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Uncertainty analysis of Electric Power Outages disruptive impacts on Flour Mill

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Abstract

Industry sectors production disruptions have negative impacts on a region's economy. Electric power outage is a risk, which has the potential to disrupt the as per planned production of the industry sectors. Due to electricity load shedding the shift times are wasted and production cannot be done even if other facilities are available. In this paper, a methodology is developed to estimate the economic losses and inoperability of Flour mill specifically caused due to uncertain electric power outages. The uncertainty analysis of economic losses and inoperability reveals that a Flour mill of production capacity 120 Tons/day when faces electricity load shedding in the range of 1 to 3 hours daily can lead to monthly economic losses from minimum of 4969611 to maximum of 14575781 PKR.

Keywords: ***electricity outages, flour mill, inoperability, economic losses, Uncertainty analysis***

1. Introduction

To date, production of industry sectors is highly dependable on electric power supply. As true in most scenarios, electric power outages will disrupt production or may make an industry sector completely inoperable (i.e., zero production until electric power is back on). Disruptions in production lead to economic losses. In an economic region, industry sectors are interconnected (i.e., output of one industry sector is input of another industry sector and vice versa. Disruptions in the production will affect the industry sectors as well as interconnected industry sectors due to inherent interdependencies.

In this research paper, we develop a methodology to estimate the economic losses of flour mill situated on Warsak road Peshawar Pakistan facing production disruptions specifically due to electricity load shedding. The load shedding is common problem which the flour mill faces. Due to electric power outages the machines in flour mill become inoperable leading to its inoperability and hence to the economic losses of the region. The inoperability and economic losses of flour mill are estimated incorporating a probabilistic model.

1.1 Goals and Objectives

A methodology of estimating the economic losses is developed in this research to calculate the economic losses resulting from flour mill especially due to electricity load shedding through the uncertainty analysis. The main goals and objectives of this research paper are as follows:

- To relate the flour mill inoperability with the electricity load shedding.
- To estimate the economic losses of flour mill due to uncertain electricity load shedding with the help of probabilistic model

The probabilistic model developed in this paper can measure the economic losses and inoperability of flour mill specifically due to electric power outages. This research does not consider other effects such as flour mill closing, the unemployment rate, the profit loss of flour mill owner and indirect economic losses due to other industries which require inputs from flour mill.

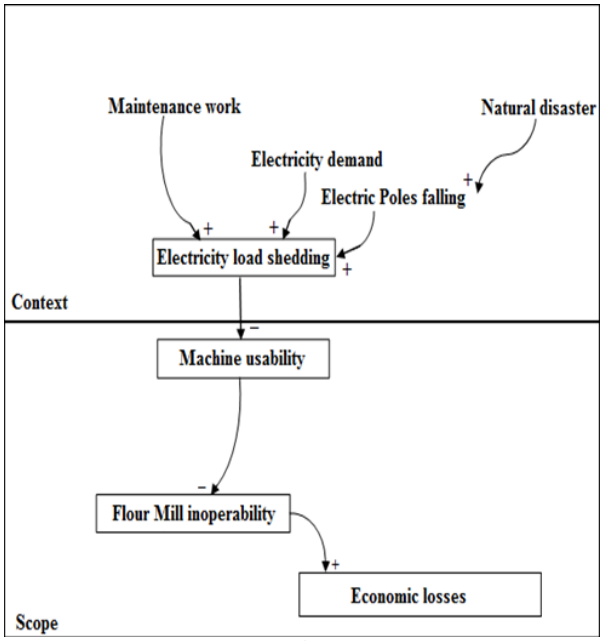

Fig. 1 Scope of the research work

Figure 1 shows the overall scope of this o research. The figure depicts different factors with which the electricity load-shedding increases or decreases directly. The electricity load shedding and machine usability are inversely related. Machine usability increases with the decrease in electricity load shedding and it decreases with the increase in electricity load shedding. When machine usability increases flour mill inoperability decreases and vice versa. With the flour mill inoperability increase or decrease the economic losses increases or decreases respectively. Hence, when electricity load shedding decreases the usability of machines increases due to which flour mill inoperability decreases which reduces the economic losses. The economic losses will be more with more inoperability of flour mill resulting from low machine usability due high electricity load shedding.

