ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PRODUCTION INTERRUPTIONS AND THEIR IMPACT IN MANUFACTURING INDUSTRY

Syeda Kumrun Nahar*, Dr. Md.Ariful Islam, Jahid Hasan, Shanta Saha, Niaz Morshed, Dr. Mohammad Muhshin Aziz Khan

* Industrial and production Engineering, Shahjalal University of Science and Technology, Bangladesh.

ABSTRACT

To cope up with the dynamic environment of free market economy Bangladesh needs to have industries with smooth running of the production system. Not only RMG sector but also other sectors such as; Steel Re-rolling Mill, Pharmaceuticals and Cement sector are stepping forward in free market. In this connection, it is essential for them to have smooth running of the production system. But this characteristic is greatly hampered by Production Interruption. This research has been conducted with the aim of finding a scenario of Production Interruption in these sectors, the root cause of the interruptions and also the consequences of Production Interruptions. For this purpose an exploratory study involving 35 manufacturing industry of four different industrial sectors has conducted. From the study five significant production interruption are identified along with nine root causes and five consequences. Some causes are more significant they are; power interruption, malfunctioning of machine, interrupted production by operator, defective product and schedu ling problem. After the analysis nine significant root causes were identified. Among the 10 consequences, found from structured questionnaire based survey, some are more significant, such as; increased production, rework etc. The analysis is performed with the help of SPSS and other statistical techniques.

KEYWORDS: Consequences and manufacturing industry, Production interruption and root causes.

INTRODUCTION

Global market become more competitive due to free market economy. Those manufacturing companies can survive who could supply good quality product with competitive price to the market. Various industrial sectors are playing important role in the economy of Bangladesh. Among them the role of Steel re rolling mill, Pharmaceutical industry, Cement industry and Ready-made garments industry are significant. In 1990-1991 the value-added share in Ready–made garments industry was 10.98%, Pharmaceuticals industry was 5.44%, Iron & steel re-rolling industry was 1.84% and cement industries was not so significant [1]. In 2005-06 this shares become in Ready-made garments industry 23.9%, Pharmaceuticals 4.7%, steel re-rolling mill 3.3% and cement industry 1.9%. From that we can see that the contribution of these sectors is increasing [1]. Some interruptions hinder the production flow and also damage the product quality. That's why it is necessary to identify the main causes behind interruption or disturbances that occur in different manufacturing sectors. It is becoming increasingly difficult to ignore the effect of production interruption in manufacturing sector. This research adopts the definition of production interruption as, Production interruption is the short or long delays imposed on the workforce or work area, which are severe enough to cause a temporary halt to the progress of the activity itself or to the overall work on the site. Work resumes on the day for several hours about 15 minutes to more than that when the interruption occurs. According to Islam et al, who performed similar studies on SME's in New Zealand, 'disturbance' to represent any undesirable event or setbacks that causes the deviation of system performance in such a way that it incurs a loss [7][8]. Several studies show the different Factors that influence production interruption. The study is mostly concerned with capacity disturbances. Capacity disturbances can be also divided into disturbances caused by machine capacity (e.g. machine breakdowns), disturbances caused by operator capacity (e.g. operator illness), and disturbances caused by tool capacity (e.g. unavailability of specific tools). Often, capacity disturbances cause real problems regarding the performance of production units. Immediate solutions must be found in the use of operator flexibility and the use of alternative routings. The combined effect of different disturbances could effectively cripple an SME's business performance which may ultimately put it at risk of complete failure [7][8]. For coping up with large number of demands and surviving in competitive market industries must need firm production flow. But at present the actual performance of production system may not be firm due to some interruptions. To take competitive advantages, it is very necessary to reduce the causes of production interruption. If

the interruption level of these sectors can be controlled, the production cost will also be reduced and thus their contribution to the national economy will be more. It is therefore, necessary to identify and minimize these interruptions for firm production flow.

