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The Costs Of Load Shedding To Small Scale Industries (Firms) At District Swat, Buner & Lower Malakand

Mukamil Shah*[1], Abid Khan[2], Zohaib Ali[3], Azmat Ali Shah[4], Brekhna Ali[5]

[1]Assistant Professor, Institute of Management Sciences, Peshawar.

[2]Institute of Management Sciences, Peshawar.

[3,4]Iqra National University, Peshawar.

[5]Institute of Management Sciences, Peshawar.

Abstract

This study attempts to quantify the costs of load shedding to the industrial sector in district swat, Buner & Lower Malakand (KP). The study has used OLS and the Direct Assessment method (DAM) to quantify the impact of different factors on income loss and the direct costs associated with load shedding. The empirical findings reveal that an increase in load shedding hours in production time has significantly increased the income loss. It is in the form of idle labour cost, overtime labour cost, alternate sources of energy and raw materials cost. Furthermore, the direct costs are the highest for the two famous industrial groups in the region. Those are silk & marble firms incurring RS—65989 & 46765 costs per month due to scheduled load shedding. There are over and above unscheduled load shedding & permission offs from WAPDA authorities without prior notifications to the firms. The study recommends overcoming the unscheduled load shedding; prior notifications & load management strategies are necessary. Therefore, firms will have preventive measures and thus be minimally affected.

1. Introduction

Energy crises have become a very hot issue for developing countries across the globe. Energy (Electricity) plays a vital role in most of the operations of small & medium enterprises. A reliable electricity supply is as useful as capital & labour in stimulating economic activity. Unfortunately, Pakistan has experienced the worst energy crises since 2007. There was a severe shortfall of electricity which has even turned into a deficit during 2010-11 as households and firms started using alternative energy sources such as gas & petroleum products. The supply and demand gap is widened, and thus the authorities are compelled to impose load shedding schedules across the

country (Naz & Ahmad, 2013 & Siddiqui et al., 2011). It has been observed that Punjab and KP are vulnerable to electricity load shedding. The annual hours of power outages (Load shedding) are 1683 in Punjab and 1216 in KP (Pasha et al., 2013). According to the recent reports on load shedding, the map is still high for Punjab and KP (world bank, 2016). This has led to a host of problems commencing from low growth, unemployment, lack of investment, and business shutdowns and has created social unrest in most sectors of the economy. Since the Industrial sector is an energy-intensive sector and thus it has been severely affected by the energy shortfall. This can further lead to damage to the overall economy. Besides the increase in demand for energy, we are lacking in generating electricity. Similarly, the inefficiency of the supply-side is among the fundamental reasons for current crises. Apart from that, there are shortages of water, volatile fuel prices, little focus on developing alternative energy sources, and consistent and higher distribution & transmission losses. The concerned authorities have paid little or no attention to decreasing the gap between demand & shortfall in power generation. There is a need for a balance and coordination between the growth & energy policies of the government (Nasir & Rehman, 2011).

The electricity crises is one of the major obstacles & has adversely affected the investment decisions in the textile sector. It has been evidenced in southern Punjab that textile businesses, around 40%, moved to Bangladesh during the period 2010-2015. Although the same crisis has hit Bangladesh, its government have managed to resolve the issue with the help of European investors in productive projects (Shahbaz & Ali, 2016). Similarly. There are cases of business closures in silk industries at district swat. The only reason was persistent electricity load shedding. These industries cannot afford the cost of alternate energy sources, are unable to fulfil targets, labours earn lower wages, and are forced to shut down their businesses.

In this regard, the present study attempts to analyze the cost of industries so that the authorities are informed of all the associated costs of load shedding. There is an issue with schedule, unscheduled load shedding, and permission offs at different feeders over time. The cost of unscheduled load shedding is severe, as they are not prepared for it. The concerned authorities can look after all these issues and make a better policy/schedule to minimise the overall cost. There are 12 to 16 Electric Supply companies (comprised of both private & public producers) in Pakistan. According to the latest analyses of the energy sector, the highest power generation sources are Thermal (62%), Hydro (25.8%) and 8.2 % from Nuclear Plants (Economic survey 2018-19). The total electricity production was 95730 GWh in 2015 (Khan & Ashraf, 2015) and 84,680 GWh in 2018-19 (Economic survey). Electricity is a vital energy source and is widely used by each economic sector. For instance, household 48 %, industrial 27 %, agricultural 9 % and 8 % by commercial users (Economic survey 2018-19). The electricity demand is a need of the modern-day & is the key input for the energy-intensive industrial sector. It is a basic element for an adequate standard of living and a necessary factor for the country's economic development (Shah & Bhatti, 2009). Unfortunately, Pakistan is witnessing an average shortfall of 4000 to 5000 megawatts in the power sector. The shortfall has further increased. Thus, we face 10 to 12 hours of load shedding across the country (Shah & Bhatti, 2009 Dawn report, 2016). According to the Grid stations schedules of

load shedding of Malakand Division district swat faces 4 to 5 hours of load shedding in winters & up to 12 hours or above in summers. The same happens in district Buner and other regions of KP. Furthermore, there is higher load shedding among rural, urban, FATA & PATA (recently merged in KP) regions, up to 18 hours per day (Shahbaz & Ali, 2016). Due to the chronic power shortages, most of the sectors and GDP of Pakistan have been hit by Load shedding. The direct national outage costs were estimated at 240 billion for domestic consumers, for services sector or commercial consumers at 472 billion, for the industry at 314 billion, and for the agriculture sector at 89 billion. The total loss or cost as a percent of GDP was 7% in 2012 (Pasha et al., 2013).

