Online ISSN : 2249-4596
Print ISSN : 0975-5861

Global Journal of Researches in Engineering: G

Industrial Engineering

Highlights

- Managing and Controlling
- Management in Supply Chain
- Investigation of Sigma
- Disasters on Passenger Vessels

Discovering Thoughts, Inventing Future

VOLUME 14 ISSUE 2 VERSION 1.0

Global Journal of Researches in Engineering: G
Industrial Engineering

Global Journal of Researches in Engineering: G
Industrial Engineering

Volume 14 Issue 2 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals Headquarters
301st Edgewater Place Suite, 100 Edgewater Dr.-Pl,
Wakefield MASSACHUSETTS, Pin: 01880,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Integrated Editorial Board
(Computer Science, Engineering, Medical, Management, Natural Science, Social Science)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Contents of the Volume

Global Journal of Researches in Engineering: G
Industrial Engineering
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

A Model for Managing and Controlling the Inventory of Stores Items based on ABC Analysis

By M. Karthick, S. Karthikeyan & M.C. Pravin
Thiagarajar College of Engineering, India

Abstract- Today, the effective inventory management plays an important role in the success of the organizations in the new business environment. It is not clearly possible for the organizations that store hundreds of inventory items to economically design an inventory management policy for each inventory item separately. To have an efficient control of a huge amount of inventory items, traditional approach is to classify the inventory into different groups. Different inventory control policies can then applied to different groups. The well-known ABC classification is simple to understand and easy to use. Moreover, various inventory items may play quite different roles in the business of the organization. Hence, the managers need to classify these items in order to control each inventory category properly based on its importance rating. In this thesis we consider a model of college hostel mess stores items (grocery and vegetables) for inventory management through ABC analysis. This research is composed of the following sections: In the first section, the criteria affecting the evaluation of the inventory control system of the studied mess stores and the priority of each one of them will be identified, in the second section, the priority of each criterion such as cost of item, annual demand for an each item hence find annual consumption cost in each inventory category (A, B, C) is Calculated based on conventional model, in the third section, presents an alternative way of classifying the different productive items of accompanies and this ABC model compares with the classic Pareto classification, which ranks productive items according to their importance in terms of frequency and costs whereas rankings obtained using the classical method are based on information about costs and demand over a period in the past "A-items" that result from this new classification.

Keywords: ABC classification, inventory control, pareto classification.

GJRE-G Classification : FOR Code: 290502p

AMODELFORMANAGINGANDCONTROLLINGTHEINVENTORYOFSTORESITEMSBASEDONABCANALYSIS

A Model for Managing and Controlling the Inventory of Stores Items based on ABC Analysis

M. Karthick [α], S. Karthikeyan [σ] & M.C. Pravin [ρ]

Abstract- Today, the effective inventory management plays an important role in the success of the organizations in the new business environment. It is not clearly possible for the organizations that store hundreds of inventory items to economically design an inventory management policy for each inventory item separately. To have an efficient control of a huge amount of inventory items, traditional approach is to classify the inventory into different groups. Different inventory control policies can then applied to different groups. The well-known ABC classification is simple to understand and easy to use. Moreover, various inventory items may play quite different roles in the business of the organization. Hence, the managers need to classify these items in order to control each inventory category properly based on its importance rating. In this thesis we consider a model of college hostel mess stores items (grocery and vegetables) for inventory management through ABC analysis. This research is composed of the following sections: In the first section, the criteria affecting the evaluation of the inventory control system of the studied mess stores and the priority of each one of them will be identified, in the second section, the priority of each criterion such as cost of item, annual demand for an each item hence find annual consumption cost in each inventory category (A, B, C) is Calculated based on conventional model, in the third section, presents an alternative way of classifying the different productive items of accompanies and this ABC model compares with the classic Pareto classification, which ranks productive items according to their importance in terms of frequency and costs whereas rankings obtained using the classical method are based on information about costs and demand over a period in the past "A-items" that result from this new classification.

Keywords: ABC classification, inventory control, pareto classification.

I. Introduction

Given that at present, all the organizations maintain thousands different types of inventory, it is likely to lose the effective inventory management. Therefore, it is particularly important for all the organizations to establish the appropriate inventory control systems or to evaluate and improve the existing inventory control systems. Because on the one hand, the organization encounters the inventory-related costs, including Cost of Holding, Cost of Ordering, Cost of Shortage the increase of each one due to the lack of a suitable inventory control system will have negative effects on the profitability of the organization. On the other hand, since the number of inventory items is largely increasing due to the increase of the customers' demands for different products, the organizations should have a quick and effective response to the customers' demands to survive and maintain their competitive advantage. The establishment or improvement of an appropriate inventory control system can lead the organization in this path. Considering that today, the organizations save a large percentage of their total investment in the inventories, it has become of a special importance to all organizations to properly manage the inventory and establish a proper inventory control system. According to what was mentioned, all the organizations need an appropriate inventory control and planning system in order to effectively manage their resources and inventories. Therefore, in order to create a perfect inventory control system, various inventory items should be classified into the significant categories based on appropriate criteria and standards. Various models and methods have been so far presented to classify inventory among which, ABC analysis approach is one of the most common methods which is widely used for planning and inventory control (Kilgour & et al 2006). Inventory classification based on ABC analysis allows the organization to classify its inventory into the significant categories. Generally, the above approach has been formed based on the Pareto Principle which is also known as "20-80" law. Regarding the organizations' inventory, this principle will be expressed as follows: In the manufacturing organizations, there are only a few inventories which mostly contribute to the cost of the annual consumption of the organization's inventory system and there are only anew inventories which a little contribute to the dollar value of the annual consumption of the inventory system. Given that the primary purpose of the inventory classification based on this approach is to create appropriate control levels for each inventory category, this question will be raised that whether the inventory classification based on single criterion ABC

Author α: PG scholar, Department of Mechanical Engineering, Thiagarajar College of Engineering Madurai, India.
e-mail: msv.karthiktce@gmail.com
Author σ: Assistant Professor, Department of Mechanical Engineering, Thiagarajar College of Engineering Madurai, India.
e-mail: skrmech@gmail.com
Author ρ: Research scholar, Department of Mechanical Engineering, Thiagarajar College of Engineering Madurai, India.
e-mail: mc.pravin@gmail.com

analysis will be able to meet all the needs of the organization's inventory control system. As a result, the organizations can apply proper control policies by identifying the most effective criteria in their inventory classification. This study has also tried to present proposed ABC model for the hostel mess stores, in order to evaluate the inventory control system of the studied in that. For this purpose, first, the criteria affecting the evaluation of the inventory control system, classification of inventory and the priority of each One of the criteria in the studied mess stores and the priority of each one of the criteria in each inventory category (A, B, C) have been identified and model will be proposed.

II. Literature Review

a) In 1987, an article was presented entitled "The application of multiple criteria ABC analysis" in which the results of the use of multiple criteria ABC analysis have been provided to classify the storage inventory. The studies conducted in this paper show that the managers can use both "cost criteria" and "non-cost criteria" in the classification of warehouse inventory and formulate specific policies by using different criteria to manage warehouse inventory.

b) In 2008, an article was presented entitled "Particle Swarm Optimization "in order to classify the inventory in which an optimization approach is proposed regarding the inventory classification problems at the conditions when inventory items should be classified based on a target or multiple targets, such as minimizing annual consumption costs, maximizing the rate of inventory turnover.

c) In 2007, an article was presented entitled "A simple IJISSM, 2012, 1(1):1-13 classification for multiple criteria ABC analysis". In this paper a simple model is proposed for multiple criteria classification of the inventory. In fact, this model covers the criteria of all the criteria in a single criterion. The study conducted in this paper shows that by appropriate conversion of the scale model of different criteria of the inventory classification, the organizations can reach some criteria of the inventory items without need for linear optimization. The model presented in this paper can be widely used by the organizations with minimum experience in the optimization. The criteria reviewed in this article include: the dollar value of the annual consumption, the average cost of each unit, and lead time.

d) In 2006, an article was presented entitled "the inventory classification based on multi criteria ABC using weighted linear optimization.

e) In 2010, an article was presented entitled "The use of techniques based on the artificial intelligence for multiple criteria ABC analysis" by" Maine-Chun-Yu". In this paper, a study has been conducted to compare the classification techniques based on artificial intelligence and traditional classification techniques (MDA).

f) In 2010, an article was presented entitled "Fuzzy AHP-DEA approach for inventory classification based on multiple criteria ABC approach". In this article, two approaches of Data envelopment Analysis and fuzzy analytic hierarchy process are combined for multiple criteria ABC classification of inventory.

g) In 2008, an article was presented entitled "The inventory control by combining ABC approach and fuzzy classification". The purpose of this study is to provide a new approach on the inventory control called "ABC fuzzy classification".

h) In 2004, an article was presented entitled "multi criteria classification approach to manage the spare parts inventory". In this article, the best strategy has been reviewed to manage inventory in each category (A, B, C) (Braglia & et al, 2004).

III. Problem Environment

A study is conducting in TCE men's hostel for my thesis. In TCE mans hostel there are two stores are available. One is for variety mess store and another one is for value mess store. Totally 550 students are in value mess and 650 students in variety mess. Here I identified the problem in inventory in both stores. Due to incorrect optimal order quantity and insufficient forecasting the more inventories_held in both mess. In the mess stores they used previous experience for order the items. They did not use any formulation or techniques such as P MODEL, Q MODEL system for find the optimal order quantity. So that only inventory problem arises there. So here in my thesis I will use both the system and find EOQ for all items thereby reduce the inventory level and reducing annual consumption cost of mess stores. In order to find the EOQ, it is very important to know about that are the various items affecting the inventory cost in stores. So ABC analysis is requiring knowing about the inventory affecting items. Form the ABC analysis we have easily know the items which are contribute in inventory, only the A types item. So, in this paper presents only the ABC classification of stores items (grocery & vegetables) of hostel mess stores.

IV. Proposed Model

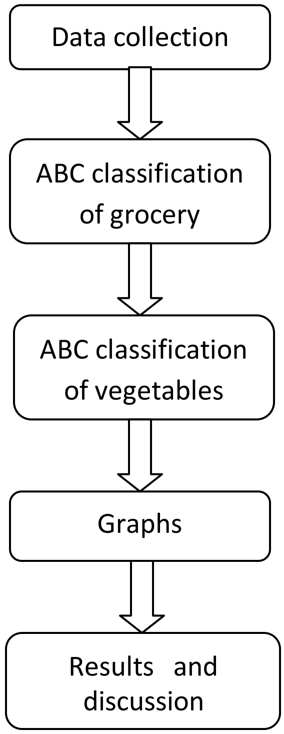


Figure 4 : Proposed model for ABC analysis

In this proposed methodology the various data's such as unit price of an item, annual demand of an item were collected from mess stores and based on this data, grocery and vegetables were segregated for doing the ABC analysis of an each and individual items.

V. Results and Discussions

a) ABC Model

Price/unit= P, Unit/year= U

Annual consumption cost (A) = P*U

Cumulative values of Annual consumption Cost C1= A1, C2=A2+A1, C3=A3+A2+A1 etc.

For grocery

Table 5.1 : ABC analysis for grocery

Sl.No	Description	Price/unit (Rs.)	Unit/year (kg)	Annual consumption Rs./year	Cumulative values of Annual Consumption(Rs.)	Classification
24	Peanut oil	85.9	15600	134004	1340040	A
1	Rice(Ponni)	34.6	21600	747360	2087400	A
2	Idly rice	28	14400	403200	2490600	A
35	Ghee	370	1080	399600	2890200	A
8	Black gram	62.9	4800	301920	3192120	A
28	Wheat flour	34.7	7200	249840	3441960	A
26	Papadam	100	2400	240000	3681960	A
54	Garlic	119	1800	214200	3896160	A
5	Red gram	64.6	3240	209304	4105464	A
6	Green gram	71.9	2880	207072	4312536	A
4	Basmati rice	84.75	2440	206790	4519326	A
21	Fried gram	53.5	3600	192600	4711926	A
25	Sesame oil	258	720	185760	4897686	A
41	Boost	334	540	180360	5078046	B
42	Bounvita	330	540	178200	5256246	B
37	Prunes	408	360	146880	5403126	B
48	Vermicelli	54	2440	131760	5534886	B
20	Asafoetida	600	180	108000	5642886	B
36	Cardamoms	599	180	107820	5750706	B
27	Maida flour	35.5	3000	106500	5857206	B
39	Tea powder	290	360	104400	5961606	B
51	Ground nut	82	1200	98400	6060006	B

29	Rolong Semolia	38.5	2400	92400	6152406	B
44	Sambar powder	154	540	83160	6235566	B
32	Sago	69	1200	82800	6318366	B
11	Tamarind	110.9	720	79848	6398214	B
34	Jaggery	60	1200	72000	6470214	B
45	Idly powder	170	420	71400	6541614	B
16	Pepper	569	120	68280	6609894	B
30	Peanut flour	55	1200	66000	6675894	B
49	Butter	273	240	65520	6741414	C
33	Millets	54	1200	64800	6806214	C
55	Dal powder	165	360	59400	6865614	C
46	Cowpea	49	300	14700	7353384	C
38	Raisins	110	120	13200	7366584	C
47	White raw rice flour	34	360	12240	7378824	C
56	Flattered rice	39	300	11700	7390524	C
17	Aniseeds	93	120	11160	7401684	C
18	Salt	3	3600	10800	7412484	C
43	Porco roso	30	360	10800	7423284	C
53	Caraway	880	12	10560	7433844	C
15	Fenugreek	41	120	4920	7438764	C
52	Cinnamon	160	12	1920	7440684	C
				Total	7440684	

From this ABC analysis of grocery items A type items have more annual consumption costs. So here 13 items have classified under A category out of 57 items.

For Vegetables

Table 5.2 : ABC analysis of vegetables

Sl.No	Description	Price/unit (Rs.)	Unit(kg)/year	Annual consumption Rs./year	Cumulative Value of Annual Consumption(Rs.)	Type
1	Onion	19	30000	570000	570000	A
3	Tomato	13	10800	140400	710400	A
4	Potato	23	6000	138000	848400	A
20	Cauli flower	24	2600	62400	910800	A
25	Amaranth	19	3000	57000	967800	B
2	Shallot	38	1200	45600	1013400	B
28	Drumstick	60	720	43200	1056600	B
8	Ladies finger	15	2400	36000	1092600	B
19	Beans	19	1800	34200	1126800	B
7	Brinjal	13	2440	31720	1158520	B
10	Cabbage	10	2400	24000	1182520	B
9	Green chilli	20	1080	21600	1204120	B
17	Ginger	54	360	19440	1223560	B
27	Panner	25	720	18000	1241560	C
12	carrot	16	960	15360	1256920	C
15	Coriander leaves	20	720	14400	1271320	C
26	Mushroom	20	720	14400	1285720	C

14	curry leaf	30	360	10800	1296520	C
11	Raw mango	25	360	9000	1305520	C
22	Broad beans	25	360	9000	1314520	C
18	Turnip	11	720	7920	1322440	C
21	Bitter guard	15	480	7200	1329640	C
24	Capsicum	30	240	7200	1336840	C
5	Yam	27	240	6480	1343320	C
23	Radish	11	480	5280	1348600	C
16	Peppermint leaves	20	180	3600	1352200	C
13	Beet root	10	240	2400	1354600	C
			Total	1354600		
			A(70%)	948220		
			B(20%)	1219140		

From this ABC analysis of vegetables items A type items have more annual consumption costs. So here 4 items have classified under A category out of 28 items.

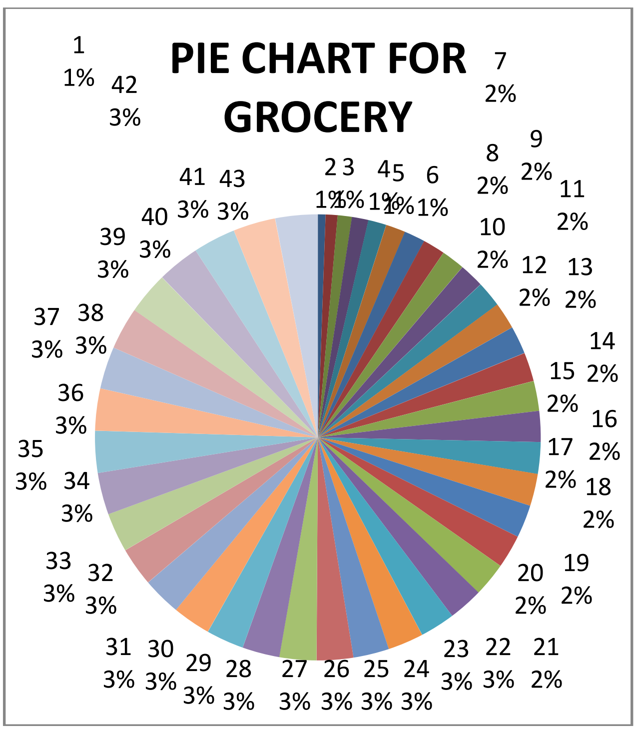


Figure 6.1 : Pie Chart

From the pie chart we clearly know 13 items have classified under A category out of 57 item and of grocery items of mess stores.

6.2. Pie Chart for Vegetables

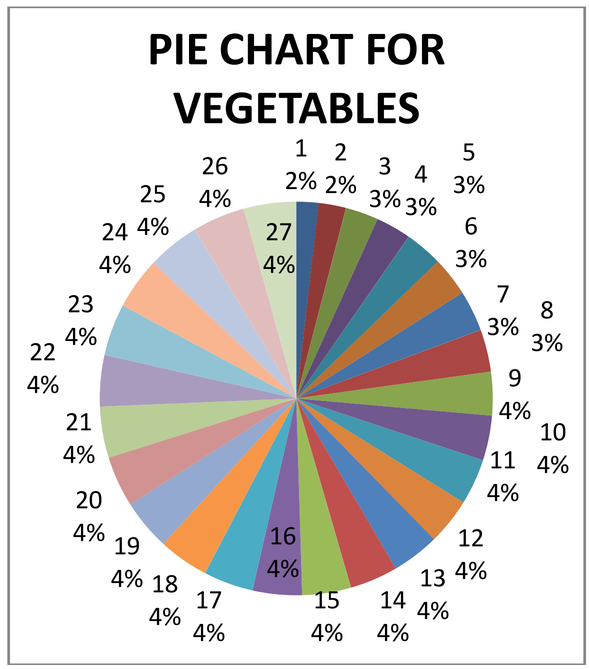


Figure 6.2 : Pie Chart

VI. Conclusion

In this study, the indices affecting the evaluation and control of the inventory control system of TCE men's hostel stores. the results of ABC classification that these criterions of "the required accuracy in ordering" in the inventory category A and the criterion of "the effect of inventory on the process" in the inventory categories B and C have the highest importance. From this ABC analysis of grocery items A type items have more annual consumption costs so here 13 items have classified under A category out of 57 item and of groceries. For vegetables here 4 items have classified under A category out of 28 items and only the A type items have more annual consumption costs and creates more inventory in stores. So Economic Order Quantity and re-order level will be calculated for these A type items hence reduce inventory and annual consumption cost.

References Références Referencias

1. Chakravarty, A. K. 1981. Multi-Item Inventory Aggregation Into Groups, Journal of Operational Research Society, pp. 19–26.
2. Guvenir, H.A. and Erel, E. 1998. Multicriteria Inventory Classification Using a Genetic Algorithm, European Journal of Operational Research, pp. 29–37.
3. Hadi-Vencheh, A. 2010. An Improvement to Multiple Criteria ABC Inventory Classification", European Journal of Operational Research, pp. 962–965.
4. Hadi-vencheh, A., and Mohammad Ghasemi, A., A fuzzy AHP-DEA Approach for Multiple Criteria Inventory Classification, http://ScienceDirect-Expert systems with applications.
5. Liang, G. S. and Liao, C. T. 2008. Controlling Inventory by Combining ABC Analysis and Fuzzy Classification, European Journal of Operational.
6. Partovi, F. Y. and Anandarajan, M. 2002. Classifying Inventory Using an Artificial Neural Network Approach, Computer and Industrial Engineering, pp. 389–404.
7. Yu, M.C. 2010. Multi-Criteria ABC Analysis Using Artificial–Intelligence–Based Classification.
8. M.A. Cohen, R. Ernst, Multi-item classification and generic inventory stock control policies, Production and Inventory Management Journal 29 (1988).
9. R. Ernst, M.A. Cohen, Operations related groups (ORGs): a clustering procedure for production/ inventory systems, Journal of Operations Management, 9, 574-598, (1990).

Global Journal of Researches in Engineering: G
Industrial Engineering
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Maritime Tanker Accident on Coastal Areas in Nigeria

By Julius Okechukwu Anyanwu
Federal University of Technology, Nigeria

Abstract- This study though limited due to poor attitude on the part of the respondents as regards to releasing some data that would have been helpful, was still able to investigate the effect of maritime tanker accidents on coastal areas in Nigeria, with a case study of Bayelsa and Rivers State. Five hypothesis were designed for this study, the study focused on the affect of oil tanker accidents around the Nigeria coastal environment (Bayelsa and Rivers State). With emphasis on the scope of work essentially, data were collected through the administration of questionnaires to the selected people connected with tanker and environmental industry in Nigeria. The analysis of the collected data was carried out with a descriptive statistical tool like the simple percentage and pie charts which hypothesis specified were tested using chi-squares test statistical tool. Result obtained shows that the major cause of marine tankers accident in Nigeria is as a result of human factor errors and this human error has greatly led to the negative effects, the tanker accidents have posed in the coastal environment (Bayelsa and Rivers State) in Nigeria. The safety practical level of the tanker industry in Nigeria had lowered drastically which for the need for proper training and certification of Nigeria oil tanker operators the level of emergence response is relatively poor as compared to other nations with massive oil maritime transport activities. Finally, the Nigerian government should fully empower and support the maritime agencies in checkmating cases of maritime pollution and environment depredation and not boycott corners process thereby sacrificing the standards for effective and efficient maritime operations in Nigeria. Recommendation were made towards the elimination of tanker accidents and the enhancement of the Nigerian coastal environment, which needed government to formulate and promulgate laws which have stringent penalties for violators of the Pollution Act. Also national authorities through the local authorities should create awareness by enlightening and sensitizing the public about their responsibility to the environment.

Keywords: accident, crude oil, maritime tanker, coastal water, pollution, safety.

GJRE-G Classification : FOR Code: 091199, 120305

MARITIMETANKERACCIDENTONCOASTALAREASINNIGERIA

Strictly as per the compliance and regulations of:

Maritime Tanker Accident on Coastal Areas in Nigeria

Julius Okechukwu Anyanwu

Abstract- This study though limited due to poor attitude on the part of the respondents as regards to releasing some data that would have been helpful, was still able to investigate the effect of maritime tanker accidents on coastal areas in Nigeria, with a case study of Bayelsa and Rivers State. Five hypothesis were designed for this study, the study focused on the affect of oil tanker accidents around the Nigeria coastal environment (Bayelsa and Rivers State). With emphasis on the scope of work essentially, data were collected through the administration of questionnaires to the selected people connected with tanker and environmental industry in Nigeria. The analysis of the collected data was carried out with a descriptive statistical tool like the simple percentage and pie charts which hypothesis specified were tested using chi-squares test statistical tool. Result obtained shows that the major cause of marine tankers accident in Nigeria is as a result of human factor errors and this human error has greatly led to the negative effects, the tanker accidents have posed in the coastal environment (Bayelsa and Rivers State) in Nigeria. The safety practical level of the tanker industry in Nigeria had lowered drastically which for the need for proper training and certification of Nigeria oil tanker operators the level of emergence response is relatively poor as compared to other nations with massive oil maritime transport activities. Finally, the Nigerian government should fully empower and support the maritime agencies in checkmating cases of maritime pollution and environment depredation and not boycott corners process thereby sacrificing the standards for effective and efficient maritime operations in Nigeria. Recommendation were made towards the elimination of tanker accidents and the enhancement of the Nigerian coastal environment, which needed government to formulate and promulgate laws which have stringent penalties for violators of the Pollution Act. Also national authorities through the local authorities should create awareness by enlightening and sensitizing the public about their responsibility to the environment.

Keywords: accident, crude oil, maritime tanker, coastal water, pollution, safety.

I. Introduction

In recent time, looking at accidents without the marine industry clearly indicates an alarming increase. Severe accidents causing extensive loss of lives and pollution have been too frequent during the last decades. Some accidents have had high impact on the society and public at large and had triggered international regulations and conventions as well as national requirements which consequences are not totally foreseeable. In 1956, Shell British Petroleum (now Royal Dutch Shell) discovered crude oil at Oloibiri, a village in the Niger Delta, and commercial production began in 1958. Today, there are 606 oil fields in the Niger Delta, of which 360 are on-shore and 246 off-shore. (Nigeria Country Analysis Brief, 2005). Nigeria is now the largest oil producer in Africa and the sixth largest in the world, averaging 2.7 million barrels per day (bbl/d) in 2006.

Nigeria's economy is heavily dependent on earnings from the oil sector, which provides 20% of GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues (CIA World Fact Book, 2005). Nigeria's state-held refineries (Port Harcourt I and II, Warri, and Kaduna) have a combined capacity of 438,750 bbl/d, but problems including sabotage, fire, poor management and lack of regular maintenance contribute to a low current capacity of around 214,000 bbl/d, according to World Markets Research Center. Plans for several small, independently owned refineries are also being developed, with the Nigerian government planning for three new refineries to come on stream by 2008. (Nigeria Country Analysis Brief, 2005).

