Identification of Barriers to the Development of Hydropower Projects in Pakistan

By

Muhammad Shabbar Raza

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Session 2015-17

Supervised by

Dr. Kafait Ullah

A Thesis submitted to the U.S.-Pakistan Center for Advanced Studies in Energy in partial fulfillment of the requirements for the degree of

MASTERS of SCIENCE in

ENERGY SYSTEMS ENGINEERING

U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E)

National University of Sciences and Technology (NUST)

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THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of MS/MPhil thesis written by Mr. Muhammad Shabbar Raza , (Registration No. 00000118556), of U.S.-Pakistan Center for Advanced Studies in Energy has been vetted by undersigned, found complete in all respects as per NUST Statues/Regulations, is within the similarity indices and is accepted as partial fulfillment for award of MS/MPhil degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the said thesis.

Signature: _____

Name of Supervisor _____

Date: _____

Signature (HoD): _____

Date: _____

Signature (Dean/Principal): _____

Date: _____

Certificate

This is to certify that work in this thesis has been carried out by **Mr. Muhammad Shabbar Raza** and completed under my supervision in, U.S.-Pakistan Center for Advanced Studies in Energy, National University of Sciences and Technology, H-12, Islamabad, Pakistan.

Supervisor: _____

Dr. Kafait Ullah
U.S.-Pakistan Centre for Advanced Studies in Energy
NUST, Islamabad

GEC member # 1: _____

Dr. Parvez Akhter
U.S.-Pakistan Center for Advanced Studies in Energy
NUST, Islamabad

GEC member # 2: _____

Dr. Hassan Abdullah
U.S.-Pakistan Center for Advanced Studies in Energy
NUST, Islamabad

GEC member # 3: _____

Mr. Imtiaz Hussain
NEPRA, Islamabad

HoD-CES _____

Dr. Naseem Iqbal
U.S.-Pakistan Center for Advanced Studies in Energy
NUST, Islamabad

Dean/Principal _____

Dr. Zuhair S. Khan
U.S.-Pakistan Center for Advanced Studies in Energy
NUST, Islamabad

Dedication

This work is dedicated to my parents and teachers especially my supervisor, Dr Kafait Ullah who helped me throughout my master's degree.

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Abstract

Hydropower is emission free and an economical renewable source. World rely on hydropower for 20 % of its total electricity needs. Hydropower technology is well developed in more than 150 countries. Pakistan is a developing country which relies on fossil fuels for its power generation requirements despite huge hydropower potential of 60,000 MW. The installed generation capacity of the system stands at 25,100 MW. Share of hydropower in this capacity is almost 6902 MW. Inclination towards thermal power and delay in the hydropower generation projects has indicated the barriers in development of the hydropower of Pakistan in recent past. Research objective of this study was to evaluate all those barriers in the development of hydropower sector in Pakistan. This study intended to unearth the limitations behind the development of hydropower projects. In this part of research, those factors were evaluated that remained important in the implementation of hydropower projects. To carry out analysis, a questionnaire was developed based on literature review. This questionnaire contained open ended questions to acquire unstructured data from different stakeholders including public sectors departments, private developers and different international organizations working in hydropower sector of Pakistan. The data was analyzed using NVIVO Word Frequency Theory and Text Search Theory. A second questionnaire was developed based on the variables identified from NVIVO analysis. Then structured interviews were conducted by using Q-Method. In this method each respondent was asked to grade each variable depending upon its severity and will justify its choice by giving a statement. Analysis of Q-method results helped to develop four distinct discourses related to hydropower sector of Pakistan. The four discourses included impediments to private sector, contingent cost overrun, lack of coherent planning in hydropower sector of Pakistan and dysfunctional government institutions.

Key Words: NVIVO Analysis, Word Frequency Theory, Text Search Theory, Q-Methodology, Hydropower development, Impediments, Pakistan.

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CHAPTER 1

1.1.Introduction

Pakistan is blessed with abundant energy resources including water, solar and wind as renewables and coal as fossil fuel based resources [1]. Being a growing economy, energy demand for industrial, commercial and domestic activities is expanding and it is a challenging concern to meet demand from the existing generation capacity [2]. The electricity shortfall during peak hours, as reported by several newspapers and state-level energy organizations exceeded beyond 5000 MW from 2011 onwards [3]. At present, a large population has no access to electricity [4]. Pakistan population is growing at 2.4% per annum while GDP is expected to grow up 5.5 % by the end of 2020 [5, 6]. To ensure the intended GDP growth, expedited energy resource exploitation is needed. The government has focused on meeting the energy demands by initiating power projects based on fossil fuels (RLNG based and Coal Fired Power Plants). The fuels for these plants are also being imported from neighboring countries. Despite of abundant potential, the share of hydropower in the energy mix of Pakistan (during fiscal year 2016/17) has fallen from the previous fiscal year 2015/16 when it was 34 % and the fossil fuel-based generation remained 62%. Table 1: Projects Commissioned under different power policies below includes the power projects commissioned in last 3 decades. A total of 15468 MW has been commissioned in last 3 decades. Approximately, more than 15000 MW commissioned power plants are thermal powered (including Coal, LNG, CNG and Oil) while the capacity of only 231 MW have been commissioned in hydropower projects. The inclination towards the thermal based generation has disturbed the hydropower balance in energy mix of Pakistan. Further it rules out the possibility of same incentives/packages for investors in hydropower of Pakistan.

Table 1: Projects Commissioned under different power policies

Prior to Power Policy 1994[7]			
Sr. No	**Project Name**	**Capacity**	**Type**
1	Hub Power Project,	1292	Thermal Power

	(HUBCO)		
Power Policy 1994			
1.	Lalpir Limited	362	Thermal Power
2.	Pak Gen. (Pvt) Limited	365	Thermal Power
3.	Altern Energy Limited	31	Thermal Power
4.	Fauji Kabirwala Power Company	157	Thermal Power
5.	Gul Ahmed Energy Ltd. (GAEL)	136	Thermal Power
6.	Habibullah Coastal Power (Pvt) Co.	140	Thermal Power
7.	Japan Power Generation (Pvt) Limited	120	Thermal Power
8.	Kohinoor Energy Limited	131	Thermal Power
9.	Liberty Power Project	235	Thermal Power
10.	Rousch (Pakistan) Power Limited	450	Thermal Power
11.	Saba Power Company Limited	134	Thermal Power
12.	Southern Electric Power Company Limited	117	Thermal Power
13.	Tapal Energy Limited	126	Thermal Power
14.	Uch Power Limited	586	Thermal Power
15.	Davis Energen Power Project	10.5	Thermal Power
16.	Kot Addu Power Company Limited (KAPCO)	1638	Thermal Power
Under 1995 Policy			
17.	**New Bong Escape Hydropower Project**	**84**	**Hydro power**
Under 2002 Power Policy			
18.	Attock Gen Limited	165	Thermal Power
19.	Atlas Power Limited	225	Thermal Power
20.	Engro Energy Limited	227	Thermal Power
21.	Saif Power Limited	229	Thermal Power
22.	Halmore Power Generation Company Limited	225	Thermal Power

23.	Hub Power Project - Narowal	220	Thermal Power
24.	Liberty Power Tech	200	Thermal Power
25.	Nishat Power Limited	200	Thermal Power
26.	Nishat Chunian Limited	200	Thermal Power
27.	Orient Power Company Limited	229	Thermal Power
28.	Foundation Power Company (Daharki) Limited	185	Thermal Power
29.	Sapphire Electric Company Limited	225	Thermal Power
30.	Uch-II Power Project	404	Thermal Power
31.	**Patrind Hydropower Project**	**147**	**Hydropower**
Under 2015 Power Policy			
32.	Sahiwal Coal Power Project	1320	Thermal Power
33.	Port Qasim Coal Power Project	1320	Thermal Power
34.	RLNG based Haveli Bahadur Shah Project	1230	Thermal Power
35.	RLNG based Bhikki Power Project	1180	Thermal Power
36.	RLNG based Balloki	1223	Thermal Power
Total			**15,468.50**
Share of Hydropower Projects			**231 MW**

1.2. The hydropower resource in Pakistan

The hydropower resources of Pakistan are estimated about 60000 MW [8]. The Hydropower resources of Pakistan are distributed into 6 geographical regions: NWFP, Azad Jammu & Kashmir, Northern Areas, Sindh, Punjab and Baluchistan [9].

Most of the resource sites located in these areas offers sites for large scale power projects with a capacity of 100 MW to 7,000 MW. Smaller sites available throughout the country generally offer less than 50 MW. In addition, canal system in Pakistan, is among world strong canal systems of the world, is blessed with total of 58,450 km watercourse indicates a huge potential for hydropower at numerous sites. The size of projects ranges as 1 -10 MW [10].

The key share of total hydropower resource existed in the Northern Areas of country including Khyber Pakhtunkhwa, Gilgit-Baltistan area, Azad Jammu & Kashmir [11, 12].

table 2: Hydropower resources in different regions of Pakistan

Province	**Total Hydropower Resources (MW)**	**Projects with Raw Sites (MW)**	**Solicited Sites (MW)**
Khyber Pakhtun Khaw	24736	8930	77
Gilgit Baltistan	21125	8542	534
Punjab	7291	238	
Azad Jammu Kashmir	6450	915	1
Sindh	193	126	67
Baluchistan	1	-	1
TOTAL	**59796**	**18751**	**4286**