2. Literature Review

A vast body of literature discusses the economic costs of power outages in the industrial sector. According to Sanghvi (1982), there are different types of power interruption costs. The author claims that the economic cost of a power outage depends on the degree of preparedness of the consumers. That is an expected and unexpected outage (load shedding). As a result, if an outage were anticipated or scheduled, the cost would be kept to a minimum or lower due to preventive measures. On the other hand, if an outage is unexpected, the alternate energy sources will be limited, and their cost will be high. Furthermore, outage costs are categorised into short-term and long-term economic costs. For instance, the cost of idle factors (labour and capital), the loss of raw materials, process restart cost, equipment damage, and sometimes the cost to human health. Long-term costs may include standby or self-generation of electricity, switching permanently to alternate energy sources (fuels), load management, and installing a voltage regulator. If there is a change in value-added in the industrial sector, then load shedding has multiplier or secondary effects on other sectors (Pasha, Ghaus, & Malik, 1989). It can be a decline in economic activity in other sectors like agriculture, banking, retail trade, communications, transport, etc. Interruption of power supply has become a common issue in some developing countries and is considered part of the environmental conditions of doing business (Poudineh & Jamasb, 2015). The effects of such a power interruption are much more than the short-term loss of production and distress faced by households. It can have long-term effects on doing business within the country and can affect investors' investment decisions. If the interruption in power supply becomes a regular occurrence, it cannot be regarded as a one-time occurrence in its routine operations. The power interruption affects the firms' profitability and harms the country's economic growth. Electricity supply is a critical underlying infrastructure for modern-day economies and has several secondary impacts that ripple through the economy. This indicates that the socio-economic impacts of power interruption could be considerably larger when the outpouring impacts and interdependency of the infrastructure are also considered. (Pasha, Pasha, & Saleem, 2013). It is reported that power outages have badly affected every sector of the Pakistani economy. Small-scale industries face load shedding in terms of hours; that is, 2623 hours followed by 2324 hours of load shedding on rural households and farms on an annual basis, whereas urban households are somewhat fortunate as compared to their rural fellow citizens, as they receive 1975 hours of load shedding on an annual basis. The 1667 hours of load shedding per year waste approximately 20-30% of the commercial

sector's good time. The long-standing issue of power outages has significant impacts on the value-added of different sectors of the economy. Because of the power outages, the agriculture sector's output decreased by 6 percent in 2011-12 compared to 2.5 percent in 2007-08. When we look at different sectors of the economy, the large-scale manufacturing sector has the highest annual value-added loss of 9.5 percent. Because of the long-term issues with power outages, people use alternative strategies to generate 3300 MW of electricity, accounting for about 4.5 percent of total electricity supplied by the public sector. According to Goldberg (2016), there are several types of costs caused by the interruption in electricity supply. The effect of frequent load shedding on economic growth is negative. Because of the importance of electricity in our lives, many impacts could result in an economic cost to society and industries. These costs depend on several factors, like the nature of the interruption, its severity, timing, magnitude, and occurrence, and the extent of advance notifications. We can only mitigate or lower the cost of power interruptions by making some adjustments (like increasing the working hours of the labour force or using alternative energy sources). It is challenging to measure the indirect cost of power interruptions that result in significant economic loss. In South African economies, interruptions in the power supply are factors that affect investor confidence. Interruption in power supply has affected every industry in the Zambian economy, and industries are unable to achieve their defined targets. It has been claimed that production has decreased by 10% to 50% for industries that do not have alternate power supply sources. In comparison, a 7% to 20% reduction has happened in the production of firms with other sources of energy or power supply. Load shedding harms the manufacturing sector in Lusaka (Zambia). The manufacturing setup depends on the supply of energy, and electricity is a major input in production (Kazungu, I. et al., 2014). The interruptions in power supply decrease firm productivity, which leaves the firms unable to meet the market demand. As a result, the income and profitability of the firm are decreased. (Bank, 2014) has claimed that some firms switch to generators at the beginning of a certain production process. It happens at times when they have advanced notification of a power outage. In this way, their production is not much affected. But it justifies the use of generators and their cost at load shedding. In some cases, larger firms have reported negligible effects on their productivity.

Shahzad, K., & Zaman, K., think that the electricity crisis has significantly affected their financial status (Shahzad, K., & Zaman, K.). Among the respondents, 70 percent strongly agreed, and 18 percent agreed that their financial burden increased because of the electricity outages. A major portion of the responses shows that load shedding has affected small and medium-sized enterprises on a large scale. During this study, it was found that the electricity crisis has changed the behaviour of investors, and now they are considering electricity supply while taking decisions for investment. Among the firms that responded, 69 percent stated that they would seriously consider power outages when making an investment decision, 26 percent were neutral, and 5 percent disagreed with considering power outages when making an investment decision. The cost of load shedding or power outages is positively related to the power outage duration (Woo & Train, 1988). The advance notices about power outages can reduce the firms' costs because they will adjust their work schedules to power outages.

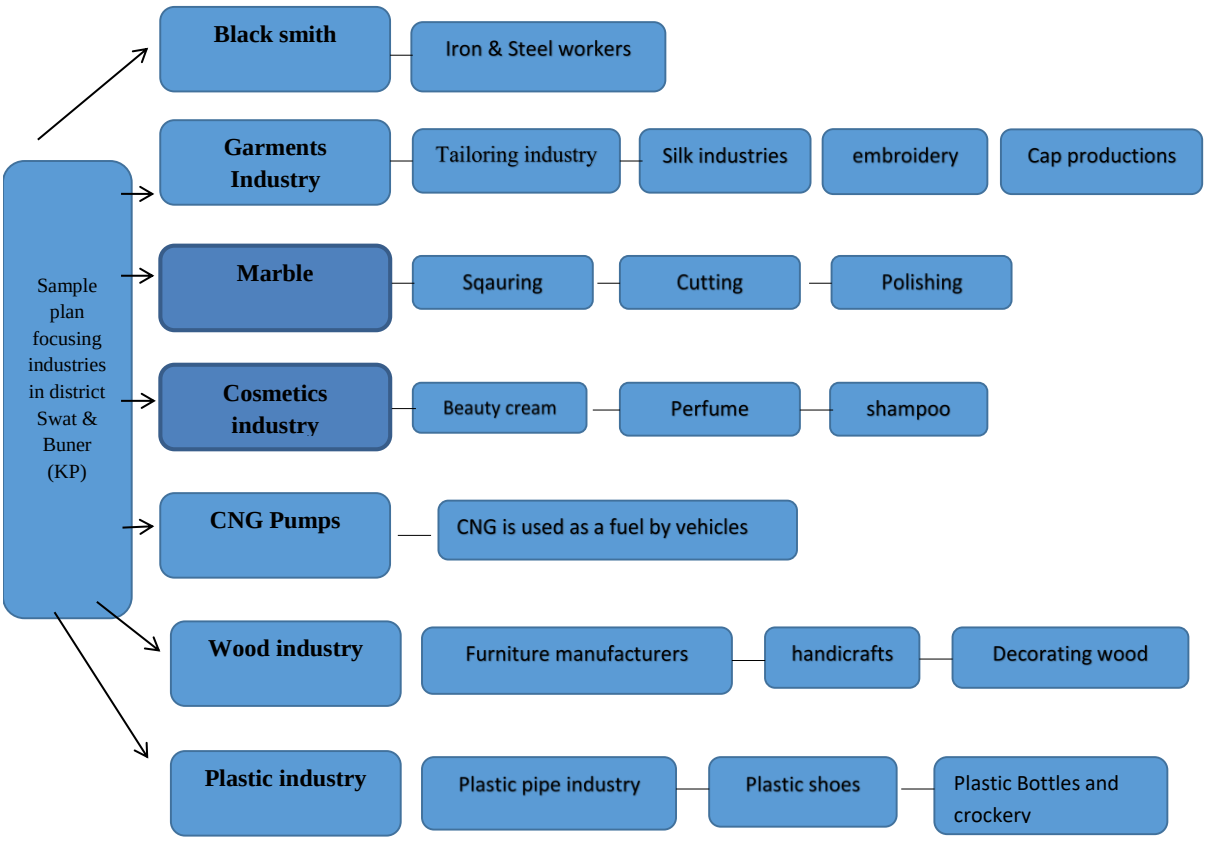
Similarly, the early day times and weekday load shedding increase the cost compared to the late-night and weekend outages of power. Likewise, it was found that food firms and large firms have more positive costs than their small counterparts. (Ighodaro, 2011). reported that the firms have adopted different coping strategies to reduce the impacts of power shortages. Besides the private supply, the non-reliable supply in the country has also influenced the manufacturers' decisions about their choice of business, input combination, and location. The firms avoid those activities that intensively depend on electricity. In the short term, the firms respond through intensive use of non-electricity inputs. About 66% of the respondents claim that they make their employees work extra hours to bridge the gap posed by the shortage of electricity. Among the respondents, 59.8% reported that power shortages had influenced their choice of location. Whereas 53.3% reported that power outages had affected their input combinations, 53% reported that power outages had affected their business choices. The choice of location is about the non-industrial and industrial estates of the country, which are the key components of Nigerian industrial policy.