RESEARCH BACKGROUND

A considerable amount of literature has been published on production interruption. Most of the researches highlight distinctive ranges of production interruptions such as; Power interruption, Malfunctioning of machine, Machine breakdown, Material handling disruption, Scheduling problem etc. Like, Matson (1999) identified some operational disturbances often observed in manufacturing industries such as, Upstream disturbances includes Materials quality problems, supplier production problems, materials delivery delays, Internal disturbances includes Machine breakdowns, variability in machine performance (quality, cost, production rate), unavailability of labour and down disturbances includes Demand variations (e.g. due to seasonality, marketing activity, competitor activity) [3]. In their major study Bellgran and Aresu (2003) indentify classification of disturbances in different life-cycle phase such as; in Basic design stage reasons of disturbances are lack of information about design, uncertainty, in Design stage reasons of disturbances includes making decision conflict, lack of time, change in design, non-conformance in drawing and in Production and Installation stage the reasons are nonconformity of materials and components, late deliveries of materials [15]. Islam et al , identified 11 risk indicators; the risk indicators have potential linkages with day-to-day operational disturbances, which degrade business performance and the business environment [8]. Several studies have performed about causes of interruption or disturbances to production in RMG sector in Bangladesh. In a study which set out to determine the causes of interruptions in RMG sector identified that worker conflict, low working salary, insufficient government policy, incompetent ports, lack of training, lack of marketing tactics, middle management, time consuming schedule, communication gap, credit problem, dependency on foreign market, etc are significant production interruptions [12]. However it has been identified, Islam et al also identified, some internal and external operational disturbances during his research on SME's in New Zealand. Among the internal disturbances, absenteeism, machine malfunction, machine breakdown, and material handling disruption were found to be the significant disturbances. Among the external disturbances, competition, delayed supply by the regular supplier, and skilled labor shortage were found to be the significant ones [9]. Islam et al ,also performed another study on that, had identified a set of detrimental operational disturbances which exist in the Ready Made Garments (RMG) sector in Bangladesh [10]. The most detrimental causes identified were absenteeism, machine malfunction, unexpected WIP, defective products and frequent changeover in production schedule. Overall, these studies highlight the necessity of detection of the production interruptions, their causes and consequences. Though several studies have performed to identify causes of production interruption or disturbances in RMG sector of Bangladesh. However, the scenario is different for other manufacturing sector in Bangladesh. This is why; this study aims to identify causes of production interruption, their root-causes and consequences in Steel re-rolling mill, Pharmaceuticals industry, Cement industry and also RMG industry in Bangladesh. For smooth running of production system and profitability of the companies, two factors are most important they are production time and cost. Due to production interruptions, production time and cost increases significantly. So, it is necessary to identify production interruptions along with their root causes and consequences. The research is, therefore, built in a specific research question – what are the typical production interruptions, their consequences or impact on manufacturing companies and the root causes behind the interruptions? Based on the findings related to the question, we have identified five significant production interruptions. They are; power interruption, malfunctioning of machine, defective product, interrupted production by operator and scheduling problem. Also significant consequences of the production interruptions are also identified along with nine root causes of the production interruptions.

RESEARCH METHODOLOGY

The research method adopted for this study is an exploratory study along with an in depth case study. The research conducted in selected steel re rolling mill, garment industry, cement industry and pharmaceuticals industry. Data were collected from 35 companies of four different manufacturing sectors by taking interview using a structured questionnaire. This study deals with various immediate causes of interruption related to the manufacturing process, their root causes and consequences. After that an in-depth case study is performed in four industries of four different sectors. This study could therefore be named as multi-method approach (combination of case study and survey methods). In this study, multi-method approach is used to collect data from 35 selected manufacturing industries as it is believed to enhance the credibility of the research results. This approach is believed to enhance the credibility of the research results while reducing the risk of observations reflecting some unique artifact [14].

