and India that are notoriously known for counterfeit drugs (Harper and Gyansa-Lutterodt, 2007).

REFERENCES

Atthirawong, W. and MacCarthy, B. (2005). "An Application of the Analytic Hierarchy Process to International Location Decision-Making." Proceedings of the 7th Cambridge Research Symposium on International Manufacturing, www.ifm.eng.cam.ac.uk/cim/imnet/symposium2002/papers/Atthirawong.pdf.

Bandyopadhyay, K., Mykytyn, P. and Mykytyn, K. (1999). "A framework for Integrated Risk Management in Information Technology." Management Decision, 37(5)437-455.

Barry, J. (2004). Supply Chain Risk in an Uncertain Global Supply Chain Environment. International Journal of Physical Distribution & Logistics Management, 34(9)695-697.

Breen, L. (2008). "A Preliminary Examination of Risk in the Pharmaceutical Supply Chain (PSC) in the National Health Service (NHS) (UK)." Journal of Service Science & Management 1, 193-199.

Buehler, K.S. and Pritsch, G. (2003). "Running with Risk." The McKinsey Quarterly, 4, 40-49.

Dyer, R.F. and Forman, E.H. (1991). An Analytic Approach to Marketing Decisions, Prentice Hall, Englewood Cliffs.

Cavinato, J.L. (2004). "Supply Chain Logistics Risks: From the Back Room to the Board Room." International Journal of Physical Distribution & Logistics Management, 34 (5)383-387.

Chan, C. K., Seow, S. G. and Tam, K. (2002). "Foreign Exchange Risk and Firm Value: An Analysis of US Pharmaceutical Firms." Managerial Finance, 28(3)52-72.

Christopher, M. and Lee, H. (2004). "Mitigating Supply Chain Risk through Improved Confidence." International Journal of Physical Distribution & Logistics Management, 34 (5)388.396.

Enyinda, C. I., Briggs, C., and Bachkar, K. (2009). "Managing Risk in Pharmaceutical Global Supply Chain Outsourcing: Applying Analytic Hierarchy Process Model." Paper Presented at the American Society of Business and Behavioral Sciences, Las Vegas, ND, February 19-22.

Enyinda, C. I. (2008). Modeling Risk Management in the Pharmaceutical Industry Global Supply Chain Logistics using Analytic Hierarchy Process Model. Ph.D. Dissertation, North Dakota State University

Enyinda, C. I., Ogbuehi, A. and Briggs, C. (2008). "Global Supply Chain Risks Management: A New Battleground for Gaining Competitive Advantage." In Proceedings of American Society of Business and Behavioral Sciences, 15(1)278-292.

Enyinda, C. I, and Tolliver, D. (2007). "Taking Counterfeit Drugs out of the Pharmaceutical Supply Chain Logistics Network in Sub-Saharan Africa: Evidence from Nigeria and Multilayered

Mitigation Approach" In Proceedings of 2007 the International Academy of African Business and Development

Enyinda, C. I. and Szmerekovsky, J. (2007). "Sense and Respond Logistics Model: A Prescription for Mitigating the U.S. Pharmaceutical Supply chain Vulnerabilities and the Risk of Counterfeit Drug." In Proceedings of 2007 the International Academy of Business and Public Administration Disciplines.

Haimes, Y. (1998). Risk Modeling, Assessment and Management. John Wiley and Sons, Inc., New York.

Harland, C., Brenchley, R. and Walker, H. (2003). "Risk in Supply Networks." Journal of Purchasing and Supply Management, 9(1)51-62.

Hallikas, J. Virolainen, V. and Tuominen, M. (2002). "Risk Analysis and Assessment in Network Environments: A Dyadic Case Study." International Journal of Production Economics, 78(1), 45-55.

Harper, J. and Gyansa-Lutterodt, M. (2007). "The Viability of Pharmaceutical Manufacturing in Ghana: Addressing Priority Endemic Disease." Regional Workshop on Pharmaceutical Production in West and Central Africa, 24th October.

Hendricks, K. B. and Singhal, V. R. (2005, Spring). "An Empirical Analysis of the Effect of Supply chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm." Production and Operations Management, 14(1)35-52.

Holton, G. A. (2004). "Defining Risk." Financial Analysts Journal, 60(6)19-25.

Keltz, H. and Hillman, M. (2007). Managing Risk in the Supply Chain – A Quantitative Study. AMR Research, Inc.

Kleindorfer, P.R. and Saad, G. H. (2005, Spring). "Managing Disruption Risks in Supply Chains." Production and Operations Management, 14(1)53-68.

Kleindorfer, P. R. (2000). "Industrial Ecology and Risk Analysis." Retrieved September 18, 2006, from http://grace.wharton.upenn.edu/risk/downloads/01-25-pk.pdf.

KPMG. (2005). Risk Management in the Pharmaceutical Industry. Retrieved February 10

2009, fromhttp://www.worldcongress.com/events/nw700/pdf/thoughtLeadership/KPMG-Pressure-Points-Web.pdf

Kuhn, G. (2008). "Risk Quantification." Protiviti Independent Risk Consulting, 1-18.

Lee, H. L, Padmanabhan, V. and Wang, Seungjin (1997). "The Bullwhip Effect in Supply Chains." Sloan Management Review 38(3)93-102.

Lee, E.-K., Ha, S. and Kim, S-K. (2001, August). "Supplier Selection and Management System Considering Relationships in Supply Chain Management." IEEE Transactions on Engineering Management, 48(3)307-318.

Lowrence, W. W. (1976). Of Acceptable Risk. William Kauffman, Inc., Los Altos, CA.

March, J. and Shapira, Z. (1987). "Managerial Perspectives on Risk and Risk Taking." Management Science, 33(11)1404-1418.

Miller, J. (2000). Millennium Intelligence, Medford, NJ: Cyber Age Books.

Min, H. and Zhou, G. (2002). Supply Chain Modeling: Past, Present and Future. Computers and Industrial Engineering, 43, 231-249.

Ross, M.E. and Nydick, R.L. (1994). Structuring the Selection Process of Licensing Candidates in the Pharmaceutical Industry Using the Analytic Hierarchy Process. Journal of Pharmaceutical

Marketing and Management, 8(1)21-36.

O'Brien, P. and Joyce, G. (2007). Risk manage: Supply Chain Risk – Are You the Weakest Link? LinkResQ Ltd, pp. 1-6

Saaty, T. L. and Vargas, L. G. (1994). Decision Making in Economic, Political, Social and Technological Environments with the Analytic Hierarchy Process. RWS Publications: Pittsburg, PA.

Saaty, T.L. (1980). The Analytic Hierarchy Process. New York: McGraw-Hall.

Spekman, R. E. and Davis, E. W. (2004). "Risky Business: Expanding the Discussion on Risk and the Extended Enterprise." International Journal of Physical Distribution and Logistics Management, 34(5) 414-433.

Srividhya, V. S. and Jayaranman, R. (2007). "Management of Supplier Risks in Global Supply Chains." Infosys, 5(3) (July-September), pp. 1-12.

Towill, D. R. (2005). The Impact of Business Policy on Bullwhip Induced Risk in Supply Chain Management. International Journal of Physical Distribution & Logistics Management, 35(8)555-575.

World Health Organization (1998) Report of the International Workshop on Counterfeit Drugs. WHO/DRS/CFD/98.1. Geneva: World Health Organization.

Zsidisin, G.A., Ellram, L.M., Carter, J.R. and Cavinato, J.L. (2004). "Analysis of Supply Risk Assessment Techniques." International Journal of Physical Distribution & Logistics Management, 34(5)97-413.