II. Problem Statement

a) *Oil Spill in Nigeria*

Oil Spill Incidents in Nigeria have occurred in various parts and at different times along our coast. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's Forcados Terminal tank failure in 1978 of about580,000 barrels and Texaco Funiwa-5 blow out in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicized of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well-blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005).

According to the Department of Petroleum Resources (DPR), between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately

Author: Department of Maritime Management Technology, Federal University of Technology, Owerri. e-mail: okey_god2002@yahoo.com

2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1,820,410.5 barrels (77%) were lost to the environment. A total of 549,060 barrels of oil representing 23.17% of the total oil spilt into the environment was recovered. The heaviest recorded spill so far occurred in 1979 and 1980 with a net volume of 694,117.13 barrels and 600,511.02 barrels respectively.

Available records for the period of 1976 to 1996 indicate that approximately 6%, 25%, and 69% respectively, of total oil spilled in the Niger Delta area, were in land, swamp and offshore environments. Also, between 1997 and 2001, Nigeria recorded a total number of 2,097 oil spill incidents.

Thousands of barrels of oil have been spilled into the environment through our oil pipelines and tanks in the country. This spillage is as a result of our lack of regular maintenance of the pipelines and storage tanks. Some of these facilities have been in use for decades without replacement. About 40,000 barrels of oil spilled into the environment through the offshore pipeline in Idoho. Sabotage is another major cause of oil spillage in the country. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and destroy oil pipelines in their effort to steal oil from them. SPDC claimed in 1996 that sabotage accounted for more than 60 percent of all oil spilled at its facilities in Nigeria, stating that the percentage has increased over the years both because the number of sabotage incidents has increased and because spills due to corrosion have decreased with programs to replace oil pipelines (SPDC, 1996).

Pirates are stealing Nigeria's crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market. Nigeria lost about N7.7 billion in 2002 as a result of vandalisation of pipelines carrying petroleum products. The amount, according to the PPMC, a subsidiary of NNPC, represents the estimated value of the products lost in the process.

Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosions in recent years. In July 2000, a pipeline explosion outside the city of Warri caused the death of 250 people. An explosion in Lagos in December 2000 killed at least 60 people. The NNPC reported 800 cases of pipeline vandalization from January through October 2000. In January 2001, Nigeria lost about $4 billion in oil revenues in 2000 due to the activities of vandals on our oil installations. The government estimates that as much as 300,000 bbl/d of Nigerian crude is illegally bunkered (freighted) out of the country.

In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and inadequate care in loading and unloading oil vessels.

III. Objectives of Study

The objectives of this study are: -

a) To find out the causes of oil tanker accidents in the Nigerian waters.
b) To investigate and examine the impact and implications of such tanker accidents on the environment.
c) To identify the efforts being made by the appropriate authorities to drastically reduce or if possible completely put a stop to tanker accidents leading to water pollution in Nigeria.
d) To identify the contributory roles of both ship owners and the Ship's Crew to these tanker accidents.
e) To assess the level of safety consciousness and preparedness for emergencies among the personnel involved coastal sea operations.

IV. Research Questions

Below are the research questions for this research work.

- What are the causes of oil tanker accidents in Nigeria?
- What are the impacts of oil tanker accidents on the Maritime environment?
- What the relevant authorities in the maritime industry contributing to the prevention of oil tanker accidents and their resultant environmental hazards?
- Is the current increase of tanker accidents rate and environmental pollution, a management, human or technical problem?
- What is the current level of emergency preparedness relating to the protection of our environment in Nigeria?

a) Hypothesis

$H0_1$: That oil tanker accident does have adverse effect around the Nigerian coastal environment.

$H0_2$: That the level of safety practices in the oil tanker industry in Nigeria had been lowered.

$H0_3$: That the current level of emergency preparedness in Nigeria is relatively low.

$H0_4$: That oil tanker accident has adverse effect on other section of the national economy.

$H0_5$: That poor national economy is a contributory factor to the problem of environment degradation in Nigeria.

b) Review of Related Literature Review

Moffat and Linden (1995) stated that "according to the official estimates of the Nigerian National Petroleum Corporation (NNPC), a total of approximately 23,000m3 of oil is spilled in 300 separate incidents

Global Journal of Researches in Engineering (G) Volume XIV Issue II Version I Year 2014

annually. However, as the oil and tanker companies frequently underestimate quantity of oil spilled and a large number of other spills go unreported, the total volume of oil spilled may be ten times higher than the official figure". This is pointing to the fact that the actual oil being spilled into the Nigerian maritime environment is far more than what an individual tanker man can estimate, showing that the contributory spills from the tankers and oil companies has far more devastating effects on the maritime environment that what is imagined.

Marton (1982), an American author pointed out the fact that "some tankers, old and rusty, are relics of bygone era, others are so futuristic, so thoroughly automated, that their crew members feel more like astronauts than tanker men. And in all likelihood, the future tanker men will need the training and temperament of an astronaut". This simply reveals the importance of maintenance of tanker and the specialized training of tanker men, which is of high necessity in the tanker industry so as to avoid tanker accidents leading to pollution and environmental degradation. It also shows the presence of some old, rusty and fairly used tankers in the developing nations of the world such as Nigeria.

Okokon (2000) calls for the need to establish a National Transportation Commission charge with the responsibility of transport research and policy question. Regulatory and control functions should also be part of the responsibilities of the so called National Transport Commission.

Ajoku (2001) also stated that "ship-owners or tanker owners must accept change and changing environment of shipping. For Nigeria to effectively take advantage of the PSC (Port State Control) certain IMO (International Maritime Organization) convention must be ratified and fully implemented in Nigeria and other West African sub-region. These include MARPOL 73/78 (International Convention for the Prevention of Pollution from ships, 1973, as modified by the protocol of 1978 relating thereto), the ratification of the convention is an important step in the right direction. Nigeria must take immediate step to demonstrate this convention along with ISM (International Safety Management) code and the STCW '95 (Standards of Training, Certification and Watch keeping for sea fares 1978 as amended in 1995)". The purpose of the ratification and implementation of these conventions in Nigeria is to enhance maritime safety and environmental protection.

Uchegbu (1998) also revealed that oceans are ecosystems, quite susceptible to pollution. They are fragile environments, which are able to measure the detrimental effects of our actions. An ocean is made up of the continental shelf and the deep ocean. Incidentally, it is the continental shelf that is most productive in terms of food supply which also receives the greatest pollution load.

c) Review of Marine Oil Tanker Accidents on the Nigerian Coastal Environment

The Nigerian coastal environment has suffered untold degradation from the activities of tanker men and tanker operations in Nigeria; worst among these activities is the issue of tanker accidents. The rate of tanker accidents is highly determined by the level of safety practices in the carriage of oil by sea, as it is widely believed in the maritime industry that eighty percent of the accidents occurring in the shipping industry are caused by human error while the remaining twenty percent is attributed to technical or equipment failure (Freudendahl 1992).

i. *Human Error*

Accidents do not just happen; they are usually the results of often many contributing elements of which each one certainly is manageable, in other words, they are caused. Examining table 1 in sub-section 2.3.4 of this chapter, which will show the list of oil tanker accidents that, had occurred in Nigeria, it is obvious that all the stated accidents are caused by human error one way or the other. The tanker accidents caused by human error range from poor maintenance and carelessness, to negligence and sometimes lack of experience in one way or the other both on the part of the operators/seafarers on one side and also on the part of the shore-based management team on the other side. Others include lack of effective safety management system between the ship and the shore and lack of adequate motivation for the seafarers. Looking at the nature of accidents in table 1, it could be clearly pointed out that no tanker accident listed was caused by an Act of God. However, within the scope of human error, the causes of accidents in the carriage of, oil in Nigeria could basically be said to be operational error or management/managerial negligence.

ii. *Equipment/Technical Malfunctions*

Although these equipments are usually operated by human beings, yet, their sudden or unexpected failure/malfunction and their consequential effects in the tanker industry cannot be underestimated. Sometimes, some of the accidents in the tanker industry are caused by technical problems which in some cases do occur without any prior warnings, such equipment failure or technical problem include; the failure of navigational equipment, loss of steering system, loss of propeller, pipe burst, hose burst, loss of propulsion power, blackout and so on. Technical problems such as loss of steering system or propeller, pipe burst, hose burst, loss of propulsion power, blackout and so on. Technical problems such as loss of steering system or *d) Environmental Degradation in Nigeria*

Pollution has been defined under S.38 of the Federal Environmental Protection Agency Decree (No. 58 of 1988) as man-made or man-aided alteration of the chemical, physical or biological quality of the environment to the extent that is detrimental to that environment or beyond acceptable limits and pollutant shall be constructed accordingly.

The increasing pressure on the natural environment caused by oil exploitation and transportation, exploited population growth, increasing human needs and demand for survival, poverty, unemployment are the chief causes of environmental degradation in the Nigerian coastal environment. However, this paper will not deal with all the causes of environmental degradation but will focus on environmental degradation resulting from accidents/incidents occurring onboard coastal oil tankers.

e) Oil Companies and the Environment

Oil is one of the very few fossil fuels formed millions of years ago through the decomposition of remains of plant and animal by the anaerobic process. Other fossil fuels are natural gas and coal. As a result of very long time frame required for their formation, they are otherwise classified as non-renewable resources. And because of their origin or sources of formation, they are known to be made up of complex hydrocarbons. The prospecting, exploration, production, transportation and utilization of these hydrocarbons pose severe threat to the environment.

i. *Oil Spill in Nigeria*

According to the official estimates of the Nigerian National Petroleum Corporation (NNPC), a total of approximately 23,000 cubic meter of oil is spilled in 300 separate incidents annually. However, as the oil and tanker companies frequently underestimate quantity of oil spilled and a large number of other spills go unreported, the total volume of oil spilled may be ten times higher than the official figure. Shell figure indicates that, since 1989, there has been 190 oil spills a year in the Nigerian coastal environment. Oil spills in Nigeria have often given rise to degradation of otherwise fertile agricultural lands as well as pollution of sea, streams, creeks, and other water bodies. This has resulted in the death of valuable plant life, animals, fishes and crabs. Each stage of oil production, starting from its exploration through storage, refining, transportation and consumption has effects and there is hardly any doubt that these effects have been devastating especially on the environment, anywhere oil operations are prevalent. For instance, in an effort to avoid environmental degradation, the entire 5000 strong U'wa tribe in Colombia vowed to commit mass suicide by leaping from a cliff unless Occidental de Colombia, a subsidiary of US Company, Occidental Petroleum, abandons its plans to drill for oil on their land in the eastern foothills of the Andes Mountains (Timbiri, 2001).

f) Oil Tanker Accidents in Nigeria

The recent increase in oil tanker accidents in Nigeria together with their associated environmental implications has called for a course for concern. Even though the most worrisome of them all as of now are the global environmental ones. Each particular problem has a linkage effect with another, which tends to exacerbate the effects of others thus creating waves of anxiety, worry and concern for all lovers of the environment. The problems created by oil tanker accidents are threats to both aquatic and terrestrial life and can lead to their extinction. The major environmental problems caused by oil tanker accidents range from pollution of air, water and land to biological losses and atmospheric contamination, these are as a result of accidents such as fire outbreak, collision, explosion, grounding, flooding, sink age and so on. Oil tanker accidents such as fire outbreak and exposure lead to the release of gases such as SO_2, NO_2, H_2S, NH_3 and CO which produce organic acids resulting in acid rain.

g) Environmental Impact of Marine Oil Tanker Accidents

The impact on the environment of oil tanker accidents in Nigeria cannot be overemphasized. The issue of environmental hazards resulting from tanker accidents in mostly and popularly traced to pollution problems caused by accidents such as explosion fire outbreak, collision grounding, sinking, flooding and so on which subsequently lead to economic losses. The pollution phenomenon occurs whenever potentially harmful substances are released into the environment during these accidents, it is usually classed according to the receiving agents of air as emission (e.g. during oil spillage, collision and grounding). And land as dumps (e.g. undissolved spilled oil and permanent grounding). Apart from pollution, wrecked tankers and permanently grounded ones constitute nuisance and obstructions to navigable waters, anchorages, fishing grounds and beaches.

h) Implications of Oil Tanker Accidents and their Environmental Impact on the National Economy

Having examined the various accidents that had occurred in the tanker industry together with their associated negative impact on the Nigerian coastal environment, the following are the implications of these tanker accidents and their environmental impact on the national economy.

i. Pollution from oil spillages spoil beaches and recreation areas, which in turn affect the tourism industry and thereby depriving of the revenue earned.

ii. Pollution from effluent and other discharges released during these accidents destroys and limits the growth of marine life, which in turn affects the marine agricultural industry such as the fishing industry.
iii. It creates bad image, default status and reputation for Nigeria in the international community as relating to the maritime, tourism and environmental sectors of the national economy.
iv. It is a potential source of acid rain thereby inducing accelerated corrosion and/or degradation of materials (e.g. roofing materials, clothing, motor vehicle and other metallic structures) around the Nigerian coastal environment thereby resulting in wastage and the erosion of personal income of the Nigerian population and subsequent effect on the national economy.
v. The pollution caused during these tanker accidents impairs vegetation, crop and soil leading to decreased leaf chlorophyll content, decreased internodes length in some plants and suppressed flowering in others, high percentage loss in crop yield has been observed and in some cases, direct mortality has been reported, this has a great adverse effect on the agricultural industry and subsequently the national economy.
vi. It causes damages to life and property from accidents such as explosion, fire outbreak, flooding and sinking thereby leading to the depletion of the national human and economic resources.
vii. It ruins wildlife-nesting areas along the Nigerian coast, which eventually adversely affects the agricultural sub-sector of the national economy.
viii. It leads to the destruction of nature and the eroding of man's food and economic base.
ix. It contaminates drinking water, which affects the society at large and subsequently the national economy.
x. It leads to the erosion of national funds due to the excessive cost of cleaning up branches for tourism purposes and high cost of treating water so as to make it potable for the society.
xi. It leads to the disruption of ecological balance, which is the primary basis for economic, agricultural, technological and scientific researches, thereby having a consequential effect on the national economy as a whole.
xii. It releases noxious vapour into the atmosphere thereby endangering man's health and other life forms, this adversely affect the productivity of the labour force in which environment and a consequential effect on the national economy.
xiii. All the above stated negative impacts lead to general loss of revenue to individuals and the community, and the erosion of the national economy, which has a resultant effect on the socio-economic life of every Nigerian.

i) Causes of Maritime Tanker Accidents in Nigerian Coastal Bodies

i. *Causes of Oil Spillage*

In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and in adequate care in loading and unloading oil vessels. Thousands of barrel so foil have been let loose in to the environment through our oil pipelines and tanks in the country. This loss is as a result of our lack of regular maintenance of the pipelines and storage tanks. Most pipelines from the flow stations are obsolete. By international standards, oil pipes ought to be replaced after 15 to 20 years, but most pipe lines in use are 20 to 25 years old, making them subject to corrosion and leakage. Some of these pipes are laid above ground level without adequate surveillance, exposing them to wear and tear and other dangers (Oyem, 2001).About 4000 barrels of oil spilled into the environment through the offshore pipeline in Idoho. Sabotage is another major cause of oil spill age in the country. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and destroy oil pipelines in their effort to steal oil from them. Pirates are stealing Nigeria's crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market.

Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosions in recent years. In July 2000, a pipeline explosion outside the city of Warri caused the death of 250 people .An explosion in Lagos in December 2000 killed at least 60 people. The NNPC reported 800 cases of pipe line vandalization from January through October 2000. In January 2001, The Nigeria lost about $4billion in oil revenues in 2000 due to the activities of vandals on our oil installations.

Nigeria lost about N7.7billion in 2002 as a result of vandalisation of pipelines carrying petroleum products. The amount, according to the PPMC, a subsidiary of NNPC, represents the estimated value of the products lost in the process. The Nigerian government and oil companies say up to 15 percent of the country's two million barrels per day oil production is taken illegally taken from pipelines in the NigerDelta and smuggled abroad.

j) Review of Oil Spill Incidents in Nigerian

Oil spill incidents have occurred in various parts and at different times along our coast. According to the Department of Petroleum Resources (DPR), between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1, 820,410.5 barrels (77%) were lost to the environment. Available records for the period 1976 to 1996 indicated that approximately 6%,25%, and 69% respectively, of total oil spilled in the Niger Delta area, were inland, swamp and offshore environments. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's For cados Terminal tank failure in1978of about 580,000 barrels and Texaco Funiwa-5blow out in1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipeline in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels The most publicized of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of ablowout at Funiwa 5 offshore station. The heaviest recorded spill so far occurred in 1979 and 1980 with a net volume of 694,117.13 barrels and 600,511.02 barrels respectively.

k) Impacts of Oil Spillage on the Environment

Little is known about the effects of petroleum pollution on shore line communities (Garrity and Levings, 1990; Mc Guiness1990; Burn set al, 1993; Gesamp, 1993) Major oil spills heavily contaminate marine shore lines, causing severe localised ecological damage to the near-shore community.

Ever since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequences of oil development. The growth of the country's oil industry, combined with a population explosion and a lack of environmental regulations, led to substantial damage to Nigeria's environment, especially in the Niger Delta region, the center of the country's oil industry.

Oil spills pose a major threat to the environment in Nigeria. If not checked or effectively managed, they could lead to total annihilation of the ecosystem, especially in the Niger Delta where oil spills have become prevalent. Life in this region is increasingly becoming unbearable due to the ugly effects of oil spills, and many communities continue to groan under the degrading impact of spills (Oyem, 2001).

In the Nigerian Coastal environment large areas of the mangrove ecosystem have been destroyed. The mangrove was once a source of both fuel woods for the indigenous people and a habitat for the area's biodiversity, but is now unable to survive the oil toxicity of its habitat. The oil spills also had an adverse effect on marine life, which has become contaminated; inturn having negative consequences for human health from consuming contaminated sea food. Oil spill hasal so destroyed farmlands, polluted ground and drinkable water and caused draw backs in fishing off the coastal waters.

Oil spills in the Niger Delta have been a regular occurrence, and the resultant environmental degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. It is only in the past decade that environmental groups, the Nigerian federal government, and the foreign oil companies that extract oil in the Niger Delta have begun to take steps to mitigate the damage. Although the situation is improving with more stringent environmental regulations for the oil industry, marine pollution is still a serious problem.

V. Research Metodology

A sample survey research method was applied to this work. The method is appropriate for the examination of the topic because the sample survey research studies a very small population due to nature of the trade by selecting by selecting and studying samples chosen from the population to discover the relative incidence on the sociological, economical, psychological variables

Table 1 : Analysis of response to Questions

VARIABLES	SAMPLE SIZE	ACTUAL RESPONSE	PERCENTAGE
Does oil tanker accidents do have an adverse effect on the Nigerian coastal environment. Yes No	90	 71 19	 79% 21%
That the level of safety practices in the tanker industry in Nigeria had been lowered. Yes No	90	 80 10	 89% 11%
That the current level of emergency preparedness in Nigeria is relatively low. Yes No	90	 78 12	 87% 13%

That oil tanker accident has adverse effect on other sectors of the national economy Yes No	90	 82 8	 91% 9%
That poor national economy is a contributory factor to the problem of environmental degradation in Nigeria. Yes No	90	 77 13	 86 14
What is the major cause of tanker accidents Human error Mechanical error	90	 88 2	 91 9

Source: field study response.

Test of Hypothesis using the Chi Square Statistics

Hypothesis 1

NULL HYPOTHESIS (H_O)	ALTERNATIVE HYPOTHESIS (H_i)
That oil tanker accidents do have adverse effect on the Nigerian coastal environment	That oil tanker accident does not have adverse effect on the Nigerian coastal environment.

$$\text{Using Chi-Square, } (X^2) = \left\{ \frac{(Fo-Fe)^2}{Fe} \right\}$$

Where: Fo = observed frequency

Fe = expected frequency

{ = Summary

Fo	Fe	Fo-Fe	$(Fo-Fe)^2$	$\frac{(Fo-Fe)^2}{Fe}$
4	4.733	-0.733	0.537	0.113
2	1.267	0.733	0.537	0.424
9	9.467	-0.467	0.218	0.023
3	2.533	0.467	0.218	0.086
25	23.667	-1.333	1.777	0.075
5	6.333	-1.333	1.777	0.281
33	33.133	1.333	0.018	0.001
9	8.867	0.133	0.018	0.002
				1.005

Source: Chi square table

Computed value of X^2

Degree of freedom = (R-1) (c – 1)

= (4-1) (2-1)

= (3) (1) = 3

Degree of Freedom = 3

The table of value X^2 at 0.05 with 3 degree of freedom is 7.815

Interpretation: Since the computed value of X^2 which is 1.005 is less than the table value of X^2 at 0.05 which is 7.815, the hypothesis is within the acceptance region. Therefore, the hypothesis is accepted by the respondents.

Hypothesis 2

NULL HYPOTHESIS (H_O)	ALTERNATIVE HYPOTHESIS (H_i)
That the level of safety practices in the tanker industry in Nigeria has been lowered	That the level of safety practices in the tanker industry in Nigeria had not been lowered.

Fo	Fe	Fo-Fe	$(Fo-Fe)^2$	$\frac{(Fo-Fe)^2}{Fe}$
5	5.333	-0.333	0.111	0.021
1	0.666	0.333	0.111	0.166
9	10.667	-1.666	2.779	0.261
3	1.333	1.667	2.779	2.085
28	26.667	1.333	1.777	0.067
2	3.333	-1.333	1.777	0.533
38	37.333	0.667	0.445	0.012
4	4.667	-0.667	0.445	0.095
				3.24

Calculated value of $X^2 = \frac{(Fo-Fe)^2}{Fe} = 3.24$

Degree of freedom = 3

The table value of X^2 at 0.05 with 3 degree of freedom is 7.815

Interpretation: Since the computed value of X^2 (3.24) is less than the table of value of X^2 (7.815), the hypothesis is therefore accepted by the respondents.

Hypothesis 3

NULL HYPOTHESIS (H_O)	ALTERNATIVE HYPOTHESIS (H_i)
That the level of safety practices in the tanker industry in Nigeria has been lowered	That the level of safety practices in the tanker industry in Nigeria had not been lowered.

Fo	Fe	Fo-Fe	$(Fo-Fe)^2$	$\frac{(Fo-Fe)^2}{Fe}$
5	5.2	-0.2	0.04	0.008
1	0.8	0.2	0.04	0.05
10	10.4	0.4	0.16	0.015
2	1.6	0.4	0.16	0.1
27	26	1	1	0.038
3	4	-1	1	0.25
36	36.4	-0.4	0.16	0.004
6	5.6	0.4	0.16	0.029
				0.494

Calculated value of $X^2 = 0.494$

Degree of freedom = 3

The table value of X^2 at 0.05 with 3 degree of freedom is 7.815

Interpretation: The hypothesis is accepted by the respondents because the calculated value of X^2 which is 0.494 is less than the table value of X^2 which is 7.815.

Hypothesis 4

NULL HYPOTHESIS (H_O)	ALTERNATIVE HYPOTHESIS (H_i)
That oil tanker accident has adverse effect on other sectors of the national economy.	That oil tanker accident does not have adverse effect on other sectors of the national economy.

Fo	Fe	Fo-Fe	$(Fo-Fe)^2$	$\frac{(Fo-Fe)^2}{Fe}$
6	5.467	0.533	0.284	0.052
0	0.533	-0.533	0.284	0.533
11	10.933	0.067	0.004	0.0004
1	1.067	-0.067	0.004	0.0004
26	27.333	-1.333	1.777	0.065
4	2.667	1.333	1.777	0.666
39	38.267	0.733	0.537	0.014
3	3.733	-0.733	0.537	0.143
				1.4774

Calculated value of X^2 = 0.48

Degree of freedom = 3

The table value of X^2 at 0.05 with 3 degree of freedom is 7.815

Interpretation: Since the computed value of X^2 (0.48) is less than the table value of X^2 (7.815), the hypothesis is therefore accepted by the respondents.

Hypothesis 5

NULL HYPOTHESIS (H_O)	ALTERNATIVE HYPOTHESIS (H_i)
That poor national economy is a contributory factor to the problem of environmental degradation in Nigeria.	That poor national economy is not a contributory factor to the problem of environmental degradation in Nigeria.

Fo	Fe	Fo-Fe	$(Fo-Fe)^2$	$\frac{(Fo-Fe)^2}{Fe}$
4	5.133	-1.133	1.284	0.250
2	0.867	1.133	1.284	1.481
9	10.267	-1.267	1.605	0.156
3	1.733	1.267	1.605	0.926
27	25.667	1.333	1.777	0.069
3	4.333	-1.333	1.777	0.410
37	35.933	1.067	1.138	0.032
5	6.067	-1.067	1.138	0.188
				3.512

Calculated value of X^2 = 3.51

Degree of freedom = 3

The table value of X^2 at 0.05 with 3 degree of freedom is 7.815

Interpretation: The hypothesis is accepted by the respondents because the calculated value of X^2 which is 3.51 is less than the table value of X^2 which is 7.815.

VI. Discussion of Findings

Below are the findings from the study carried out during the course of the study.

It was discovered that the major cause of marine tankers accidents in Nigeria is as a result of human factor errors and this human error has greatly led to the negative effects, the tanker accidents have posed in the coastal environment in Nigeria. Water bodies have suffered a great deal of infection that has triggered the death of aquatic organisms, widespread of diseases and reduced food cultivation. The safety practice level of the tanker industry in Nigeria had been lowered drastically which for the need for proper training and certification of Nigeria oil tanker operators. The level of Emergence response is relatively poor as compared to other nations with massive oil maritime transport activities. Tanker operators and the managers have a very important role to play in the safety of their tankers and the protection of the marine environment. Finally, the Nigerian government should fully empower and support the maritime agencies in checkmating cases of maritime pollution and environmental degradation and not boycott corners process thereby sacrificing the standards for effective and efficient maritime operations in Nigeria.