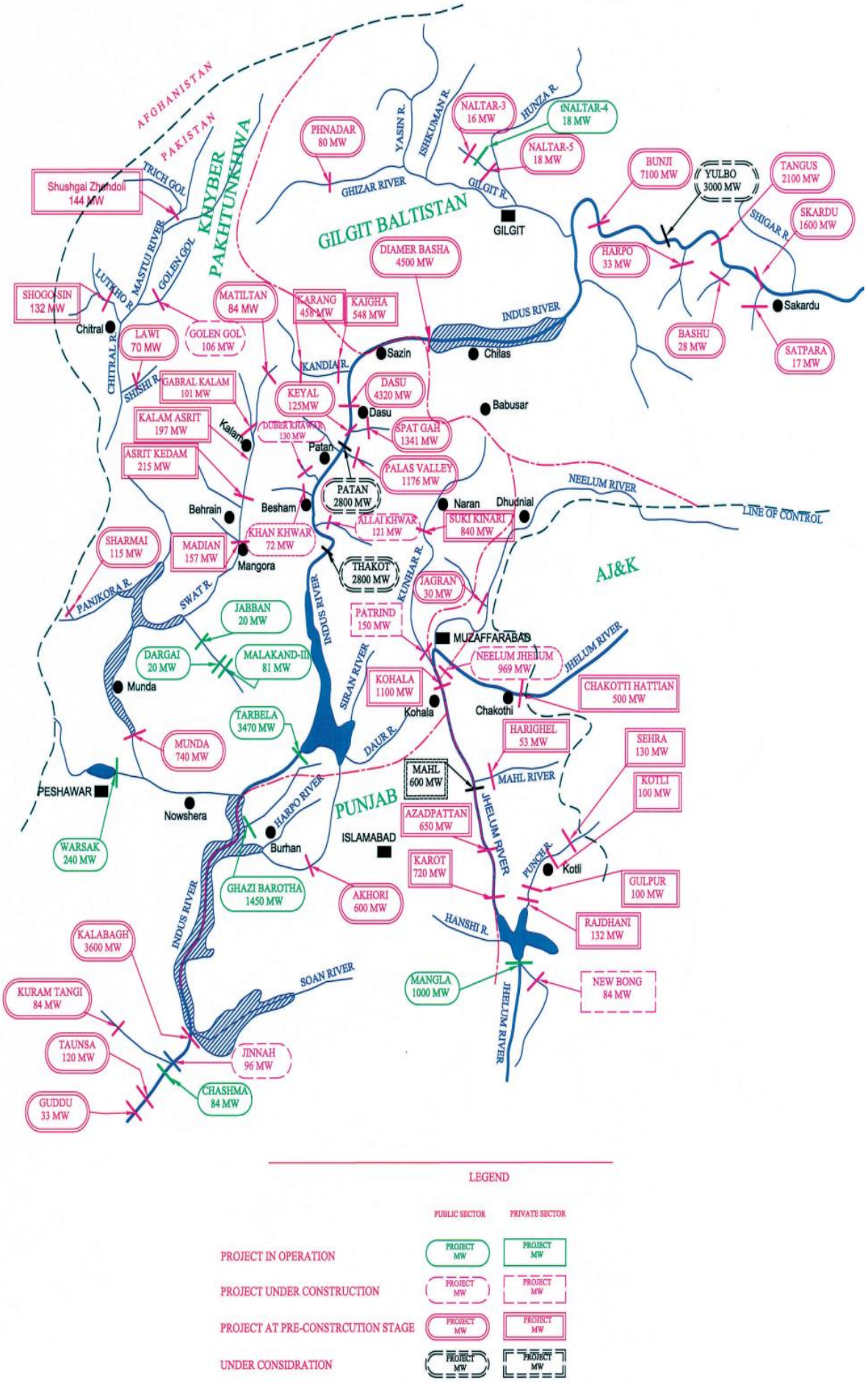

Figure 1: Major Hydropower Sites in Pakistan

1.3.An overview of institutional and policy framework growth in hydropower sector of Pakistan

In last 3 decades a lot has been in redemption of power sector issues, many new initiatives were taken, many departmental setups were inaugurated, and many policy frameworks were presented to welcome private sector investment. The Table 3: The Timeline of power sector development in the context of policy and institutional growth present an overview of this multi-sector growth in Pakistan.

Table 3: The Timeline of power sector development in the context of policy and institutional growth

Sr. No	Year	Major Milestones Achieved
1.	1993	Constitution of Energy Task Force
2.	1993	Policy Framework and Packages of Incentives for Private Sector Power Generation Projects in Pakistan"
3.	1994	Policy Framework and Packages of Incentives for Private Sector Hydel Power Generation Projects in Pakistan
4.	1994	Establishment of PPIB as one Window facilitator
5.	1997	Approval of NEPRA ACT
6.	1998	Incorporation of NTDC
7.	1998	Power Policy for New Private Independent Power Projects 1998
8.	2001	Establishment of PCRET; a merger between the Pakistan Council for Appropriate Technologies (PCAT) and National Institute of Silicon Technology (NIST).
9.	2003	Establishment of Alternative Energy Development Board(AEDB)
10.	2006	First renewable energy policy
11.	2013	Ministry of Water and Power announced a national level policy
12.	2015	PPIB Announced Power Generation Policy for IPPs
13.	2015	Incorporation of CPPA-G
14.	2017	Establishment of Ministry of Energy by merging the Ministry Of Petroleum And Natural Resources and Ministry Of Water And

		Power.

WAPDA, The Water and Power Development Authority, was created in 1958 to manage water and power sector requirement of country. Initially Pakistan had policy of BOO (Build-Own-Operate) for private sector power plants since 1986. The pace of progress remained slow till 1990. In 1993, Pakistan had installed capacity of 10800 MW. Pakistan was facing a shortage of 2000 MW in peak hours. The 40 % of total population had no access to electricity whereas per capita electricity consumption was estimated as 300KWh per annum. The studies carried out by the government, estimated that demand is expected to surge at a rate of 8% per annum. To accomplish this increased demand, an addition of total of 54000 MW was needed to be added in the grid till year 2018 [5].

In 1993, GOP realized the shortage of electricity in country and decided to take some immediate steps. Government of Pakistan constituted an Energy Task Force. This Energy Task Force comprised the best professionals from the power sector. The main objective of this force was to formulate a comprehensive and consolidated policy to revamp the power sector. On the basis of recommendations by energy task force, GOP formulated a policy titled as "Policy Framework and Packages of Incentives for Private Sector Power Generation Projects in Pakistan" [13]. .

Power policy of 1994 was announced to attract the private sector in power generation. Although it remained successful in attracting investment in thermal sector only, but incentives and packages given were insufficient to attract investment in hydropower sector of Pakistan. As an indicator of failure of this policy, no hydropower project was registered. The government then decided to formulate a separate policy for hydropower projects. Government presented a policy framework titled as" Policy Framework and Package of Incentives for Private Sector Hydel Power Generation Projects in Pakistan". Investors accepted the packages and incentives being offered. As an apparent success of this policy, 41 projects were registered. Due to political turmoil and few other reasons, agreements under process with investors were terminated by the new government. This discouraged the interest of private investor and made them reluctant to invest in the hydropower sector [14].

GOP considered Pakistan electricity market as less competitive, so government planned to modify electricity market to make it "competitive power market". Government planned to privatize the thermal power sector, transmission, distribution and assets of public sector and restructure the sector. This was to be done by setting an autonomous regulatory authority called as NEPRA [15]. NEPRA Act was approved by parliament in December 1997. NEPRA was made in charge for the supervision of the power sector and to exercise its power to license for installation regarding power generation, transmission and distribution. It was made responsible to regulate tariffs [16].

The planned WAPDA's restructuring involved a privatization process. In this plan, its eight area electricity boards were to be converted into eight public limited companies. WAPDA owned 11 thermal power stations were also changed into public limited companies (GENCOs). The transmission system was to be changed into a single public limited company (NTDCL). It was GOP's intention to privatize the thermal generation companies and distribution companies (DISCOS). The transmission company was planned to be the asset of public sector. The role of WAPDA was planned to revert to an organization responsible for the maintenance of existing dams, the building of additional dams on the main rivers [17].

Government intended to present a new policy framework in 1998. Government anticipated total power demand ranging between 19,000 and 25,500 MW up to July 2008 and anticipated shortfall was around 5000MW-8000MW. The response to the this policy was too discouraging that no projects was registered in response to this policy[18, 19].

WAPDA arranged a ‘Hydropower Development Plan Vision 2025’ (Vision 2025). This vision suggested a road map to accomplish the forecasted power deficits through the addition in capacity of power generation. The plan categorized projects that were to be executed in the short, medium and long term. All these identified projects were planned to be implemented by either the public sector or by public-private partnership or private sector. The choice of implementing projects by the public-private partnership, public sector, private sector was dependent upon the mandate. WAPDA claimed to add 792 MW in national grid in its short-term plan by 2007. In medium term plan of 15 years, WAPDA planned to add 6130MW by several projects including 2400 MW Kalabagh Dam, 740 MW Kohala,60MW Gulpur Dam, 245 MW Abbasian in AJK. Long term plan included

capacity addition of 15633MW by construction of Munda Dam, Sukki Kinari, Karrrang in KPK and Dasu, Patan, Thakot and Bungi in Northern Areas. The proposed commissioning dates for these projects were proposed to be in 2020.

Pakistan Council of Renewable Energy Technologies (PCRET) was established on May 8, 2001. PCRET was a result of merger of the Pakistan Council for Appropriate Technologies (PCAT) and National Institute of Silicon Technology (NIST). It was the prime institution in the country with objective to coordinate and promote activities based on R&D in renewable energy technologies sector [20].

From 2002-2007, the issue of power shortage was much less severe. Government was able to produce abundant electricity and government of Pakistan was planning to export 500MW to India. Government of Pakistan was almost failed to forecast the future load demand thus did not have a focus on capacity expansion [21]. The tenure of 1998-2008 was a regime of military rule, in this era country GDP was well established and hence government started several electrification projects. In 2002, out of 140 million populations only 50% had access to electricity but in 2008,80 % had access to electricity [22]. Government did not focus on generation capacity expansion projects therefore it resulted in unending severe energy crisis.

Alternative Energy Development Board (AEDB), established in May 2003, was the sole agency of the Federal Government that with the purpose to promote, facilitate and to boost expansion of renewable energy sector in Pakistan. The main motive of this agency initiation was accelerated promotion of Alternative and Renewable Energies (AREs). The organizational powers of AEDB was reassigned to MOWP in 2006 [23].

In 2006, GOP declared its first renewable energy policy for accelerated development in small-scale hydro, wind power projects and solar photovoltaic in Pakistan [24]. Ministry of Water and Power announced a national level policy in 2013, to coup the energy shortfall. This policy was based on three principles: competition, efficiency and sustainability [25]. This policy claimed to formulate the short term and long-term plans for hydropower development. These plans included the development of Dasu Dam 2160 MW, Bunji Dam, Patan 2800 MW and Thakot Dams 2800 MW.

Private power infrastructure development board under MOWP announced power generation policy in 2015. Government tried to restructure the mechanism of projects

registration and revised the different rates like water use charges (WUC) and tariff [26]. Overall this policy was little different with the previous policies on major incentives and clauses.

The latest development in context of hydropower development was on 4 August 2017 when GOP created a new federal and executive level ministry "Ministry of Energy" by merging the Ministry of Petroleum and Natural Resources and MOWP[27].

1.4. Hydropower Development in Pakistan

1.4.1. Projects completed under Public Sector

In the subcontinent, Hydropower development started with the development of the Renala hydropower (1 MW) in 1925. After the decade, the Malakand-I hydropower (1.7 MW) station was built. Later in 1953, Dargai hydropower station, having capacity of 20 MW, was commissioned.

GOP signed the Indus Water Treaty in Karachi on September 19, 1960. By the Indus Water Treaty, Pakistan had rights to usage of water of Jhelum, Chenab and Indus. Government planned the projects related to water resources and power resources. Government in this regard initiated "Mangla Dam" project in collaboration with U.S.A government in 1961. This project was completed in 1967. Mangla dam project is located in AJK on Jhelum River. The installed capacity of Mangla Dam is 1000 MW and it have water reservoir of the capacity of 5.34 MAF [28].

Tarbela Dam, world's largest rock filled, and earth filled dam, was commissioned in 1976 as a component of Indus Basin Project. The construction of Tarbela Dam was completed in three stages to accomplish the river diversion requirements. The development of Tarbela Dam was completed in three phases. The installed capacity of Tarbela Dam is 3450 MW.

Warsak Hydroelectric Project located on River Kabul in Distt. Peshawar (KPK), was financed in two phases under Colombo Plan. It was financed by the Government of Canada. The first phase was finalized in 1960, included the Dam construction, civil works four generating unit for capacity of 40 MW each and 132 KV transmission system

and irrigation purpose tunnels. The work of 2nd Phase included two additional generating units. These units added 80 MW capacities in 1980-81.