2. Literature review

Muhammad Nasir et. al., in 2011 estimated the electricity load shedding effects on loss of production, delays in order delivered and on the rate of employment of employees [1]. In 2010, Kaseke calculated the cost of load shedding of power on the mining sector [2]. A methodology of estimating losses in production and delays in order in textile industries due to electricity load shedding was developed in 2013 [3]. Muhammad Khurshid and Wasim Anwar estimated the impact of electricity unavailability with the parameter return on asset ratio (ROA) on different industries in 2013 [4]. Hafiz Pasha (2012) determined the impact of load shedding on domestic users [5]. In 2014 Akif Zia et. al., (2014) included the effects of unserved energy in generation and expansion planning and concluded that due to electric power outages the industry faces a loss of Rs.157 billion [6]. In 2014 Yousaf and Ayyub conducted interview in textile industry to find out the employees perception about electricity load shedding [7]. In 2012 Richard J. Campbell discussed the problem of power outages resulting from abnormal weather [8]. Muhammad Shahbaz in 2015 estimated the recent and future cost which the service, industrial and agriculture sector face due to electricity load shedding [9]. In 2003 Muhammad Tariq and Jehangir Shah explained the factors, resulting in the closure of different industries in KPK [10]. In 2009 Pasha conducted a research, in which the causes of electric power outages and their economic losses in various industry sectors were highlighted [11]. In 2005 Simono et. al., discussed the different factors resulting in the uncertainty in the occurrence of outages [12]. In 2008 Wijayatunga et. al., find out the effect on economy when industries were facing electric power outages in Bangladesh [13]. In 1989 Pasha et. al., studied the effect of electricity load shedding on cost Pakistani industries [14]. In 2005 Bose et. al., found the results of power outages in India [15]. In 1982, Bental et. al., developed a methodology of estimating the cost of electric power outages [16]. In 2005 Altinay, G and Karagol, E correlated the economic growth with the electricity consumption [17]. In 2001, Aqeel, A and M.S. Butt related Pakistani economy and energy utilization [18]. In 2008 Erbaykal, E. developed relationship of the Turkey economy with consumption of energy [19]. In 2008 Sari, R et. al., related production of industries with energy consumption in the United State [20]. Lassana Cissokho and Abdoulaye Seek in 2013 study the impact of electricity load shedding on small and medium size enterprises productivity [21]. Hugh Byrd and Steve Matthewman studied the impacts of electric power outages blackouts on economic losses among other issues [22]. Sudeep Dattatraya Kulkaraniirlekar described the sources of uncertainty in the electric power outages and their possible effects in 2015 [23]. Sinan Kofeoglu in 2015 studied the economic impact of abnormal weather condition causing unexpected electricity load shedding on the customer interruption cost in industrial, service and residential sectors [24]. Colambage, D. Punsara, et. al., in 2016 studied the effect of unsupplied electricity on industries in Sri Lanka [25]

3. Methodology

The two step methodology is followed in this paper. In the first part mathematical modeling of inoperability and economic losses of flour mill for electricity load shedding is done. The second step involves calculation of economic losses and inoperability of flour mill through uncertainty analysis.

3.1 Modeling of economic losses:

The modeling of economic losses requires parameters such as overall production of flour, percentage production of flour varieties, working days per month, price of flour varieties and the electric power outages in hours per day.

By multiplying the overall production of flour with the percentage production of flour variety we obtain the production rate of different flour varieties

Production of flour varieties = overall production rate of flour $*$ $(\sum_{i=1}^{n} f_k)$……..... (1)

Where f_k is the percentage production of flour varieties and its value depend on the demand of customer and must follow the following condition

$\sum_{i=1}^{n} f_k$=1

By multiplying equation (1) with variable p_k which shows the prices of flour varieties we get the monetary value of flour

Overall Monetary value = overall production rate of flour $*$ $(\sum_{i=1}^{n} f_k \cdot p_k)$. . . . . (2)

Where "p_k" show the prices of flour varieties in rupees per Ton.

Multiply equation (2) with daily electric power outages in hours per day and working days per month to get the

economic losses per month due to inoperability of flour mill due to electricity load shedding.

Monthly Economic Losses = [overall production rate of flour $*(\sum_{i=1}^{n} f_k \cdot p_k)]*$Monthly working days$*$Electric power outages per day …….. (3)

3.2. Economic losses analysis

For the economic losses analysis, equation (3) was deployed. The data of electric power outages and other parameter were taken through visits and surveys. The response of data of electric power outages was different by different flour mills. In addition, electricity load shedding durations were treated as uncertain. The duration of electricity load shedding was following Triangular distribution. A sample of one thousand was taken from this distribution curve and was fed to the modeling equation (3) for their economic analysis.