VII. Conclusion

Marine oil tanker accidents in Nigeria had over the years contributed immensely to the degradation of the Nigerian coastal environment, hence, the need to examine and investigate into the causes of these tanker accidents together with the practices and problems associated with them in Nigeria. The chapter one of this research work had so far given a general overview into the introduction to this research project, this includes the focus of the study, purpose of study, research questions, area of study and the significance of study, particular emphasis was laid on subjects such as the review of the impact of marine oil tanker accidents on the Nigerian coastal environment, environmental degradation in Nigeria, oil companies and the environment, oil spill in Nigeria, tanker accidents in Nigeria and their implications on the national economy, the assessment of the current level of pollution control in the Nigerian coastal environment and the need for improvement on the level of environmental protection in Nigeria. Chapter three consists basically of the methodology utilized in this research work, which includes the systems and techniques engaged in the collection of data used for the research project. Chapter four deals with the presentation of collected data and the statistical analysis of variables, data were also subjected to hypothetical testing of which the valid results and their interpretations were expressly stated and chapter five presents the summary, findings, recommendations and conclusion of the study.

VIII. Recommendations

In view of the many problems, findings and conclusion drawn in this research work, the following recommendation are made towards the elimination of tanker accidents and the enhancement of the protection of the Nigerian coastal environment.

- The Federal Government should fully establish a body such as the coastal guard changed with the responsibility of enforcing already existing laws and regulations that has to do with the protection of the Nigeria coastal environment. Such laws include the petroleum regulation of 1969, oil in Nigeria waters act of 1968, criminal code of Nigeria , Federal environment protection decree no 58.
- There is also for the government to formulate and promulgate laws which have more stringent penalties for violators of the pollution act. If the tanker operator and managers become aware of stringent consequences, it will make them to be more safety conscious during the normal cause of their operation which will in turn enhance the protection of the environment.
- Knowing that it take time , money and energy to combat the menace of pollution the federal government and the local authorities need to put all resources together to ensure adequacy in the protection of our environment .
- The Nigeria government should also establish a central coordinating unit saddled with the responsibility of pollution and environmental protection in a unified manner so no one aspect of the environment will be left without control or protection.
- The National Authorities through the local authorities should create awareness by enlightening and sensitizing the public about their responsibility to the environment.
- The federal Ministry of Transport should establish an efficient Port State Control (PSC) which will see to the issue of safety on board ships particularly Nigerian Tankers in all the Nigeria ports.
- NIMASA in conjunction with the ship owners association of Nigeria should ensure that seminars, retraining and workshops are organized for both ship owners and the shore based management team to facilitate success in creating awareness about the vital role they can play in the general safety of their tankers and the protection of marine environment.

References Références Referencias

1. Akpofure, E. A. Efere, M.L. and Ayawei, P., (2000).The Adverse Effects of Crude Oil Spills in the NigerDelta. Urhobo Historical Society.
2. Allen, J.R. (1965). Late Quaternary of the Niger Delta, and Adjacent Areas. Sedimentary Environments and Litho facies AAPGV.49.p547-600.
3. BurnK.A.S.D.Garrity & S, C. Levings, 1993. How many years until Mangrove Ecosystems Recover from Catastrophic Oil Spills? Mar. Pollut. Bull. 26,239-248.
4. Dublin-Green C.O.,A. Awobamise and E.A. Ajao, (1997). Large Marine Ecosystem Project For the Gulf Of Guinea (Coastal Profile Of Nigeria),Nigeria Institute of Oceanography Encyclopedia Americana, 1994. International Edition, Grolier Incorporated.
5. Energy Information Administration, (2003). Nigeria Country Analysis Brief. Energy Information Administration.
6. Environmental Watch, (2001). Volume 2, No.13, October 16th- October 31st ISSN: 1119-2739, by Augustine Timbiri of our Environmental Desk.
7. Gabriel D. (1995) A 10 minute guide on the IMO'S ISM Code, CYMEPA, Puzzle Designs Ltd, Lima sol, Cyprus.
8. Garrity S.D. & S.C. Levin's, 1990. Effects of an Oil Spill on the Gas tropods of a Tropical Intertidal Reef Flat.Mar.Environ.Res.30, 119-153.
9. GESAMP (IMO/FAO/UNESCO/WMO/IAEA/UN/UNEP, 1993 Joint Group of Experts on the Scientific Aspects of Marine Pollution. Impact of Oil and Related Chemicals and Wastes on the Marine Environment. GESAMP Reports and Studies No 50. International Maritime Organization London, U.K.
10. Hoff, R. (1993). Bioremediation: An Overview of its Development and use for Oil Spill Cleanup. Mar.Pollut.Bull. 26,476-481.
11. House D.J (1987): Seamanship Techniques, William Heinemann Ltd, London, U.K.
12. Ibe, A.C., (1988).Coastline Erosion in Nigeria University of Ibadan Press.
13. IMO (1978) International Safety Guide for Oil Tankers and Terminals, International Chamber of Shipping (ICS), and Oil Companies International Marine forum (OCIMF), London, U.K.
14. IMO (1996) Guidelines on The Application of the IMO International Safety Management (ISM) Code, International Chamber of Shipping (ICS) and International Shipping Federation (ISF), London, U.K.
15. IMO (1997), International Convention for the Prevention of Pollution from Ships (MARPOL73/78), International Maritime Organization (IMO), London, U.K.
16. IMO (1997), International Convention for the Safety of life at Sea, 1974 and its protocol of 1978 (SOLAS 74/78) International Maritime Organization (IMO) London, U.K.
17. LONGMAN (1987) Dictionary of Contemporary English, Longman Singapore Publishers p.t.e Ltd, Singapore.

18. Mangrove Forests in Botany. Bay, New South Wales, Australia. Exp. Mar Biol. Ecol. 142121-135.
19. MARTON G.S. (1978): Tanker operations, second Edition, Cornell Maritime Press. Maryland, USA.
20. McGuiness, K.A., (1990). Effects of Oil Spills on Macro- invertebrates of Salt marshes and
21. MikalaK, (1995).Use of GIS as a Tool for Operational Decision Making, Implementation of National Marine Oil Spill Contingency Plan for Estonia. CarlBro Internationala/s, Glostrup, Denmark.
22. Ntukekpo D.S. (1996). Spillage: Bane of Petroleum, Ultimate Water Technology $ Environment.
23. NWORUH G.E. (2001) Basic Research Methodology for Researchers, Trainees and Trainers in Management Science, Ambix Publishers, Owerri Nigeria.
24. Olagoke W. (1996).Niger Delta Environmental Survey: Which Way Forward? Ultimate Water Technology & Environment.
25. Oshineye, A. (2000). The Petroleum Industry in Nigeria: An Overview. Modern Practice Journal of Finanace & Investment Law. Learned Publishments Limited.Vol. 4.No.4.
26. Oyem, A. (2001). Christian call for Action on Nigerian Oil Spill. Sage-Oxford's Christian Environmental Group.
27. Ozekhome, M.(2001). Legislation for Growth in the Niger Delta, Mid week Pioneer.
28. Parthiphan, K. 1994. Oil Spill Sensitivity Mapping Using a Geographical Information System. Department of Geography, University of Aberdeen. EGIS Foundation.
29. PHILIP W. (1999): The Tanker Market, Trade and Transport (U.K) Ltd, London, U. K.
30. Prince R. (1993). Petroleum Spill Nioremediationin Marine Environments. Critical Rev. Micobiol. 19(4),217-242.
31. Reddy,G.S.and BrunetM., (1997). Numerical Prediction of Oil Slick Movement in Gabes Estuary. Trans of International, Epinay/Seine, Cedex, France.
32. Salu, A.O. (1999). Securing Environmental Protection in the Nigerian OilI industry. Modern Practice Journal of Finance & Investment Law. Learned Publishments Limited. Vol. 3.No.2.
33. Sandberg, E.C. (1996). Development of Remote Sensing for Coast Guard Applications. Remote Sensing. No. 28, pp12.
34. Ship-to-Ship Transfer Guide (Petroleum). Third Edition, 1997, by International Chamber of Shipping (ICS) and Oil companies International Marine Forum, London, U.K. The Admiralty Manual of Seamanship Volume III, London, U.K. The Environment, the Guardian Newspaper, Monday, July 22, 2002.
35. Smith, L.A. & L. Loza, 1994.Texas Turns to GIS For Oil Spill Management. Geo Info Systems.pp48.
36. Smith, W. (1977).The Control of Oil Pollution on the Sea and Inland Waters. Graham and Trotman Ltd, United Kingdom.
37. TED Case Studies, (1997). The Russian Arctic Oil Spill Case No265, Komi, http://www.american.edu/-projects/mandala/TED/ted.htm.
38. The Petroleum Industry and the Nigerian Environment, (1985). The Petroleum Inspectorate Nigerian National Petroleum Corporation$ Environmental Planning and Protection Division, The Federal Ministry Of Works And Housing.
39. UCHEGBU S. N. (1998): Environmental Management and Protection, Precision Printers & Publisher, Enugu, Nigeria.
40. WARK K. & WARNER C.F (1981) Air pollution, its origin and control, Harper and Row Publishers, New York, US.

This page is intentionally left blank

Global Journal of Researches in Engineering: G
Industrial Engineering
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Risk Assessment and Management in Supply Chain

By Faizal. K & Dr. PL. K. Palaniappan
Thiagarajar College of Engineering, India

Abstract- Supply chains have expanded rapidly over the decades, with the aim to increase productivity, lower costs and fulfil demands in emerging markets. The increasing complexity in a supply chain hinders visibility and consequently reduces one's control over the process. Cases of disruption such as the ones faced by Ericsson have shown that a risk event occurring at one point of the supply chain can greatly affect other members, when the disruption is not properly controlled. Complexity and disintegration are emerging as major challenges in supply-chain risk management. It has become more difficult to identify risks as supply-chain operations have fallen into the hands of outside service providers, and are therefore less visible. The risks, their identification and impact depend on the position of the companies in the chain, and on the level of analysis they can carry out. . Supply chain management thus faces a pressing need to maintain the expected yields of the system in risk situations. This work provides a review of definitions and classifications of types of risk; a holistic view of risk assessment and management is taken here. This project aims to analyse how supply chain risks could be effectively managed. This is done firstly by positioning the research agenda in Supply chain Risk Management (SCRM).Then, methods for effective management of supply chain risk are identified and analysed.

GJRE-G Classification : FOR Code: 290502

RISKASSESSMENTANDMANAGEMENTINSUPPLYCHAIN

Risk Assessment and Management in Supply Chain

Faizal. K [α] & Dr. PL. K. Palaniappan [σ]

Abstract- Supply chains have expanded rapidly over the decades, with the aim to increase productivity, lower costs and fulfil demands in emerging markets. The increasing complexity in a supply chain hinders visibility and consequently reduces one's control over the process. Cases of disruption such as the ones faced by Ericsson have shown that a risk event occurring at one point of the supply chain can greatly affect other members, when the disruption is not properly controlled. Complexity and disintegration are emerging as major challenges in supply-chain risk management. It has become more difficult to identify risks as supply-chain operations have fallen into the hands of outside service providers, and are therefore less visible. The risks, their identification and impact depend on the position of the companies in the chain, and on the level of analysis they can carry out. . Supply chain management thus faces a pressing need to maintain the expected yields of the system in risk situations. This work provides a review of definitions and classifications of types of risk; a holistic view of risk assessment and management is taken here. This project aims to analyse how supply chain risks could be effectively managed. This is done firstly by positioning the research agenda in Supply chain Risk Management (SCRM).Then, methods for effective management of supply chain risk are identified and analysed.

I. Introduction

Supply Chain Management (SCM) is a principle emphasizing the utilization of an efficient integrated system of suppliers, producers, warehouses, retailers and customers, so that items can be produced and distributed system-wide at the right quantities, locations, and time to minimize costs and maximize services. A supply chain is the linkage of series of organizations with facilities, functions, processes, and logistics activities that are involved in producing and delivering a product or service. In the past, when firms manufactured in-house, sourced locally and sold direct to the customer, 'risk' was less diffused and easier to manage. With the advent of increased product/service complexity, and outsourcing of supply networks across international borders, risk is increasing and the location of risk has shifted through complex changing supply networks. Managing risk in supply chains is an important topic in supply chain management. The topic's importance is due to several industry trends currently in place: increase in strategic outsourcing by firms, globalizations of markets, increasing reliance on suppliers for specialized capabilities and innovation, reliance on supply networks for competitive advantage, and emergence of information technologies that make it possible to control and coordinate extended supply chains. These trends have manifested themselves in an increase in outsourcing and off-shoring of manufacturing and R&D activities, low cost country (LCC) sourcing, and collaboration with international supplier partners. While these increase the strategic options for firms, they also increase the probability of experiencing adverse events in supply chains that significantly threaten normal business operations of firms in the supply chains. Along with the increase in these initiatives, there has been an increase in the potential and magnitude of supply chain risks. Many industrial cases have shown different outcomes after risk events due to diverse actions (or lack of action) taken in facing supply chain disturbances and disruptions. One typical example is Ericsson's crisis in 2004. Since Ericsson used a single-sourcing policy, a fire accident in its chips' supplier immediately disrupted the material supply. Ericsson's loss was estimated to reach USD 400 million for its T28 model.

Author α: *PG Scholar, Department of Mechanical Engineering, Thiagarajar College of Engineering, Madurai.*
e-mail: faizal18888@gmail.com
Author σ: *Assistant Professor, Department of Mechanical Engineering, Thiagarajar College of Engineering, Madurai.*
e-mail: pazhantce@gmail.com

a) Risk

Risk can be broadly defined as a chance of danger, damage, loss, injury or any other undesired consequences. A more scientific definition of risk was provided by the Royal Society (1992): ''the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge".

i. *Sources of Risk*

a. *Supply Risk*

Supply risk relates to potential or actual disturbances to the flow of product or information emanating within the network, upstream of the focal company. Therefore, it is risk associated with a company's suppliers, or supplier's suppliers being unable to deliver the materials the company needs to effectively meet its production requirements/demand forecasts. It adversely affects inward flow of any type of resource to enable operations to take place; also termed as 'input risk'. It includes.

Global Journal of Researches in Engineering (G) Volume XIV Issue II Version I Year 2014

- Dependency on key suppliers
- Consolidation in supply markets
- Quality and management issues arising from off-shore sourcing
- Potential disruption at 2nd tier level
- Length and variability of replenishment lead-times

b. Demand Risk

Demand risk relates to potential or actual disturbances to flow of product, information, and cash, emanating from within the network, between the focal company and the market. This demand risk can be a failure on either the high or low side to accurately accommodate the level of demand. It encompasses uncertainties in both product volume and mix which includes.

- Loss of major accounts
- Volatility of demand
- Concentration of customer base
- Innovative competitors

c. Process Risk

Processes are the sequences of value-adding and managerial activities undertaken by the company. Process risk relates to disruptions to these processes. It affects a firm's internal ability to produce and supply goods/services, which results from the consequences of a breakdown in a core operating, manufacturing or processing capability. It includes.

- Manufacturing yield variability
- Lengthy set-up times and inflexible processes
- Equipment reliability
- Limited capacity/bottlenecks
- Outsourcing key business processes

d. Control Risk

Controls are the assumptions, rules, systems and procedures that govern how an organization exerts control over the processes. In terms of the supply chain they may be order quantities, batch sizes, safety stock policies etc. Control risk is therefore the risk arising from the application or misapplication of these rules. It includes.

- Inappropriate rules that distort demand
- Poor visibility along the pipeline
- Lack of collaborative planning and forecasts
- Bullwhip effects due to multiple echelons

II. Environmental Risk

Environmental risk is the risk associated with external and, from the company's perspective; uncontrollable events. It consists of any uncertainties arising from the supply chain and environmental interactions. These may be the result of accidents, man-made or natural disasters. It includes.

- Natural disasters
- Terrorism and war
- Regulatory changes
- Strikes

Following figure shows some of the Risk sources and their characteristics.

Figure 1.1 : Risk sources and their characteristics

a) Risk Assessment

Risk assessment is used to analyze the degree of risk associated with each hazard. The goal of risk assessment is to indicate which areas and activities in the value chain are most susceptible to hazards. It balances the probability of demand, the likelihood of reliable supply, the most effective allocation of resources, and the probability of success of new product introductions, market conditions, and the opportunity costs of alternative decision paths.

b) Risk Management

It is a process of measuring or assessing risk and then developing strategies to manage the risk. Risk management is the broad activity of planning and decision making designed to deal with the occurrence of hazards or risks. Risks include both unlikely but high-impact disruption risks, as well as more common volatility in demand, internal processing, and supply.

Some of the factors impacting exposure to Risks are also given below:

i. Customers reactions.
ii. Competitor reactions.
iii. Supplier reactions.
iv. Government reactions.

III. Summary of Literature Review

Increasing product/service complexity, outsourcing and globalisation have led to complex and dynamic supply networks, there by increasing the factors impacting exposure to risks. The review shows various types of risks and there classifications based on different categories which affects the Supply chain operations. It also addresses the importance of Supply chain Risk Management (SCRM) to make decisions that optimally align organizational processes and decisions to exploit opportunities while simultaneously minimizing risk. Understanding the types of risks and their probability of occurrence as well as the associated impacts is a starting point for companies to develop effective Risk Management strategies.

IV. Problem Description

To gain cost advantage and market share, many firms implemented various initiatives such as outsourced manufacturing and product variety. These initiatives are effective in a stable environment, but they could make a supply chain more vulnerable to various types of disruptions caused by uncertain economic cycles, consumer demands, and natural and manmade disasters. The objective of the problem is to maximize productivity by reducing Supply Chain Risks. In this work, an effective method for managing 'Supply chain Risk' in a manufacturing industry involving in Casting is proposed with aid of a flow chart and a strategy is developed for its Mitigation.

a) Identification of Problem

- Obtaining various sources of risk which impacts on Supply chain operations.
- Obtaining an effective method for managing Supply chain risk.
- To develop a Flow chart for Supply chain risk management.
- To develop a framework strategy for Supply chain Risk Mitigation.

i. *Definition*

a. Supply Chain Risk Management (SCRM)

SCRM is viewed as "the management of supply chain risk through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity". Risk management is the process of measuring or assessing risk and then developing strategies to manage the risk. These strategies can involve the transference of risk to another party, risk avoidance or mitigation, and channel risk sharing. SCM risk assessments balance the probability of demand, the likelihood of reliable supply, the most effective allocation of resources, and the probability of success of new product introductions, market conditions, and the opportunity costs of alternative decision paths. A framework for Supply Chain Risk Management is shown below:

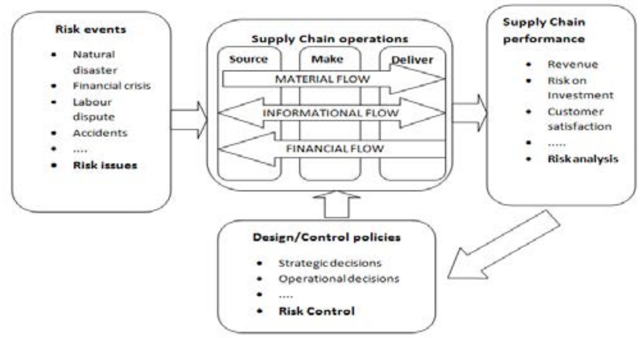


Figure 3.1 : Framework for Supply Chain Risk Management

This figure shows that the continuity of supply chain operations can be affected by various risk events. A solid risk analysis process could identify the impact of disruption on supply chains. This could be established by monitoring supply chain performance, for example the production or financial performances. With a proper implementation of risk control, for instance via risk mitigation strategies, the impact of disruption on flows could be diminished, or even avoided.

b) Objectives

The main objective is to analyse how supply chain risks can be effectively managed. Firstly, this is done by positioning the agenda in supply chain risk management (SCRM). Then, methods for effective management of supply chain risk are identified and analysed.

Based on the framework shown above, we can classify the objective into two sub-categories

Objective I: Identifying Supply Chain Risk Management Agenda.

It is important to identify the current agenda in this field. The exploration of various definitions, for both terminology and processes involved in this area, helps to clarify future scope. To achieve this objective, we hereby raise two questions as follows:

FQ1: What risk issues should be considered in supply chain operations?

FQ2: How does a risk event affects supply chain operations?

Objective II: Identification of Effective Management of Supply Chain Risk.

The second objective focuses on finding how supply chain risk can be effectively managed. To achieve this objective, an investigation of selected approaches and methods will be conducted to analyse their competency and robustness in sustaining supply chain operations. Hence, to achieve the above objective, we raised three questions that focuses on risk analysis and risk control.

FQ3: How can we analyse supply chain performance from a risk management viewpoint?

FQ4: What kind of mitigation policies should be used for managing risk in supply chains?

FQ5: What modelling techniques and approaches are possible in this area?

V. Proposed Methodology

Supply chain Risk Management process can be mainly classified into two categories:

- Risk Analysis.
- Risk Control.

Risk Analysis deals with Identification, Estimation and Evaluation of risks, whereas Risk Control deals with Mitigation and Monitoring of risks. The Risk Management process can be developed with the aid of a flow chart which is shown below.

Review Process

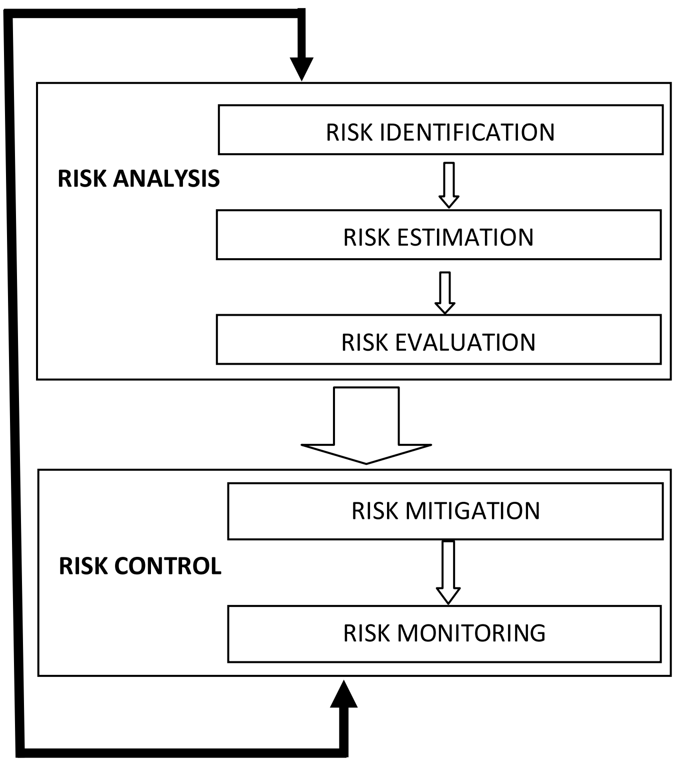


Figure 4.1 : Flow chart for Supply Chain Risk Management

Risk Management process which is constituted of two main elements; Supply chain Risk Analysis and Supply chain Risk Control, henceforth referred to risk analysis and risk control respectively. The term risk assessment is also interchangeably used in referring to risk analysis. The first process covers the identification, estimation and evaluation of risk. Proper implementation of all stages in this process will result in the recognition of potential risk events affecting supply chain. However, not all risk events fall under the category of disruption risk events, and therefore the potential impact caused by an individual risk event needs to be carefully estimated and evaluated according to the individual supply chain operation's definition.

a) *Risk Identification*

A key aspect of supply chain risk management is identification. Identification involves creating a list of potential events that could harm any aspect of the supply chain's performance. Risk identification allows an organization to take steps to create plans to manage risks before they occur. This is typically more cost effective then waiting to react to adverse events when they occur.

i. *Methods for Identifying Risk*

Geomapping/Supply chain mapping – Visual maps of supply chains reveal supply chain structures, dependencies, and handoffs that may contain risk. Supply Chain Operation Reference (SCOR) mapping and Value Stream Mapping are two types of supply chain mapping that can be used. Looking at historical problems – Historical problems may have a high chance of recurring. Those problems may have happened to the organization itself or to others. Researching industry trends – Other organizations and industry groups may have already researched risks that are applicable. Group of experts brainstorming – People with experience in different areas of your organization and supply chain have lots of knowledge of risks. Getting them together increases the knowledge sharing. (The Delphi method is one technique to conduct expert interviews.) Assessment surveys – Well designed surveys can be an effective way to quickly gather information on risks in your supply chain. Site visits – Site visits to supply chain partners allow you to collect detailed and less "filtered" information on risks. Information audits – Data system audits can reveal issues and trends from the past. It can show areas of the supply chain that have had poor performance in the past and are thus more likely to perform poorly in the future.

ii. *Tools used in risk identification*

Risk checklists – a list of risks that are common for our environment. It may come from past experience or industry research. Cause-and-effect diagrams – a diagram that traces back the causes for events. Gantt charts – a bar chart showing the precedence and timing of activities. It can help identify the critical path, i.e. the most critical organizations and processes that would be bottlenecks if they experienced a disruption. (It can also be used later during Risk Assessment to determine the effect of disruptions at different points in a supply chain).

b) *Risk Assessment and Evaluation*

Supply Chain Risk assessment provides management with an understanding of where the greatest risks may exist in order to prioritize resources for risk mitigation and management. Performing such assessments will involve clarifying the nature of the risk, understanding conditions that may lead to the event, knowing how frequently such events have happened or can be expected to happen, and the potential impact of such events. The team can then prioritize addressing the risks. Risk assessment is typically made up of two measures: Likelihood and Impact. Likelihood– measures the probability that the event will occur. The exact probability may be difficult to determine unless there is historical data that can be used to find the frequency of the event occurring. Alternatively an organization can use a subjective likelihood, or degree of belief, based on the opinions of experts. A time horizon is necessary to define the probability in a useful way (e.g., the likelihood that an event will occur in the next year or 50 years). Impact – measures the consequences on the organization if the event occurs. It can be measured directly, for example in terms of dollars. It can also be measured on a scale, for example from zero to one with zero being very little negative consequence and one being a very bad consequence. Methods for measuring impact include "what-if" simulations, financial models, and opinions of teams of experts. Impact may also be measured in terms of other SCOR metrics besides financials. Summary risk score – A summary risk score can be calculated for each risk by multiplying the Impact times the Probability to get an expected value of the risk. Then risks can be ranked by risk score. Also the risks can be shown on a map or graph. An example is shown below.