3. Methodology

In district swat, Buner & Lower Malakand (KP), industrial units or businesses are majorly affected by load shedding. For instance, the Marbles industry, wooden industry, cosmetics, plastic industry, garments (Tailoring, silk, embroidery, and cap producers) and Blacksmith (Iron & steelworkers). Swat district headquarters of the Malakand division is considered a gateway to other districts in a sense that provides skilled labour, raw materials, and other inputs to the rest of the districts. Malakand division consists of seven districts named Chitral, Buner, upper and lower Dir, Malakand, Swat and Shangla. The total swat area is 5337 sq. km, and its population was 1,811,425 in 2009 (Shah Khan, 2012). According to the swat chamber of commerce (Naveed khan), 1,200 to 1,500 industries are actively working in district swat. These industries (Figures) include wholesales businesses, Retailers, manufacturers, showrooms & Franchises and mainly the baseline producers. We categorise these firms because a few of them are not using electricity in their operations while others are running due to electricity. In other words, our concern is only with energy-intensive industries in the region (specifically district Swat, Buner, and lower regions of Malakand).

A questionnaire was used to collect primary data from the sample points. Questions were structured based on the Zambian study by Mwilla et al. (2017) and the study's objectives. The given respondent firms observed the desired costs. A final version of the questionnaire was tested before data collection. A questionnaire was used to collect primary data from the sample points. Questions were structured based on the Zambian study by Mwilla et al. (2017) and the study's objectives. The given respondent firms observed the desired costs. A final version of the questionnaire was tested before data collection.

Figure 1: Selected Firms & its sub workings



The study is based on the data collected from the production firms in District Swat, Buner and Lower Malakand. As per the availability of time and resources, we have collected data from 290 firms in three districts of the Malakand division. Among the seven districts in Malakand Division, District swat, Buner and lower Malakand are selected for the following reasons. They are industrial hubs and famous globally for their garments and marbles industries. There is a minimum number of industries in the rest of the districts of the Malakand division, and access to them was costly for us in terms of finance & time. Therefore, the target population has collected the data through the multi-stage random sampling method. In the first step, firms in district Swat (Kanju, Matta, Islampur & Mingora with surroundings), then district Buner (including Daggar & sawari), and Lower Malakand (comprised of Batkhela, Dargai & Skhakot) were selected on proportion allocation method. Samples are taken by applying the proportional allocation method. Areas/ places with a higher number of energy-intensive firms have more sample units and vice versa with fewer firms in a certain area.

Direct Assessment Method (DAM)

This is an economic appraisal technique that estimates the cost of power shortages by allowing the electricity consumers to state their losses in the form of monetary terms (Kaseke & Hosking, 2012). The technique is based on the principle that the lost materials, time and production in each of the production sectors or lost goods during load-shedding can be calculated directly. This can be

aggregated to get a total (ibid, 2012). This technique depends on the individual respondent's self-assessment method of valuing power outages.

To estimate the cost of power outages through the direct assessment method, the total value lost by the electricity users due to power outages must be ascertained by summing up all the direct costs incurred during power outages. The direct cost incurred by the firms goes beyond the output loss. Because along with loss in output, there are other direct costs as well, such as material destruction costs in stock, payment of overtime and idle labour, damage to equipment, the offer of bonuses to meet the demand and time cost or opportunity costs are also components of the cost of power outages.

The relationship of total direct cost can be captured with the help of the following equation.

In equation 1 TDCi represents the total direct cost for the ith consumer, MLi shows the raw materials lost or cost of output lost due to power outages, LCi represents the cost of labour including the cost of idle labour and labour overtime cost, EDCi shows the cost of damaged equipment and MCI represent maintenance cost (if any) because of power outages.

This method also has certain shortcomings because this method only provides a measure of the direct cost of production, such as the lost output. Still, it does not measure the indirect cost like an inconvenience. Similarly, it does not consider the fact that the forgone production can be partially made up after power outages. Thus, it overestimates the cost incurred by the producer due to load shedding. At the same time, the proponents of this technique argue that this overestimation is a compensation for the omission of indirect cost (Borestein, Beshnell, & Wolak, 2002) and (Bose, Shukla, Srivasta, & Yaron, 2006). The Self-assessments based on business surveys may tend to strategic misrepresentation (Pasha, Ghaus, & Malik, 1990). The reported load shedding cost can be an exaggeration to impress the power supply companies with a more reliable power supply.

Although this method has its shortcomings, its flexibility links it to the behaviour of the observable market in the studies related to the cost estimation of power outages (Pasha, Ghaus, & Malik, 1990). Therefore, this study also uses the direct assessment method to assess the cost of load shedding for the production firms located in districts Swat, Buner & Malakand (Khyber Pakhtunkhwa).