Table-1: The demography of studied organization

Classification	Criteria	Number of organization	Percentage of organization (%)
Size of organization based on labour intensity	Moderate labour intensive (100-900)	28	80.00
	High labour intensive (900-1500)	07	20.00
Types of organization based on business category	Steel re-rolling mill	09	25.71
	Pharmaceuticals sector	07	20.00
	Cement sector	09	25.71
	RMG sector	10	28.57
Plant location	Dhaka city	23	65.71
	Chittagong city	12	34.29
Total number of organization		35	100.00

Data collection method and sample

Data are collected by two methods, questionnaire based survey and direct observation. In this study related key person from Industrial Engineering department, Planning department and Production manager were interviewed directly using a structured questionnaire. In this study, 35 manufacturing companies of four different sectors in Bangladesh are selected. Some of these companies are export oriented and some are local market based. The demography of the studied organization is presented in table-1. From the questionnaire based survey, two types of data are collected one is based on frequency of occurrence and the other one is based on loss of production hour due to production interruption.

Validity and reliability of measurement scale

The validation process for the survey instrument includes three steps: content validity, construct validity and reliability [4]. The literature review and in-depth interviews conducted with business executives and researchers established the basis of content validity for the survey requirement. The purpose of construct validity is to show that the items measure what they purport to measure. Uni-dimentionality is established with exploratory factor analysis, where |0.4| is generally considered to be the lowest significant factor loading to define the construct (Hair et al., 1998). The study found that all respondents answered all questions and the responses on the ordinal scales were reasonably dispersed. Finally, the measuring scales were tested to verify the reliability of instrument with the help of Cronbach's alpha (α) [5]. The values of α were 0.69, which ensure the validity and reliability of the measuring scale.

RESULTS AND DISCUSSION

From structured questionnaire and direct observation 10 causes of production interruption, 25 root causes and 10 consequences are identified that occur in overall sectors. After that factor analysis, descriptive statistics and pearson's correlation method are performed to identify significance of the production interruptions identified in previous study and the other causes identified in this study. Similar analysis are performed to identify the consequences and the significant root-causes of production interruptions are also identified.

Identifying significant production interruptions for different sectors

From structured questionnaire and direct observation 10 production interruptions are identified in corresponding four industries. The descriptive statistics of total sample given below in Table-2:

Table 2: Descriptive statistics of production interruptions in total sample

Production interruptions	N	Mean	Std. Deviation
Power interruption	35	3.1714	.61767
Malfunctioning of machine	35	3.0857	.44533
Strike	35	2.0286	1.09774
Interrupted production by operator	35	1.8286	1.12422
Defective product	35	2.5714	.95090

Inadequate facility	35	2.0000	1.00000
Delayed supply of raw materials	35	2.3857	.81478
Defective raw materials	35	1.8857	.83213
Scheduling problem	35	2.4571	1.01003
Machine breakdown	35	2.4286	.97877

Mean represents the frequency of occurrence of different interruptions in total sample i.e. in 35 manufacturing companies are shown. In table 2 the interruptions which have mean of higher values than others, occurs more frequently. Those values which are pretty close to scale mean value are considered significant primarily. For example, in the diagram mean of power interruption is 3.1714, which is close to the scale mean value, for that reason it is considered significant interruption here. The descriptive statistics of the five significant production interruptions in four different sectors are mentioned below in table-3. The descriptive statistics of these causes in four sectors is given below:

Table 3: Descriptive statistics of causes in four sectors

Production interruptions	Steel re-rollng mill		RMG sector		Pharmaceuticals Industry		Cement Industry	
	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev	Mean	Std.dev
Power interruption	3.70	0.86	2.9	0.316	2.86	0.378	3.22	0.44
Malfunctioning of machine	2.80	0.66	2.7	0.675	2.68	0.355	2.80	0.66
Interrupted production by operator	2.80	0.66	2.0	0.943	2.43	0.976	1.30	0.5
Defective products	1.30	0.5	3.0	1.054	2.71	0.756	2.11	0.92
Scheduling problem	1.90	0.72	2.90	0.316	2.07	0.535	1.90	0.92