Ghazi Barotha Hydropower (1450 MW), was completed during the 2003-2004. This project is located downstream of Tarbela Dam in District Attock, Punjab. This is a major run of river project that is built on the run off of the Tarbela Dam.

Table 4: Projects Completed under public sector by WAPDA

Project name	**Location**	**Year of completion**	**Electricity installed capacity (MW)**
Tarbela Dam	Tarbela (KPK)	1976	3478
Mangla Dam	Mangla (AJK)	1967	1000
Ghazi Barotha	Attock (Punjab)	2003	1450
Chashma Barrage	Chashma (Mianwali, Punjab)	1971	184
Warsak dam	Peshawar (KPK)	Phase-I (1960) Phase-II (1980)	243
Renala hydel power station	Renala Khurd (Punjab)	1925	1.1
Nandipur hydel power station	Gujranwala (Punjab)	1963	13.8
Chichoki hydel power station	Sheikhupura (Punjab)	1959	13.2
Shadiwal hydel power station	Gujrat (Punjab)	1961	13.5
Jinnah Hydropower Project	Jinnah Barrage, Mianwali (Punjab)	2013	96
Rasul Power Station	Mandi-Bahauddin, (Punjab)	1952	13.8

Dargai Power Station	Dargai (KPK)	1952	20
Khan Khwar Dam	Shangla (KPK)	2012	72
Allai Khuwar Dam	Battagram (KPK)	2013	121
Satpara Dam Project	Skardu (GB)	2013	17.3
Kurram Garhi Hydel Power	Bannu (KPK)	1957	4
Chitral Hydel Power	Chitral	1975	1
Duber-khwar Hydro-Power Project	Kohistan (KPK)	2013	130

[28].

1.4.2. Projects Under construction under Public Sector

Neelum Jehlum 969 MW that is expected to complete in Feb, 2018 [29] , Dasu Dam 4320MW that was expected to start in June 2017 and was planned to be completed in 2023 [30], Gollen Goal 108 MW is expected to complete in 2018 [31], Keyal Khuwar Hydropower projects 128 MW is expected to complete in 2020 [32], Kuraam Tangi Dam 83.4 MW is expected to start in 2017 [33].

Table 5: Under construction Public Sector Projects

Project name	Location	Electricity installed capacity (MW)	Commencement date	Expected completion date
Neelum-Jhelum Hydroelectric project	Muzaffarabad (AJ&K)	969	2008	2018

Tarbela 4th Extension Hydropower Project	Tarbela	1410	2013	2017 but extended
Dasu Dam	Dasu, Kohistan (KPK)	4320	2017	2023
Golen Gol Hydropower Project	Chitral (KPK)	108	2002, project was reinstated in 2011	June 2006 then revised to 2018
Keyal Khwar Hydropower Project	Kohistan (KPK)	128	2016	2020
Kurram Tangi Dam	Bannu (KPK)	83.4	2016	2019

1.4.3. Projects Under construction under Private Sector

The only project completed under IPPs is New Bong Escape Hydropower Project (84 MW). The scheme achieved financial close in 2009 and completed in 2013 [34]. The projects under-construction include Patrind Hydropower Project 147 MW and Gulpur Hydropower project 102 MW [35]. 130 MW Sehra Hydropower Project is having PPA under negotiation while EPC is under approval. Letter of support (LOS) has been issues to Karot Hydropower Project, Kohala Hydropower Project and Azad Pattan Hydropower Project. Financial close (FC) is underway for Suki Kinari Hydropower Project. Over all more than 5500 MW capacity is expected to be added in national grid till 2024 MW [36]. Although mechanism of Public-Private Partnership was also introduced in former policies but no still no projects on the basis of Public-Private Partnership has been registered.

Table 6: Hydel IPPs Under process

Name of Project	**Location**	**Company Name**	**Power**	**Expected Completion Date**
Patrind Hydropower	Kunhar	Star	147	2017

Project	River, KP/AJ&K	Hydropower Limited		
Gulpur Hydropower project	Poonch River/Gulpur, AJ&K	Mira Power Ltd	102	2019
Sehra Hydropower Project	Poonch River, AJ&K	Farab Energy & Water Project, Iran	130	2021
Karot Hydropower Project	Jehlum River, Distt. Rawalpindi Punjab	Karot Power Company Pvt Ltd	720	2021
Suki Kinari Hydropower Project	Kunhar River/Mansehra, KP	S.K Hydro Pvt Ltd	870	2022
Kohala Hydropower Project	Jehlum River/Kohala, AJ&K	China International Water & Electric Company	1100	2023
Chakothi-Hattian Hydropower Project	Muzaffarabad, AJ&K	Suhail Jute Mills Ltd	500	2024
Kaigah Hydropower Project	Kaigah/Indus River, KP	Telecom Valley Pvt Ltd	548	2024
Mahl Hydropower Project	Jhelum River, AJK/Punjab	-	590	2024

Azad Pattan Hydropower Project	Jehlum River/Sudhnoti, AJ&K	Alamgir Power Pvt Ltd	640	2024
Asrit-Kedam Hydropower Project	Near Kalam/Swat River, KP	Younas Brothers Group	215	2024

1.5. Studies related to hydropower impacts and challenges and gaps in Pakistan

Various studies have been completed in China, India, Turkey, Nepal, Greece, UK, USA, Malawi and Spain to assess the different aspects of hydropower including social, economic, technical and environmental impacts of hydropower and their challenges [37-47]. The results of these studies have been used to alter the policies, rectify the different issues identified towards the hydropower development.

The studies conducted in hydropower sector in Pakistan included the hydropower resource assessment in Pakistan [8], social and environmental assessments reports specific to projects carried by different agencies [48-51] and academic research related to different aspects of hydropower and renewable energies in Pakistan [52-56]. A study was made to identify the barriers and challenges to the recently completed five hydropower projects [57]. This study focused particularly on the concerns faced by these selected projects.

A study, focusing on hydropower sector of Pakistan, supported by scientific research methods has not been conducted. This indicated a large study gap on academic level that needed to be fulfilled.

1.6. The Problem Statement

Irrespective of immense identified hydropower potential in Pakistan and steps taken to develop resource by private and public sector, hydropower is not exploited. Table 7: Projects being commissioned under different polices represents an overview of hydropower and thermal power projects registered under different power polices. The objective of the study is to assess the barriers existing in the course to the hydropower development including different phases.

Table 7: Projects being commissioned under different polices

Project Category	Power Policy 2015	Power Policy 2002	Power Policy 1998	Power Policy 1995	Power Policy 1994
Thermal Projects Capacity	13053 MW	3262 MW	No Project Registered	Not applicable	4340 MW
Hydropower Projects Capacity	860 MW	5373 MW	No Project Registered	84 MW	0

Currently Pakistan is facing Energy crisis, Installation of new power plants is need of the hour. In response to energy crisis, GOP initiated several power projects. Pakistan is investing majorly in coal fired plants under CPEC financing while ignoring the hydropower potential. Total capacity added to national grid due to previous policies was about 15,468.50MW while Share of hydropower projects in capacity addition is about 231 MW. This reflects that hydropower generation market is facing impediments due to which private investors did not invested in (Large, Small and Micro) hydropower.

The similar studies have been carried in developing countries, in Turkey [58] Nepal[44] Malawi [45], China [40] and others when they realized that they are failing to achieve their hydropower goals. Like these countries, our research will result in identification of different impediments existing in the hydropower sector of Pakistan which may be rectified in futuristic developments. The results of the study will highlight specific areas needing advancement and justify the need of reforms. Therefore, these results may provide a direction for the setting of key performance indicators for the upcoming development and modification of existing power structure. Furthermore, results of studies may aid to define upcoming expected reforms in policy and organizational structure.

Thesis Structure

The thesis is composed of seven chapters arranged in the following manner

Chapter 1 discusses the main purpose of the study, its objectives, limitations and the methodology used for the work.

Chapter 2 covers a detailed literature review on different aspects of hydropower and renewable energies and recent work being done in other countries in other countries.

Chapter 3 includes the research methodology. It explains the different steps of methodology being followed

Chapter 4 covers the results and discussions. The

chapter gives detail about consensus statement and the all four discourses developed.

Chapter 5 gives the conclusion of the study. The chapter explains future recommendations for the better exploitation of hydropower in Pakistan.

Summary

Irrespective of immense identified hydropower potential in Pakistan and steps taken to develop resource by private and public sector, hydropower is not exploited. Total capacity added to national grid due to previous policies was about 15,468.50MW while Share of hydropower projects in capacity addition is about 231 MW. This reflects that hydropower generation market is facing impediments due to which private investors did not invested in (Large, Small and Micro) hydropower.

The results of the study will highlight specific areas needing advancement and justify the need of reforms. Therefore, these results may provide a direction for the setting of key performance indicators for the upcoming development and modification of existing power structure. Furthermore, results of studies may aid to define upcoming expected reforms in policy and organizational structure.

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CHAPTER 2

2.1.Literature Review

With the intended objective to identify the barriers, a comprehensive and diversified literature was reviewed. The reviewed literature included the project reports, power policies of Pakistan, and scientific research conducted regarding research similar aspects of hydropower. This literature was reviewed to get familiar with level of similar research conducted on the field and to analyze the hydropower situation in Pakistan. Another series of research paper was studied to develop a comprehensive research methodology.

2.2.Literature reviewed related to the different regions

For instance, the global installed capacity of hydropower is 1.064 TW out of its overall technical potential of 1.88 TW[1] [59, 60]. According to World Energy Council, East Asia (with global share of 31.6 %), Europe (24.4%) and North America (16.1%) are major contributors of global hydropower generation in 2016 [61]. South and Central Asia only shares 6 % of global hydropower. Similarly, Africa and South East Asia and Pacific region are less focused on hydropower generation [62, 63].

The study conducted by Zeineb Abdmouleh focused on different mechanisms of both effective and disastrous precedents, through case studies of establish regulatory framework for renewable energies. They classified results into different variables like fiscal, legislative, financial, political, technological and environment. They briefly explained that public sector and private sector aspects of financial factors. They emphasized on agreements between power producers and consumers like power purchase agreement and legislation related to grid access as necessary legislative support required for renewable energy penetration [64]. A study conducted to assess the success and failures in hydropower sector of world listed few factors as important lessons learnt from evaluated projects. The list of factors included the unpleasant environmental consequences associated with the hydropower projects of large scale, for medium and large-scale hydropower projects suitable availability of financial aid from funding entities

[1] https://www.worldenergy.org/data/resources/resource/hydropower/

and donors especially, community management of small hydropower plants, , adorable policies for hydropower projects include exemptions, appropriate tax, feed-in tariff policies, and enactment of extensive supports in the form subsidies [65].

2.2.1. Studies conducted in European region.

A study conducted in Spain assessed the economic impacts of stringent environmental regulations imposed on hydropower plants. In Spain, different constraints due to environmental situations were imposed on the operation and maintenance of hydropower plants. Three of these environmental constraints including minimum flow rate based on environmental conditions of river, rates of change of river flows and mandatory run-off-river operation were considered. To analyze the economic impact of these regulations, a hydropower located in Spain was selected. The impact of implementing environmental regulation resulted in change in water flow and ultimately the power output which provided the economic impacts. In other words, this paper represented the financial loss to the investor due to stringent regulations due to environment [66].