Econometric Model

For the relationship between dependent and all independent variables

$$\text{Income Loss} = \beta o + \beta 1 \text{LShi} + \beta 2 \text{EBilli} + \beta 3 \text{idli} + \beta 4\ \text{ovrtlbr} + \beta 5 \text{AEi} + \beta 6\ \text{ULhi} + \beta 7 \text{Invi} + \mu$$

Variables of the study are described in table 01. They will be used for estimating the cost of load shedding to small industries using the Ordinary Least Square (OLS) technique and Direct Assessment method (DAM) theoretical framework (Kaseke & Hosking, 2012) & (ibid, 2012). We have used the DAM because of the nature of the study, flexibility, and ease of data collection in

monetary terms. Studies like (Pasha, Ghaus & Malik, 1990), (Bancy, 2007) and most recently (Mwila, et al., 2017) has used these methods and variables. Therefore, the study has taken the same variables, although a new variable has been added, i.e. investment decision. Advanced heavy machinery or investing in the capital shows a positive relationship with income (Diacon & Maha, 2015). The dependent variable of the study is Income loss. It has been explained with the following explanatory variables.

Table 1 Variables Description

Independent Variable	Description
Load shedding hours (LSh)	The cost of load shedding hours on income where only the production hours load shedding is considered for the study (Mwila, et al., 2017). Considering the overall load shedding hours will exaggerate the income loss. Therefore the study taking the load shedding of production hours.
Electricity Bill (EBill)	Electricity Bills are the major costs incurred by firms while productions are low due to load shedding effect.
Labor cost (LC)	The total cost incurred by a firm to an idle labor & the labor overtime cost resulted from load shedding (Mwila, et al., 2017). When there is absence of alternate source of energy labors are idle in load shedding hours, on the other hand fulfilling supply demands requires a firms to work overtime. The overall labor cost is associated to load shedding.
Alternate sources of energy (AE)	Any cost incurred by a firm to maintain the alternate sources of energy while load shedding (Mwila, et al., 2017). Meeting the consumer demands pushes a firm to use alternate sources of energy. As it costs a firm therefore the study interested to know about the impact.
Utilization of load shedding hours (ULh)	The cost of load shedding hours, whether they are utilized for any other activity to minimize the income loss or not. There are firms which utilizes the load shedding hours for packing, loading/ unloading cutting cloth etc. Therefore their income loss may be less than those who solely rely on electricity.

Total Investment (Inv)	Firms have invested in heavy machinery and it costs them much while load shedding. On the other hand it has positive/ negative relationship with income (here we consider under load shedding) (Diacon & Maha, 2015).

4. Empirical Results

Table 2 Method: Least Squares (Gauss-Newton / Marquardt steps)

Dependent Variable: INCOME_LOSS

	Coefficient	Std. Error	t-Statistic	Prob.
C	20.02615	9.579210	2.090584	0.0375
Load.hours	0.135363	0.076701	1.764821	0.0787
Elec.bill	-3.96E-05	2.41E-05	-1.643903	0.1014
Work.hour	0.786864	0.534119	1.473201	0.0141
Alt.source	-4.679323	1.347701	-3.472079	0.0006
Gen.cost	-4.06E-05	3.24E-05	-1.252325	0.2115
Mon.loss	-6.47E-05	0.000132	-0.490238	0.6244
Id.labour	1.842687	0.987833	1.865383	0.0632
Aovtm.lab_cost	-0.000656	0.002988	-0.219497	0.8264
A.monthdamage_cost	0.001959	0.001398	-1.400885	0.1624
load.utlz	-3.455424	1.575207	2.193633	0.0291
Ltot.Invest	2.700094	1.017753	2.652996	0.0084

R-squared	0.394024	Mean dependent var	25.62759
Adjusted R-squared	0.356151	S.D. dependent var	10.18680
F-statistic	10.40370	Durbin-Watson stat	1.629499
Prob(F-statistic)	0.000000	Wald F-statistic	82.32325

According to the regression model's findings, load shedding hours have a substantial link with revenue loss, with a one-unit change in load shedding hours resulting in a 0.13-fold increase in

income loss. It indicates that the more hours of load shedding during production period, the greater the financial loss for businesses. Working hours and income loss have a strong correlation. Increased working hours result in a 0.7-fold increase in income loss. Because when you have lengthy working hours / production hours and load shedding occurs, you will undoubtedly lose money. In other words, businesses must pay their employees on a daily/weekly basis, and because load shedding reduces output, they lose money. There's a link between switching to a different power source and losing money. In the existence of an other power source, the enterprises' income loss is reduced by 4.6 times. Because enterprises use generators to continue on their commercial activities, load shedding has no influence on output hours. As a result, in the existence of alternative energy sources, they do not suffer financial losses (generators). A substantial association exists between labour hours and income loss over time, with one unit increase in labour hours resulting in a 0.34 times reduction in income loss. This is one of the methods through which businesses recoup their income losses. Although increased wages are paid over time, the greater impact is in favour of the concerned businesses. As a result, their income losses are decreased, and in certain situations, demand objectives are met.

The existence of idle labour is associated with a considerable loss of income. According to the regression model, every unit increase in idle labour resulted in a 1.8-fold increase in income loss. Many hours are wasted owing to load shedding, according to previous research (Siddiqui et al. 2011), and this has resulted in greater expenditures for the individual organisations. When load shedding hours are used for other productive purposes, the firm's income loss is reduced by 3.4 times. Tailors, for example, cut cloth, sew buttons, and pack cosmetics and plastics; carpenters, on the other hand, use a manual saw while load shedding (Firms Owners). Load shedding causes larger income loss for businesses with more investment. With a 1% increase in investment, the businesses' income loss increases by 2.7 times. Because businesses have invested in heavy gear and are unable to utilise generators even if they can afford it, they are losing money. Load shedding has a long-term influence on investors' investment decisions (Poudineh & Jamasb, 2015).

Firms Legal Status

In all, 290 businesses took part in our poll. The research includes firms from the district swat and Buner. There are 75 blacksmiths (iron and steel workers), 72 timber firms, 63 garments (tailors and silk) enterprises, 37 marble firms, 23 CNG pumps, 14 cosmetic firms, and 6 plastic firms. Individual proprietorship enterprises make up the Malakand division in general, and District swat & Buner, in terms of legal standing. In terms of the legal status of the businesses, table 01 indicates that 241 of the 290 are sole proprietorships. While 37 of the companies are partnerships, ten are private limited corporations, and two are public limited companies (Firms).

Table 3: Factory * Load Shedding hours

Firm Type	Load Shedding hours recoded				Total
	101-110	111-120	121-130	Over 130	
Blacksmith	20	40	10	5	75
CNG	4	0	0	19	23
Cosmetics	6	8	0	0	14
Marble	0	23	4	10	37
Plastic	2	2	2	0	6
Silk	4	6	0	4	14
Tailor	0	0	10	39	49
Wood	17	55	0	0	72
Total	53	134	26	77	290

Load shedding hours

Only the hours of load shedding in production time were examined in this study. It suggests that overall load shedding is often greater than 200 hours per month, although load shedding during production hours is typically less (see table 02). 77 businesses experience monthly load shedding of more than 130 hours. Garments (tailors & silk) are the most affected, followed by CNG Pumps, and this is only due to their working hours each day (see table 06). Load shedding in production hours would increase as the number of working hours per day increased. Following that, 134 businesses would have 111 to 120 hours of load shedding every month, while 53 businesses will experience 100 to 110 hours of load shedding per month.