After that further analysis is performed to identify the significant interruptions, which are mentioned below in table-4. From further analysis it is found that five interruptions are comparatively significant and have significant effect on operation. The loss of production hours due to causes varies from organization to organization and also sector to sector. From the analysis it is found that some interruptions are significant in total sample. They are Power interruption, malfunctioning of machine, scheduling problem, interrupted production by operator, Machine breakdown and defective product. n this research, the identification of significant causes involves two steps. They are: Factor analysis and Pearson correlation method. At first factor analysis is performed to reduce less significant causes among 10 causes that are identified from different sectors. In this study, factor analysis is performed to reduce the less significant production interruptions. For this analysis the causes which have values |0.4| and above are considered significant causes [6] . From descriptive statistics and factor analysis significant production interruptions are chosen This process is applied in the four sectors to identify which causes are responsible for production interruption in every sector. The summaries of analyses are shown below for the four sectors and total sample respectively:

Table 4: Factor loading values of causes in total sample

Name of the causes	**Total sample-(35)**
Power interruption	.607**
Malfunctioning of machine	.789**
Defective product	.658**
Interrupted production by operator	.551**
Scheduling problem	.531**
Machine breakdown	.323
Defective raw materials	.307

Delayed supply of raw materials	.376
Strike	.314
Inadequate facility	-.261

***indicates the confidence level p<0.05 ** indicates the confidence level p<0.01**

From the Table-4 it is found that Malfunctioning of machine, Power interruption, Defective product, interrupted production by operator and Scheduling possess factor loadings above |0.4|. That indicates these are the significant production interruptions. In the Table-3 the mean occurrence of significant causes of production interruption is shown for the four types of manufacturing industry. It indicates which causes most frequently occur in which sector. After that factor analysis is performed to identify sector-wise significant interruptions. The significant interruptions for four industrial sectors are depicted below:

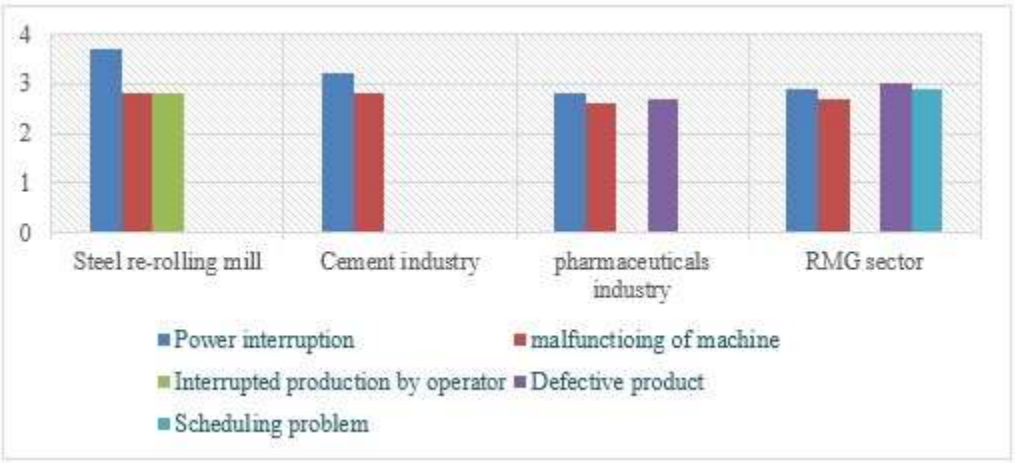

Fig-1: Significant production interruptions in different sectors

Here, in the Fig-1it can be seen that, Power interruption and malfunctioning of machine are the significant causes in four sectors. Therefore, key personnel of these sectors should pay deep attention towards power interruption and malfunctioning of machine. They should also focus on other significant causes, because their effect is not less. From the questionnaire based survey and case study two types of data were collected, one is based on frequency of occurence and the other one based on loss of production hours. Descriptive statistics of lost operating hours due to production interruptions are mentioned below in table-5:

Table-5: Descriptive statistics of lost operating hours

Production interruptions	Max (Hours)	Min (Hours)	Mean (Hours)	Standard deviation (Hours)
Power interruption	11	1.5	5.25	2.16
Malfunctioning of machine	5.5	1	3.01	0.99
Strike	1	0.5	0.57	0.013
Interrupted production by operator	8	1	1.73	1.38
Defective product	7.5	0.5	2.36	1.48
Inadequate facility	1	1	.78	0.12
Delayed supply of raw materials	1	0.5	1.20	0.78
Defective raw materials	2	1	.80	0.27
Scheduling problem	6	1	2.17	1.64
Machine breakdown	3	1	1.41	.89

Here, from the data of lost operating hours percentage of lost operating hours against operating hours are identified. During the study of one month, altogether business operating hours considered for this study is 1872hrs. Comparative findings from the anylysis of two data set such as, data based on frequency and data based on lost operating hours are mentioned in Table-6.The comprison for interruptions is made on a scale of (1 to 5) . Here, 1=highest score and 5=lowest score.

From the Table-9, it can be seen that Power interruption, Malfunctioning of machine and Defective product are the significant causes of production interruption based on mean frequency of occurrence.whereas, Power interruption, Malfunctioning of machine and Scheduling problem are the significant interruption while considering percentage of lost hours.

Table-6: Ranking based on mean frequency of occurrence and percentage of lost production hours

Name of the Interrruptions	Mean of the frequency of occurrence	Ranking baed on mean frequency	Percentage of lost hours against operating hours	Ranking based percentage of lost hours against operating hour
Power interruptions	3.1714	1	11.2%	1
Malfunctioning of machine	3.0857	2	3.74%	2
Interrupted production by operator	2.4286	5	2.08%	5
Scheduling problem	2.4571	4	3.35%	3
Defective product	2.4857	3	3.20%	4

Total percentage of lost hours due to the five significant production interruptions in four different sectors are depicted below in Fig-2.

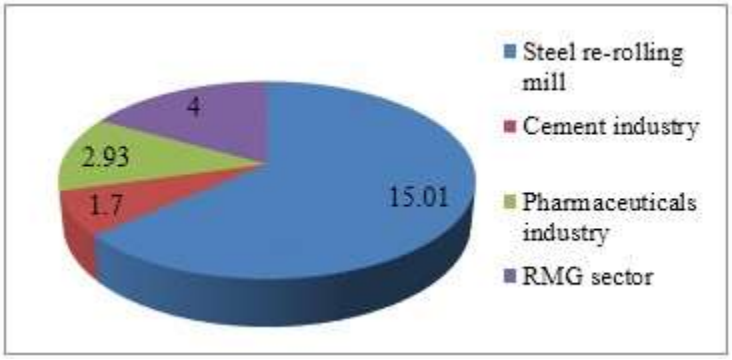

Fig-2: Percentage of lost hours in four industrial sectors for five significant production interruptions.

Where, operating hours for steel re-rolling mill is (24*24) =576 hrs. due to three shifts, similarly for cement industry it is 576 hrs. Operating hours for RMG sector is (24*10)= 240 hrs. and for pharmaceuticals industry (24*8)=192 hrs. After that, different significant production interruptions are identified for different sectors. In Fig-3, lost of production hours due to five significant interruptions and the sector based significant interruptions is shown. The sector-wise significant interruptions are mentioned above in Fig-1.