A study conducted in U.K focused on the identification of several hydropower projects to recover waste energy. The study included projects site that was able to generate 17.9 GWh per annum. This study included four step approaches to identify the techno-economic barriers to the projects. The techno-economic challenges included precise and accurate design of turbine and generator to support minimum and maximum power requirement, sustainability of grid connection due to variation in flows, feed-in-tariff mechanism [47].

A study was conducted in Greece to analyze the techno-economic perspective of small hydropower plants. Greece parliament has passed a law allowing private sector to participate in hydropower sector. Greece regulatory authority and ministry of development planned to develop SHP to produce 600 MW. Technical perspective included study of efficiency of different turbines and in relation to the turbine flow rate. The researcher performed cost-benefit analysis of small hydropower station to find out expected IRR that was calculated to be 18 %. Further to study financial and economic perspective in detail, they studied the impact of varying capacity factor, turnkey cost as capital cost, impact of subsidies in hydropower sector, price escalation of electric power,

maintenance and operation cost and taxation system on IRR. Their study concluded that subsidizing the hydropower sector, increasing capacity factor effect in a positive manners while unpredictable taxation system, inflation in operation and maintenance cost have negative impacts on rate of return which results in discouraging the involvements of private sector [43]. A study conducted in Turkey tried to describe economic, social, legal and environmental challenges to hydropower in contest of Turkey. To economic benefits, this study stated the harnessing the hydropower potential will ultimately lower the dependence of turkey on oil and will result in reduction lowering the bill of imports hence it will ultimately create positive balance of trade. The environmental challenges include negative impacts of aquatic life, dust and CO_2 emission and erosion, landslide, and excavation debris. To the techno-economic challenges, 10% of total electricity transmitted was lost in national grid network. To the legal barriers, many projects in planning phase did not properly estimated damage to environment and social consequences of projects so as an opposition these projects had to face to a legal trial. Due to strict laws and legal system of Turkey, court ordered to terminate various projects [67]. Another study carried in Turkey to analyze the growth of hydropower in context of its hydropower development vision. Hydroelectric potential in Turkey is of the order of 433,000 GWh that is one of the highest hydropower potential in the Middle East [46]. The technically exploitable is almost half of this, 216,000 GWh, while economically exploitable is 28.0% of technical exploitable potential that is almost 127,381 GWh. The share of hydropower in turkey energy mix was even less than 20% in 2009. Turkish government devised a vision 2023. According to the vision 2023, Turkish government will be produced 30% of total electricity demand from renewable energy resources. To accomplish the goal of vision 2023, multidisciplinary involvement, long term planning, high upfront investment, modification on pattern of local land usage is needed. While environmental perspective of fish migration, mercury addition to food chain and sedimentation issues should be addressed [58].

The study to assess the challenges to renewable energies in Finland concluded that cost of renewable supplies, lack of government supported policies and lack of competitiveness with conventional resources are the major issues towards the development of renewable energy resources [68].

2.2.2. Studies conducted in American Region

A studies conducted in Canada claimed that insufficient local capacity to design plants and prepare the projects, lack of clarity among national level long term goals, lack of legitimacy issues of territories are major challenges to the hydropower sector of Canada [69].

Another study conducted for Colombia categorized the problems into legal, economic, institutional barriers and technical barriers. While legal barriers included policy issues, environmental licensing's, grid connectivity problems. The Institutional barriers included administrative problems, lack of interest in hydropower. Lack of training and awareness was a major technical barrier. High capital cost, regulatory framework issues, lack of financial incentives were categorized as economic barriers.

2.2.3. Studies conducted in African Region

The study conducted in Malawi focused on the advances in and future challenges of renewable energy technology. This study performed the political, economic, social, technical, legal analysis of development in renewable energy. The total hydropower in Malawi was about 1.478 GW but almost three-fourth of this potential is unexploited. As political factors, the abovementioned study included the political interference as barrier to the hydropower. The lack of subsidies and unreliable financing mechanisms were economic challenges that needed to be addressed [45].

2.2.4. Studies conducted in Asian Region

A study was conducted in reference with hydropower development in China. This study identified the opportunities in hydropower sector of China. Theoretical resource of the hydropower in china is estimated to be 649,000 MW while installed capacity is 542,000 MW. This study conducted theoretical study of data to identify challenges to hydropower development. This study concluded that migration and resettlement is the major issue in hydropower development, while geological damage, environmental changes, immature industrial system and water resource management are challenging issue to the hydropower development in China. This study suggested to control the price of electricity, creating social awareness regarding hydropower sector, focusing on environmental damages to reduce them and involving the use of laws related to

resettlement similar to other countries successful in hydropower development as it a problem existent to all projects [40]. The alternative way to mega reservoir-based hydropower projects is to have small hydropower plant on run-of-the-river sites. For the sustainability perspectives it is necessary to include some of the basic parameters. A case study conducted in China, about the sustainability of small hydropower, concluded that their certain key performance indicators regarding sustainability. The research consummated its findings by declaring coordination between central government, international collaboration and role of NGOs as an essentials to enhance or at least maintain the stability of smaller hydropower plants [70]. Zhang Peidong and Yang Yanli stated that the incomplete financing system for renewable energy projects, lack of coordination and consistency in policy and investments inadequacies in the technical development for renewable energy are major challenges for renewable energies in China [71]. According to the Junfeng Li, Lingjuan Ma, in a report published in collaboration with Energy Policy Network and Chinese Renewable Energy Industry Association, gird connected to access renewable energy sources, failure in enforcement policy and renewable energy act, dysfunctional wind energy development organizations and lack of renewable energy associated industry. To overcome these issues, it is recommended to enhance a clear ratification in transparency in a renewable energy fund system, establishing market based scenarios, feed in tariff system and increase support for renewable energy research and development activities are required [72, 73].

A study was conducted in India to determine the sustainability of small hydropower plant from the investor's point of views and government perspective. The sustainability in this research included economic, environmental, social sectors sustainability. This study used qualitative methods to obtain the data. Interviews were conducted to obtain data related to hydropower in India. This study focused on the areas of Himachal Pradesh, J&K and Uttarakhand as huge potential of small hydropower plants exist there. The results of the study indicated various obstacles to the SHP development. Study indicated that involvement of various provincial governments, government policies that are ambiguous, high upfront cost, power evacuation issues due to limited connectivity of grid and lack of hydrological data was major obstacle to the projects developments. In social sustainability perspective, land acquisition, corruption, getting skilled labor in

remote areas, management problems in SHP and the lack of accountability in operation and maintenance of SHP are the problems of major concerns [39].

A study conducted to overview situation of hydropower in Nepal. The hydropower potential in Nepal is about 83000MW, out of which 43000 MW is economical exploitable potential. Nepal has installed only 1000MW of hydropower. The results of this study included opposition from society, lack of trained local community and increased dependence on aid are socio-cultural barriers. Maoist insurgency, poor institutional capacity, corruption and issues in licensing are political and regulatory issues [44]. Another research focusing on issues related to renewable energies as whole stated that Nepal has policy barrier as small projects are evaluated only on the financial basis and compared with large projects which have better results of cost benefit analysis, lack of affordability, financial barriers to the large scale hydropower projects, institutional barriers as AEPC is single governmental agency for RETs, political instability and changing form of government as political barriers and lack of awareness in rural areas regarding use of RETs [74]. Researcher believed that all above mentioned challenges exists in hydropower sector of developing countries.

The studies conducted in Iran to address challenges to renewable energy policies represent that Iran lack the policies proved effective in implementation, lack of technical training and awareness, low price of conventional energies and lack of planning regarding investment in energy sector discriminating renewable and conventional energy sectors [75]. The study conducted to assess the design challenges and economic impacts of small hydropower in Iran described the encouragement of decentralized supply network, economic impacts calculations, site specific technical designs and advance control unit designs is necessary for small hydropower plants to address the issues[76].

2.2.5. Studies conducted related to Pakistan

A study was conducted to have an overview of hydropower in Pakistan. This study focused the share of hydropower total energy mix in 2007. It also tried to forecast the development of hydropower, including micro-hydel, in the country in upcoming years. The paper gave an overview of the institutional steps taken by government of Pakistan to enhance the penetration, the policy growth in Pakistan [52].

Another study conducted related to Pakistan to analyze the challenges to the green energy technologies. This study focused on the solar, wind, biomass, fuel cell and hydropower technologies. This study did not use a scientific methodology to perform the analysis but presented a general perspective about the research theme. This study concluded that infrastructure development including commercialization, decentralized delivery system market development, financial incentives and monitoring and evaluation is required for proper integration of green energy technologies in energy mix [53].

The study conducted by to analyze the barrier to renewable energy technologies in Pakistan. This study did not involve any scientific approach for problem identification. This study classified the barriers into six categories listed as: 1) Institutional barriers 2) Financial and fiscal barriers 3) Policy and regulatory barriers 4) Information and social barriers 5) the barriers related to market structure 6) Technological barriers [77].

An empirical study to overview the hydropower portfolio in Pakistan was carried in 2012. This study diligently presented and explored the hydropower resource by categorizing it into categories, projects on rivers, projects on canals and resource on provincial level. This study recommended enhancing the openness of the information and enhancing the coherence in the data, to conduct the study on the cost benefit of alternatives of hydropower in comparison with hydropower in Pakistan [54].

A study was conducted to assess the growth in renewable energy sector of Pakistan and to analyze the role of renewable energy to provide a remedy to the energy crisis in Pakistan. This study presented an overview of renewable energy technologies being used or that can be used to overcome electricity crisis in Pakistan. The study suggested that government of Pakistan should take some necessary steps to increase usage of renewable energies. The recommended steps included the guarantee of electricity purchase, providing the step up grid structure should be responsibility of power purchaser, enhanced protection against the political risks, advanced tariff determination that may involve indexation of inflation and undetermined tax rates, reduction in import duties to renewable energy sector and giving exemption on taxes income tax, withholding tax and sales tax [78].

A study conducted to analyze the delay in Duber Khwar, Allai Khwar, and Khan Khwar, KPK, Pakistan. All of these projects were initiated by WAPDA in 2003 and took almost

double time than the expected to complete and their cost increased to double. The study used a quantitative method including interviewing and data analysis to identify the reasons of the delay. The study concluded that lack of political will, funds were not released on time by the Government, project was started without having a proper investigation of site and force majeure including bad weather, flood, earth quake, land sliding etc were major factors responsible for delay in projects [45].

The study conducted on status and future challenges of national energy mix. This study described the impact of current energy mix on oil imports and other environmental conditions, transmission and distribution and GDP. The scope of study included the role of renewable energy resources including solar, wind, biomass and hydropower in future energy mix. The study described the institutional framework for development of different energy resources. The study concluded that still there many barriers existing for the penetration of renewable energy into energy mix. The highlighted barriers of this study includes weak policy framework, institutional barriers, regulatory barriers and financial barriers [17].

The study conducted to assess the challenges to the renewable energy technologies in South Asian countries including Pakistan concluded inconsistent policies lacking incentives for private sector, poor structure of feed in tariff, fossil fuel subsidies and weak implementation framework are policy constraints. Low industrial setup for manufacturing and lack of standardization are technical challenges faced by renewable technologies. High financial risk due to high initial cost, limited knowledge of market potential are economic challenges to the growth of these technologies [79]. A study conducted by Rashid focused on identifying most critical successful factors and analyzing the impacts on renewable energy in Pakistan. The study concluded that renewable developers should be comprehensively aware about environmental factors. The category of environmental factors included credit management system, legal environment, peace situation, political situation, and local community influence. The claimed that renewable energy projects failure was due to lack of awareness, instance political instability, and lack of political will etc [80].