Table 4: Factory * Source of load shedding schedule

Firm Type	Source of load shedding schedule			Total
	None	Social Media	Print Media	
Blacksmith	45	0	0	75
CNG	23	0	0	23
Cosmetics	14	0	0	14
Marble	37	0	0	37
Plastic	6	0	0	6
Silk	14	0	0	14
Tailor	49	0	0	49
Wood	72	0	0	72

Total	290	0	0	290

Source of Load shedding schedule:

Table 03 shows the results of the source of load shedding programme. We can clearly see that businesses lack a source of information about load shedding schedules. Firms are only notified in exceptional circumstances / emergencies that load shedding will take place for a whole day / a few day, etc. According to the respondents, this topic piqued their interest since in 2007-08, there were meetings between WAPDA officials and firm owners to discuss load shedding. The current trend has shifted, and we hardly ever receive advance notice of load shedding. The firms benefited from the preceding meeting and notifications since they were able to move their off days and breaks, resulting in little disruption to the production plan. In other words, expenditures can be reduced if firm owners/managers are notified promptly, and a specific load-shedding timetable is followed. In terms of responding quickly to turn on generators, change break hours, and so forth.

Table 5: Factory * Billing per Month by Group

	Billing per Month by Group				
Firm Type	Under 50000	51000-100000	101000-150000	Over 500000	Total
Blacksmith	70	0	5	0	75
CNG	4	0	14	5	23
Cosmetics	10	4	0	0	14
Marble	8	12	14	3	37
Plastic	2	4	0	0	6
Silk	10	0	4	0	14
Tailor	49	0	0	0	49
Wood	72	0	0	0	72
Total	225	20	37	8	290

Billing per month:

The monthly power bill, or the cost of electricity utilised, is shown above the table. There are 225 companies with monthly costs under 50,000 dollars and 37 companies with monthly bills ranging from 101,000 to 150,000 dollars. Eight businesses, on the other hand, have a monthly bill of more

than 500,000 dollars. It comprises CNG pumps as well as marble companies that use high-energy-intensive machinery. Despite the fact that average power bills range from 50,000 to 150,000 dollars.

Table 6: Factory * Major Operational constraint

Firm Type	Major constraint					Total
	Finance	Electricity	Competition	Inflation	Other	
Blacksmith	0	60	0	12	3	75
CNG	0	16	0	2	5	23
Cosmetics	0	13	0	1	0	14
Marble	1	35	0	1	0	37
Plastic	0	6	0	0	0	6
Silk	2	12	0	0	0	14
Tailor	0	40	5	4	0	49
Wood	0	59	6	7	0	72
Total	3	241	11	27	8	290

Major Operational Constraint

Major Operational Constraint was the topic of the previous inquiry. As seen in table 05, electricity has remained the biggest stumbling block for 241 of the 290 businesses. Due of heavy machinery, certain businesses, such as marbles, blacksmiths, and silk, rely completely on electricity and cannot afford alternate energy sources. Only a few other companies have stated that inflation is a big stumbling block for their operations.

Table 7: Factory * working hours per day

Firm Type	working hours per day								Total
	7.00	8.00	9.00	10.00	11.00	12.00	13.00	24.00	
Blacksmith	0	28	16	12	12	2	0	5	75
CNG	0	4	0	0	0	0	0	19	23
Cosmetics	0	8	0	6	0	0	0	0	14
Marble	0	2	6	7	11	9	0	2	37
Plastic	0	0	2	2	0	2	0	0	6
Silk	0	0	0	2	0	6	2	4	14

Tailor	0	2	4	14	10	17	2	0	49
Wood	2	18	25	25	2	0	0	0	72
Total	2	62	53	68	35	36	4	34	290

Working Hours per day:

The table (06) above displays the firm's working hours, which have been related to the load shedding hours suffered by each firm. We calculated each firm's load shedding hours each month using their working hours. Due to their 24-hour operating schedule, CNG pumps are heavily impacted by load shedding (see table 02). Table 06 reveals that 34 businesses operate on a 24-hour schedule. 36 firms, on the other hand, work 12 hours a day. The rest of the businesses work between 8 and 11 hours per day, which is standard across the region. Firms' daily labour patterns vary according to the season.

Table 8 Factory * working days per week

Firm Type	working days per week			Total
	6.00	6.50	7.00	
Blacksmith	72	0	3	75
CNG	4	0	19	23
Cosmetics	10	0	4	14
Marble	35	0	2	37
Plastic	6	0	0	6
Silk	6	8	0	14
Tailor	49	0	0	49
Wood	72	0	0	72
Total	254	8	28	290

Working Days per week:

The majority of businesses in the country operate six days a week, and we have the same situation in the study region, as shown in table 07. Where 254 out of 290 businesses operate on a six-day workweek with one day off. Despite the fact that 28 businesses are operating throughout the day and night. It mostly consists of CNG pumps and a few marble companies. We also have companies that work 6.5 days a week and take a half-day off on Friday.

Table 9: Factory * Income by groups per month

Firm Type	Income by groups per month	Total

	Under 51000	51000-100000	101000-150000	151000-200000	Over 200000	
Blacksmith	65	6	0	1	3	75
CNG	4	2	0	0	17	23
Cosmetics	3	9	2	0	0	14
Marble	8	22	1	4	2	37
Plastic	0	2	4	0	0	6
Silk	6	3	4	1	0	14
Tailor	46	3	0	0	0	49
Wood	65	5	2	0	0	72
Total	197	52	13	6	22	290

Income by Groups per month:

In most cases, respondents are hesitant to inquire about their income level. However, we have attempted to extract information using approaches. By enquiring about their monthly production units, sales, and predicted income, for example. Table 08 shows that 197 businesses earn less than $50,000 every month. After that, 52 businesses earn more than 50,000 dollars per month and can earn up to 100,000 dollars each month. Whereas 13 companies make more than $100,000 and 22 companies earn more than $200,000. In the research region, CNG pumps have the highest income, while woodworkers and blacksmiths (iron and steel craftsmen) have the lowest.