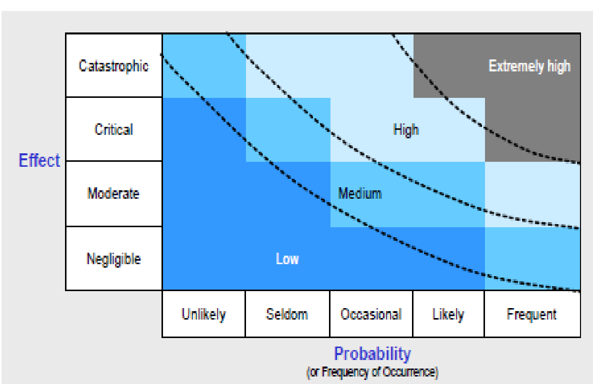


Figure 4.2 : Qualitative Risk assessment

i. *Tool used in Risk Assessment*

Failure Mode Effect Analysis (FMEA) – It is used to prioritize the risk using Risk Priority Number (RPN), which can be calculated from probability of occurrence, severity and detection of risk and also using Risk Score Values (RSV) in which Severity and Occurrence of risk is calculated.

Other methods for assessment include:

- Fault tree analysis – This is a graphical technique that provides a systematic description of the combinations of possible occurrences in a system, which can result in an undesirable outcome. This method can combine hardware failures and human failures. The most serious outcome is selected as the "Top Event". A fault tree is then constructed by relating the sequence of events, which individually or in combination, could lead to the top event. FTA is both a design and a diagnostic tool. As a design tool FTA is used to compare alternative design solutions and the resulting Top event probability. As a diagnostic tool FTA is used to investigate scenarios that may have led to the Top event.
- Event tree analysis – Event tree analysis (ETA) is an analysis technique for identifying and evaluating the sequence of events in a potential accident scenario following the occurrence of an initiating event. ETA utilizes a visual logic tree structure known as an Event Tree (ET). The objective of ETA is to determine whether the initiating event will develop into a serious mishap or if the event is sufficiently controlled by the safety systems and procedures implemented in the system design. An ETA can result in many different possible outcomes from a single initiating event, and it provides the capability to obtain a probability for each outcome.

c) *Risk Monitoring and Mitigation*

Once areas of risk have been identified, an organization needs to monitor their internal and external environment. This helps them to predict when risky events are becoming more likely. It also helps to identify new risks and is tightly linked to the best practice of Supply Chain Risk Identification. Supply Chain Operation References focus on supply chain metrics enables Supply Chain Risk monitoring. Real time metrics and periodic reports give decisions maker's knowledge upcoming risks. Statistical analysis of key metrics can reveal trends. Visibility into supplier and customer metrics increases the ability to monitor. Reports on risk monitoring can be combined with existing management reviews and meetings. Monitoring can also include monitoring qualitative sources of information such as news or weather reports to identify events that are precursors to risks. In the Plan step, an organization can plan methods for monitoring Source, Make, Deliver, and Return risks. These methods may include specific metrics to monitor and "watch-out" lists of precursor events. It may also include monitoring the environment external to the organization's supply chain.

- Deliver risk monitoring can be done with customer service metrics.
- Make risk monitoring can be done automatically through an organization's data systems such as an ERP system.
- Source risk monitoring is enhanced with visibility into suppliers' metrics.

It is important to monitor indicators that would appear early in a risk event or, better, even before it occurs by indicating an increasing likelihood. If monitoring only reveals a risk well after its first occurrence, it will likely be too late to adequately respond to it. Monitoring can also be used to test the effectiveness of risk controls. If a plan to mitigate or prevent a risk has been implemented, monitoring can check to see if the corresponding metrics show no signs of the risk occurring. Five operational strategies for managing disruption risks are given below:

Table 4.1 : Operational strategy for managing disruption risk

Operational Strategy	Description
Stockpile Inventory	Hold inventory that can be used to fill customer demand even if supply is interrupted.
Diversify Supply	Source product from multiple vendors/facilities so that a problem at one vendor/facility does not affect the entire Supply.
Backup Supply	Have an emergency supplier (or logistics provider) that is not normally used but that can be activated in the event of a Supply problem.
Manage Demand	Influence demand to better match the actual supply by, for example, adjusting prices or offering incentives to encourage Customers to purchase products that are less supply-constrained.
Strengthen Supply Chain	Work with suppliers to reduce the frequency and/or severity of supply problems.

i. *Risk Mitigation Strategies*

- Multiple sources of supply: - having multiple sources of supply for a raw material reduces the impact of one source failing to deliver materials.
- Strategic agreements or partnerships with suppliers: - strategic agreements with suppliers can lead to continued service in the event of capacity constraints.
- Collaborative Planning Forecasting and Replenishment (CPFR): - by sharing demand and fulfilment data with supply chain partners, there is a reduced risk of unforeseen demand swings or supply shortages.
- Joint product design and delivery: - designing products with suppliers reduces the risk of material non-performance or material shortages.

d) Supply Chain Operation Reference (Scor) Model

Supply Chain Operations Reference (SCOR) model provides a unique framework that links performance metrics, processes, best practices, and people into a unified structure. The framework supports communication between supply chain partners and enhances the effectiveness of supply chain management, technology, and related supply chain improvement activities. It features an intentionally broad scope and definitions that can be adapted to the specific supply chain requirements of any industry or application.

SCOR is based on Five Core management process:

Table 4.2 : SCOR process

SCOR PROCESS	DEFINITIONS
PLAN	Processes that balance aggregate demand and supply to develop a course of action which best meets sourcing, production and delivery requirements
SOURCE	Processes that procure goods and services to meet planned or actual demand.
MAKE	Processes that transform product to a finished state to meet planned or actual demand.
DELIVER	Processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management and distribution management.
RETURN	Processes associated with returning or receiving returned products for any reason.

i. *SCOR Performance*

The performance section of SCOR consists of two types of elements: Performance Attributes and Metrics.

a. Performance Attributes

A performance attribute is a group of metrics used to express a strategy. An attribute itself cannot be measured; it is used to set strategic direction. SCOR identifies five core supply chain performance attributes: Reliability, Responsiveness, Agility, Costs, and Asset Management. Consideration of these attributes makes it possible to compare an organization that strategically chooses to be the low-cost provider against an organization that chooses to compete on reliability and performance.

b. Metrics

A metric is a standard for measurement of the performance of a process. SCOR metrics are diagnostic metrics. SCOR recognizes three levels of predefined metrics:

- Level 1 metrics are diagnostics for the overall health of the supply chain. These metrics are also known as strategic metrics and key performance indicators

(KPIs). Benchmarking level 1 metrics helps establish realistic targets that support strategic objectives.

- Level 2 metrics serve as diagnostics for the level 1 metrics. The diagnostic relationship helps to identify the root cause or causes of a performance gap for a level 1 metric.
- Level 3 metrics serve as diagnostics for level 2 metrics.

Table 4.3 : SCOR Level 1 metrics

Perspectives	Metrics	Measure
Supply chain reliability	On-time delivery Order fulfillment lead time Fill rate Perfect order fulfillment	Percentage Days Percentage Percent age
Flexibility and responsiveness	Supply chain response time Upside production flexibility	Days Days
Expenses	Supply chain management cost Warranty cost as percentage of revenue Value added per employee	Percentage Percentage Dollars
Assets/utilization	Total inventory days of supply Cash-to-cash cycle time Net asset turns	Days Days Turns

ii. *Benefits of adopting the SCOR model*

- Rapid assessment of supply chain performance
- Clear identification of performance gaps
- Efficient supply chain network redesign and optimization
- Enhanced operational control from standard core processes
- Streamlined management reporting and organizational structure
- Alignment of supply chain team skills with strategic objectives
- A detailed game plan for launching new businesses and products
- Systematic supply chain mergers that capture projected savings

In this work, a Case study is taken up to develop an effective method for managing 'Supply chain Risk' in a manufacturing industry involving in Casting, by collecting the sample data and a strategy is developed for its Mitigation. AutoKast Ltd, a Casting industry undertaking by Government of Kerala is taken here as the case study. The industry is fully equipped to manufacture all kinds of Ferrous Castings weighing from 20 kg to 8000 kg single piece. The present annual production capacity is 6000 Metric Tons. AutoKast produces and markets different grades of Grey Iron and SG Iron Castings for the domestic and international markets.

VI. Case Study: Risk Assessment and Management in Casting Industry

a) *Risk Identification*

Sources of risk

i. *Demand Risk*

It is the occurrence of an undesired event, which is mostly caused by fluctuation in customer demand. Forecast becomes more inaccurate if the fluctuation is really high, and the further result from forecast inaccuracy is the bullwhip effect as the most undesired outcome from this risk.

ii. *Supply Risk*

It refers to the increments of purchasing cost that is caused by price increase from suppliers, delivery delay from suppliers that can increase production cost, quality cost because of the low quality of inbound materials or even defects.

iii. *Operational Risk*

It is being the risk that has an effect on a company's internal ability to produce goods or services.

iv. *Environmental Risk*

Here several factors which were taken into consideration are technological, social, political and economic circumstances. However, natural phenomena, such as geological, metrological, disease and any other uncontrollable events have to be taken into consideration too.

b) *Risk Assessment*

To develop the risk mitigation strategies, the risk that constitutes the supply chain operations has to be identified using an effective tool. The method of assessment follows Failure Mode Effect Analysis (FMEA) guidelines. The concept of assessing the risk basically uses the score for the probability of the risk occurrence, the impact from the risk, and the identification method that the firm has to reduce the impact of the risk. All the values are calculated to obtain the risk priority number (RPN) and risk score value (RSV) by using the formula below.

$$RPN = \text{Occurrence score} * \text{Severity score} * \text{Detection score}$$

$$RSV = \text{Occurrence score} * \text{Severity score}$$

c) FMEA Analysis

Failure mode effect analysis is used to prioritize the risk using Risk Priority Number (RPN), which can be calculated from probability of occurrence, severity and detection of risk and also using Risk Score Values (RSV) in which Severity and Occurrence of risk is calculated.

i. *Occurrence Rating Scale*

Estimation of likelihood that a failure will occur.

Table 5.1 : Occurrence rating scale

Rating	Description	Potential Risk Rate
10	Certain probability	Risk occurs at least once a day or risk occurs almost every time
9	Risk is almost inevitable	Risk occurs predictably or risk occurs every 3 or 4 days
8 7	Very high probability	Risk occurs frequently; or risk occurs about once per week
6 5	Moderately high probability	Risk occurs about once per month
4 3	Moderate probability	Risk occurs occasionally or risk occurs once every 3 months
2	Low probability	Risk occurs rarely or Risk occurs about once per year
1	Remote probability	Risk almost never occurs no one remembers last risk occurrence.

ii. *Severity Rating Scale*

Table 5.2 : Severity rating scale

Rating	Description	Definition
10	Certain probability	Risk could cause loss of client
9	Risk is almost inevitable	Risk could cause major or permanent delay
8 7	Very high probability	Risk causes minor to moderate delay with a high degree of client dissatisfaction
6 5	Moderately high probability	Risk causes minor delay with some client dissatisfaction
4 3	Moderate probability	Risk causes very minor or no delay but annoys client
2	Low probability	Risk causes no delay and client is unaware
1	Remote probability	Risk causes no delay and has no impact on system

iii. *Detection Rating Scale*

How likely will the failure be detected?

Table 5.3 : Detection rating scale

Rating	Description	Definition
10	No chance of detection	There is no known mechanism for detecting the risk
9 8	Very Remote/Unreliable	The risk can be detected only with thorough inspection and this is not feasible or cannot be readily done
7 6	Remote	The risk can be detected with manual inspection but no process is in place so that detection is left to chance
5	Moderate chance of detection	There is a process for double-checks or inspection but it is not automated and/or is applied only to a sample and/or relies on vigilance
4 3	High	There is 100% inspection or review of the process but it is not automated
2	Very High	There is 100% inspection of the process and it is automated
1	Almost certain	There are automatic "shut-offs" or constraints that prevent risk

d) Sample Data Collection

Risk has to be prioritized before adopting effective mitigation strategies. All the inherent risks have been identified and the next stage is to assess each risk by using the FMEA method. Every risk is assessed by its likelihood value, impact value and detection method value. Determining those values is based on the secondary data and interviews with the experts. By having Chief Operating Officer, Procurement Manager and Distribution Manager as the key informants, the quality of the data and analysis is highly enhanced. All the informants enter values for the probability, impact and detection methods for each risk, and then they are adjusted by using past historical data (sales, volume of productions, suppliers performance and the occurrence of risks). All the values which informants have given in the interviews are shown below:

i. *Tabulated Risk Score Values*

Table 5.4 : Risk Score Values

RISKS	OCCURENCE			SEVERITY			DETECTION		
	COO	PRCMGR	DISTMGR	COO	PRCMGR	DISTMGR	COO	PRCMGR	DISTMGR
Demand Risks									
Demand fluctuation	8	8	6	7	7	5	5	5	6
Economic condition	6	6	3	4	3	4	5	5	6
Supply Risks									
Product arrival variability (delays)	6	6	7	6	7	7	6	5	6
Wooden pattern life cycle risk	6	6	6	6	6	5	6	5	5
Uncertainty in pattern availability	7	7	6	4	5	5	5	5	5
Bottlenecks in transportation routes	7	7	8	5	5	5	7	7	7
Operation Risks									
Lack of skilled workers	5	4	4	9	8	8	7	6	7
Breakdown of Fractioning machine	3	4	4	6	5	5	6	7	6
Breakdown of Refining machine	3	4	4	6	5	5	5	6	6
The condition of cargo-handling equipment	3	4	3	6	5	5	6	7	6
Carelessness and lack of motivation among the workforce	3	4	3	6	5	5	6	7	6
Environmental Risks	5	4	5	9	8	8	5	4	5

(Source: Interviews)

ii. Validated Risks Score and Calculated RPN & RSV

Table 5.5 : RPN and RSV calculation

RISKS	Occurrence (o)	Severity (s)	Detection (d)	RPN (o*s*d)	RSV (o*s)
Demand Risks					
Demand fluctuation	8	5	6	240	40
Economic condition	6	5	3	90	30
Supply Risks					
Inbound product Quality	6	6	6	216	36
Product arrival variability(delays)	6	6	5	180	36
Wooden pattern life cycle risk	7	5	5	245	35
Uncertainty in pattern availability	7	5	7	245	35
Bottlenecks in transportation routes	6	5	7	210	30

Operation Risks					
Lack of skilled workers	4	8	7	224	32
Fractioning machine breakdown	4	5	6	120	20
Refining machine breakdown	4	5	6	120	20
The condition of cargo-handling equipment	3	5	6	90	15
Carelessness and a lack of motivation among the workforce	3	5	6	90	15
Environmental Risks	5	8	5	200	40

e) Pareto Analysis

The 80:20 rules says that 20% of the work can gain 80% of all the benefits that can be obtained.

i. *Risk Priority Number's Pareto Chart*

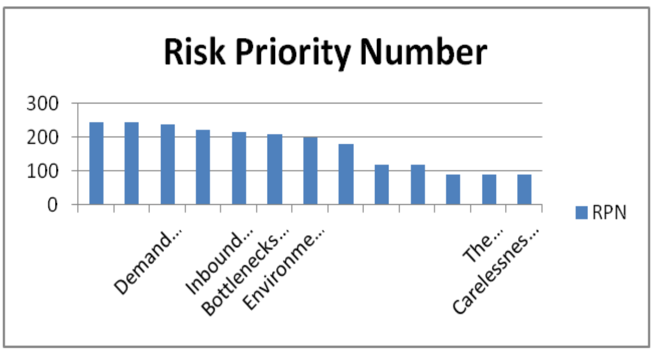


Figure 5.1 : Risk Priority Number's Pareto chart

ii. *Risk Score Value's Pareto Chart*

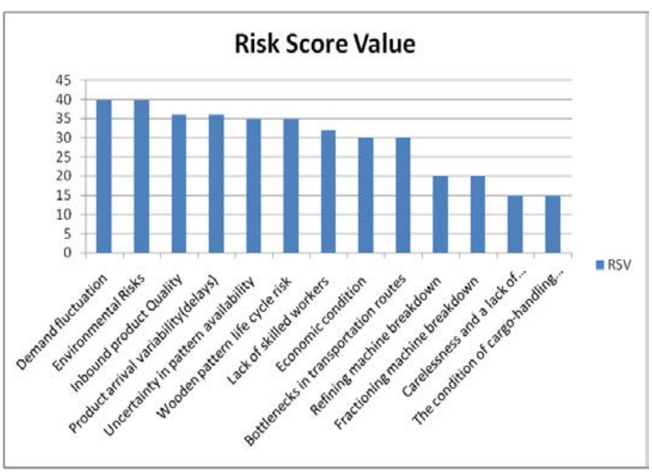


Figure 5.2 : Risk Score Value's Pareto chart

iii. *RPN versus Risk Score Scatter Diagram*

The two Pareto charts determines the critical RPN values for Risk scores. These charts are made simply to give guidance for prioritising risk response planning. Selecting critical values really depends on the nature of the business or project, for this reason the critical value for this project is based on the Pareto chart. From the charts, also the Pareto rule, the critical value for RPN is 200 and for risk the score is 35. A scatter diagram for the RPN is plotted against the risk score values. The aim of doing this is to find the intersection of those two critical values to reveal the set of risks that have high risk scores which need to be responded to and managed first. Identifying the process with high risk score helps the management in finding a way for its effective mitigation. The scatter diagram is shown on the graph below:

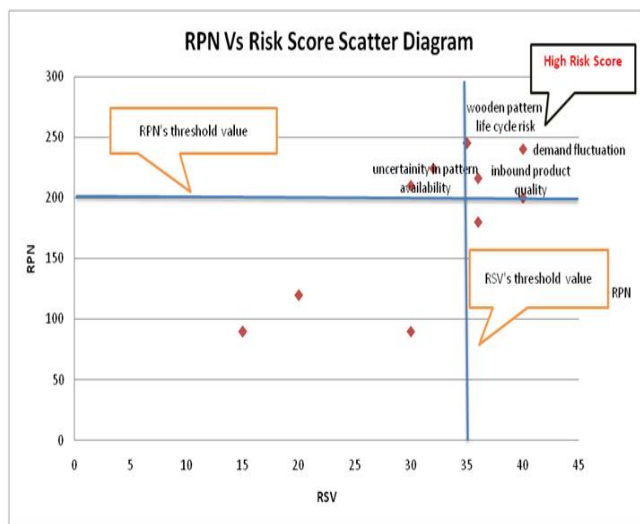


Figure 5.3 : RPN versus Risk Score Scatter Diagram

f) Risk Mitigation

Once the supply chain risk has been identified and assessed, information about the level of urgency of the risk can be obtained. Since the level of risk has been revealed, those high scored risks have to be mitigated by using specific supply chain strategies.

i. *Risk Mitigation Strategies framework for company's Casting Supply chain*

The Scatter diagram shows a cluster of risks above a particular threshold level that widely affects

Supply chain operations in a Casting industry. It shows three out of the four highest risks are of the supply type; inbound product quality, wooden pattern life cycle risk and uncertainty in pattern availability. The other risk is categorised as demand risk. The risks which categorised under the supply are mostly caused by the supplier. The impact of the low quality of the inbound products affects the quality of Castings. The key tool for mitigating this risk is by making good relationship with the supplier. Implementing collaborative relationships with the suppliers are extremely desirable to reduce or to prevent the occurrence and impact of the risk such as uncertainty in pattern availability. It supports the improvement of flexibility and ability of firm, thereby reducing the risk. Mitigation of supply risk can also be done by redundant suppliers (reconfiguring supply base). This strategy increases supply flexibility for the firms due to having more suppliers, and it automatically increases the buyer's bargaining power. The choice of which strategy is the most suitable for the casting supply chain entirely depends on the nature of the firm and its external parties.The fluctuations in demand are inherent in many Supply chain operations. The effect of these risks is decreased forecast accuracy, thus it might increase the cost of inventory or stock. In order to mitigate these risks, the firm can use pool or aggregate demand, which is termed as "Risk pooling". The impact of fluctuations in demand can be also be reduced by using postponement strategy in which the process starts by making a generic or family product that is later differentiated into specific end-product. A framework of Risk Mitigation Strategies for company's Casting Supply chain is shown below:

Table 5.6 : Risk Mitigation Strategies for company's Casting Supply chain

Category of Risk	Risk	Level of Risk	Mitigation Strategies
Demand Risk	Fluctuating demand	High	Collaborative forecast planning.
	Economic condition	Low	Product postponement.
Supply Risks	Inbound product Quality	High	Reconfiguring supply base (add more suppliers).
	Product arrival variability(delays)	Low	
	Wooden pattern life cycle risk	High	
	Uncertainty in pattern availability	High	Increase of patterns level (safety stock level).
	Bottlenecks in transportation routes	Low	
Operation Risk	Lack of skilled workers	Low	Implementing training and skill development programmes.
	Breakdown of Fractioning machine	Low	
	Breakdown of Refining machine	Low	
	The condition of cargo-handling equipment.	Low	Implementing Quality Management.
	Carelessness and lack of motivation among the workforce.	Low	Implementing Human safety Management.
Environmental Risk	Natural/Man-made disasters.	Low	Implementing Optimum Inventory level. Decentralized Inventory resources.

VII. Conclusion

The idea behind working on this project was to make aware the industries that neglecting the risks involved behind the supply chain increase their losses. Impacts of these risks and their occurrences can be minimized or even nullified. The SCOR model can play a substantial role in pursuing the overall objective of a real collaborative process within and between companies, aiming at maximizing the overall performances of the supply chain with reduced risk.

Here the given sample data gives the company's exposure to risk for the daily production process. So an effective Supply Chain Risk Management (SCRM) needs to be implemented in procurement and production process.

a) Future Work

The Future work of the thesis includes developing Risk Mitigation strategies that suits to the Industry scenario and also Cost benefit analysis is to be carried out by collecting real time data.

References Références Referencias

1. Carter C.R, Rogers D.S (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution and Logistics Management* 38(5), 360-387.
2. Chopra S, Sodhi M.S (2004). Managing risk to avoid supply-chain breakdown. *MIT Sloan Management Review* 46 (1), 53-62.
3. Christopher M, Lee H (2004). Mitigating supply chain risk through improved confidence. *International Journal of Physical Distribution and Logistics Management.* 34 (5), 388-396.
4. Christopher M, Peck H (2004). Building the resilient supply chain. *International Journal of Logistics Management* 15 (2), 1-13.

5. Gaonkar R. S, Viswanadham N (2007). Analytical Framework for the Management of Risk in Supply Chain. *IEEE Transactions and Automation Science and Engineering, 4*(2), 265-273.
6. Juttner U (2005). Supply Chain Risk Management Understanding the Business Requirements from a Practitioner Perspective. *The International Journal of Logistics Management, 16*(0957-4093), 120-141.
7. Khan O, Burnes B (2007). Risk and supply chain management: Creating a research agenda. *International Journal of Logistics Management* 18 (2), 197-216.
8. Kleindorfer P.R, Saad G.H (2005). Managing disruption risks in supply chains. *Production and Operations Management* 14 (1), 53–68.
9. Klimov R, Merkuryev Y (2008). Simulation Model for Supply Chain Reliability Evaluation. *Technological and Economic Development of Economy Baltic Journal on Sustainability, 14*(3), 300-311.
10. Knemeyer (2009). Proactive planning for catastrophic events in supply chains. *Journal of Operations Management* 27, 141-153.
11. Manuj I, Mentzer J.T (2008). Global Supply Chain Risk Management Strategies. *International Journal of Physical Distribution & Logistics Management, 38*(3), 192-223.
12. Musa S.N, Wei S, Tang O (2012). Information flow and mitigation strategy in a supply chain under disruption. Working paper, Department of Management and Engineering, Linkoping University.
13. Rice J, Caniato F (2003). Building a secure and resilient supply chain. *Supply chain management review, 7*(5), 22-30.
14. Ritchie B, Brindley C (2004). Risk characteristics of the supply chain-A contingency framework. Supply Chain Risk.
15. Sheffi Y (2005). *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*. Cambridge, MA, MIT Press.
16. Sodhi M.S (2005). Managing demand risk in tactical supply chain planning for a global consumer electronics company. *Production and Operations Management* 14 (1), 69–79.
17. Sodhi M.S, Son B, Tang C.S (2012). Researcher's perspectives on supply chain risk management. *Production and Operations Management* 21 (1), 1-13.
18. Tang C. S (2006). Perspectives in supply chain risk management. *International Journal of Production Economics, 103*, 451-488.
19. Tang O, Musa S.N (2011). Identifying risk issues and research advancements in supply chain risk management. *International Journal of Production Economics* 133, 25-34.
20. Tomlin B (2006). On the value of mitigation and contingency strategies for managing supply-chain disruption risks. Management Science 52 (5) 639–657.
21. Wagner S. M, Bode C (2006). An Empirical Investigation into Supply Chain vulnerability. *Journal of Purchasing and Supply Management, 12*, 301-312.
22. Zsidisin (2003). Managerial perceptions of supply risk. *Journal of Supply Chain Management* 39, 14-26.