Other than these many studies [11, 12, 16, 21, 81-84] that focused on renewable energies and their impacts also included hydropower as a key renewable energy.

Table 8: Variables identified in studies conducted in different regions of the world

Author, Country& Year	**Identified Variables**
Souvik Sen [85] Developing Countries, 2016	• Monopoly of conventional energy suppliers • High capital cost • Less incentives for GHG emission reduction • Financial risk due to electricity prices • Lack of skilled labor • Lack of awareness among society • Policies inclined towards conventional resource exploitation • Lack of decentralized distribution system • Lack of research and development in renewable technologies • The weak financial strengths of governments limits to invest in renewable energies
Europe	
I. Yuksel[46] Turkey, 2010	• Economic challenges High upfront cost, lack of long-term planning and management, require multidisciplinary involvement • Social aspects Resettlement issue, Water quality and management issues, limit the social activity • Environmental issues • Terrestrial habitats are Inundated, hydrological alterations, sedimentations and siltation issues, fish migration
Toivanen [86] Finland, 2014	• High cost of renewable supplies • Lack of government supported policies Lack of competitiveness with conventional resources
Mignon [87] Sweden, 2015	• Delay in grid connectivity • Lack of basic infrastructure in remote project sites • Limited grid connectivity in areas • Infrastructure challenges • Financial challenges regarding cost and risk and return • Issues in getting access to capital/loans • Lack of institutional transparency • The investor reservation regarding acceptance of tariff

Iordanis M. Eleftheriadis [88] Greece, 2015	• Lack of financial resources • Grid capacity issues • Permit issuance regarding different project approval • Lack of planning in hydropower sector
Milena Panić, Marko Urošev [89] Serebia, 2013	• Administration problems regarding registration of projects • Project sites are legally out of bound for investors • Lack of synchronization between departments • Financial hurdles and lack of support from government • Issues in loans and payments
• **America**	
Krupa[69] Canada, 2012	• Insufficient local capacity to design plan and prepare the projects • Lack of clarity among national level long term goals • Lack of legitimacy issues of territories
Morals [90] Colombia, 2015	• Legal barriers Policy issues, environmental licensing's, grid connectivity • Institutional barriers Administrative problems, lack of interest in hydropower • Technical barriers Lack of training and awareness • Economic barriers High capital cost, regulatory framework issues, lack of financial incentives, •
Africa	
Collen Zalengera[45] Malawi	• Political interference in renewable energies • Excessive unplanned electrification • Economic capability of government • Technical design and awareness challenges • Social opposition to the projects • Lack of awareness regarding newer technologies
Asan Vernyuy Wirba [91] Cameroon, 2014	• Lack of renewable energy polices • Governance issues • Tariff determination process is dubious • Operation and maintenance issues Lack of planning and management issues
Asian Region	

Hari Bansha Dula[92] Asia, 2013	• Limited access to technologies • Increased incentives to thermal sector • Electricity market inefficiency • Lack of infrastructure for development • Limited connectivity of transmission structure • Financial capability of government • Institutional barriers
Judith A. Cherni, Joanna Kentish [93] China,2006	• High cost of renewable energies Weak local manufacturing industry, lack of competition, small market, electricity from coal, lack of international investment • Grid connectivity issues • Technical inefficiency, difficulties in getting NOC for connections to national grid • Institutional barriers • low financial aid, lack of finance mechanisms, energy import issues and tariff issues
Xiao-zhu Li, Zhi-jun [94] China, 2017	• Resettlement challenges • Negative downstream effect • Projects site lack infrastructure • Weak financial strength of government • Long approval process • Increase dependence on coal
Xiao Lin Chang [40] China, 2010	• Migration and resettlement issues • Limited connectivity of grid • Lack of coordination between departments • Cost and tariff issues • Water management issues • Geological disaster management • Immature industrial system • Negative downstream effects
Yun Li and	• Absence of overall coordination mechanism

Yanbin Li [41] China, 2015	• Difficulties in project approval • High rise in developmental cost • Resettlement issues of inhabitants • Requirement for environmental compensations • Transmission system restrictions • Inconsistency in price of electricity • High tax on hydropower enterprises • Lack of local understanding related to hydropower
Zhang [95] China, 2017	• Inconsistent renewable energy policies • Lack of financial incentives for renewable energies • Weak industrial setup to promote renewables • Challenges in project approval process
Jong-Han Yoon, [96] South Korea, 2015	• Lack of institutional support for renewables • Lack of financial incentives • Ambiguous policy design • Disordered legal system and unsystematic national plan • Insufficient financial supports in policy • Lack of coordination between departments
Abudukeremu Kadier, Mohd Sahaid Kalil[97] Malaysia, 2017	• Insufficient financial incentives • Lack of local technical skills and expertise • Lack of project management • Bureaucratic involvement • Inadequate hydrological data
Ameesh Kumar Sharma [98] India, 2017	• Administrative challenges Involvement of too much departments • Social challenges Land compensation issues, demands for jobs, excavation work cause social disturbance • Economic challenges High water use charges (WUC), lack of construction material availability, lack of local manufacturing, lack of basic infrastructure • Environmental challenges • Technical and design related challenges
Rakhshanda	• Social challenges

Khan [39] India, 2014	Corruption, social opposition, rehabilitation cost, job demands, opposition & technical design related problem, management problems • Miscellaneous challenges • Required clearance from various departments, ambiguous policies, grid connection and power evacuation issues, lack of hydrological data, lack of basic infrastructure on remote site, improper project planning and management, high interest rates, •
Sovacool et al., [44] Nepal, 2011	• Poor institutional capacity • Dependence upon International aids and loans • Regulatory barriers • Political instability • Corruption
Surendra K.C, Samir Kumar Khanal [74] Nepal, 2010	• Policy barriers • Institutional barriers • Financial barriers • Political barriers • Human resource barriers • Lack of affordability • Lack of awareness
Ashraf Chaudhary[53] Pakistan, 2009	• Lack of development of infrastructure • Lack of commercialized electricity market • Less electricity market developments • Lack of financial incentives for green energies • Monitoring and evaluation issues during projects implementations •
Mirza [77] Pakistan, 2009	• Lack of well-defined policies for private sector participation regulatory barriers • Lack of financial support and fiscal incentives • The barriers related to market structure • Information and social barriers • Lack of coherence as an institutional barrier •
Batool and Abbas[57] Pakistan, 2017	• Lack of political will • Funds was not released on time by the government • Project was started without having a proper investigation of the site • Force majeure including bad weather, flood, earthquake, land sliding, etc. • Land acquisition issues • Stringent law and order situation of the project area
Rafique and	• Weak policy framework

Rehman[17] Pakistan, 2017	• Lack of institutional support • Regulatory barriers to the private sector power generation. • Lack of incentives for renewable energies as financial barriers
Ahmed Bilal [78] Pakistan, 2014	The suggestion to enhance penetration of renewable energies included • The guarantee of electricity purchase • Providing the grid structure should be responsibility of power purchaser • Enhanced protection against the political risks • Advanced tariff determination that may involve indexation of inflation • Inclusion of undetermined tax rates in tariff • Reduction in import duties to renewable energy sector • Exemption on taxes income tax, withholding tax and sales tax
Zafar[99] Pakistan, 2017	• Absence of fossil fuel generator competitiveness • Undeveloped infrastructure • Unskilled workforce • Improper financial strategies • Limited technological access • Feed in tariff is required in tariff setting • Collaboration of public departments is required • Involvement of public sector in renewable energies development is required • Proper financing structure of project is needed

Summary

The similar studies have been carried in developing countries, in Turkey Nepal[44] Malawi, China and others when they realized that they are failing to achieve their hydropower goals. Like these countries, our research will result in identification of different impediments existing in the hydropower sector of Pakistan which may be rectified in futuristic developments.

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CHAPTER 3

3.1.Research Methodology

To bring about the intended objectives and to answer the research questions, this study has involved a diverse method approach. This section will explain the methods that were exercised for both, data collection and analysis, respectively.

3.2.Data Collection

A comprehensive study of different documents related to hydropower sector of Pakistan was carried. Power structure of Pakistan is designed as it included government, donor agencies, construction companies and educational institutes for research based input as stakeholder in hydropower sector [100, 101] . This study included documents published from different stakeholders of the hydropower sector in Pakistan, including government documents, different project reports and documents published by international donor agencies [57].

Government as a key stakeholder of Pakistan includes WAPDA, the ministry of water and power, ministry of finance, planning commission of Pakistan, provincial energy departments, private power infrastructure board to carry one window operation to facilitate private investor and NEPRA as independent regulator. So, Government documents included different power policies of different regimes of Pakistan, provincial power polices developed by provincial energy departments, private power policies published by the private power infrastructure board, tariff and energy mix related reports published by NEPRA, reports published by WAPDA and Ministry of water and power. All these documents are publically available on their sites.

The documents from international donor agencies included reports published by agencies like USAID, World Bank, Asian Development Banks, UK-AID and Chinese Bank. These agencies have been funding different projects including Tarbela extension projects, Mangla extension projects and projects underway under CPEC etc. These agencies have conducted comprehensive studies on different social and technical aspects of hydropower sector in Pakistan. Their study included feasibility studies, social and environmental

impact assessments, economic impact assessments and other project completion auditing reports.

On academic level, various studies have been carried in educational institutes, related to different social and technical perspectives of hydropower in world and specifically related to Pakistan. To create diversity in data for analysis, not only research papers related to Pakistan, but papers related to other neighboring countries were also included in the data analysis.

Table 9: Details of Data collection

Sr. No	Details of Data collection
1.	Interviews from officials from 1. Public Sector Organization WAPDA, PPIB, MOWP, Planning Commission, NEPRA 2. Provincial Energy Departments 3. Developers/Contractor Companies 4. Research Organization
2.	Research Papers related to Hydropower Sector of Pakistan
3.	Reports/studies conducted by different organizations related to hydropower sector of Pakistan
4.	Research papers related to hydropower sector of different regions of the world
5.	Reports related to hydropower sector of different regions of the world

3.3.Developing a questionnaire and Interviews

This methodology included two questionnaires; first one included open-ended questions to seek the information from respondent depending upon his experience and practical exposure to field while the second questionnaire included the close and discrete type of questions that needed to be answer in numerical numbers.