Table 10 Factory * Income Loss per Month

Firm Type	Income Loss per Month			Total
	Up to 20%	21%-40%	41%-60%	
Blacksmith	30	39	6	75
CNG	9	13	1	23
Cosmetics	12	2	0	14
Marble	5	30	2	37
Plastic	4	2	0	6
Silk	4	9	1	14
Tailor	29	20	0	49
Wood	29	39	4	72

Total	122	154	14	290

Income Loss per month:

The current study is interested in learning how much money each business loses as a result of load shedding at each site. Table 09 shows the results, which demonstrate that 122 businesses, including woodworking, tailoring, and blacksmithing businesses, are losing up to 20% of their monthly revenue. Then there are 154 businesses that are losing between 21 and 40 percent of their monthly revenue. Finally, 14 businesses are experiencing monthly income losses of more than 40% and up to 60%. Few businesses are losing a significant amount of money because they can't afford other energy sources (i.e. generators) or their machinery is too heavy for generators to handle.

Table 11 Generator Cost by Firms per month

Generator cost	
Firm Type	Average generator cost / month
Blacksmith (75)	11367
Marble (37)	4202
CNG (23)	113660
Silk (14)	6285
Tailor (49)	6037
Plastic (6)	20666
Cosmetics (14)	20357
Wood (72)	7166

Generator Cost by Firms per month:

The results of the generating costs incurred by each business are shown above in table 10. CNG Pumps have the highest average expenses of RS. 113660, while Marble businesses have the lowest average costs of RS. 4202. Silk and cosmetics companies, like marble companies, have comparatively cheap prices. The causes for the disparity include the number of working hours each day by each business, as well as the utilisation and cost of generators. Marble companies may only use generators for polishing; otherwise, their heavy machinery cannot be run on generators. Average businesses such as plastic, cosmetics, and blacksmith have generator costs of RS. 20666, RS. 20357, and RS. 11367, respectively, as indicated in the data.

Table 12: Factory * Monetary value of lost raw material

	Monetary value of lost raw material						
Firm Type	.00	100.00	750.00	2000.00	14000.00	20000.00	Total

Blacksmith	71	2	0	0	1	1	75
CNG	23	0	0	0	0	0	23
Cosmetics	14	0	0	0	0	0	14
Marble	37	0	0	0	0	0	37
Plastic	4	0	0	0	0	2	6
Silk	10	0	2	0	1	1	14
Tailor	49	0	0	0	0	0	49
Wood	70	0	0	2	0	0	72
Total	278	2	2	2	2	4	290

Monetary Value of Loss of raw materials:

The question above wanted to know what the study's main goal was. That is, whether or not any raw materials are lost as a result of power outages. Table 11 displays the monetary worth of raw materials lost (if any) by businesses. According to research, raw materials are lost after or as a result of load shedding (Alfred et.al 2017). Our findings demonstrate that over 97 percent of businesses experience little or minor material losses as a result of load shedding.

Table 23: Factory * Number of Labor's working at Firms

Firm Type	Number of labour recoded			Total
	Up to 5	6-10	Over 10	
Blacksmith	60	12	3	75
CNG	1	16	6	23
Cosmetics	2	1	11	14
Marble	3	19	15	37
Plastic	0	0	6	6
Silk	2	2	10	14
Tailor	8	36	5	49
Wood	16	35	21	72
Total	92	121	77	290

Number of Labours working at each firm:

We posed the aforementioned question to learn more about the job situation in the research region. However, because fewer businesses participated in the survey, the question's intended goal was not met. Despite the fact that we learned the number of labourers employed by each business (see

table 12), There are 92 businesses with up to 5 labourers, 121 firms with 6 to 10 labourers, and 77 firms with more than 10 labourers in their separate firms.

Table 34: Factory * Idle labor cost

Firm Type	Idle labour cost recoded					Total
	Up to 5000	5000-10000	11000-15000	16000-20000	Over 20000	
Blacksmith	45	7	7	7	9	75
CNG	12	3	1	0	7	23
Cosmetics	10	1	1	1	1	14
Marble	4	3	0	2	28	37
Plastic	6	0	0	0	0	6
Silk	2	0	2	0	10	14
Tailor	49	0	0	0	0	49
Wood	49	5	9	7	2	72
Total	177	19	20	17	57	290

Idle Labour cost by Groups per month:

Table 16 shows the costs of idle labour experienced by businesses during load shedding hours. When labourers are at work, even during load shedding hours, they either incur no expenses or they suffer expenditures when they are idle due to load shedding. There are 177 enterprises (including those that incur no cost and those that incur costs up to 5000 rupees) that incur costs of up to 5000 rupees per month due to their labours being idle. Firms with monthly idle labour expenses above 20,000 are at the opposite end of the spectrum. Then there are 20 businesses that spend 11 to 15 thousand rupees each month on idle labour.

Table 45: Factory * labour over time cost

Firm Type	labour over time cost recoded				Total
	Up to 5000	5000-10000	10000-15000	Over 15000	
Blacksmith	75	0	0	0	75
CNG	23	0	0	0	23

Cosmetics	14	0	0	0	14
Marble	29	6	2	0	37
Plastic	6	0	0	0	6
Silk	12	0	0	2	14
Tailor	49	0	0	0	49
Wood	72	0	0	0	72
Total	280	6	2	2	290

Labour over time cost per month:

Once again, we're interested in learning about the second component of labour costs spent by businesses. Similar to table 13, firms either have no labour over time costs or have monthly costs of up to 5000 rupees. As indicated in table 14, most businesses do not incur overtime labour costs as a result of load shedding. As a result of load shedding, they do not work beyond time and hence incur no labour overtime expenditures. Despite the fact that six businesses cost between 5 and 10,000 rupees per month, and two firms cost between 10 and 15,000 rupees per month and beyond 15000 rupees per month,

Table 56: Factory * Equipment Damage cost

	Equipment Damage cost recoded				
Firm Type	Up to 5000	5000-10000	10000-15000	Over 15000	Total
Blacksmith	72	2	0	1	75
CNG	14	4	2	3	23
Cosmetics	13	1	0	0	14
Marble	20	6	4	7	37
Plastic	4	0	0	2	6
Silk	12	1	0	1	14
Tailor	49	0	0	0	49
Wood	71	1	0	0	72
Total	255	15	6	14	290

Equipment Damage cost per month:

Table 15 shows a total of 255 enterprises, including those with no damage costs or costs of up to Rs. 5000 each month. It signifies that load shedding hasn't caused any damage to their equipment.

Although there are 15 enterprises that spend about 10,000 rupees per month on broken equipment and 14 firms that spend above 15000 rupees per month.