4. Results

Case Study: <u>Flour Mill</u>

New Age Flour & Gen:Mill(Pvt)Ltd: Pirbala Peshawar, Pakistan

Fig. 2 Box Plot of economic losses of Flour Mill

Fig. 2 shows economic losses box plot for Flour Mill. It shows that for a triangularly distributed electric power outages Tri~ (1, 2, 3) hours daily then 50% of monthly economic losses will be more than Rs.9703378 while 75% of total economic losses will be equal to or less than Rs.11208234.

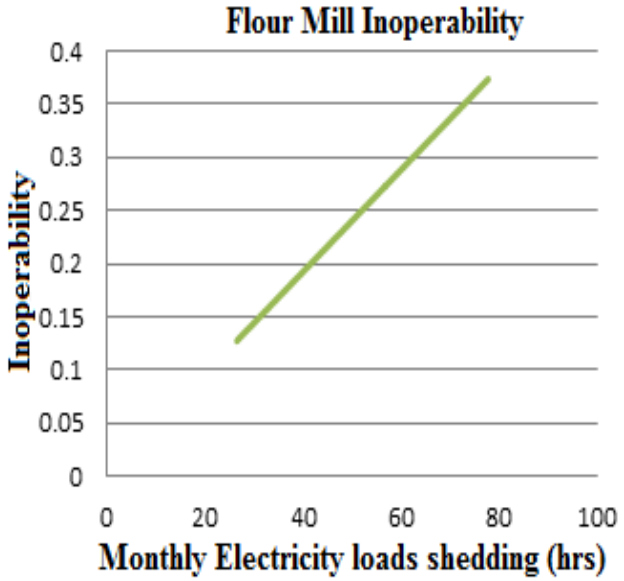

Fig. 3 Electricity load shedding effects on inoperability of Flour Mill.

Fig. 3 depicts the impact of monthly electric power outages in hours on the flour mill's inoperability. The figure depicts that the inoperability increases directly with the increase in duration of electric power outages from 12.7% inoperability to a maximum of 37% when the monthly duration of load shedding increases from 26 hours to a max of 78 hours monthly for triangularly distributed electric power outages Tri `(1, 2, 3) hours daily.

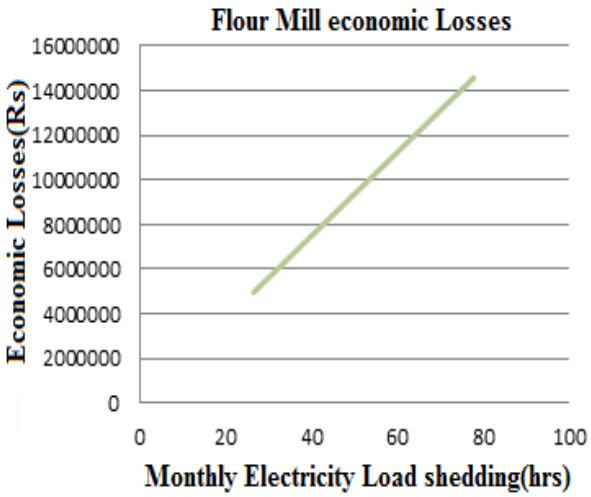

Fig. 4 Electricity load shedding Impacts on Economic Losses for Flour Mill

Fig. 4 shows the relationship of monthly economic losses and electric power outages for a single flour mill. The economic losses increases directly with the electricity load shedding duration with the minimal economic losses of Rs. 4969611 which reaches to a maximum value of Rs.

14575781, when the duration of electric power outages increase from 26.5 hours to 77.8 hours monthly.

5. Conclusions and Future work

Electricity load shedding is also a serious risk for the flour mill operability and economic losses. This paper concludes that a flour mill facing a daily one hour of electric power outages will suffer from economic losses of approximately Rs.4969611 per month. Economic losses will increase to Rs.14575781 per month as the electricity load shedding increase to 3 hours daily as depicted in Fig. 4. In addition, this research also revealed that the flour mill's inoperability is directly proportional with the electricity load shedding. This paper developed a methodology to estimate the economic losses and economic of flour mill situated on Warsak road, Peshawar. However, this methodology can be applied to flour mills of other regions. In future, other impacts of electricity load shedding may also be included in the developed probabilistic model.

References

[1] Siddiqui, Rehana, et al. (2008)"The cost of unserved energy: evidence from selected industrial cities of Pakistan." The Pakistan Development Review.227-246.

[2] Kaseke, N. (2010)"The Cost of Power Outages in Zimbabwe's Mining Sector". The African Executive 277, 1–40.