Literature reviewed in early studies of research, lead to the development of a hypothesis about certain major variables as these were highlighted as stringent factors in several

studies [45, 74, 77, 102-105] . Therefor depending upon literature reviewed, a questionnaire was to be developed. This questionnaire included open ended questions just to seek the deep insight related to Pakistan. The questionnaire was based on five major variables, including political, economic, social, technical, legal and environmental variable. These were major variables leading to or generating sub-variables as identified in various other studies [45, 77, 102-105]. This questionnaire included open ended questions focusing on these variables. Questionnaire attached in Appendix-A. Unstructured interviews were conducted with different officials of stakeholder organizations of hydropower in Pakistan. Different stakeholder from public and private sector were involved as to get the broader perspective of developer, constructor and policy makers. The other purpose to involve this much diverse respondents was to assess the same issue from different viewpoints. This helped in getting in heterogeneous data. In these unstructured interviews, privacy was insured to respondents to gain maximum deep information. These interviews were recorded after seeking due permission of respondents. Then, by the help of these recorded files, interview data was compiled into Word files, to be used in next analysis. Although audio files can be integrated into NVIVO Plus, but interviews used mix languages of native Urdu and English, depending upon ease of respondent. Twenty different respondents were interviewed, and their response was collected. The details of respondents interviewed are given below in Table 10: Detail of respondents interviewed.

Table 10: Detail of respondents interviewed

Respondents Description	**No. Of Respondents Engaged In Interviews**
Officials from public sector organization	9
Officials from provincial energy departments	3
Officials from developers/contractor companies	6
Officials from research organization	2

3.4. Data analysis in NVIVO

Primary sourced data included interviews data while secondary data included documents from stakeholders and research papers. This data was integrated into NVIVO Plus. A total of research papers, 20 Interviews files and 60 reports published related to different projects by international agencies were integrated into NVIVO Plus.

NVIVO Plus is software tool being used for data analysis. NVIVO plus is not a freeware software but its trial versions are available on QSR-International site online[2]. To carry out the analysis, similar 14 days trial version was downloaded. NVIVO has two distinguish queries as keys; one is the word frequency query and other is the text search query. Word frequency query tell about most frequent words in data and their linkage in statements. Text search query helps to find out certain word of phrase with in data to analyze its theme and linkage. Another important feature of NVIVO is creation of nodes as data holding spaces in NVIVO [106]. These nodes were considered as variables that can be obtained on basis of word frequency or can be generated by users. After creation of Nodes, the word text search theory can be used to find out data similar in context of Node, and then this data can be linked to nodes [107].

To carry out data analysis, first word frequency query was applied. In word frequency query, results showed the 1000 words with highest frequencies. Few of those words were not leading to identification of any prominent variable. The words leadings to some specific variables were identified and marked as node. This resulted in creation of 60 Nodes. Detailed study of data through this text search theory was carried and contextual statements related data was linked to Nodes.

3.5. Developing second questionnaire and using Q-Methodology

All these identified nodes were considered as variables for next analysis done by using Q-method. Q-method have been used in various other energy related researches including study to analyze engagement of stakeholder in the infrastructure of large-scale energy projects [108], to understand perception of energy stakeholders on energy access debates in Africa and EU [109], to assess the views of key stakeholders about Energy vision 2030 of Finland [86] and to assess risk in affectivity of hydropower energy policy by

[2] https://www.qsrinternational.com/nvivo/nvivo-products

stakeholder perspective in Switzerland [110]. Q-methodological study has also been used to determine reasons of failure of power sector reforms in Pakistan [111].

While performing Q-methodological study, the steps involved are as (1) Getting the concourse; (2) development of the Q-sample set; (3) choice of the respondents P set; (4) Q-sorting; and (5) analysis and interpretation.

In the study of Q methodology, respondents are provided a set of statements relevant to some topic; these statements are called the Q-set. Respondents, P-set, that are requested to rank the statements according to their own perspective. This raking is done by forced quasi-normal distribution. Then the results of individual rankings are subjected to factor analysis [112] [113].

A verbal concourse was obtained by data analysis in NVIVO by interviewing people. All those variables were the raw material for developing Q. Next, concourse was converted into a set of statements. Statements are annexed on Annexure-B. This set of statements was given to the participants. Each statement is known as Q-sort and this set is called the Q set (or Q sample). This set normally contains of 40 to 50 statements, but statements less or more are also possible certainly. In this research, we used sixty Q-sorts. Questionnaire is annexed.

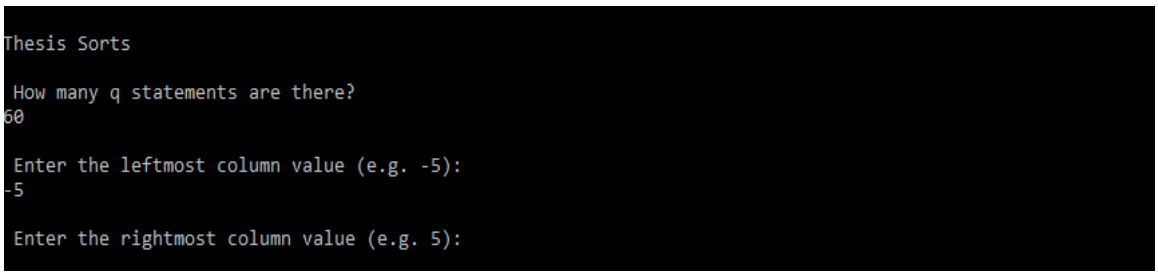

Figure 2: PQ Software Screenshot showing column values and no of Q sorts

The numbers of respondents required for a Q methodological study are not too large [114]. The involvement of respondents in a large numbers in Q methodology can itself cause problem [115]. Therefore, aim is to have limited persons which are often two to four and hardly more than six that may define each projected viewpoint. This set of respondents is called P-set. The selection of members of P set was not random. It was an organized set of participants who were ideally appropriate to the theme of research under

consideration[116]. The Q set is given to the respondent. The participants were asked to rank the Q-sorts. Typically, participants were requested to follow the distribution that is provided. The participants were requested to read all of the q-sort statements thoroughly. In this way, respondents got an early understanding about the type of variables and the issue. The respondent was requested to begin with sorting while reading. Respondents were asked to divide the statements into the three piles: statements he agrees with, the statements he disagrees with and third pile contained the statements about which he is neutral [117] [118]. Then, the respondent was requested to rank, according to the condition of instruction, the statements and to place them in the score sheet given. As a matter of simplicity, participants were not asked to rank a complete rank of the Q set statements starting from 1 to n. Instead, respondents were asked to simply give each item a ranking position. These ranking were made on fixed quasi-normal distribution chart and Likert scale [119] [120]. An 11 point scale was employed, possible ranking values ranging from -5 for items that had least importance in the view of a particular participant and to +5 for statements that were considered as most important. [115]. P-set had 13 elements [121] The detail of respondents is given in Table 11: Q-methodology respondents list.

Table 11: Q-methodology respondents list

Description of Respondents	**No. Respondents Engaged**
Academics	2
Government Officials(MOWP, PCoP, MoF, PPIB, NEPRA)	6
Officials of developer companies	5

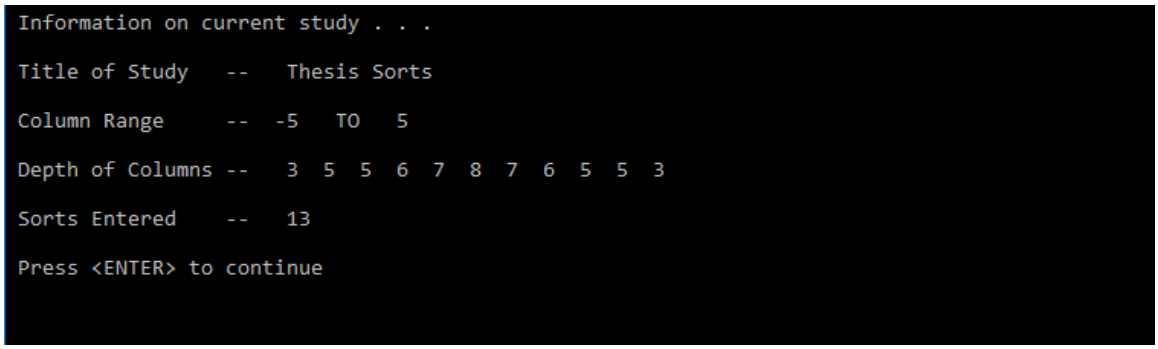

Figure 3: Screenshot of PQ Software

Q methodology involved by-person factor analysis procedure correlation. Therefore, it is the complete configurations that are produced by the each respondent. It shows the results as given in the screenshot below.

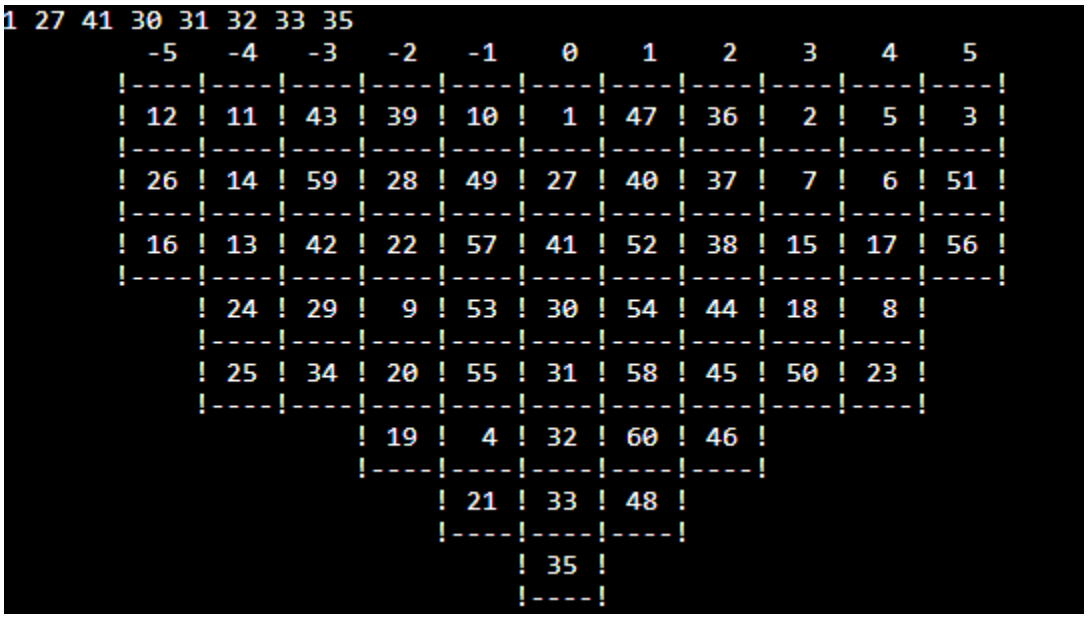

Figure 4: Q-sort response of certain respondent on 11 point fixed quasi-normal distribution chart

This configuration is further interred correlated and then factor analyzed. The initial correlation matrix appropriately reflects the correlation of each Q sort arrangement with every other Q sort arrangement. The correlation matrix of all Q sorts is calculated. This represented the level of correlation among the individual sorts, in points of view between the individual Q sorters. Next, this correlation matrix is used to perform a factor analysis. This factor analysis is performed with the purpose to recognize the number of natural groupings of Q sorts by being similar or dissimilar to one another. People having similar views on the topic will be sharing the same factor [108]. To subject this matrix to factor

analysis is to produce a set of factors onto which the participants load on the basis of the item configurations they have created [122].

In statistical packages like SPSS, Principal components analysis is the by default method of factor extraction. QCENT and QPCA first take the rawdata file created by QENTER and calculate a correlation matrix into file named with. cor extension. Then, an unrotated factor loadings file with extension. unr is created by the application of the respective method of factor analysis.