Table 67: Factory * Maintenance and running cost

Firm Type	Maintenance and running cost of Machinery				Total
	Dis agree	Neutral	Agree	Strongly Agree	
Blacksmith	13	12	15	35	75
CNG	5	0	9	9	23
Cosmetics	0	6	4	4	14
Marble	11	6	10	10	37
Plastic	0	4	0	2	6
Silk	10	0	2	2	14
Tailor	0	14	16	19	49
Wood	0	21	35	16	72
Total	39	63	91	97	290

Maintenance and Running cost per month:

The findings of the Likert scale are shown in Table 16. The question was raised as to whether load shedding affects the businesses' machinery in terms of maintenance and operating expenses. Following the pilot survey, the question was restructured as a Likert scale. Fewer businesses have disclosed the costs of damaged equipment, labour, and other associated expenses. The results are different in this case since the majority of the companies have said unequivocally that they incur the expense. The remaining 91 enterprises are in agreement, 63 are indifferent, and just 39 are opposed to paying repair and operating costs as a result of load shedding.

Table 18: Factory * cope or remedy of Load shedding

Firm Type	cope or remedy of Load shedding			Total
	Reduced Labour	Switching Working Hours	Non	
Blacksmith	3	0	72	75
CNG	0	0	23	23
Cosmetics	0	0	14	14
Marble	2	2	33	37

Plastic	0	0	6	6
Silk	1	0	13	14
Tailor	0	0	49	49
Wood	0	0	72	72
Total	6	2	282	290

Cope or Remedy strategy of Firms due to load shedding:

A question was posed about the business' coping or remediation plan. To learn about their tactics for adjusting working hours, shutting down, and decreasing labour owing to heavy load shedding. We discovered that they only make judgments on a temporary basis. Aside from that, 95% of the population does not use any of the aforementioned methods or tactics (see questionnaire). Despite the fact that one or two shut down instances were discovered in the district swat. Furthermore, there are only six enterprises that have reduced their workforce and two examples where employees' working hours have been changed.

Table 19: Factory * Alternate utilization of Load shedding time

	Alternate utilisation of Load shedding time		
Firm Type	.00	1.00	Total
Blacksmith	70	5	75
CNG	23	0	23
Cosmetics	4	10	14
Marble	37	0	37
Plastic	4	2	6
Silk	14	0	14
Tailor	12	37	49
Wood	50	22	72
Total	214	76	290

Alternate Utilization of Load shedding hours:

In terms of how load shedding hours are used in other ways, 76 businesses (mostly tailors, woodworkers, and cosmetics companies) cut and pack during load shedding hours. The remaining data in table 18 reveal that 214 enterprises do not or cannot employ load-shedding hours for any other productive activity.

The impact of load shedding on Firms / Cost Estimation:

We've gone through the procedure one by one, as seen in the tables above. Initially, we established that load shedding occurs solely during business hours. In other words, the study takes into account load shedding hours throughout everyday working hours (production time). We have no desire to collect information on overall load shedding or overall cost per day / month. As a result, we can avoid exaggerating the expense.

For calculating the cost of idle labour or the labour cost over time. For starters, the study only looked at idle labour or labour that works for a company over a long period of time. In the marble business, for example, four labourers are idle while production time is reduced by three hours each day. The hourly rate was assessed to be RS 200. As a result, 4 times 3 times 200 equals RS 2400, which is the cost of idle labour for the marble business each day due to load shedding. To estimate the idle labour cost for each business, we repeated the process for all other enterprises. For each kind of company, raw material costs (if any), equipment damage costs, and maintenance expenses were estimated. Because of their location and working hours every day, each firm's cost pattern varies. Finally, the overall cost was calculated by adding the average cost of all connected costs (ibid, 2012).

Following table shows the results of total direct expenditures borne by each firm, as indicated in Chapter 3. The Direct Assessment Method is used to estimate the overall direct cost (DAM).

Its formula is given below:

TDCi=MLi+MCi+LCi+EDCi

TDCi is the total direct cost for the ith firm

MLi is the cost of raw materials lost due to load shedding

MCi is the maintenance cost as a result of load shedding

LCi is the Labour cost (includes labour over time and cost of idle labour)

EDCi is the equipment damaged cost due to load shedding.

Table 70: Total Direct cost for each Firm

Firm Type	Total Direct cost
Blacksmith	12614
Marble	46765
CNG	34728
Silk	65989
Tailor	1167
Plastic	16833

Cosmetics	10629
Wood	7645

Total Direct Cost per month

Finally, we've added up each firm's total direct costs. By aggregate, we imply the cost of raw materials, labour, equipment damage, and (if any) maintenance costs, among other things. We can observe that load shedding has a significant impact on the silk and marble industries. Their monthly expenditures are 65989 and 46765 rupees, respectively. Because they require heavy machinery, silk and marble companies cannot afford alternate energy sources. As a result, they bear the biggest expenses in terms of idle labour or over time, lost revenue, damaged equipment, and so on. Pumps for compressed natural gas (CNG) follow. The lowest monthly expenditures spent as a result of load shedding are tailor's 1167 rupees. Tailors typically use their load shedding hours for cutting and mending buttons, etc., resulting in the lowest monthly expenditures.

5. Conclusion

Most of the firms have income loss of around 30 percent per month, while others are losing 50 percent of their income due to load shedding. However, raw material loss in 97 % of the total firms is relatively low or zero. Whereas more than half of the firms are incurring a fair labour cost of above RS. 10,000 per month (including the cost of idle labour & overtime). The equipment damage cost is shown low in figures, and it’s hardly 5000 a month for most firms. The regression model shows that the higher number of load shedding hours in production time has resulted significantly in the income loss. Income loss is in the form of idle labour cost, labour overtime cost, maintenance & raw materials costs, etc. The Sum of all mentioned costs is also aggregated into the total direct costs. The study has found that major & famous industries of the region are highly affected by load shedding. As shown in the figures, the monthly costs due to load shedding are RS. 65989 & 46765 for silk & marble firms. It is because they cannot afford alternative sources of energy. The direct costs are RS. 12614 for Blacksmith, 34728 for CNG, 16833 for Plastic, 10629 for cosmetics and RS. 7645 for wooden firms. This study attempted to know the direct costs (labour, raw materials, equipment damage and income losses). One of the alarming factors is excess unscheduled load shedding, of which none of the firms is aware of it. There would be permission offs and no prior notifications if it took place in past, so it must be followed now.