Global Journal of Researches in Engineering: G
Industrial Engineering
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

The Causes and Minimization of Maritime Disasters on Passenger Vessels

By Julius Okechukwu Anyanwu
Federal University of Technology, Nigeria

Abstract- The issue of maritime disaster has become very worrisome to all stakeholders of the maritime industry, particularly the main actors in the industry. The causes and the consequent effects of maritime disasters are so numerous hence justifies this research work. Research and statistics show that human error is to blame in over 70% of marine accidents. As a matter of need and concern to the researcher and the maritime industry, the researcher was angered to carry out this work on minimization of maritime disasters with the view of contributing to the way of minimizing this menace. Research problems were stated while research questions were also formulated in order to help address the problem statements of this subject. Statistical data were extracted from Mikael E and Oscar E. on Maritime disasters from 1852 to 2011. The data collected were analysed and findings were also made. The finding shows the causes and the effect of maritime disasters such as poor education and training, inadequate policies and procedures, external factors like bad weather, Technical factors like unavailability of advanced equipments like GMDSS, human factor and its effects such as financial loss to both, the ship owner and the nearby local communities is huge, loss of job, collision with an offshore structure or a port leads to infrastructure damage and thus cause a heavy blow to human efforts among others. Recommendations such as proper implementation of the latest STCW requirements, master took the proper measures (such as reduce speed, change course, go to a safe place, send distress signal, putting in place advanced technology systems that would reduce the risk of accidents were made at the end of the research to help curb this ugly menace.

Keywords: disaster, maritime, minimization.

GJRE-G Classification : FOR Code: 291299, 290502p

THECAUSESANDMINIMIZATIONOFMARITIMEDISASTERSONPASSENGERVESSELS

Strictly as per the compliance and regulations of:

The Causes and Minimization of Maritime Disasters on Passenger Vessels

Julius Okechukwu Anyanwu

Abstract- The issue of maritime disaster has become very worrisome to all stakeholders of the maritime industry, particularly the main actors in the industry. The causes and the consequent effects of maritime disasters are so numerous hence justifies this research work. Research and statistics show that human error is to blame in over 70% of marine accidents. As a matter of need and concern to the researcher and the maritime industry, the researcher was angered to carry out this work on minimization of maritime disasters with the view of contributing to the way of minimizing this menace. Research problems were stated while research questions were also formulated in order to help address the problem statements of this subject. Statistical data were extracted from Mikael E and Oscar E. on Maritime disasters from 1852 to 2011. The data collected were analysed and findings were also made. The finding shows the causes and the effect of maritime disasters such as poor education and training, inadequate policies and procedures, external factors like bad weather, Technical factors like unavailability of advanced equipments like GMDSS, human factor and its effects such as financial loss to both, the ship owner and the nearby local communities is huge, loss of job, collision with an offshore structure or a port leads to infrastructure damage and thus cause a heavy blow to human efforts among others. Recommendations such as proper implementation of the latest STCW requirements, master took the proper measures (such as reduce speed, change course, go to a safe place, send distress signal, putting in place advanced technology systems that would reduce the risk of accidents were made at the end of the research to help curb this ugly menace.

Keywords: disaster, maritime, minimization.

I. Introduction

According to Faulks (1990), the essence of maritime transport is to facilitate shipping activities by providing avenues through which large quantities of goods or freight can be transferred from one geographic space to another through water. In order to realize the principles objective of maritime transport, four important elements are necessary and these elements constitute maritime transport systems. These four elements are the vessel or vehicle, the way, the motive power and the terminal.

Following Garrick B. J (1999) there are several basic aspects of maritime activity that make it unique: ships are confined and isolated systems, self-sufficient on energy supply, they have a limited manpower and resources, and they have a limited response capacity to face emergencies. These particular characteristics made maritime trade a risky activity, where a fault in navigation or in usual port operations can give rise to injuries or lost of life, to damage of property and sometimes irreparable damage to maritime environment. Environmental and operational risks that can give rise to costly demands and complaints, are nowadays, in opinion of Palmgren (1999), a significant matter to owners, and the evaluation of these and other risks is an essential requirement to maritime trade safety Although risk, inherent to maritime industry, cannot be completely removed (UK P&I Club, 1999; Peek and Rawson, 2000), it can be reduced to acceptable levels through the use of risk management principles. However before putting in practice a risk management plan, the owner must identify, evaluate and prioritize the main existing risks.

On the other hand, several researches (UK P&I Club, 1999, US Department of Transportation, 1999) identify human error as cause of 60 and 80 per cent of maritime accidents, giving us an idea of the importance on maritime safety of quality living conditions on board – related to ship condition and maintenance– and quality of crews – related to crew competence and qualification. Since human factors –trigger of human errors– are the main source of risk in maritime activities, it seems interesting to develop methodologies that allow evaluating quantitatively and qualitatively the real incidence of several human factors over maritime accidents happening with the aim of taking human factors into account in properly developing risk management plans.

a) *Statement of the Problem*

Maritime activity is, without any doubt, a risky activity, and maritime disasters, that had happened through the years and which will happen in an inevitable way, are due to the complex environment of ship operation. Although maritime transport has a relatively low death and injury rate –180 estimated fatalities in 1995, against 45000 fatalities in road accidents happened the same year in the European Union–, the consequences of an accident happening are sometimes far reaching. The repercussions of oil pollution or large loss of life in a passenger carrying vessel, can reverberate for many years and take their toll on businesses, small economies and even governments (European Transport Safety Council, 2001a).

Author: Department of Maritime Management Technology, Federal University of Technology, Owerri. e-mail: okey_god2002@yahoo.com

On the other hand, and such it is indicated by Caridis (1999:11) "despite the significant advances that have been achieved in recent years in the field of marine technology, the number of maritime accidents that occur on a world – wide basis has not reduced significantly". This is due to, without any doubt, and as it has been shown in several studies, the high proportion of maritime accidents related to human factors– up to 80%.

So, even nowadays, when navigation instruments use new and advanced technologies, human error is generally accepted to be the main cause of such casualties. In relation to this, it is pointed out (Moreton, 1997) the wrong tendency to think that these new and improved technologies and rules can counteract the human limits increasing safety at sea, even when such technologies and rules are frequently developed in an isolated way, instead of being developed in an integrated way as a component of the navigation system.

In that sense, and following the Report on suggestion for the integration of human factors in safety and environmental analysis (Thematic Network for Safety Assessment of Waterborne Transport, 2003), there is a broad agreement that the key means of lessen the human element contribution to accidents will be via safety management, including inspection and training.

b) *Purpose of Study*

The general purpose of the study is minimization of maritime disasters. But specifically, the objectives of the study include;

i. To examine the major causes of maritime disaster.
ii. To find out the effect of maritime disaster to Nigerian economy in particular.
iii. To examine if the duration of maritime disaster influences survival rate.
iv. To find out casualties rate in Maritime disasters
v. To identify the various ways of minimizing maritime disasters

c) *Research Question*

Based on the specific objectives of the study, the following research questions were highlighted;

i. What are the major causes of maritime disasters?
ii. What are the various effects of maritime disaster to Nigerian economy in particular?
iii. Does duration of maritime disaster influences survival rate?
iv. What is the rate of casualties in Maritime disasters?
v. What are the various ways of minimizing maritime disasters?

d) *Significance of the Study*

This study is important because it focus on transportation. Transportation plays a vital role in the economic and socio-cultural development of any nation. This study is very significant and important to many categories of people, these include to the researcher, maritime transport practitioners, students and future researchers, administrators and policy makers, the government and academicians.

i. *To the researcher*

Although, there are little researches carried out in this area, all so this study is different from other studies because of its unique focus on maritime disaster, hence this research work afforded the researcher the opportunity of providing her with fresh dimension in understanding how the maritime disaster could be minimized.

ii. *To the students*

Students of maritime studies and students of allied studies will in no doubt see this material as a valuable document.

iii. *To the government and policy makers*

Another significance of this study is that, its report will be of great importance to the federal government since it equally highlight the negative implications associated with maritime disaster, hence helping Nigerian maritime sector as a federal agency and pivoting measures of curbing inefficiencies in Nigerian Shipping in particular and Nigerian Maritime sector in general. This research work will in no doubt guide policy makers in their policy and decision making.

iv. *To the stakeholders*

Stakeholders will find this material very valuable and as working document.

v. *To future researchers*

Moreover, the contribution of this study to knowledge can be seen in the sense that it will serve as a framework (both theoretical and empirical) for further research into the subject matter thereby filling an academic gap in the literature maritime disaster.

vi. *To the general Public*

This will help enlighten the general public about the various maritime accidents for over the years.

Finally, a rigorous research of this nature, culminating in concrete conclusions and recommendations will no doubt help to provide fresh dimensions for understanding the performance of public enterprises in Nigeria.

II. Literature Review

a) *Conceptual Framework*

The maritime transport system is a very complex and large-scale (Grabowski et al., 2010) socio-technical environment (STE) system comprising human and man-made entities that interact with each other and operate in a physical environment (Mullai, 2004). The main elements of the system are objects of transport, means of transport, infrastructures, and facilities, which are linked by the information system and transport-related activities. The human is a very important element that designs, develops, builds, operates, manages, regulates, and interacts with other elements of the system.

i. *Accidents, risks and risk analysis*

In essence, the concept of risk is defined as the likelihood of consequences of undesirable events (Vanem and Skjong, 2006; Hollnagel, 2008). Accidents and incidents are negative outcomes of the systems. The terms "marine accident and incident" and "marine casualty" denote undesirable events in connection with ship operations (IMO, 1996). An accident is an undesired event that results in adverse consequences, for example injury, loss of life, economic loss, environmental damage, and damage to or loss of property (Harrald et al., 1998; Grabowski et al., 2010). Accidents are due to an unexpected combination of conditions or events (Hollnagel et al., 2006).

ii. *Reason s why Maritime Accidents Occur*

Research and statistics show that human error is to blame in over 70% of marine accidents. Maritime accident occurs due to;

- Trips and falls,
- fire,
- pollution and collisions,
- failure in safe working practices.

Incidents most times result in crew injuries or fatalities, also the ship is being consequently delayed or damaged.

Consequently, when there is a mechanical failure, human error can play a role either by way of a lack of maintenance, monitoring, inadequate or lack of suitable equipment or protective devices, as well as breakdown in communication or procedures.

iii. *Manning Issues*

Crew fatigue and complacency can often be a major factor in incidents. The prudent ship owner or manager will ensure that these are addressed by way of additional manning or rotating the ship staff more regularly if the ship is employed on a demanding trade route.

However, owners and managers who are unable to do this could be due to; shortage or unavailable trained seafarers as a result of commercial or operational considerations.

Therefore good equipment can cost more, but safety should be accorded a higher priority, because a ship cannot be operated safely without the seafarer.

iv. *Ship Design*

Ship design is carried out by man and most times could have very little practical knowledge of the designing. However, in the modern world of shipbuilding, ship design team most times integrates the propositions of seafarers who are familiar with or may have sailed on the type of ship that is being designed.

Also proper supervision in ship building process ensures that discrepancies and potential problem areas are addressed. Highly skilled officers are also able to join the ship during the final fitting-out process in order to familiarize themselves with the ship.

vi. *Operating Standards*

Improved methodology in ship design does not completely address the problem, as the seafarer then has to decipher the operating manuals that are supplied with the equipment. The Confidential Hazardous Incident Reporting Programme (CHIRP) has recently concluded a study, with the help of the UK's Marine Accident Investigation Board, which shows that a substantial number of accidents are caused by operating manuals that are hard to understand.

Language can often be a major problem. The manual may not be written in the language of the crew on board, and is often merely a generic document. Given that adequate facilities are available for translation of manuals into just about any language, this is unacceptable.

vii. *Lack of Unified Standards*

Equipment problems are further compounded by the lack of a unified standard for essential equipment, including oily water separators, voyage data recorders and lifeboat launching equipment, and until regulatory and industry bodies are able to agree on a common standard, it is the seafarer who will be faced with understanding and operating equipment that is unfamiliar and unduly complex, often in less than ideal conditions.

b) The theoretical Framework

The key definitions and concepts relevant to model design are the maritime transport system, risks, risk analysis, and accident modeling.

The maritime transport system The maritime transport system is a very complex and large-scale (Grabowski et al., 2010) socio-technical environment (STE) system comprising human and man-made entities that interact with each other and operate in a physical environment (Mullai, 2004). The main elements of the system are objects of transport, means of transport, infrastructures, and facilities, which are linked by the information system and transport-related activities. The human is a very important element that designs, develops, builds, operates, manages, regulates, and interacts with other elements of the sys-tem. Individuals, groups, their relationships, and communication constitute organizational systems. These elements are embedded in very complex, interdependent, and dynamic relationships.

Accidents, risks and risk analysis In essence, the concept of risk is defined as the likelihood of consequences of undesirable events (Vanem and Skjong, 2006; Hollnagel, 2008). Accidents and incidents are negative outcomes of the systems. The terms "marine accident and incident" and "marine casualty" denote undesirable events in connection with ship operations (IMO, 1996). An accident is an undesired even that results in adverse consequences, for example injury, loss of life, economic loss, environmental damage, and damage to or loss of property (Harrald et al., 1998; Grabowski et al., 2010). Accidents are due to an unexpected combination of conditions or events (Hollnagel et al., 2006). Risk analysis is the systematic use of available information to identify hazards and estimate the risk to people, the environment, and property (Mullai, 2004; Lars Harms-Ringdahl, 2004). In order to understand risks, risk analysis attempts to provide answers to three fundamental questions: "What can go wrong?" "What are the consequences?" and "How likely is that to happen?" – known as the "triplet definition" of risk (Kaplan et al., 2001). These questions can lead to other questions, which, in turn, require additional answers and efforts. Risks can also be measured as a combination of consequences relative to the number of risk receptors exposed to the undesirable events. This form of risk estimation has become a legal requirement in several countries (OECD, 2004). Thus, the risk can be expressed as a function (f) of frequency, consequence, and exposure (Eqs.(1) and (2)) (Mullai, 2007).

$$Ri=f(Fi,Ci,Ei) \quad (1)$$

$$Ri=f(Fi,Ci) \quad (2)$$

Where: Ri– individual, societal, and aggregated risks. The latter are compounded human risks (fatality, injury, and other health risks), environmental risks, property risks, and other risks.

Fi– frequency– likelihood, probability;

Ci– consequences for risk receptors, i.e. human, the environment, property, and other, e.g. disruption and reputation.

Ei– exposure, i.e. the number and categories of risk receptors exposed to but not necessarily affected by the undesirable events.

By definition, the concepts of risk and risk analysis have a wider scope than those of accident and accident analysis. The accident is a constituent element of the risk. Risk analysis encompasses a wider range of processes than accident analysis, including exposure analysis and risk estimation and presentation Accident models Different terms are used to describe accident phenomena as well as analysis tools, for example approaches, techniques, frameworks, methodologies, methods, and models. The term accident model isfrequently used in the literature (Leveson, 2004; Grabowski et al.,2000; Nikolaos et al., 2004; Laracy, 2006).

Accident analysis, which always implies an accident model (Hollnagel, 2002), is a very important process for providing inputto the development of proactive and cost-effective regulations (Psarros et al., 2010). An accident model is an abstract conceptual representation of the occurrence and development of an accident; it describes the way of viewing and thinking about how and why an accident occurs and predicts the phenomenon (Huang et al., 2004; Hollnagel, 2002). Hollnagel (Hollnagel, 2002; Hollnagel et al., 2006) divide accident models into three main types, namely Sequential, epidemiological, and systemic and functional. Each type consists of a set of assumptions on how the reality is viewed and how accident analysis should be performed and the theoretical foundation and limitations (Hollnagel, 2002; Hollnagel et al., 2006). Epidemiological accident models describe an accident as the outcome of a combination of factors. Such models are rarely strong, as they are difficult to specify in great detail. Systemic accident models consider accidents as emergent phenomena and are based on control theory, chaos models, stochastic resonance, and systems approach.

In the latter, the system is viewed as a whole rather than individual components or functions. Systemic models are difficult to represent graphically (Hollnagel, 2002; Hollnagel et al., 2006). Most accident models are sequential viewing accidents as a sequential chain of events that occur in a specific order (Harraldet al., 1998; Hollnagel, 2008; Leveson, 2004; Nikolaos et al., 2004; Van Drop et al., 2001; Özgecan and Ulusc u, 2009; Celik et al., 2010). Three typical sequential models, namely the Bowtie model, Swiss cheese model, and a framework for maritime risk assessment.

c) Empirical Framework

A work on A Maritime Disaster: Reactions and Follow-up by Atle Dyregrov and Rolf Gjestad in 2003. In 1999, 69 people survived a maritime disaster on the Norwegian coast, during which 16 others died. Besides immediate psychosocial assistance, post-disaster intervention included psychological debriefings after one week, follow-up debriefing a month later, screening of those in need of individual help, and help for those returning to the scene of the disaster. The results of the psychometric tests showed that a considerable number of survivors scored above clinical cut-off points for extreme stress reactions. These results were compared with results from other studies of maritime disasters. Although the life threat and exposure in this disaster were extreme, the scores were lower than for the other studies, with one exception. The authors concluded the lower distress scores compared to other maritime disasters were probably impacted by the structured and caring system that was implemented to care for survivors. Almost all (93%) considered the debriefing meetings as helpful, and they were able to discriminate between different functions served by the meetings.

A significant portion of survivors of disasters experience symptoms of posttraumatic stress disorder (PTSD) (Bolton, O'Ryan, Udwin, Boyle, & Yule, 2000;

Briere & Elliot, 2000; Yule, Bolton, Udwin, Boyle, & O'Ryan, 2000). In a meta analysis of 52 studies examining the mental health consequences of natural and technological disasters, Rubonis and Bickman (1991) found rates of psychopathology increased by 17% compared with predisaster or control-group levels. Given the diversity of disasters, both manmade and natural, no unitary PTSD prevalence would be expected. Systematic reports on survivors of shipping disasters are rare, although observations and case reports are abundant. When the Italian ships *Andrea Doria* and the Swedish ship *Stockholm* collided outside of Massachusetts in 1956, two psychiatrists were on board one of the ships that came to the rescue. Friedman and Linn (1957) describe how the passengers behaved as if they were numb from being injected by medication. The psychiatrists viewed their helplessness as an emotional regression. They were in shock and any attempt at conversation was impossible before the shock reaction lifted. They had a need to tell their story again and again, afterwards. Leopold and Dillon (1963) studied 27 of 35 survivors following a ship collision and explosion and found that 72% suffered from emotional disturbances following the disaster. When they again studied the group four years later, there was a dramatic degree of physical, psychological, and social aftereffects from the disaster. One of the first maritime disasters to be studied in any detail from a psychological perspective was the capsizing of the ferry *Herald of Free Enterprise* outside of the Belgian city of Zeebrügge in 1987. Joseph, Yule, Williams, and Hodgkinson (1993a) studied 73 adult survivors, two to three years after the disaster and found the mean Impact of Event Scale (IES) score to be 35, while the mean score on the General Health Questionnaire (GHQ-28) was 10. On the GHQ more than 66% scored above the cut-off score of > 4 that indicates a risk of a psychological disturbance. The same research group also documented different forms of guilt feelings among survivors (Joseph, Hodgkinson, Yule, & Williams, 1993), as well as an increase in the use of alcohol, tobacco, sleeping pills, antidepressants, and tranquilizers (Joseph, Yule, Williams, & Hodgkinson, 1993b). Joseph, Andrews, Williams, and Yule (1992) studied crisis support and psychiatric symptomatology in 23 adult survivors following the sinking of the cruise ship *Jupiter* off the cost of Athens in October 1988. The survivors' mean IES score when assessed 3 to 9 months following the disaster was 32.3. After 12 to 14 months, the IES score was 29.9. On the GHQ-28, the respective scores at the two time points were 12.6 and 8.9. The authors also found that perception of greater crisis support was related to less symptomatology. The same research group also studied adolescent survivors of the same disaster. To date, this is one of the few longitudinal studies of a maritime disaster. Yule, Bolton, Udwin, Boyle, O'Ryan, and Nurrish (2000) have shown that approximately 50% of adolescent survivors of the *Jupiter* disaster developed PTSD sometime during the follow-up period compared with an incidence of 3.4% in a control group. Between five and eight years after the disaster, 34% of these still suffered from PTSD. In another English study, Thompson, Chung, and Rosser (1994) studied the reactions of 27 survivors following the collision and sinking of the riverboat *Marchioness* on the Thames. Fifty-one persons in a birthday party drowned and 40 survived. Of the 27 survivors studied, 22 were men with a mean age of 28. Their mean IES score was 46 and the GHQ-28 mean was 15.5 when they were assessed more than one year following the disaster. The survivors knew those who were killed, and 25 of the 27 had lost close friends. Elklit and Bjerre Andersen (1994) studied 24 of 31 Danish survivors following the fire on board the ferry *Scandinavian Star* in 1990 where 159 people died. Their mean IES score 1½ years after the disaster was 23.0 and after three years, the score was 21.7. The group generally received much crisis support from Danish Red Cross in the early period following the disaster. It should be mentioned that most survivors escaped safely into the lifeboats without being exposed to either fights for survival or the sight of the people that were killed. The largest maritime disaster in the Northern hemisphere in modern times was the sinking of the *Estonia* in the Baltic Sea in 1994 where 852 died and 137 survived. Eriksson and Lundin (1996) studied 42 of the 53 Swedish survivors three months following the disaster and found their IES score to be 28.5. The survivors reported fairly high levels of dissociative symptoms in the form of reduction of awareness, derealization, depersonalization, and dissociative amnesia during the disaster. This peritraumatic dissociation was related to more post-traumatic symptoms on the IES. There is no standardized way of helping survivors in the aftermath of disasters. A range of disaster interventions has been described by authors such as Hodgkinson and Stewart (1991), Dyregrov (1992), and Raphael (1986). In Norway, psychosocial disaster intervention has been used since the mid- 1980s to assist the bereaved and survivors (Dyregrov, 1992). Early intervention is emphasized to try to prevent the development of adverse reactions. Following several Scandinavian disasters, the lack of long-term follow-up to secure good help for those who have survived or lost family members has been identified (Dyregrov, 2002; SOU, 1999). Although early intervention is debated (Shalev, 2000 and *Advances in Mind Body Medicine, No. 3*, 2001), there is no alternative to treating survivors with a caring system. Proactive post-disaster service delivery, including screening those in need of further help, is still at a developmental stage. There is also lack of agreement as to the optimal type of screening instruments, and only rarely (McDermott & Palmer, 1999) have screening inventories been used to secure help for those most in need of further follow-up. Both demographic and event-related factors might influence the choice of screening questionnaires. The use of psychological debriefing, or group follow-up after critical incident situations, has been highly debated over the last decade (Raphael & Wilson, 2000). Although the term "debriefing" originally referred to Dr. Jeffrey Mitchell's structured group meetings for emergency personnel responding to critical events, the term debriefing has been used to describe almost any type of intervention initiated after a critical incident event. Though individual and group follow-up has been in use following disasters for several decades, the debate on debriefing is somewhat new. Participants of debriefings usually rate the method as useful and important for them (Carlier, Voerman, & Gersons, 2000; Jenkins, 1996; Robinson & Mitchell, 1993; Turner, Thompson, & Rosser, 1993), but the few randomized studies undertaken have failed to find that "debriefing" makes a difference in the reported symptom level over time. However, these studies and the critics of debriefing (see Rose & Bisson, 1998) have based their criticism mostly upon individual follow-up of patients provided with a one-hour intervention following medical emergencies (burn victims, traffic accidents, and pregnancy loss). There are other flaws in this research as well, as cited by Dyregrov (1998) and Mitchell and Hopkins (1998). More recent documentation using meta-analysis of studies to evaluate group meetings that more rigorously follow the "Mitchell Model" has shown strong and clinically valid effects of this method (Everly & Boyle, 1999). Watchorn (2000 & 2001) has presented data showing that those who take an active part in the debriefing meetings seem to gain most from these meetings and that persons reporting high dissociation (feelings of "standing outside oneself" or "watching oneself from a distance") and a low level of disclosure are the ones at greater risk to experience later problems.

III. Methodology

- *Research Design*

Adopted for this investigation is ex-post facto design. Isan edighi, Josnuwa, Asim and Ekuns (2004:15) pointed out that ex-post factor design in research is the one in which there is a systematic empirical inquiring in which the researcher does not have direct control of independent variables because, their manifestations have already occurred. The ex-post factor design is justified for use in this study because the variables it investigates have no direct control by the researcher.