There are quite a few well programmed Q methodology software package accessible which let the conduction of proper analysis. PCQ, for Windows, is perhaps the best among all products commercially available. PQ Method performs the job effectively. This software is also offered as a freeware from the internet. This package facilitates the user to input the data, to automatically generate the preliminary by-person correlation matrix. These packages makes process of factor extraction, rotation and estimation very simple [123]

Summary

To carry out analysis, a questionnaire was developed on basis of literature reviewed. This questionnaire contained open ended questions to acquire unstructured data from different stakeholders of hydropower sector. All this data was integrated into NVIVO. “Word Frequency query” is process in NVIVO that tells the frequency of certain word or phrase in integrated data. This process was used to identify key variables that remained important in the hydropower development. Another series of structured interviews was conducted by using the results of the Word Frequency index. A second questionnaire was developed on the basis of variables identified from NVIVO analysis. These structured interviews was be based upon Q-Method. In this method each respondent was asked to grade each variable depending upon its severity and will justify its choice by giving a statement. Than both of these answers, numerical and opinion statement, was analyzed by using PQ software. This helped to grade all of those barriers identified by NVIVO analysis in reference to their impacts and importance on hydropower development

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CHAPTER 4

4.1.Results and Discussions

The results were analyzed. Final results output was generated in file with. Lis extension. The file results file contain extensive details of results i.e correlation matrix between sorts entered, un-rotated factor matrix, Cumulative Communalities Matrix, Factor Scores with Corresponding Ranks, Correlations between Factor Scores, Factor Scores or Z-score For each Factor, Descending Array of Differences Between each two Factors, Exact Factor Scores (á la SPSS) in Z-Score and T-Score units, Factor Q-Sort Values for Each Statement, Factor Q-Sort Values for Statements sorted by Consensus vs. Disagreement and Distinguishing Statements for Factors Both the Factor Q-Sort Value (Q-SV) and the Z-Score (Z-SCR) are Shown. For our analysis, factor Q-sort values for each statement, factor scores of each statement for each factor and identified consensus

statements by using a descending array of differences between each two factors to and disagreement statements to develop a concourse [111].

The Table 12: Correlation Matrix between factors below describes the relation/similarity among different discourses. Each entry in matrix describe correlation between discourse numbers in left most column to the discourse number in top most row. Therefor all diagonal entries are 1.00 as these show correlations of each factor with itself.

Table 12: Correlation Matrix between factors

Factor No.	1	2	3	4
1	1.0000	0.6701	0.2757	0.3997
2	0.6701	1.0000	0.3135	0.4156
3	0.2757	0.3135	1.0000	0.2016
4	0.3997	0.4156	0.2016	1.0000

The "Table 13: Determinant score (from −5 to +5) for each discourse", below present factor scores of each statement in each discourse A, B, C, D. Statement score range -5 to +5 (-5 as least important, +5 as most important) for each discourse.

Table 13: Determinant score (from −5 to +5) for each discourse

No.	Statement	Discourses A B C D
1.	GB has disputed legal status in Pakistan	-2 1 -1 5
2.	Project management issues during the implementation of projects	2 0 0 2
3.	Risk involved in contract termination with the government	-4 2 -5 -2
4.	Bidding procedure for hydropower project is complicated and time taking	2 2 0 1
5.	Less budget is allocated to hydropower projects	0 1 4 3
6.	Bureaucratic involvement influences technical decisions	0 3 3 -3
7.	Project delays due to financial interests of the officials	1 -3 -4 1
8.	Cost increases due to delay in the project approval	5 4 5 4
9.	Increase in the project cost due to compensation of the environmental damages	1 0 1 -5
10	Hydro projects create a negative downstream effect	-5 -4 -1 -4

11	Construction of hydro projects causes hydrological damage	-5 -5 -5 -4
12	Risks with private investment due to fluctuations in exchange rate	-4 -5 -5 3
13	Risks involved with private investment due to state expropriation	-2 -2 -5 2
14	Structure of electricity market discouraged the involvement of private investors	3 -3 -2 1
15	Promotion of thermal based IPPs by giving them special incentives	4 2 1 0
16	Fear of investors regarding the nationalization of projects	-1 0 -5 2
17	Limited financial resources at government disposal to develop hydropower project	-2 4 4 5
18	Weak institutional structure to involve private investors in the hydropower projects	4 2 -3 0
19	Lack of local technical expertise to handle the mega hydro power projects	-4 -3 4 2
20	Earth quakes and floods in past slowed process of development	-2 -1 -2 0
21	Lack of social immobilization and involvement in project planning and execution create social opposition	2 0 0 2
22	Power evacuation problem due to limited connectivity of national grid in remote areas	5 5 3 4

23	Lack of coordination between the different departments	5 3 2 4
24	Poor load forecasting misread the need for large hydropower projects	0 0 0 4
25	Indus Water Treaty reduced the right to use water of certain rivers for hydropower	-3 -2 -2 -5
26	Inflation rate is unpredictable in Pakistan	0 0 -2 0
27	Politicians were involved in business of IPPs	1 1 -4 1
28	Environmental protection agencies of provinces creates delay in issuing NOC	1 2 -3 1
29	CPPA-G created a delay to issue Power Purchase Agreements (PPAs) to small projects	4 4 2 3
30	Provinces were unable to provide the sovereign guarantees for the projects	-2 -2 -1 1
31	Lack of control on river flows due to existence of river origins in other countries	-3 2 -3 0
32	National grid is incapacitated	3 5 4 5
33	Weak mechanism to handle the disputes between developers and governments	4 4 -3 0
34	Less special financial incentives for the hydropower sector	-1 -4 1 1

35	Government did not prioritize hydropower development	2 3 1 3
36	Financial losses in power sector due to the issue of circular debt	-1 1 2 -1
37	Private investor reservation regarding long time required to recover the capital from hydropower projects	-3 -4 1 2
38	Weak industrial set up for manufacturing of equipment	-4 -5 5 -4
39	Weak accountability mechanism to counter corruption	1 1 0 -3
40	Political consensus was not developed on hydropower projects	-1 4 4 0
41	Lack of proper planning in hydropower sector	3 1 3 0
42	WAPDA lacked officials having experience in hydropower development	-4 -2 -3 -1
43	Real time data was not available for 3few rivers in KPK	-3 -1 -4 -5

44	WAPDA did not properly invested in R&D of hydropower sector	-2 -3 2 -4
45	Projects delayed due to land acquisition and resettlement issues	3 1 4 4
46	Delay in issue of payments to the contractor delayed the projects	-1 -1 -1 -1
47	Law and order situation in country is stringent	0 0 2 -1
48	Project delays due to nepotistic interests of the officials	0 -4 -2 -3
49	Law for land acquisition is outdated	-1 -2 1 -1
50	Political instability impeded the growth	1 -1 3 -3
51	Poor performance level in public offices	2 -1 -1 -1
52	Improper planning of WAPDA to achieve its vision 2025	0 -3 0 -2
53	On site health and safety issues were observed	-5 -2 -2 -4
54	Project areas lacks a lot of infrastructures and other basic utilities	1 -1 1 -3
55	Political exploitation of local community on projects impacts	-1 -4 0 -2

56	Dissatisfaction of investors on tariff determination process	2 0 -1 3
57	Unpredictable taxation system	-3 -1 3 -2
58	International companies restricted their activities due to terrorism issue in project area (KPK and GB)	3 3 0 -2
59	Weak hydropower policies were unable to attract private investor	4 3 -1 -1
60	Problems in getting loan or aid due to lobbing in international agencies	2 5 0 -2

4.2. Consensus and disagreement statements

This study reveals that there are a number of issues upon which all the four discourses have agreement.

The consensus statements represented those statements that are marked important by all stakeholders in hydropower sector. The criteria for a statement to be considered as consensus statement was as any statements having score ranging in + scale and greater than 1 is considered as consensus statement. The criteria referred to the statements marked important by all respondents and significant in all discourses developing.

Table 14: Consensus Statements based on factor loading

Statements	**Factor Score**
Cost increases due to delay in the project approval	5 4 5 4
Power evacuation problem due to limited connectivity of national grid in remote areas	5 5 3 4
Lack of coordination between the different departments	5 3 2 4

CPPA-G created a delay to issue Power Purchase Agreements (PPAs) to small projects	4 4 2 3
National grid is incapacitated	3 5 4 5

"Cost increases due to delay in the project approval" is categorized as consensus statement among all discourses and identified by respondents belonging to public sector and private sector both. There are many other factors that lead to delay in approval of project. This is regular trend about hydropower in Pakistan that hydropower project proposals must face various revisions and delay in other approval process. A detailed feasibility is conducted after completion of PC-I and PC-II. As a final approval source of financing is identified and validate than this PC-I is forwarded to concerning ministry. PC-I undergoes several revisions which results in cost overrun due to inflation, rupee devaluation against dollars and other contingent costs added into projects. There are a number of projects approved in public and private sector suffered from such process. For such mega projects, approval is needed from CCI (Council of Common interest). Most of the time provinces do not agree with federal government decision. Clashes between federal and provincial government lead to an ultimate delay in project pre-math. An extended hierarchy involved in approval process created hindrance and delay in projects ultimately results in costs increment to project cost. Projects either in private sector or in public sector must face a cost overrun due to this obvious delay. Private sector however is least affected by this cost overrun as compared to the projects being developed in public sector. Public sectors seem it difficult to manage the increased cost because of huge dependence upon aids and loans to finance the projects.

Then concerns about national grid are another problem having unanimity. Pakistan has centralized power network controlled by NTDC and DISCOs. NTDC is responsible for 500KV network system and grids operation and maintenance. Power is being transferred to all DISCOs by NTDC at 500 KV. The grid network does not offer connectivity to remote projects site present in few northern area and GB. In addition to this limited connectivity there is a problem of high technical losses that reach up to 17%. Both the private sector and public sector apprehend this limited connectivity as costly barriers towards development. Therefore, national grid should be upgraded and expanded to the

projects site. Most of the resources exist in northern area, GB FATA. All these areas have limited access to national grid. Apart from limited connectivity, National grid has efficiency, stability and limited load handling issues. Technical incapability to connect with new power plants encumbers the power sector growth.

The hydropower sector involves many departments i.e. environment protection agencies, IRSA, NEPRA, water wing of ministry of water, irrigation department, planning commission and ECNEC etc. There is deficiency of coordination between departments involved in projects which hinder the pace of projects approval and development. CPPA-G is responsible for issuance of signing power purchase agreement between power producer/developer and buyer/DISCO. Many private sectors claim that CPPA-G linger on while signing the power purchase agreement. Micro hydropower plants are willing to accomplish their installation, but the delay is due to PPA.

The disagreement statements represented those statements that are marked as insignificant by all stakeholders in hydropower sector. The criteria for a statement to be considered as consensus statement was as any statements having score ranging in - scale and lesser than -1 is considered as consensus statement.