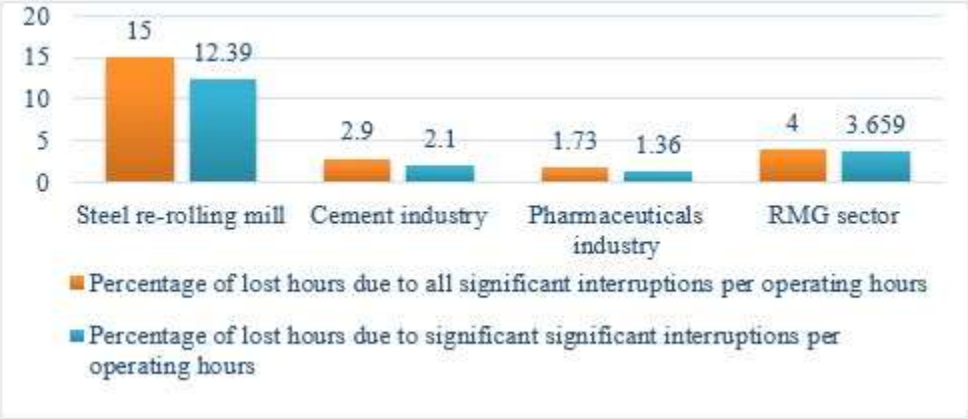

Fig-3: Percentage of lost operating hours due to five significant interruptions and sector wise significant interruptions.

Consequences identified for production interruption:

The dictionary definition of consequence is a result or effect of some previous occurrence. For this research we have choose the definition of consequences as the monetary, time and other losses that resulted due to the production interruption. Disturbances are linked to undesirable consequences which may originate from different circumstances [11]. At first ten consequences are identified from questionnaire and direct observation. After that similar analysis i.e. factor analysis and Pearson correlation (between causes and consequences) is performed to find out significant consequences for different sectors. Pearson correlation is performed between interruptions and consequences. The factor loadings of consequences are mentioned below in Table-7:

Table 7: Factor loadings of consequences in total sample

Consequences	Component
Increased production cost	-0.76**
Rework	0.58**
Work in process	0.31
Increase inventory cost	0.35
Increase in non-value adding time	0.78**
Loose relationship with buyer	0.57**
Scrap	0.22
Delay in delivery	0.61**

***indicates the confidence level p<0.05 ** indicates the confidence level p<0.01**

Those consequences are selected which have factor loading value above |0.4|. After that Pearson correlation method is applied to identify the significant consequences. From both analysis those causes which commonly occur in different sectors are identified. They are: *Increase in non-value adding time, Rework, loose relationship with buyer, delay in delivery and increased production cost.* Correlation between causes and consequences are mentioned below in **Table-8**

Table-8: Correlation between causes and consequences

Causes	Delay in delivery	Increase in non-value adding time	Increased production cost	Rework	Loose relationship with buyer	Work in process	Increase in Inventory cost	Scrap
Power interruption	0.456*	.745**	.867**	.311*	.440*	.211	.241	.198
Malfunctioning of machine	.567**	.786**	.487*	.675**	.311*	.256	.277	.267
Interrupted production by operator	.372*	.457*	.448*	.301	.342*	.214	.256	.268
Defective products	.324*	.696**	.451*	.561**	.285	.172	.215	.418*
Scheduling problem	.871**	.680**	.452*	.423*	.845**	.189	.197	.162

From the table, it can be seen that causes of production interruption are strongly correlated to delay in delivery, material wastage, increased production cost etc. Among them Power interruption has strong correlation with increased production cost.

Identification of root-causes:

From the structured questionnaire and direct observation 25 root causes of production interruption were identified which are responsible for 11 causes of production interruption. Then factor analysis method is performed to reduce the less significant data. After that Pearson correlation method is used between six significant causes and root causes (factor loading more than |0.4|) to identify which root-causes strongly associated with these causes of production interruption. The summary of the analysis is delineated below:

Table-9: Correlation coefficients among causes and root-causes

Causes / Root-causes	Power interruption	Malfunctioning of machine	Interrupted production by operator	Defective product	Scheduling problem
Load shedding	**0.46***	**0.21**	**0.16**	**0.18**	**0.15**
Gas rules	**0.63****	**0.19**	**0.09**	**0.11**	**0.07**
Inappropriate maintenance	**0.25**	**0.32***	**0.18**	**0.27**	**0.24**
Unskilled operator	**0.11**	**0.32***	**0.75****	**0.28**	**0.18**
Poor inspection	**0.13**	**0.27**	**0.20**	**0.429***	**0.12**
Shortage of raw materials	**0.07**	**0.12**	**0.07**	**0.41***	**0.24**
Unavailability of tools	**0.09**	**0.11**	**0.14**	**0.15**	**0.17**
Improper scheduling	**0.15**	**0.18**	**0.12**	**0.25**	**0.32***
Information gap	**0.05**	**0.10**	**0.17**	**0.21**	**0.40***