- *Population for the study*

Though secondary data from Mickel E and Oscar E formed the major base for analysis, the population for the study also consists of all the staff of NPA traffic dept in Lagos, Nigeria

- *Instrument*

The instrument for data collection was the questionnaire. It consists of two sections, A and B. Section A deals with demographic or personal characteristics of the respondents. B deals with item measuring the specific variables used in the research questions. The questionnaire is a close ended type developed on Linkert Scale to elicit information to the respondents on the degree to which the respondents possessed the attributes of variables under investigation. The section B consists of Sub-Sections each handling a particular variable of the study.

a) Data Presentation and Analysis

For the purpose of this research, secondary data were collected to address the research questions, 18 maritime disasters over the period 1852–2011 were compiled and analyzed. The data cover the fate of over 15,000 passengers and crew members of more than 30 different nationalities.

Table 1 : Maritime disasters from 1852 to 2011

Name of ship	Year	Cause of disaster	Water	Nationality	Duration	WCF Order	Casualties	Survivors
HMS Birkenhead	1852	Grounding	Indian Ocean, RSA	British	Quick	Yes	365	191
SS Arctic	1854	Collision	North Atlantic, CAN	US	Slow	Yes	227	41
SS Golden Gate	1862	Fire	Pacific Ocean, MEX	US	Slow	No	206	172
SS Northfleet	1873	Collision	English	Channel, UK British	Quick	Yes	287	80
RMS Atlantic	1873	Grounding	North Atlantic, CAN	British	Slow	No	538	330
SS Princess Alice	1878	Collision	River Thames, UK	British	Quick	No	697	140
SS Norge	1904	Grounding	North Atlantic, UK	Danish	Quick	No	635	160
RMS Titanic	1912	Collision	North Atlantic, CAN	British	Slow	Yes	1,496	712
RMS Empress of Ireland	1914	Collision	St Lawrence River, CAN	British	Quick	No	983	465

RMS Lusitania	1915	Torpedoed	North Atlantic, UK	British	Quick	Yes	1,190	768
SS Principessa Mafalda	1927	Technical	Atlantic Ocean, BRZ	Italian	Slow	No	309	877
SS Vestris	1928	Weather	Atlantic Ocean, USA	British	Slow	No	125	183
SS Morro Castle	1934	Fire	Atlantic Ocean, USA	US	Slow	No	130	412
MVPrincess Victoria	1953	Weather	North Channel, UK	British	Slow	No	135	44
SSAdmiral Nakhimov	1986	Collision	Black Sea, UKR	Russian	Quick	No	423	820
MS Estonia	1994	Technical	Baltic Sea, FIN	Estonian	Slow	No	852	137
MSPrincess of the Stars	2008	Weather	Philippine Sea, PHI	Philippine	Slow	Unkn own	791	59
MV Bulgaria	2011	Weather	Volga, RUS	Russian	Quick	Unkn own	110	76

Source: Mikael Elinder and Oscar Erixson

Duration refers to the time period between the first indication of distress and the sinking. Quick (Slow) implies that the time period was shorter (longer) than 30 minutes. WCF order indicates if the captain gave the WCF (women Children Frist) order.

b) Analysis of Research Questions

Table 2 : What are the major causes of maritime disasters?

Causes	No	Percentage
Grounding	3	16.6
Collision	6	33.3
Fire	2	11.1
Torpedoed	1	5.5
Total	18	100

The above table shows that grounding represents 16.6% of the causes of marine accidents, collision 33.3%, and fire 11.1% while Torpedoed is 5.5%. From the research questionnaire

Table 3 : What are the causes Marine accidents

S/N	RESPONSES	SA	X4	A	X3	D	X2	SD	X1
1	Human factor	8	32	2	6	0	0	0	0
2	Poor education and training	6	24	4	8	0	0	0	0
3	Inadequate policies and procedures	9	36	1	3	0	0	0	0
4	External factors like bad weather	8	32	2	6	0	0	0	0
5	Technical factors like unavailability of advanced equipments like GMDSS	8	32	1	3	1	3	0	0
	Total	39	156	10	26	1	3	0	0

From the above table, it could be deduced that almost all the respondents agreed that the causes of maritime accident include human factor 8 strongly agree and 2 agree, poor education and training 6 strongly agree and 4 agree, inadequate policies and procedures 9 strongly agree and 1 agree, external factors 8 strongly agree and 2 agree and technical factors 8 strongly agree, 1 agree and 1 disagree.

Table 4 : What are the various effects of maritime disaster to Nigerian economy in particular?

Name of ship	Year	Casualties	Survivors
HMS Birkenhead	1852	365	191
SS Arctic	1854	227	41
SS Golden Gate	1862	206	172
SS Northfleet	1873	287	80
RMS Atlantic	1873	538	330

SS Princess Alice	1878	697	140
SS Norge	1904	635	160
RMS Titanic	1912	1,496	712
RMS Empress of Ireland	1914	983	465
RMS Lusitania	1915	1,190	768
SS Principessa Mafalda	1927	309	877
SS Vestris	1928	125	183
SS Morro Castle	1934	130	412
MVPrincess Victoria	1953	135	44
SS Admiral Nakhimov	1986	423	820
MS Estonia	1994	852	137
MS Princess of the Stars	2008	791	59
MV Bulgaria	2011	110	76
Total		**9499**	**5484**

Source: Extracted from table 1

From the above table, it can be observed that death/casualties are one of the effects of maritime disasters. It can also be deduced that materials and cargoes on board the vessel are liable to loss as well.

From the research question,

Table 5 : What are the various effects of maritime disaster to Nigerian economy in particular

S/N	RESPONSES	SA	X4	A	X3	D	X2	SD	X1
6	Collision leads to detrimental environmental effects.	8	32	2	6	0	0	0	0
7	Financial loss to both, the ship owner and the nearby local communities is huge	6	24	4	8	0	0	0	0
8	Ship collision renders substantial threat to human life.	9	36	1	3	0	0	0	0
9	Collision with an offshore structure or a port leads to infrastructure damage and thus cause a heavy blow to human efforts.	8	32	2	6	0	0	0	0
10	Loss of jobs	8	32	1	3	1	3	0	0
	TOTAL	39	156	10	26	1	3	0	0

Source: Researchers

From the above table, it shows that almost all the respondents agreed that the effect of maritime accident include detrimental environmental effects 8 strongly agree and 2 agree, financial loss 6 strongly agree and 4 agree, threat to human life 9 strongly agree and 1 agree, marine structures damage 8 strongly agree and 2 agree and loss of job 8 strongly agree, 1 agree and 1 disagree.

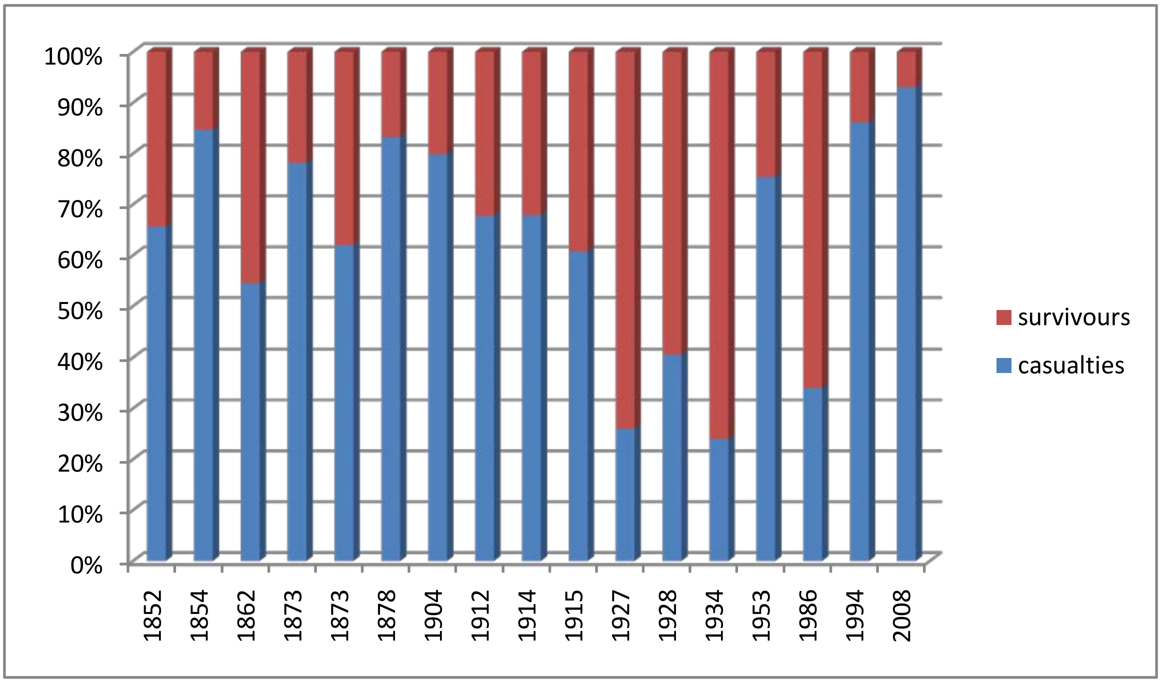
Table 6 : Does the duration of maritime disaster influences survival rate?

Quick	8	Survivors	2700	Casualties	4690
Slow	10	Survivors	2784	Casualties	4809
Total	**18**	**Total**	**5484**	**Total**	**9499**

The above table shows that 8 accident/disaster cases recorded quick duration while 10 accident cases recorded slow duration. The table further show that 2784 survivors were recorded during slow duration of the disaster and 2700 survivors were recorded during quick duration of the disaster. Also 4690 casualties were recorded during quick duration of the disaster while 4869 were recorded during slow disaster duration.

Table 7 : What is the rate of casualties in Maritime disasters?

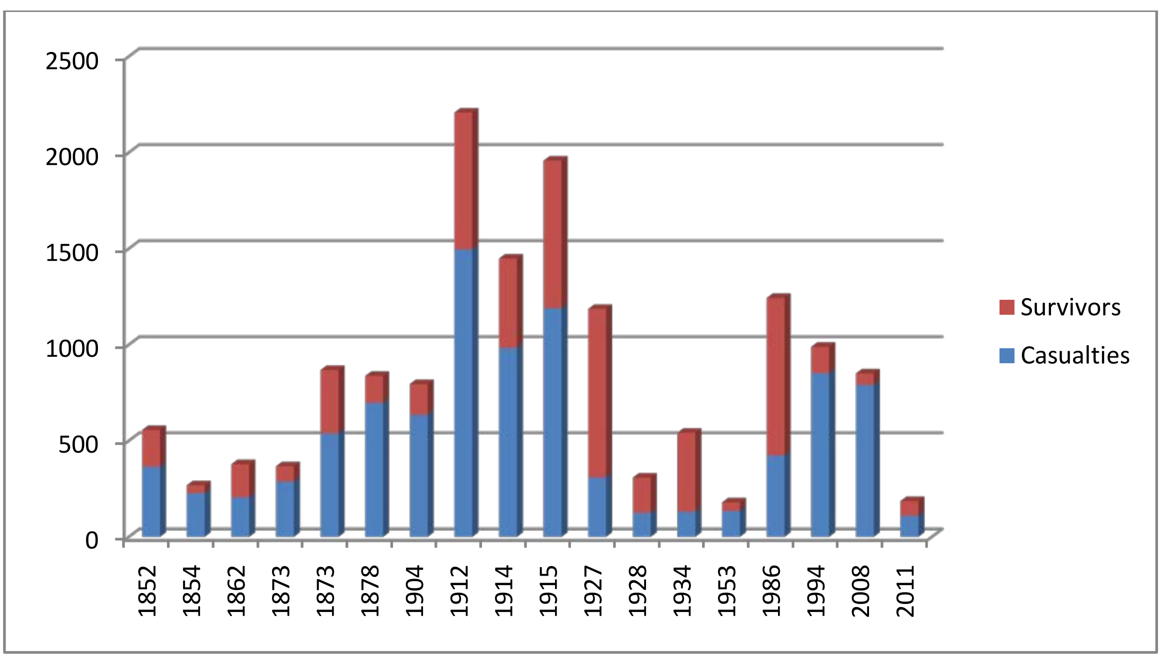
Name of ship	Year	Casualties	Survivors
HMS Birkenhead	1852	365	191
SS Arctic	1854	227	41
SS Golden Gate	1862	206	172
SS Northfleet	1873	287	80
RMS Atlantic	1873	538	330
SS Princess Alice	1878	697	140
SS Norge	1904	635	160
RMS Titanic	1912	1,496	712
RMS Empress of Ireland	1914	983	465
RMS Lusitania	1915	1,190	768
SS Principessa Mafalda	1927	309	877
SS Vestris	1928	125	183
SS Morro Castle	1934	130	412
MV Princess Victoria	1953	135	44
SS Admiral Nakhimov	1986	423	820
MS Estonia	1994	852	137
MS Princess of the Stars	2008	791	59
MV Bulgaria	2011	110	76
Total		**9499**	**5484**



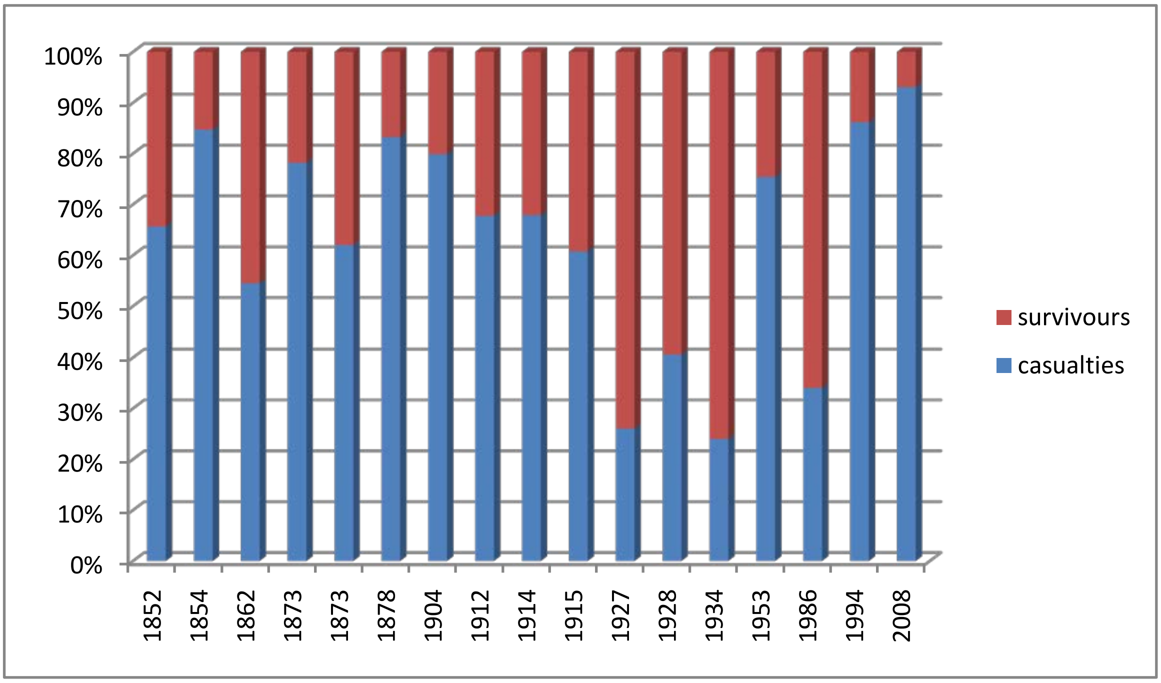
Source: Researchers

The above table and figure shows that the number of casualties and survivors in percentages recorded between the period of 1852 to 2011 of maritime disasters is 9499 of the total of 14903. This figure represents 63.7% of the total passengers and crew members on board.

This could be further analysed using charts as show in fig 1 and 2.



Source: Researchers



Source: Researcher

Table 6 : What are the various ways of minimizing maritime disasters?

S/N	RESPONSES	SA	X4	A	X3	D	X2	SD	X1
1	proper implementation of the latest STCW requirements	8	32	2	6	0	0	0	0
2	Education and training of personnel	6	24	4	8	0	0	0	0
3	Effective compliance to Policies and procedures	9	36	1	3	0	0	0	0
4	Master took the proper measures (such as	8	32	2	6	0	0	0	0
	reduce speed, change course, go to a safe place, send distress signal								
5	Putting in place advanced technology systems that would reduce the risk of accidents	8	32	1	3	1	3	0	0
	Total	39	156	10	26	1	3	0	0

Source: Researchers

From the above table, it could be deduced that almost all the respondents agreed that various ways of minimizing maritime distress include proper implementation of the latest STCW requirements with 8 strongly agree and 2 agree, education and training 6 strongly agree and 4 agree, compliance to policies and procedures 9 strongly agree and 1 agree, Master took the proper measures (such as reduce speed, change course, go to a safe place, send distress signal 8 strongly agree and 2 agree and putting in place advanced technology systems that would reduce the risk of accidents 8 strongly agree, 1 agree and 1 disagree.

IV. Conclusions

This research on minimizing maritime disasters has observed that poor crew competence, lack of communication, lack of proper maintenance, lack of application of safety or other procedures, inadequate training, poor judgment of the situation, and so forth has contributed to more than 80 percentage of marine accidents occasioned by human factor.

It also observed the various consequences of maritime disasters such as threat to human life, lose of job and finance both to the ship owners and the communities, environmental hazards and destruction of maritime facilities among others. The duration of maritime accidents has also been seen as slow in most cases, this means that urgent and quick responses should be in place to salvage lives and properties in case of any mishap at seas.

The study also see education and training of ship personnel as very important which might constitute one of the most important risk reduction measures.

It also noted that training programs that ensure proper implementation of STCW requirements are some of the ways towards achieving this goal. Also training with marine simulators furthers the enhancement of this requirement.

The issue related to technical factors is the central question to what extent accidents might have been averted if the ship had a higher structural strength, a different tank subdivision, or different design characteristics. The central premise behind the new IMO/IACS requirements for bulk carriers and the new IMO/SOLAS requirements for Ro/Ro ferries is that these requirements would enhance safety.

On research question 2 on the effect of maritime accident, if the ship involved in a collision is a tanker or a chemical vessel then there are high chances of the chemical or oil leaking to the sea. Oil spills, both a major and a minor, can lead to untoward conditions for the marine life and also to the nearby coastal areas.

Job loss and financial loss to both, the ship owner and the nearby local communities is huge.

Ship collision renders substantial threat to human life. There has been accidents in past when the ship has sank within minutes, giving no chance to the people on board to escape.

Damage of infrastructures due to collision is a heavy blow to human efforts. Past collisions with bridges and port structures have resulted in heavy financial and efforts loss.

V. Recommendations

This study has been thoughtful considering the implication of the subject matter to the maritime industry and other concern stakeholders.

The following recommendation has been very imperative;

- Considering the causes of maritime disaster as discussed in this research work, the researcher suggest adequate training and full compliance to marine rules and regulations in other to minimize the rate of accidents. Hence emphasis on the existence and establishment of proper policies and procedures should be made.
- There should be adequate training with marine simulators.
- Strict sanctions should be imposed on defaulters.
- The issue with respect to technical factors relates to the possible role of advanced technology systems that would reduce the risk of accidents if in place. This could include highly sophisticated marine equipments like VTMIS, ECDIS, and collision avoidance systems.

References Références Referencias

1. Alvesson, M. *Understanding organizational culture*. London: Sage. (2002).
2. Anderson, P. *ISM Code – A practical guide to the legal and insurance implications*. London: Informa Professional. (2005).
3. Axel Ax:son Johnsons institut för sjörätt och annan transporträtt. (2006). *The Swedish maritime code in Swedish and English* (3d ed.). Stockholm: Axel Ax:son Johnsons institut för sjörätt och annan transporträtt.
4. Becker SW & Eagly AH The heroism of women and men. *American Psychologist* 59(3):163-178. Cameron CA (2004).
5. Berg, B. L. *Qualitative research methods for the social sciences*. Boston: Allyn & Bacon. (2009).
6. Borg, E., Westerlund, J. *Statistik för beteendevetare*. Stockholm: Liber AB. (2006).
7. Branch, A. E. *Elements of shipping*. Abingdon, UK: Routledge. (2007).
8. Committee on the effect of smaller crews on maritime safety, Marine board, Commission on engineering and technical systems, National research council. (1990). *Crew size and maritime safety*. Washington DC: National academy press.
9. Garrick, B.J. (1999) Risk assessment methodologies applicable to marine systems, *Proceedings of the Marine Safety Council* 56/3, 50–52.
10. Grabowski, M., Merrick, J.R.W., Harrald, J.R., Mazzuchi, Th.A., Rene van, J., 2000. Dorp risk modeling in distributed, large-scale systems. IEEE Transactions on Systems, Man and bernetics Part A: Systems and Humans 30 (6), 2000.
11. Grabowski, M., et al (2010). Sailing on friday: developing the link between safety culture and performance in safety-critical systems. IEEE Transactions on Systems, Man and Cybernetics – Part A: Systems and Humans 40 (2).
12. Hollnagel, E.,. (2002) Understanding accidents – from root causes to performance variability. In: IEEE 7 Human Factors Meeting Scottsdale Arizona.
13. Hollnagel, E., 2008. Risk + barriers = safety? Safety Science 46, 221–229.
14. Joyce CA ed (2007) *The World Almanac and Book of Facts 2008* (World Almanac Books).
15. Faulks (1990): Principles of Transport 4th Edition. MC.Graw-Hill Book company. (UK) limited. England.
16. Frey BS, Savage DA, & Torgler Interaction of natural survival instincts and internalized social norms exploring the Titanic and Lusitania disasters. *Proceedings of the National Academy of Science U S A* 107(11):4862-4865. B (2010).
17. Frey BS, Savage DA, & Torgler B. Behavior under Extreme Conditions: The Titanic Disaster. *Journal of Economic Perspectives* 25(1):209-222. (2011).
18. Hall W (1986) Social class and survival on the S.S. Titanic. *Social Science & Medicine* 22(6):687-690.
19. IMO (International Maritime Organisation), 1996. Code of the Investigation of Marine Casualties and Incidents, FSI 5/10/2.

20. Mawson AR Understanding mass panic and other collective responses to threat and disaster. *Psychiatry* 68(2):95-113. (2005).
21. Mickel E and Oscar E. Gender, Social Norms and Survival in Maritime Disasters. Research Institute of Industrial Economics (IFN). P.O Box 55665, SE-102 15 Stockholm, Sweden.
22. Mullai, A., (2004). A risk analysis framework for maritime transport of packaged dangerous goods. In: Brindley, C. (Ed.), Supply Chain Risk. Ashgate Publishing Company, Aldershot, Hampshire, England, pp. 130–159.
23. Mullai A. A (2007) Risk Analysis Framework for Maritime Transport of Packaged Dangerous Goods: A Validating Demonstration. PhD thesis, Lund University, Lund Institute of Technology, Department of Industrial Management and Logistics, Lund, Sweden,; Volume I & II, pp. 1–210, 1–330.
24. Palmgren, N.G. (1999) Foreword of managing risk in shipping. In: The Nautical Institute (Ed.). *Managing risk in shipping*, London.
25. Trivedi PK. *Microeconometrics: Methods and Applications* (Cambridge University Press). (2005).

Global Journal of Researches in Engineering: G
Industrial Engineering
Volume 14 Issue 2 Version 1.0 Year 2014
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Investigation of Sigma Level at the Stage of Testing Cement after Packing and Improving it using FMEA Approach

By Md. Golam Kibria, Md. Enamul Kabir & S. M. Mahbubul Islam Boby
Khulna University of Engineering &Technology (KUET), Bangladesh

Abstract- Sophisticated customer demands and advanced technology have changed the way of conducting business. Financial condition of a manufacturing company largely depends on the defect rate of a product. Understanding the key features, obstacles, and shortcomings of the six sigma method allows organizations to better support their strategic directions, and increasing needs for coaching, mentoring, and training. The objectives of this paper are to study and evaluate processes of the case organization, to find out the current sigma level and finally to improve the existing Sigma level through decreasing defects. According to objectives, current sigma level has been calculated, manufacturing process analyzed and suggestions given for improvement. Especially in analyzing phase different analysis tools like Production Layout, Process Block Diagram, Cause and Effect Diagram, Cheek Sheet, Process control chart are used. FMEA is used as improvement tool. By using this it has been possible to improve productivity by reducing defects rate. This research work has been carried out in a cement manufacturing company to show how to implement Six- Sigma in this type of industry. This research related work does not only apply to cement manufacturing company but also in any other types of organizations. By implementing Six-Sigma a perfect synchronization among cost, quality, production time and control time can be achieved.

Keywords: six-sigma, improvement, process control chart, sigma level, FMEA.

GJRE-G Classification : FOR Code: 290502p

INVESTIGATIONOFSIGMALEVELATTHESTAGEOFTESTINGCEMENTAFTERPACKINGANDIMPROVINGITUSINGFMEAAPPROACH

Strictly as per the compliance and regulations of:

Open Association of Research Society, USA
Research | Diversity | Ethics

Investigation of Sigma Level at the Stage of Testing Cement after Packing and Improving it using FMEA Approach

Md. Golam Kibria [α], Md. Enamul Kabir [σ] & S. M. Mahbubul Islam Boby [ρ]

Abstract- Sophisticated customer demands and advanced technology have changed the way of conducting business. Financial condition of a manufacturing company largely depends on the defect rate of a product. Understanding the key features, obstacles, and shortcomings of the six sigma method allows organizations to better support their strategic directions, and increasing needs for coaching, mentoring, and training. The objectives of this paper are to study and evaluate processes of the case organization, to find out the current sigma level and finally to improve the existing Sigma level through decreasing defects. According to objectives, current sigma level has been calculated, manufacturing process analyzed and suggestions given for improvement. Especially in analyzing phase different analysis tools like Production Layout, Process Block Diagram, Cause and Effect Diagram, Cheek Sheet, Process control chart are used. FMEA is used as improvement tool. By using this it has been possible to improve productivity by reducing defects rate. This research work has been carried out in a cement manufacturing company to show how to implement Six- Sigma in this type of industry. This research related work does not only apply to cement manufacturing company but also in any other types of organizations. By implementing Six-Sigma a perfect synchronization among cost, quality, production time and control time can be achieved.