[3] Haider Ali and Muhammad Nawaz (2013) "Energy Crisis and Productive Inefficiency: Micro-Evidence from Textile Sector of Faisalabad". The Pakistan Development Review pp. 447–465

[4] MuzammilKhurshid (2013), "Energy Crisis and Performance of Industry of Pakistan: An Empirical Study of KSE Listed Companies".International Journal of African and Asian Studies Vol.2 pp. 50-55

[5] Pasha, H.A. and Saleem, W., 2013. "The impact and cost of power load shedding to domestic consumers". The Pakistan Development Review, pp.355-372.

[6] Akif Zia Khan, Sun Yingyun, AhsanAshfaq, and SarmadMajeed Malik "Generation Expansion Planning Considering the Equilibrium Between System Reliability and Cost: A Pakistani Case Study" 2nd Intl' Conference on Advances in Engineering Sciences and Applied Mathematics (ICAESAM'2014) May 4-5, 2014 Istanbul (Turkey)

[7] Rana Muhammad Yousaf and Rana Muhammad Ayyub(2014) "Exploring perceptions of employees on possible effects of energy shortage on textile industry-a case study" Sci.Int(Lahore),26(2),909-914, ISSN 1013-5316

[8] Campbell, R.J., (2012). "Weather-related power outages and electric system resiliency". Washington, DC: Congressional Research Service, Library of Congress.

[9] Shahbaz, M., (2015). "Measuring Economic Cost of Electricity Shortage: Current Challenges and Future Prospects in Pakistan". 1-30

[10] Tariq, M., (2003). "Causes of Industrial Failure and Its Implications in NWFP". Capacity Building for Science and Technology, p.42.

[11] Ghaus-Pasha, A., (2009). "Economic Cost of Power Outages".Working Paper.

[12] Simonoff, J.S., Zimmerman R., Restrepo C.E. et al. (2005) "Electricity Case: Statistical Analysis of Electric Power Outages", CREATEReport#05-013, NewYorkUniversity- Wagner Graduate School

[13] Wijayatunga, P. D. C. and M. S. Jayalath (2008) "Economic Impact of Electricity Supply Interruptions on the Industrial Sector of Bangladesh". Energy for Sustainable Development 7:3, 5–12.

[14] Pasha, H.A., Ghaus, A. and Malik, S., (1989). "The economic cost of power outages in the industrial sector of Pakistan". Energy Economics, 11(4), pp.301-318.

[15] Bose, R. K, M. Shukla, L. Srivastava, and G. Yaron (2005) "Cost of Unserved Power in Karnataka, India". Energy Policy 34, 1434–1447.

[16] Bental, B. and Ravid, S.A., (1982). "A simple method for evaluating the marginal cost of unsupplied electricity". The Bell Journal of Economics, pp.249-253.

[17] Altinay, G., Karagol, E., (2005). "Electricity consumption and economic growth: evidence from Turkey". Energy Economics 27, pp.849–856

[18] Aqeel, A and M.S. Butt (2001), "The Relationship between Energy Consumption and Economic Growth in Pakistan", Asia-Pacific Development Journal, Vol. 8, No. 2, pp. 101-109

[19] Erbaykal, E. (2008), "Disaggregate Energy Consumption and Economic Growth: Evodence from

Turkey", International Research Journal of Finance and Economics, Issue, 20, pp. 172-179

[20] Sari, R., B. T. Ewing and U. Soytas (2008), "The Relationship Between Disaggregate Energy Consumption and Industrial Production in the United States: An ARDL Approach", Energy Economics, Vol. 30, pp. 2302- 2313

[21] LassanaCissokho and Abdoulaye (2013), "Electric Power Outages and the Productivity of Small and Medium Enterprises in Senegal"ICBE-RF Research Report No.77/13

[22] Matthewman, S. D., & Byrd, H. (2014). "*Blackouts*: *Sociology of Electrical Power*. *Failure*" Social Space, 1-25.

[23] SudeepDattatrayaKulkaraniirlekar (2015), "Blackouts in the power system" Electric Journal of 'Electrical and Electronics Research, Vol 3, pp 1-7

[24] SinanKofeoglu(2015) " Economic Impacts of Electric Power Outages and Evaluation of Customer Interruption Costs" Doctoral dissertation,Aalto University School of Electrical Engineering

[25]Colambage, D. Punsara, et al.(2016) "Assessment of cost of unserved energy for Sri Lankan industries." Electrical, Electronics, and Optimization Techniques (ICEEOT), International Conference on. IEEE. pp.1644-1648