***indicates the confidence level p<0.05 ** indicates the confidence level p<0.01**

The Pearson correlation is performed on those root causes, which have factor loading value above|0.4|. From analysis it is found that these 10 root causes are closely correlated with the immediate causes. For example, load shedding and gas rules are significant root causes of power interruption, it is shown for other causes also.

This study set out with the aim of detecting the significant production interruptions, their root-causes and consequences of these interruptions in manufacturing sectors. Islam et al. in his study identified some internal disturbances, they are; absenteeism, machine malfunction, machine breakdown, and material handling [9]. Considering these factors questionnaire was developed. From the questionnaire based survey five significant production interruptions are identified such as; Power interruption, Malfunctioning of machine, Interrupted production by operator, Defective products and Scheduling problem. Though some production interruptions are proven to be more significant for one sector and less for others. For that reason, a sector based analysis is performed. From that it is found that, power interruption and malfunctioning of machine are significant production interruption for all of these sectors. From the analysis of percentage of lost hours due to the production interruptions, it is found that significant amount of loss of production hours occurred due to these significant interruptions. Time is one of the most important element in manufacturing system. A deep consideration should be given on that. The consequences of the production interruptions are also identified. The data of consequences are taken in percentage increase. From the analysis it is found that Increase in non-value adding time, Rework, loose relationship with buyer, delay in delivery and increased production cost are significant consequences of interruptions. From the data it is found that that production cost increased 27.77% due to production interruptions. Because increase in labour cost, material cost, cost of machining etc. The percentage increase of these costs in production cost is mentioned below in Fig-4;

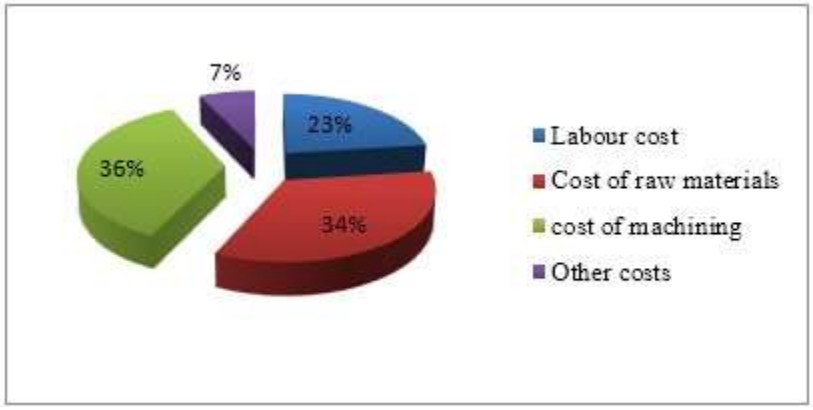

Fig-4: Percentage incraese in Production costs

From the diagram it can be clearly seen that due to production interruption cost of raw materials , labour cost, cost of machining and other cost like cost of using generator or own power station increases respectively 34%, 35%, 23% and 7%. Also due to other causes and their associated consequences companies has to bear huge expanses, which increases their production cost. Also the goodwill of the companies are greatly hampared due to production interruptions. The study also reveals some potential root causes of production interruptions. It will help in reducing the production interruptions in their root.