Keywords: six-sigma, improvement, process control chart, sigma level, FMEA.

I. Introduction

Six- Sigma is a statistical measurement of only 3.4 defects per million. Six-Sigma is a management philosophy focused on eliminating mistakes, waste and rework. It establishes a measurable status to achieve and embodies a strategic problem-solving method to increase customer. Satisfaction and dramatically reduce cost and increase profits. Six-Sigma gives discipline, structure, and a foundation for solid decision making based on simple statistics. The real power of Six Sigma is simple because it combines people power with process power.

Author α: Lecturer, Department of Industrial Engineering & Management (IEM), Khulna University of Engineering &Technology (KUET), Khulna-9203, Bangladesh. e-mail: kibira.ipe.kuet@gmail.com
Author σ ρ: Undergraduate student, Department of Industrial Engineering & Management (IEM), Khulna University of Engineering &Technology (KUET), Khulna-9203, Bangladesh.
e-mails: enamkuet@yahoo.com, bobyipe@yahoo.com

The Six Sigma is a financial improvement strategy for an organization and now a day it is being used in many industries. Basically it is a quality improving process of final product by reducing the defects; minimize the variation and improve capability in the manufacturing process. The objective of Six Sigma is to increase the profit margin, improve financial condition through minimizing the defects rate of product. It increases the customer satisfaction, retention and produces the best class product from the best process performance. If an organization is focused on customer satisfaction, then Six Sigma will offer a method and some tools for the identification and improvement of both internal and external process problems to better meet customer needs by identifying the variations in organization's processes that might influence the customer's point of view, negatively.

II. Literature Review

Though Fredrick Taylor, Walter Shewhart and Henry Ford played a great role in the evolution of six-sigma in the early twentieth century, it is Bill Smith, Vice President of Motorola Corporation, who is considered as the Father of Six-sigma. Fredrick Taylor came up with the methodology of breaking systems into subsystems in order to increase the efficiency of manufacturing process. Henry Ford followed his four principles, namely continuous flow, interchangeable parts, division of labor and reduction of wasted effort, in order to end up in an affordable priced automobile. The development of control charts by Walter Shewhart laid the base for statistical methods to measure the variability and quality of various processes.

Later during the 1950s, the Japanese Manufacturing sector revolutionized their quality and competitiveness in the world based on the works of Dr. W. Edwards Deming, Dr. Armand Feigenbaum, and Dr. Joseph M Juran. Dr. W. Edwards Deming developed the improvementcycle of 'Plan-Do- Check-Act', better known as the PDCA cycle. Dr. Joseph M Juran gave to the world his 'Quality Trilogy' and it was Dr. Armand Feigenbaum who initiated the concepts of 'Total Quality Control' (TQC). Between 1960 and 1980, the Japanese understood that everyone in an organization is important to maintain quality and so training programs were conducted for almost all employees not considering the department they belong to. Any organization that is dynamically working to build the theme of six-sigma and to put into practice, the concepts of six-sigma, in its daily management activities, with noteworthy improvements in the process performance and customer satisfaction is considered as a six –sigma organization [3].

M. Sokovićet al. undertook papers to identify areas in the process where extra expenses exist, identify the biggest impact on production expenses, introduce appropriate measurement system, improve process and reduce expenses on production times, and implement improvements [4]. Gustav Nyren represented the variables influencing the chosen characteristics variable and then optimized the process in a robust and repeatable way [5].John Racine focuses on what six-sigma is today and what its roots are both in Japan and in the west and what six-sigma offers the world today [6]. Zenon Chaczkoet al. introduced a process for the module level integration of computer based systems which is based on the Six-sigma Process Improvement Model, where the goal of the process is to improve the overall quality of the system under development [7]. Philip Stephen highlighted a distinct methodology for integrating lean manufacturing and six-sigma philosophies in manufacturing facilities [8]. Thomas Pyzdek focuses that helps the user identify worthy papers and move them steadily to successful completion, the user identify poorly conceived papers before devoting any time or resources to them, the user identify stalled papers and provide them with the attention they need to move forward again, the user decide when it's time to pull the plug on dead papers before they consume too much time and resources and provide a record for the user that helps improve the paper selection, management and results tracking process.

III. Methodology

The preface of implementing Six-sigma is very complicated job with several steps, which relates to observe carefully, and concentrating deeply in all of the processes. Data was collected through interviews, discussions and questionnaire. All data were useful here for better understanding the production system. The collected data then interpreted into suitable format for the concerned study. The methodology, which is used in this study, enables to collect valid and reliable information and to analyze those data to conclude with a correct decision. Defects were observed and their root causes were investigated. After getting the existing scenario of the organization, the current sigma level was calculated and then the way to improve this level was analyzed.

IV. Data Analysis and Results

a) Process Measurement

In this measurement stage, different variables are identified to measure. As it has been trying to improve the sigma level of the organization, initially the present sigma level has been measured by using an Excel based sigma calculator.

Sigma level is a procedure to know the existing condition of a production shop. The calculation of sigma level is based on the number of defects per million opportunities (DPMO).

In order to calculate DPMO, three distinct pieces of information are required:

i. The number of units produced.
ii. The number of defect opportunities per unit.
iii. The number of defects.

The actual formula is:

$$\text{DPMO} = \frac{(\text{Number of defects} * 1000000)}{((\text{Number of defects opportunities per unit}) * \text{number of units})}$$

For this purpose, the relevant data is collected. By using collected data, the defect rate of each process is calculated and converted into the total defects. Moreover, in order to observe the situation better Sigma level is calculated in the final stage of testing cement after packing. After packing that means the final product actually gives the Sigma level of the manufacturing company.

- Sigma level at the stage of testing cement after packing:

No. of defects (D) = 17 total defects

No. of opportunities for a defect (O) = 7 opportunities (categories of defect types) [Compressive strength 3 days, Compressive strength 7days, Compressive strength 28 days, Initial Setting Time, Final Setting Time, Fineness, Residue]

No. of units (U) = 122

Total number of opportunities (TOP) = U * O = 854 total opportunities

DPU = D / U = 17/122= .139344262 defects per unit

DPO = D / TOP = 17/854 = 0.019906323

DPMO = DPO * 1000000= 0.019906323*1000000= 19906.323

Out of a million opportunities, the long term performance of the process would create 19906.323 defects.

Defects	17
Opportunities	122
Defect Opportunities per unit	7

DPMO	19906.32
Sigma Level	3.6

After plotting the required information into sigma level calculator, the calculator shows that the Sigma level at the stage of testing cement after packing is 3.6. Hence, to improve this level, different quality improvement tools have to be employed and the organization has to be set a milestone to achieve.

b) Process Analysis

It is a very important stage to consider because lack of proper analysis may lead to the process to a wrong way, which will deviate, from the main function of improvement. In this stage, different basic tools of quality are preferably used to analyze the real condition of the processes.

i. *Process Block Diagram*

To find out the existing problem of a complete production process, it is more preferable to represent the operation sequence by process flow diagram. For this purpose, the operation sequence is analyzed and obtained a chart shown in following figure.

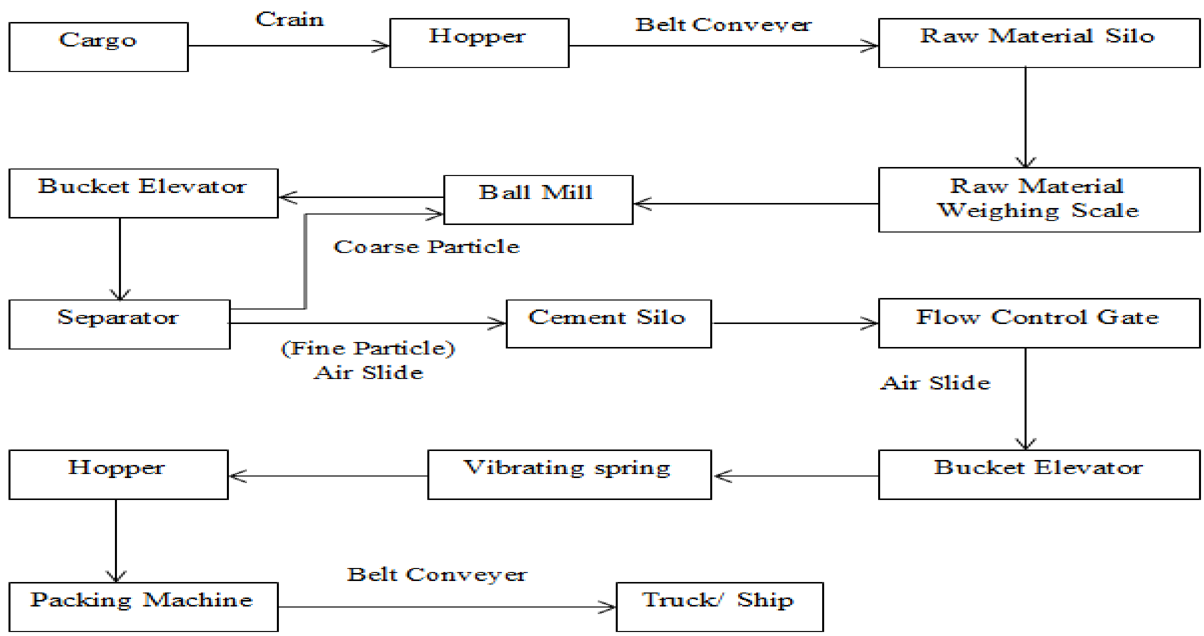


Figure 1 : Process Block Diagram of the Cement Industry

ii. *Cause and Effect Diagram*

To analyze a problem cause & effect diagram is one of the best tools. After obtaining process flow diagram, the next step is to find the root cause and sub-cause of the existing process. The required cause & effect diagram is shown in the Figure 4.2

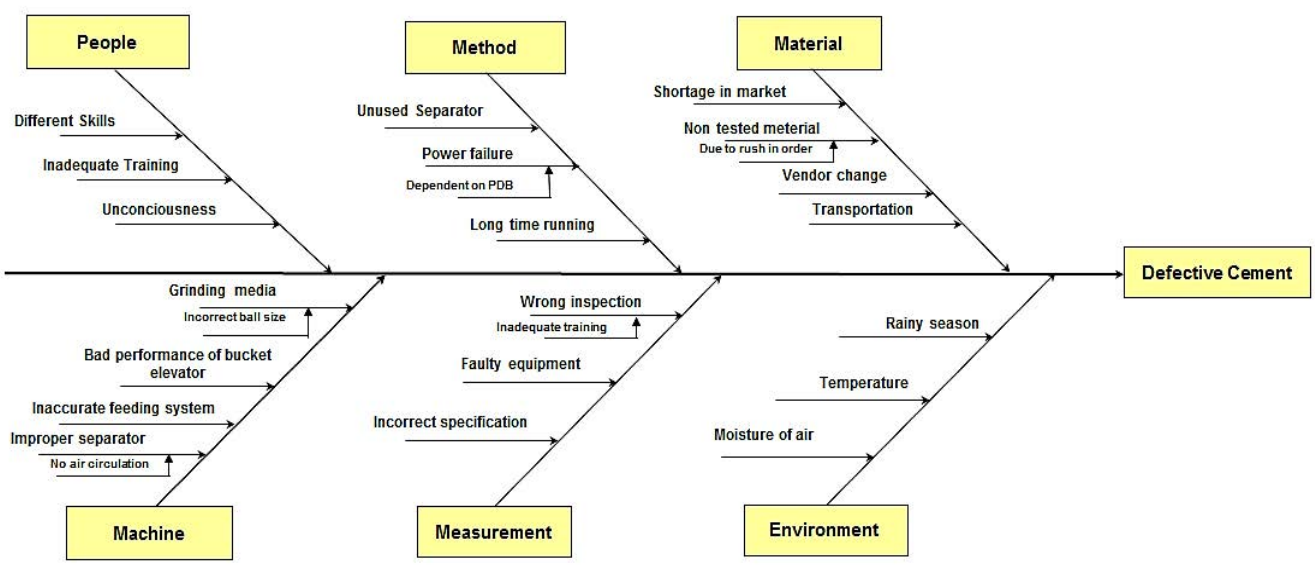


Figure 2 : Cause and Effect Diagram of Case Organization

iii. *Cheek Sheet*

A check sheet is very useful in data collection activity. It is more effective to identify defects. Here defects are seen in a tabular form in time basis. The required Cheek Sheets are given in Table 1, 2, 3 and 4.

Table 1 : Check sheet for month August 2013

Defect	August																															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Fineness																										1						1
Residue			1																													1
Initial setting time																1																1
Final setting time																																
Compressive strength (3 days)																																
Compressive strength (7 days)																																
Compressive strength (28 days)			1																													1
Total			2													1									1							4

Table 2 : Check sheet for month September 2013

Defect	September																														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Fineness																															
Residue																		1							1						2
Initial setting time																															
Final setting time																						1									1
Compressive strength (3 days)							1																					1			2
Compressive strength (7 days)																															
Compressive strength (28 days)																															
Total							1											1				1			1			1			5

Table 3 : Check sheet for month October 2013

Defect	October																															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Fineness												1																				1
Residue																																
Initial setting time	1																															1
Final setting time								1																								1
Compressive strength (3 days)																																
Compressive strength (7 days)																																
Compressive strength (28 days)					1																											1
Total	1				1			1				1																				4

Table 4 : Check sheet for month November 2013

Defect	November																														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Fineness														1																	1
Residue																				1											1
Initial setting time																															
Final setting time								1																							1
Compressive strength (3 days)																															
Compressive strength (7 days)												1																			1
Compressive strength (28 days)																															
Total								1				1		1						1											4

iv. *Process Control Chart*

A control chart is a graphical and analytic tool for monitoring process variation. The natural variation in a process can be quantified using a set of control limits. Control limits help distinguish common-cause variation from special-cause variation. Typically, action is taken to eliminate special-cause variation and bring the process back in control. Process has seven constraints (Fineness, Residue, Initial setting time, Final setting time, Compressive strength 3 days, Compressive strength 7 days & Compressive strength 28 days). Seven control charts have been drawn by taking each constraint. All control charts have two axis, in X-axis days are plotted & Y-axis constrains (each control chart has individual constrain) are plotted.

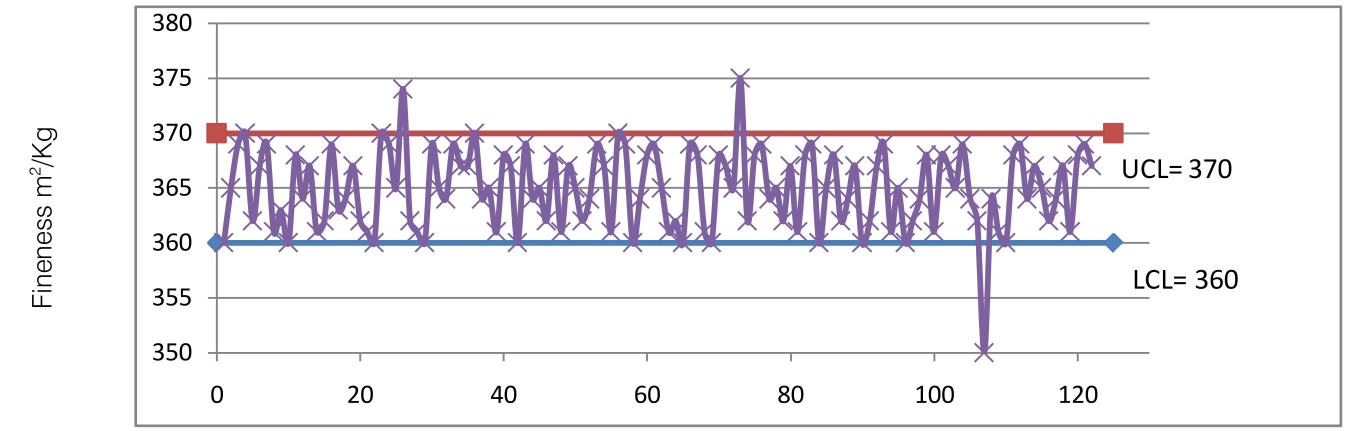


Figure 3 : Control chart for Fineness

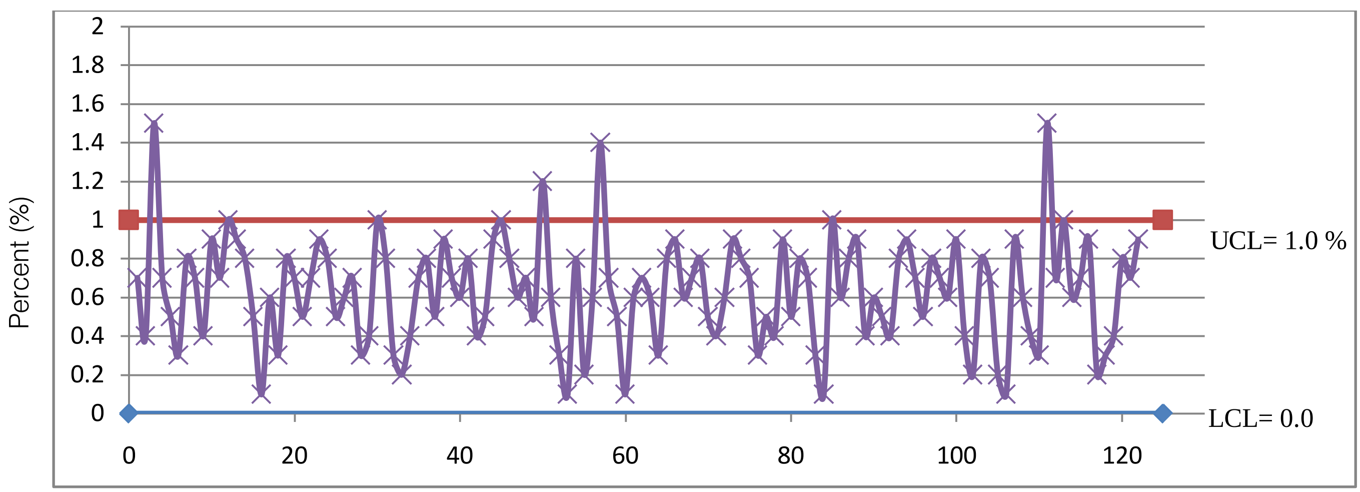


Figure 4 : Control chart for Residue

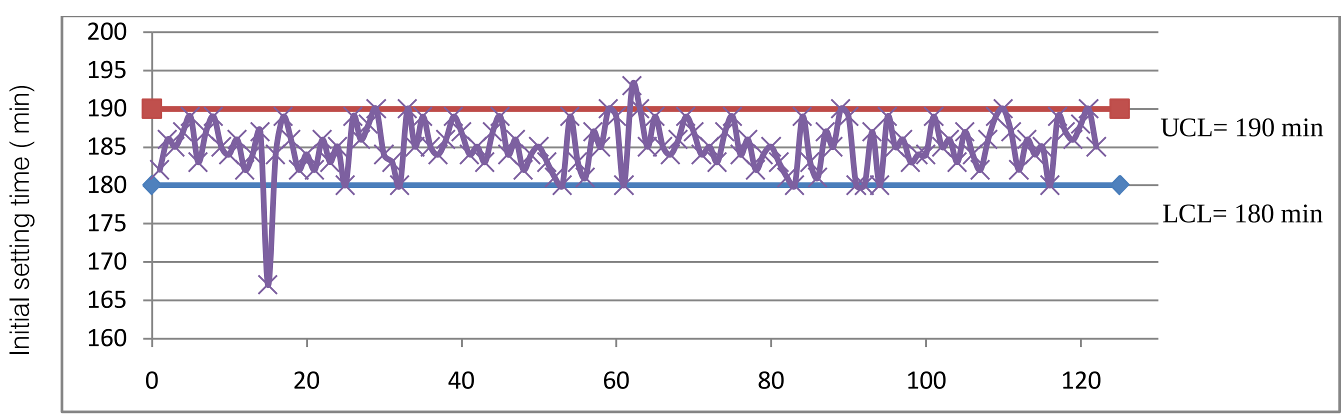


Figure 5 : Control chart for initial setting time

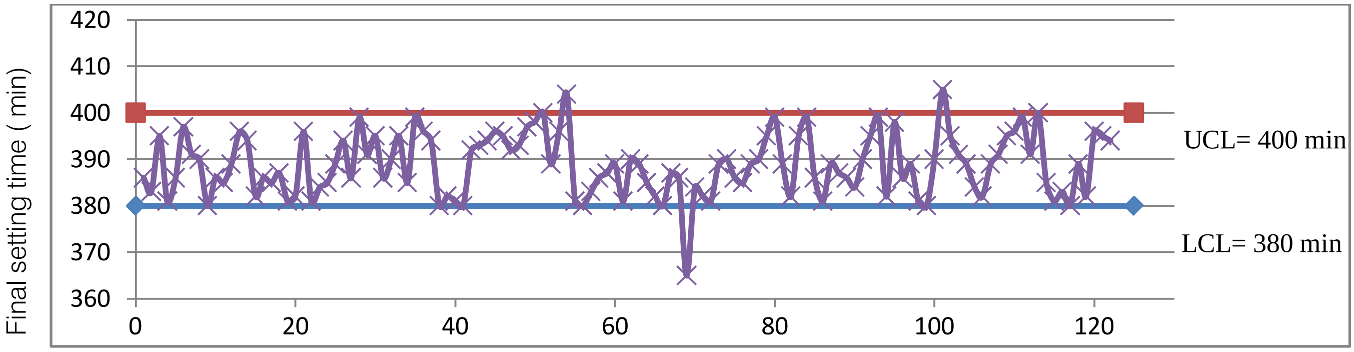


Figure 6 : Control chart for final setting time

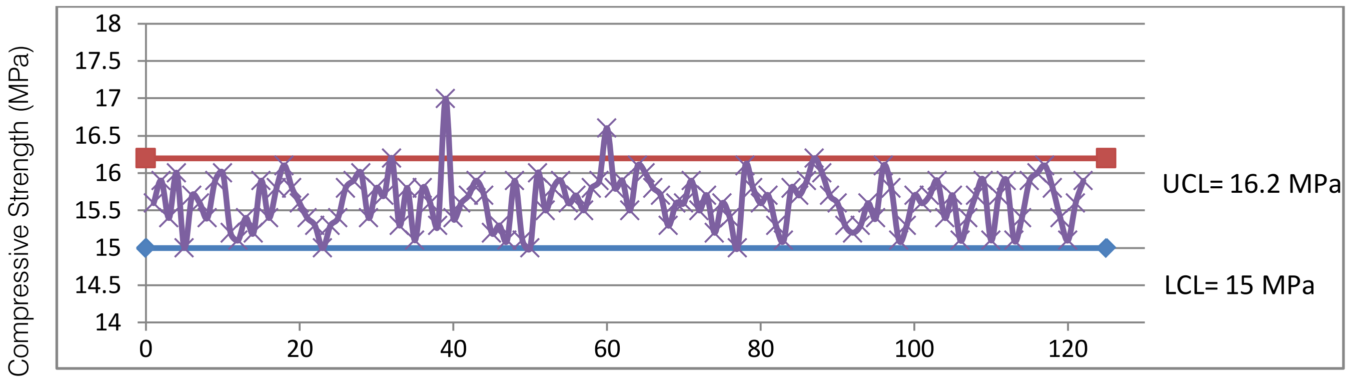


Figure 7 : Control chart for Compressive Strength (3 Days)

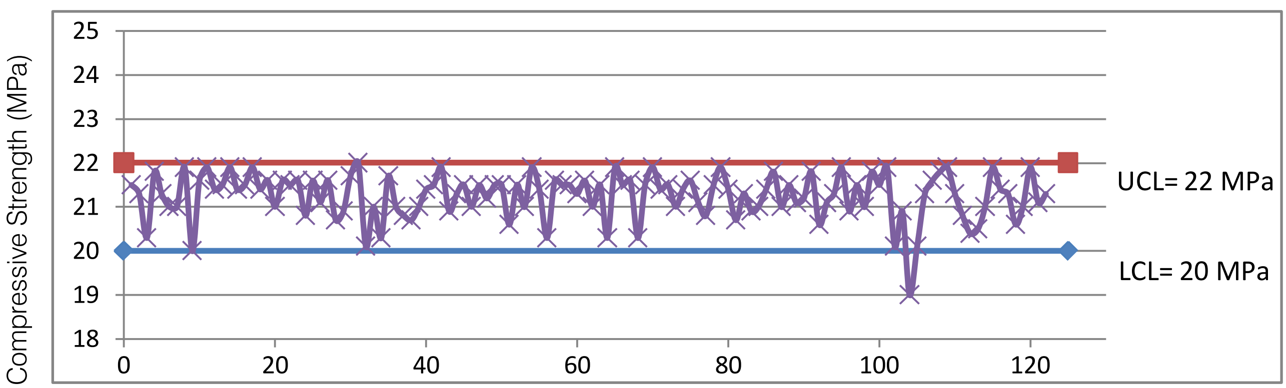


Figure 8 : Control chart for Compressive Strength (7 Days)