6. Recommendations

Apart from the genuine problems (persistent transmission & distribution losses, resource shortage, and low capacity to build dams) of Pakistan's energy sector. There is lope holes and curing those can help us up to some extent. It is stated by almost all the Firms owners / Managers that there is no such source of information from WAPDA. We recommend proper load management & a certain plan of load shedding from the authorities. A few years back, there was load shedding as today,

but at least we, the industrialists, were usually informed about the load shedding schedule. There used to be written agreement or approval from the industries that load shedding would occur at a certain date & time. In other words, there are permission offs of load shedding. It's locally known as permitted at a certain feeder. But there is a lack of timely notification. Furthermore, the routine load shedding occurs even if there was a blackout the whole day. It is highly suggested & requested that the authorities inform us regarding the load shedding schedule, the permitted load shedding, & routine load shedding to be balanced. As the schedules of load shedding were discussed & agreed upon with a group of industries in the past (Especially during the Musharraf era); therefore, we demand the same in future. We expect certain rules & schedules from authorities so that our production processes are smooth and thus we can proceed with our economic activities. Unscheduled load shedding is very costly for most industries. For example, labours go home after unscheduled load shedding in the silk & marble industries. There are times when the duration is short while labours are gone and vice versa as when they wait for power to come, and it does not. This is very important for such industries that can't afford alternative energy sources, and thus they are highly affected. Such costs can be minimized with prior notifications.

References

1. Amadi, H. N., & Okafor, E. N. (2015). Analysis of methodologies for the evaluation of power outage costs. International Journal of Engineering Research and Technology, 4, 956-960.
2. Balducci, P. J., Roop, J. M., Schienbein, L. A., De Steese, J. G., & Weimar, M. R. (2002). Electric power interruption cost estimates for individual industries, sectors, and US economy (No. PNNL-13797). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).
3. Beenstock, M. (1991). Generators and the cost of electricity outages. Energy Economics, 13(4), 283-289.
4. Cissokho, L., & Seck, A. (2013). Electric power outages and the productivity of small and medium enterprises in Senegal. Investment Climate and Business Environment Research Fund Report, 77, 13.
5. Dawn. (2016). 7 Facts regarding Pakistan Energy Crisis. Islamabad: Dawn news.
6. De Nooij, M., Koopmans, C., & Bijvoet, C. (2007). The value of supply security: The costs of power interruptions: Economic input for damage reduction and investment in networks. Energy Economics, 29(2), 277-295.
7. Diboma, B., & Tatietse, T. T. (2013). Cost Estimates and Study of the Characteristics of the Discontinuity of Electricity Supply of Industries in Cameroon. Journal of Scientific Research and Reports, 145-172.
8. Diacon, P. E., & Maha, L. G. (2015). The relationship between income, consumption and GDP: A time series, cross-country analysis. Procedia Economics and Finance, 23, 1535-1543.
9. Economic Survey of Pakistan 2016-17, Ministry of Finance, Government of Pak.
10. Economic Survey of Pakistan 2018-19, Ministry of Finance, chapter 14; Energy.

11. Electricity access in Pakistan, The World bank report in March 2016 (Load shedding map; page 25/38).
12. Goldberg, A. (2016). The economic impact of load shedding: The case of South African retailers (University of Pretoria, Thesis PhD).
13. Ighodaro, C. A., & Oriakhi, D. E. (2011). Electricity infrastructure failure and the development of micro sized enterprises in Nigeria: Evidence from Benin City. Global Journal of Social Sciences, 10(1&2), 1-13.
14. Kazungu, I. (2014). Power Rationing Dilemma: A Blow to Small and Medium Enterprises (SMES) Performance in Moshi Municipality, Tanzania. International Journal of Economics, Commerce and Management, 2(7), 1-14.
15. Khan, S., & Ashraf, H. F. (2015). Analysis of Pakistan's electric power sector. Department of Electrical Engineering, Blekinge Institute of Technology, Sweden.
16. Munasinghe, M., & Gellerson, M. (1979). Economic criteria for optimizing power system reliability levels. The Bell Journal of Economics, 353-365.
17. Mwila, A., Sinyenga, G., Buumba, S., Muyangwa, R., Mukelabai, N., Sikwanda, C., . . . Bwalya, B. k. (2017). Impact of load shedding on small scale enterprises. Energy Regulation board, 1-36.
18. Nasir, M., & Rehman, F. U. (2011). Environmental Kuznets curve for carbon emissions in Pakistan: an empirical investigation. Energy Policy, 39(3), 1857-1864.
19. Naz, Lubna. & Ahmad, M. (2013, December). What inspires energy crises at the micro level: empirical evidence from energy consumption pattern of urban households from Sindh? In Proceedings of the Pakistan Society of Development Economics (PSDE) 29th Annual General Meeting (AGM) and Conference p-29.
20. OECD, W. (2014). World Bank (2014). Global value chains: Challenges, opportunities and implications for policy.
21. Pasha, H. A., Ghaus, A., & Malik, S. (1990). The economic cost of power outages in the industrial sector of Pakistan. Energy Economics, 11(4), 301-318.
22. Pasha, H. A., & Saleem, W. (2013). The impact and cost of power load shedding to domestic consumers. The Pakistan Development Review, 355-372.
23. Poudineh, R., & Jamasb, T. (2017). Electricity supply interruptions: sectoral interdependencies and the cost of energy not served for the Scottish economy. The Energy Journal, 38(1).
24. Reichl, J., Schmidthaler, M., & Schneider, F. (2013). The value of supply security: The costs of power outages to Austrian households, firms and the public sector. Energy Economics, 36, 256-261.
25. Sanghvi, A. P. (1982). Economic costs of electricity supply interruptions: US and foreign experience. Energy Economics, 4(3), 180-198.
26. Siddiqui, R., Jalil, H. H., Nasir, M., Malik, W. S., & Khalid, M. (2011). The cost of unserved energy: evidence from selected industrial cities of Pakistan. The Pakistan Development Review, 227-246.

27. Sichone, Y. M., Mulenga, P., Phiri, C., Kapena, S., & Fandamu, H. (2016). Electricity load shedding: An econometric analysis of the productivity of firms in the manufacturing sector in Lusaka. International Journal of Commerce and Management Research.
28. Shahbaz, M. (2015). Measuring Economic Cost of Electricity Shortage: Current Challenges and Future Prospects in Pakistan. University Library of Munich, Germany.
29. Shah, S., & Bhatti, M. K. L. (2009). Crisis of Electrical Energy in Pakistan and Future guideline for Policy makers. International Journal of Basic and Applied Sciences, 9(9), 1-17.
30. Shahzada, K., & Zaman, K. The impact of electricity crises on the consumption behavior of small and medium enterprises: evidence from Pakistan. Energy and the developing society 2014, 1, 1-19.
31. Shoaib, M. (2013). Pakistan Economic Survey 2012–13. Ministry of Finance, Government of Pakistan.
32. Woo, C. K., & Train, K. (1988). The cost of electric power interruptions to commercial firms. The Energy Journal, 9(Special Issue 2).
33. Zafar, A., & Mustafa, S. (2017). SMEs and its role in economic and socio-economic development of Pakistan. International Journal of Academic Research in Accounting, Finance and Management Sciences, 6(4).