CONCLUSION

The minimization of lost operating time and cost are becoming the most vital issue. Production interruptions hinder daily performance and as well as lost operating time increases. In this context, the study focuses on the, identification of different production interruptions, their root causes and also consequences occur due to them in four industrial sectors, such as; Steel re-rolling mill, Cement industry, Pharmaceuticals industry and Garments industry in Bangladesh. The exploratory study including 35 manufacturing industries had extracted five significant production interruption which are frequently occur in the four sectors some of them are power interruption, malfunctioning of machine, and scheduling problem etc. From the study nine root causes are identified, some of them are inappropriate maintenance, unskilled operator, information gap and load shedding etc. The consequence of these interruption has identified among them some are relatively more significant, such as; Increase in non-value adding time, Rework, loose relationship with buyer, delay in delivery and increased production cost. From the study some ideas about the existing scenario of production interruption in manufacturing industry are gathered. The data analysis is performed by using SPSS software to find out the significant causes of production interruption in these four sectors. From the study it is also found that, different causes are also significant for different sectors, though some causes are commonly occur, such as; power interruption and malfunctioning of machine frequently occur in the four industrial sector. They are basically the significant causes for all the sectors. Due to production interruptions production cost and time

significantly increases. Companies should focus on this. This finding has important implication for policy or decision makers of manufacturing companies. The identified production interruptions should provide a quick benchmarking for manufacturing companies. For smooth running of production process it is compulsory to ensure interruption free production. By ensuring this, the productivity of the company can also be increased.

ACKNOWLEDGEMENTS

The authors would like to thank the Department of Industrial and Production Engineering, SUST for dministrative support.

REFERENCES

[1] Bakth Zaid , Size Structure of Manufacturing Industry and Implications for Growth and Poverty: Bangladesh country report, web: http://www.bids.org.bd/files/Bangladesh.pdf, February, 2011.
[2] Black TR , Doing quantitative research in the social sciences: an integrated approach to research design, measurement and statistics. Sage, Thousand Oaks,1999.
[3] Duncan McFarlane, Jeremy Matson, Assessing and Improving The Responsiveness of Manufacturing Production Systems, UK Engineering and Physical Sciences Research Council (EPSRC) Grant GR/L41523, August,1999.
[4] Hair JF, Anderson R, Black W(1998) Multivariate Data Analysis, Prentice Hall, Upper Saddle River, NJ.
[5] Hinton PR , Statistics explained, 2nd edn. Routledge, New York, 2004.
[6] Islam Faruk M., Statistical Packages for Social Science(SPSS), 4th Edition, Systech Publications Ltd 2009, p(23), 2005.
[7] Islam MA, Tedford JD, Haemmerle E ,Managing operational risks in small- and medium-sized enterprises (SMEs) engaged in manufacturing–an integrated approach. International Journal of Technology, Policy and Management 8(4):420-441, 2008.
[8] Islam MA, Tedford JD, Haemmerle E ,Proceedings of the 2006 IEEE International Conference on Management and Innovation and Technology, Singapore. In: Strategic risk management approach for small and medium-sized manufacturing enterprises (SMEs)—a theoretical framework. Singapore, IEEE. pp 694-695, 2006.
[9] Islam MA, Tedford D ,Risk determinants of Small and medium-sized Manufacturing Enterprise(SMEs)- an exploratory study in New Zealand, New Zealand, Springer, August, 2012.
[10] Islam M A, Rashed A A C, Begum M N, Operational Disturbance And Their Impact on The Manufacturing Business- An Empirical study in The RMG sector of Bangladesh, IRACST, ISSN: 2249-9563, 2012.
[11] Monostori L, Szelke E, Kadar B (1998) Management of changes and disturbances in manufacturing systems. Annual Reviews in Control 22:85-97
[12] Patuakhali science and Technology University (PUST), Problems and Prospect of Garments Industry in Bangladesh and the Supportive Policy, web: http://www.scribd.com/doc/14270128, Current-State-of-Affairs, 2010.
[13] Brewer J, Hunter A , Foundation of multi-method research: synthesizing styles. Sage, Thousand Oaks, 2006.
[14] Bellgran,M.,&Aresu,E, .Handling disturbances in small volume production .Robotics and Computer-Integrated Manufacturing, 19(1), 123-134, . 2003.