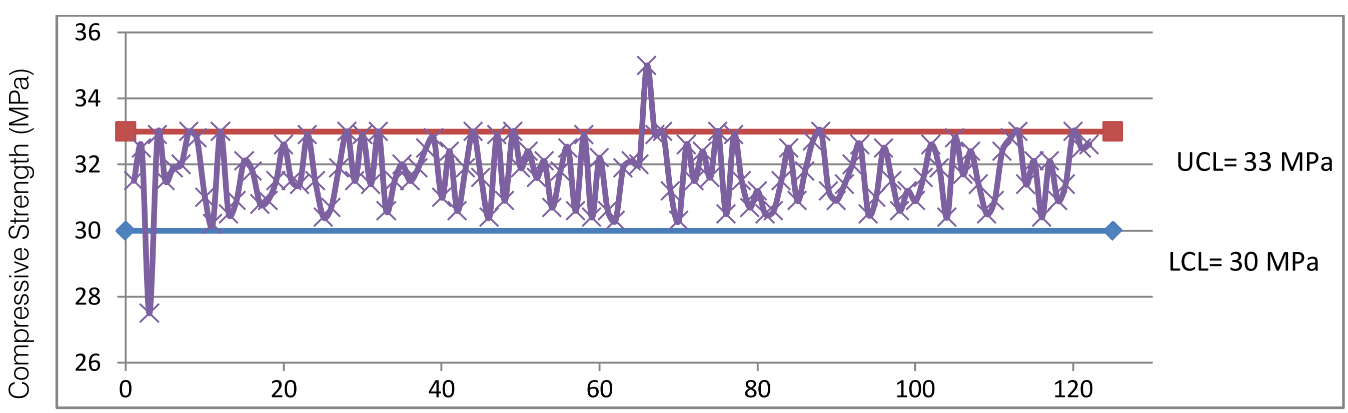


Figure 9 : Control chart for Compressive Strength (28 Days)

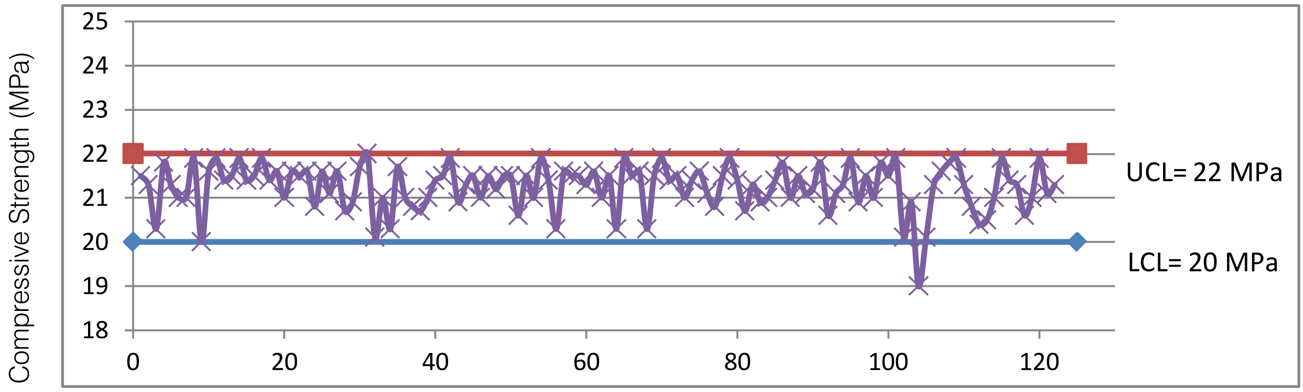


Figure 8 : Control chart for Compressive Strength (7 Days)

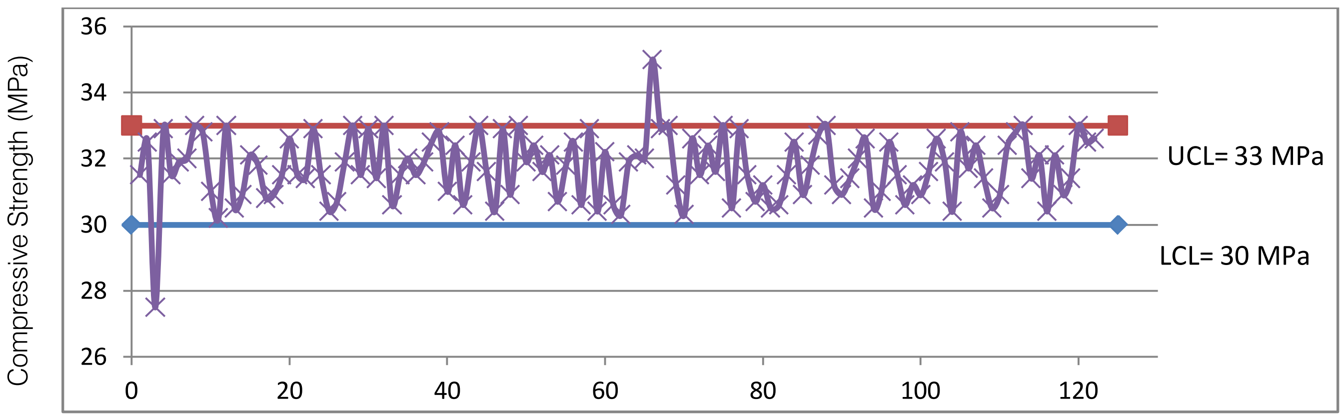


Figure 9 : Control chart for Compressive Strength (28 Days)

c) Process Improvement

In this stage, improvement strategies are developed for achieving the desired goal. According to the analysis, perfect measures should be taken to progress the current situation. As the major concern to improve sigma level here in the case organization to improve the productivity, it is highly needed to diagnose the critical issues. For this reason FMEA (Failure Mode and Effect Analysis is used to improve the current situation of the production shop.

i. *FMEA (Failure Mode and Effect Analysis)*

A failure modes and effects analysis (FMEA) is a procedure in product development and operations management for analysis of potential failure modes within a system for classification by the severity and likelihood of the failures. A successful FMEA activity helps a team to identify potential failure modes based on past experience with similar products or processes, enabling the team to design those failures out of the system with the minimum of effort and resource expenditure, thereby reducing development time and costs. In FMEA, failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. A FMEA also documents current knowledge and actions about the risks of failures for use in continuous improvement. FMEA is used during the design stage with an aim to avoid future failures. Later it is used for process control, before and during ongoing operation of the process. Ideally, FMEA begins during the earliest conceptual stages of design and continues throughout the life of the product or service. And for the Case Organization FMEA chart (Table-8) is given below according to the following three tables- Table 5, 6 and 7.

Table 5 : Table for Severity Number

Score	Severity Guidelines	
	AIAG	Sig-Sigma
10	Hazardous without warning	Injure a customer or employee
9	Hazardous with warning	Be illegal
8	Very high	Render product or service unfit for use
7	High	Cause extreme customer dissatisfaction
6	Moderate	Result partial malfunction
5	Low	Cause a loss of performance which is likely to result in a complaint
4	Very low	Cause minor performance loss
3	Minor	Cause a minor nuisance but can be overcome with no performance loss
2	Very minor	Be unnoticed have only minor effect on performance
1	None	Be unnoticed and not affect the performance

Bad ↔ Good

Table 6 : Table for Occurrence Number

Score	Occurrence guidelines		
	AIAG	Sig-Sigma	
10	Very high persistent loss Ppk < 0.55	More than one per day	>30%
9	Very high persistent loss Ppk >= 0.55	Once every 3-4 days	< 30%
8	High frequent failures Ppk>= 0.78	Once every week	< 5%
7	High frequent failures Ppk>= 0.86	Once per month	< 1%
6	Moderate occasional failures Ppk >= 0.94	Once every 3 months	< 0.03%
5	Moderate occasional failures Ppk >= 1.00	Once every 6 months	< 1 per 10,000
4	Moderate occasional failures Ppk >= 1.10	Once per year	< 6 per 100,000
3	Low relatively failures Ppk >= 1.20	Once every 1-3 years	< 6 per million
2	Low relatively failures Ppk >= 1.30	Once every 3-6 years	<3 per 10 million
1	Low relatively failures Ppk >= 1.67	Once every 6-9 years	< 2 per billion

Bad ↔ Good

Table 7 : Table for Detection Number

Score	Detection guidelines	
	AIAG	Sig-Sigma
10	Almost impossible absolute certainty of non-detection	Defect caused by failure is no detectable
9	Very remote controls will probably not detect	Occasional units are checked for detect
8	Remote controls have poor chance detection	Units are systematically sampled and inspected
7	Very low controls have poor chance detection	All units are mutually inspected
6	Low controls may detect	Manual inspection with mistake-proofing modifications
5	moderate controls may detect	Process is monitored (SPC) and manually inspected
4	Moderately high controls have a good chance to detect	SPC is used with an immediate reaction to out of controls condition
3	High controls have a good chance to detect	SPC as above,.100% inspection surrounding out of control conditions
2	Very high controls almost certain to detect	All units are automatically inspected
1	Very high controls certain to detect	Defect is obvious and can be kept from affecting customers

Bad ↔ Good

Table 8 : FMEA (Failure Mode and Effect Analysis) Chart

Row Number	Process Steps	Potential Failure Mode	Potential Effects of Failure	Severity (1-10)	Potential Cause(s) of Failure	Occurrence (1-10)	Current Controls	Detection (1-10)	Risk Priority Number (RPN)	Recomended Action
1	Cargo	Production rate	Production rate	7	Low water level, if Mongla port is busy	5	Use small cargos, by road.	7	245	Increase depth of water level; Raise the facilities of Mongla port.
2	Hopper	Suddenly block raw material supply path	Raw materials supply rate to silo	8	Small size of outlet	5	By decreasing supply flow	6	240	Give the desired size at outlet of hopper
3	Conveyer Belt	Tear and wear	Production system stops	9	Long time running; Absence of proper lubrication at head and tail pulley	5	Repair	6	270	Weekly inspection; Proper lubrication system
4	Raw Material Weighing Scale	Raw materials not in correct proportion	Defective cement	8	Problem in feed rate	4	Desired feed rate provides	2	64	Continuous inspection to control the proper feed rate
5	Ball Mill	Linear and grinding media; feed rate	Defective cement	8	Long time running	8	Repair when fine particles are in low rate	5	320	Continuous inspection and change grinding media and linear when needed
6	Bucket Elevator	Problem in motor or chain	No cement will flow from ball mill	5	Long time running and problem in lubrication	5	Repairs motor; provide proper lubrication system	7	175	Continuous inspection of lubrication; replace motor if running for long time
7	Separator	Rotor speed; air circulation flow	Fine and coarse cement not separated	5	If anything collapse at air circulation path; problem in air blower	7	Repairs	5	175	Continuous inspection and if needed replace air blower
8	Vibrating spring	Elasticity of spring decreases	Fine particle will not flow to cement silo properly	5	Continuous running	5	Repairs	6	150	Continuous inspection and if needed replace spring
9	Packing Machine	Problem in sensor	Defective packing	7	Long time running; and PLC problem	4	Replace; Check the PLC system	2	56	Continuous inspection

If the recommended actions are followed then the risk priority number will be decreased at desired level as a result defective product will be decreased and hence the sigma level will be improved.

V. Discussions

There were some uncertainties in the validity and reliability of the sampled data that are used in previous to analyze and improving sigma level of the cement manufacturing process. During the study not all, the information has collected instantly, but some previous records have also used for better understanding. The Sigma Level calculated for the case organization at the final stage of finished product is 3.6. From the Six-Sigma value chart it can be concluded that the case organization is an average industry. Analyzing tools is used and it finds out where the maximum and serious defects were in different sections. Then the Cause and Effect diagram determine the root causes of the problems. The check sheet represents defects at daily basis, which helps to find out in which day there were defects. Seven control charts are drawn to specify the process in control or not. The main reason for defective cement is then Compressive Strength. In addition, according to defects then Fineness, Setting time, Residue, Limestone, Slag and Fly ash. By using FMEA (Failure Mode and Effect Analysis), Risk Priority Number (RPN) at different stages of the manufacturing process were determined. From this case study the highest RPN was 320 (Ball Mill) and the lowest RPN was 56 (Packing Machine) in out of 1000. As the RPN increases, it indicates more risks and defects.

VI. Recommendations

There are several approaches to choose from, when the goal is to increase the sigma level of a cement manufacturing company. The techniques used in this paper have been limited due to insufficient time and resources. In this paper only Process block diagram, Cause and Effect diagram, Cheek sheet, process control chart are used for process analysis. FMEA isused as process improvement neglecting other improvement tool like 5S, Kaizen and Supermarket. An important suggestion for future work is to test if the findings are applicable to other steps of manufacturing and machines within the factory. Moreover, to take customers opinion about the product, this will help to identify the problems and can be solved easily.

References Références Referencias

1. Stevenson WJ,2005, 'Competitiveness, Strategy and Productivity', Richard T. Hercher, Jr, Wanda J, Zeman, 'Operations Management' 8th edition, McGraw-Hill/Irwin, a business unit of the McGraw-Hill companies, Inc, 1221 avenue of the Americas, New York, NY,10020,p (47-53).
2. Park, SH, 2003, 'Six Sigma for Quality and Productivity Promotion', Asian Productivity Organization, Japan.
3. Siddhartan Ramamoorthy, 2003, 'Lean Six Sigma Applications In Aircraft Assembly', B.E, Mechanical Engineering, University of Madras, India.
4. Soković, M., Pavletić, D., and Krulčić, E., Six Sigma process improvements in automotive parts production, Journal of Achievements in Materials and Manufacturing Engineering, Vol. 19 No. 1, pp 96-102 (2006).
5. Nyrén G., A Six Sigma paper at Ericsson Network Technologies, Master's Research paper, MSc Programmes in Engineering, Luleå University of Technology (2007).
6. Racine J., A Directed Research Paper of the Evolution of Six Sigma, Master's Research paper, MBA Program, Strayer University (2005).
7. Chaczko Z., Rahali E., and Tariq R., The Apllication of Six Sigma to Integration of Computer Based Systems, World Academy of Science, Engineering and Technology 34, pp 332- 337 (2007).
8. Stephen, P., Application of DMAIC to Integrate Lean Manufacturing and Six Sigma, Master's Research paper , MSc in Industrial and Systems Engineering, Virginia Polytechnic Institute and State University, (2004).
9. Abid, M.A., Rehman, A.U., and Anees, M, 2010, "How to minimize the defect rate of final product in textile plant by the implementation of DMAIC tool of six-sigma", a program of "Master of Industrial Engineering-Quality and Environmental Management", University of BORAS, School of Engineering.

Appendix

MCML'S Quality Policy:
Residue-<1.00 %
Blaine-360-370 m2/Kg
IST (Initial setting time) –180-190 min
FST (Final setting time)–380-400 min
Compressive strength (3 days) –15-16.20 MPa
Compressive strength (7 days) –20-22 MPa
Compressive strength (28 days) – 30-33 MPa

Data after Packing for August-2013:

Date	Fineness m^2/Kg	Residue (%)	Setting Time (min)		Compressive Strength (MPa)		
			IST	FST	3 days	7 days	28 days
01-08-13	360	0.7	182	386	15.6	21.5	31.5
02-08-13	365	0.4	186	383	15.9	21.3	32.5
03-08-13	369	1.5	185	395	15.4	20.3	27.5
04-08-13	370	0.7	187	381	16.0	21.8	32.9
05-08-13	362	0.5	189	386	15.8	21.3	31.5
06-08-13	367	0.3	183	397	15.7	21.0	31.9
07-08-13	369	0.8	187	391	15.6	21.0	32.0
08-08-13	361	0.7	189	390	15.4	21.9	33.0
09-08-13	363	0.4	185	380	15.9	20.0	32.8
10-08-13	360	0.9	184	386	16.0	21.6	31.0
11-08-13	368	0.7	186	385	15.2	21.9	30.2
12-08-13	364	1.0	182	389	15.1	21.4	33.0
13-08-13	367	0.9	184	396	15.4	21.5	30.5
14-08-13	361	0.8	187	394	15.2	21.9	30.9
15-08-13	362	0.5	184	382	15.9	20.4	32.1
16-08-13	369	0.1	167	386	15.4	21.5	31.8
17-08-13	363	0.6	189	385	15.8	21.9	30.8
18-08-13	364	0.3	186	387	16.1	21.4	30.9
19-08-13	367	0.8	182	381	15.8	21.6	31.5
20-08-13	362	0.7	184	382	15.6	21.0	32.6
21-08-13	361	0.5	182	396	15.4	21.6	31.5
22-08-13	360	0.7	186	381	15.3	21.5	31.4
23-08-13	370	0.9	183	384	15.0	21.6	32.9
24-08-13	369	0.8	185	385	15.3	20.8	31.5
25-08-13	365	0.5	180	389	15.4	21.6	30.4
26-08-13	374	0.6	189	394	15.8	21.1	30.7
27-08-13	362	0.7	186	386	15.9	21.6	31.9
28-08-13	361	0.3	188	399	16.0	20.7	33.0
29-08-13	360	0.4	190	391	15.4	20.9	31.5
30-08-13	369	1.0	184	395	15.8	21.7	32.9
31-08-13	365	0.8	183	386	15.7	22.0	31.4

Data after Packing for September-2013:

Date	Fineness m^2/Kg	Residue (%)	Setting Time (min)		Compressive Strength (MPa)		
			IST	FST	3 days	7 days	28 days
01-09-13	364	0.3	180	390	16.2	20.1	33.0
02-09-13	369	0.2	190	395	15.3	21.0	30.6
03-09-13	367	0.4	185	385	15.8	20.3	31.5
04-09-13	367	0.7	189	399	15.1	21.7	32.0
05-09-13	370	0.8	185	396	15.8	21.0	31.5
06-09-13	364	0.5	184	394	15.6	20.8	31.9
07-09-13	365	0.9	186	380	15.3	20.7	32.5
08-09-13	361	0.7	189	382	17.0	21.0	32.8
09-09-13	368	0.6	187	381	15.4	21.4	31.0
10-09-13	367	0.8	184	380	15.6	21.5	32.4
11-09-13	360	0.4	185	392	15.7	21.9	30.6
12-09-13	369	0.5	183	393	15.9	20.9	31.9
13-09-13	364	0.9	187	394	15.7	21.8	33.0
14-09-13	365	1.0	189	396	15.2	21.3	31.6
15-09-13	362	0.8	184	395	15.3	21.5	30.4
16-09-13	368	0.6	186	392	15.1	21.0	32.9
17-09-13	361	0.7	182	393	15.9	21.5	30.9
18-09-13	367	0.5	184	397	15.1	21.2	33.0
19-09-13	365	1.2	185	398	15.0	21.5	31.9
20-09-13	362	0.6	183	400	16.0	21.5	32.4
21-09-13	364	0.3	181	389	15.5	20.6	31.6
22-09-13	369	0.1	180	396	15.8	21.5	32.1
23-09-13	367	0.8	189	404	15.9	21.0	30.7
24-09-13	361	0.2	183	381	15.6	21.9	31.8
25-09-13	370	0.6	181	380	15.7	21.4	32.5
26-09-13	369	1.4	187	383	15.5	20.3	30.6
27-09-13	360	0.7	185	386	15.8	21.6	32.9
28-09-13	364	0.5	190	387	15.9	21.5	30.4
29-09-13	368	0.1	189	389	16.6	21.5	32.2
30-09-13	369	0.6	180	381	15.8	21.3	30.6

Data after Packing for October-2013:

Date	Fineness m^2/Kg	Residue (%)	Setting Time (min)		Compressive Strength (MPa)		
			IST	FST	3 days	7 days	28 days
01-10-13	365	0.7	193	390	15.9	21.0	30.3
02-10-13	361	0.6	190	389	15.5	21.5	31.9
03-10-13	362	0.3	185	385	16.1	20.3	32.1
04-10-13	360	0.8	189	382	16.0	21.9	32.0
05-10-13	369	0.9	185	380	15.8	21.5	35.0
06-10-13	368	0.6	184	387	15.7	21.6	32.9
07-10-13	361	0.7	186	386	15.3	20.3	33.0
08-10-13	360	0.8	189	365	15.6	21.5	31.2
09-10-13	368	0.5	187	384	15.7	21.9	30.3
10-10-13	367	0.4	184	382	15.9	21.4	32.6
11-10-13	365	0.6	185	381	15.5	21.5	31.5
12-10-13	375	0.9	183	389	15.7	21.0	32.4
13-10-13	362	0.8	187	390	15.2	21.4	31.6
14-10-13	368	0.7	189	386	15.6	21.6	33.0
15-10-13	369	0.3	184	385	15.4	21.1	30.5
16-10-13	364	0.5	186	389	15.0	20.8	32.9
17-10-13	365	0.4	182	390	16.1	21.5	31.5
18-10-13	362	0.9	184	395	15.8	21.9	30.7
19-10-13	367	0.5	185	399	15.6	21.4	31.2
20-10-13	361	0.8	183	389	15.7	20.7	30.5
21-10-13	368	0.7	181	382	15.3	21.3	30.6
22-10-13	369	0.3	180	395	15.1	20.9	31.5
23-10-13	360	0.1	189	399	15.8	21.0	32.5
24-10-13	365	1.0	183	386	15.7	21.4	30.9
25-10-13	368	0.6	181	381	15.9	21.8	31.8
26-10-13	362	0.8	187	389	16.2	21.0	32.7
27-10-13	364	0.9	185	386	16.0	21.5	33.0
28-10-13	367	0.4	190	387	15.7	21.1	31.2
29-10-13	360	0.6	189	384	15.6	21.22	30.9
30-10-13	362	0.5	180	390	15.3	21.8	31.4
31-10-13	367	0.4	180	395	15.2	20.6	32.0

Data after Packing for November-2013

Date	Fineness m^2/Kg	Residue (%)	Setting Time (min)		Compressive Strength (MPa)		
			IST	FST	3 days	7 days	28 days
01-11-13	369	0.8	187	382	15.3	21.1	32.6
02-11-13	361	0.9	180	398	15.6	21.3	30.5
03-11-13	365	0.7	189	386	15.4	21.9	31
04-11-13	360	0.5	185	389	16.1	20.9	32.5
05-11-13	362	0.8	186	381	15.8	21.5	31.5
06-11-13	364	0.7	183	380	15.1	21.0	30.6
07-11-13	368	0.6	184	395	15.3	21.8	31.2
08-11-13	361	0.9	184	390	15.7	21.52	30.9
09-11-13	368	0.4	189	405	15.6	21.9	31.6
10-11-13	367	0.2	185	395	15.7	20.1	32.6
11-11-13	365	0.8	186	391	15.9	20.9	31.9
12-11-13	369	0.7	183	389	15.4	19.0	30.4
13-11-13	364	0.2	187	384	15.7	20.1	32.8
14-11-13	362	0.1	184	382	15.1	21.3	31.7
15-11-13	350	0.9	182	389	15.4	21.6	32.4
16-11-13	364	0.6	186	391	15.7	21.8	31.4
17-11-13	361	0.4	189	395	15.9	21.9	30.5
18-11-13	360	0.3	190	396	15.1	21.3	30.9
19-11-13	368	1.5	187	399	15.7	20.8	32.4
20-11-13	369	0.7	182	391	15.9	20.4	32.8
21-11-13	364	1.0	186	400	15.1	20.5	33.0
22-11-13	367	0.6	184	385	15.4	21.0	31.4
23-11-13	365	0.7	185	381	15.9	21.9	32.1
24-11-13	362	0.9	180	383	16.0	21.4	30.4
25-11-13	364	0.2	189	380	16.1	21.3	32.1
26-11-13	367	0.3	187	389	15.8	20.6	30.9
27-11-13	361	0.4	186	382	15.4	21.0	31.4
28-11-13	368	0.8	188	396	15.1	21.9	33.0
29-11-13	369	0.7	190	395	15.6	21.1	32.5
30-11-13	367	0.9	185	394	15.9	21.3	32.6

Global Journals Inc. (US) Guidelines Handbook 2014

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (FARSE)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSE" title to individuals. The 'FARSE' title is accorded to a selected professional after the approval of the Editor-in-Chief /Editorial Board Members/Dean.

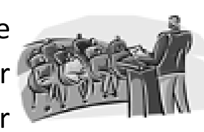
- The "FARSE" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSE or William Walldroff, M.S., FARSE.

FARSE accrediting is an honor. It authenticates your research activities. After recognition as FARSE, you can add 'FARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSE designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSE title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

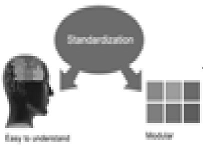


You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSE can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSE, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.



The FARSE will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSE member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSE members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSE member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSE is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSE can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSE member can decide its price and we can help in making the right decision.

The FARSE member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN ENGINEERING (MARSE)

The ' MARSE ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The "MARSE" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSE or William Walldroff, M.S., MARSE.

MARSE accrediting is an honor. It authenticates your research activities. After becoming MARSE, you can add 'MARSE' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSE designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSE, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSE member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSE, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

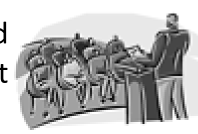
Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA)
The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.
The author fees of such paper may be waived off up to 40%.



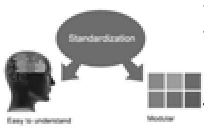
The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.



After nomination of your institution as “Institutional Fellow” and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.

The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

MANUSCRIPT STYLE INSTRUCTION **(Must be strictly followed)**

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, “Abstract” word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

save our planet

Global Journal of Researches in Engineering

Visit us on the Web at www.GlobalJournals.org | www.EngineeringResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9755861