Table 15: Disagreement statements on the basis of factor loading

Sr. No	Statement	Factor Score
1.	Hydro projects create a negative downstream effect	-5 -4 -1 -4
2.	Construction of hydro projects causes hydrological damage	-5 -5 -5 -4
3.	Earth quakes and floods in past slowed process of development	-2 -1 -2 0
4.	Indus Water Treaty reduced the right to use water of certain rivers	-3 -2 -2 -5
5.	On site health and safety issues were observed	-5 -2 -2 -4
6.	Real time data was not available for few	-3 -1 -4 -5

	rivers in KPK	

The disagreement statements were more related to environmental factors. Although the studies related to hydropower in developed countries include the harsh environmental aspects like ecological damage, hydrological cycle change and others. The respondents' views about such factors lead to a conclusion that such aspects never had receding impacts for hydropower in Pakistan. As claimed at different forum regarding losing the right to use the water for certain rivers as limitation associated with Indus Water Treaty, respondent response negated the effect. Respondents claimed that IWT never had any perverse effect. But slowed development after Ayub Khan Era is mainly responsible for hydropower sector issues. Although it was highlighted in initial stage interviews that data acquisition issues have been observed in the Pakistan. Especially the developers in KP region highlighted the issue. But there has not been a single project that faced delay just due to data acquisition issue.

From factor analysis four dominant discourses were recognized listed in Table 13: Determinant score (from −5 to +5) for each discourse presents the loading of each statement on each discourse. This helped to identify the consensus statements, represented in table above, on the behalf of factor loadings. To interpret our results, only statements utilized were with a significance level of $P < 0.01$. The Table 14: Consensus Statements based on factor loading represented the statements that carry similar scores among all discourses. As it is clear from the above table, all statements have scored ranging in + scale and greater than 1. Table 12: Correlation Matrix between factors describes the correlation between factor loadings. Four discourses derived from the loadings, interview results and previous data analysis described in research methodology are given as,

- Impediments to the private investment in hydropower sector
- Lack of coherent planning in hydropower sector
- Contingent cost overruns
- Dysfunctional governmental institutions

4.3. Impediments to the private investment in hydropower sector

The discourse focuses on electricity market obstructions to the private sector as one the main barriers in hydropower development in Pakistan. This discourse is imparted by statements that mentioned Table 16: Factor A, Z-scores and Factor Score. The table below elaborates the Z-Score[4] and Factor Score[5] of each statement in a discourse.

Table 16: Factor A, Z-scores and Factor Score

No.	Statement	Z-Score	Factor Score
22	Power evacuation problem due to limited connectivity of national grid in remote areas	2.183	5
8	Cost increases due to delay in the project approval	1.69	5
23	Lack of coordination between the different departments	1.65	5
29	CPPA-G created a delay to issue Power Purchase Agreements (PPAs) to small projects	1.512	4
18	Weak institutional structure to involve private investors in the hydropower projects	1.512	4
59	Weak hydropower policies were unable to attract private investor	1.341	4
33	Weak mechanism to handle the disputes between developers and governments	1.261	4

A well developed and coherent institutional structure, policy and legal frameworks, special fiscal incentives and well structure market is necessarily important to invoke private investment in any sector. The previous conditions have been discouraging for private investors in all aspects.

[4] The Z-Score describes the deviation of certain statement from the mean value of a group. If a Z-score is 0, it represents the score is identical to the mean score. A Z-Score having positive value indicates the score is greater than the mean value. A negative Z-score indicates value below mean value of data.

[5] Factor Score describe the score of each statement in the discourse being scored in range of -5 to +5.

Powers sector project involves different ministries and institutions like NEPRA, CPPA-G, EPA, IRSA and others while hydropower even more departments. Power sector of Pakistan is designed such that control of H.V transmission is in the jurisdiction of NTDC. NTDC is responsible for maintaining and up gradation of existing grid transmission network and expansion of grid network. Power is being transferred to all DISCOs by NTDC at 500 KV. Major resource lies in Northern Areas, Only 1 500 KV grid is located in the Northern Areas, KPK which also have too much technical issues that needed to be resolved to ensure continuous supply [124]. PESCO and TESCO are the distribution companies responsible for power supply. Even TESCO and PESCO network is not equipped with any 220 KV grid, an essential part of mega network [125].

Private investor for the project had to deal with various departments in different phases of the project and these were dysfunctional and unsynchronized. The investor investing small hydropower was having problematic concerns in issuing of NOC by CPPA-G that was in authority to purchase electricity from investors. As a vindication to the above mentioned discourse, the public and private sector has successfully installed over 300 micro and mini hydroelectric power plants in the areas that are not connected to the national grid [21]. PCRET have installed 228 plants of total capacity 3 MW in North Western region [53].

NEPRA has been acting as regulator; acting in compliance to assure the transparency raised the concerns of investor. There are many uncertainties are involved during construction of hydropower, but NEPRA has defined a specific tariff. Private investors claimed that NEPRA does not compensate depending upon the realities of projects cost. The private investors working on certain projects claimed that Tariff determination process needs modification to be market competitive and hydel encouraging. NEPRA had defined a cost plus tariff. But cost is always site specific. EPC and Non-EPC Cost varies for project-to-project in case of hydropower. NEPRA set a same standard for all type projects. Tariff determined by NEPRA is on the basis of 25 years, but age of hydropower is almost 50 years. Site Specific issues vary depending upon location, hydrography and geology of project sites and other factors that affects the cost.

The past power policies were more encouraging the thermal based IPPs. Past policies hastened the installation of thermal based IPPs in 1993 polices. Irrespective of

environmental concerns associated with costly imported fuels stimulated growth of coal fired power plants and RLNG based power plants has been observed due to facilitation provided in policies. The prior policies included a stipulate of policy regarding paying capacity price even if they were on shutdown call by national power control center (NPCC). Bing submissive to recent polices equipped with cost plus tariff CPPA-G is forced to purchase the costly power from these IPPs and undermining the economic public sector power projects [126]. Even after policy of 2002, interviews of private sector respondents reflected that they were reluctant to go for such projects facing connectivity issues. Legal framework designed for private sector was not that much secure that contracts made under policy of 1994 were terminated. Litigations did not go in the favor of investors which set a bad precedent for forthcoming investors.

The perception about Pakistan Market has not been encouraging for private investor due to factors like corruption, terrorism, political instability. The respondents narrated that they were having severe on-site threats for local and foreigners working there. There have been such incidents which involved killing and kidnapping of foreign nationals. Although have a minor impact, but nepotistic interest of officials also created delay on different phases of projects.

Polices for thermal sector included special financial incentives like tax rebate, import duties and others while hydropower sector lacked such lucrative package. The respondents claimed that hydropower sector is being developed by foreign investors. Therefor they are being given lesser incentives as compared to IPPs.

A policy and institutional growth was unable to diffuse the private investment into hydel sector. This bi-directional growth was comparatively matured in 2002 and resulted in a registration of 10 projects that are in some phase towards the development [36].

4.4.Lack of coherent planning in hydropower sector

The discourse B focuses on the unclear capacity planning for expansion of hydropower among barriers in delay in exploitation of hydropower development in Pakistan. Statements which paved the way for the discourse are mentioned in Table 16: Factor A, Z-scores and Factor Score.

Table 17: Factor B high Z-score and Factor score

No.	Statement	Z-Score	Factor Score
32	National grid is incapacitated	5	1.937
22	Power evacuation problem due to limited connectivity of national grid in remote areas	5	1.836
60	Problems in getting loan or aid due to lobbing in international agencies	5	1.836
40	Political consensus was not developed on hydropower projects	4	1.490
35	Government did not prioritize hydropower development	3	1.18

Discourse B based on statements colligated to political, economic, social and technical aspects of planning. Many private investors and public sectors officials highlighted the issue of coherent planning lacking in involvement of all aspects or stakeholders in resource exploitation. The role and responsibilities of each stakeholder and their intended gains were not well-defined therefore they were unable to perform their function properly including removing social and political obstructions, timely equity arrangements by developers and other agencies, timely development activities and transmission system arrangements for efficiency enhancement and to incorporate new generation unit. Irrespective of claims to develop dams and other hydro resources, no clear mechanism to involve the local community and political parties was developed. Even developers claim that they had to face delays due to nepotistic interests of politicians, officials and common public and there was no method to overcome such issues. While the government sector officials claim that private developers were unable to serve their designated role in a project by not following the timelines. Fewer projects initiated by the private sector also suffered lack of diligence. Few respondents claimed the planning and demands set by

international agencies were contradicting the ground realities being faced by developers and government. Another precedent of lack of coherent planning was from 2002-2007, when the issue of power shortage was much less severe but lack of planning lead to unending crisis. On the capacity there was momentarily surplus electricity so that GOP initiated project to export 500MW to India. Government of Pakistan was almost failed to forecast the future load demand thus did not have a focus on capacity expansion. GOP started a number of electrification projects. In 2002, out of 140 million populations only 50% had access to electricity but in 2008, 80 % had access to electricity. In six year tenure electrification projects was on peak but without proper planning to meet their future demands. WAPDA even envisaged a plan to develop hydropower resources according to its vision 2020. There are fewer projects that was supposed to commission in 2020 are yet to be started. After restructuring of WAPDA, role of WAPDA was limited to management of hydropower resources, but to somehow concerned organization could be meet goals pertinent to its core functional area.

4.5. Contingent cost overruns

The discourse C focuses on focuses on the weak financial status of government as one the main barriers in hydropower development in Pakistan. This discourse is imparted by statements that mentioned in table below.

Table 18: Factor C high Z-score and Factor score

No.	Statement	Z-Score	Factor Score
8	Cost increases due to delay in the project approval	1.787	5
38	Weak industrial set up for manufacturing of equipment	1.787	5
5	Less budget is allocated to hydropower projects	1.678	4
19	Lack of local technical expertise to handle the mega hydro power projects	1.678	4

17	Limited financial resources at government disposal to develop hydropower project	1.569	4
45	Projects delayed due to land acquisition and resettlement issues	1.414	4

The projects started in the public sector had to face the complicated and lengthy process for approval, which involve various approval bodies like PC-1 approved by planning commission of Pakistan, approval by the executive committee of the national economic council (ECNEC), Departmental Development Subcommittees (DDSC), Divisional Development Working Party (DDWP), Central Development Working Party (CDWP), Provincial Development Working Party (PDWP), and ministry of finance[127] . This results in delay and ultimately increased in project estimated cost. A trend of various revisions in PC-I has been observed while each revision resulted in an increase in cost. As an evidence the cost increments and budget reserved by public sector development program in Gollen Goal hydropower project cost in PC-I Rs. 7035.128 million increased to Rs. 29077.701 Million, a four time rise in price in revised and approved PC-I[31].

Disparity and privation tend to generate tremendous contingent social issues during the execution of project. The local community hinders the projects development for their self needs like on-site jobs and other political issues. The other real issue is during land acquisition and resettlement phase. Realizing the government needs politically and socially exploited people raise returns to their land. Therefor hindrance and overestimation of land results in cost overrun of the project.

Projects being developed by public sector through work order of WAPDA by the involvement of contractors suffer from the delay in payments. Projects were unable to get regular financial share as government allocates limited budget for developmental projects due to certain reasons. A recent study focusing on recently completed 5 selected hydro projects also consummated that delay in payments was a major reason of delay.

4.6. Dysfunctional governmental institutions

The discourse C focuses on focuses on Dysfunctional governmental institutions failed to accomplish their goals and to overcome the managerial issues. This discourse is imparted by statements that mentioned Table 19: Factor D high Z-score and Factor score.

Table 19: Factor D high Z-score and Factor score

No	Statement	Z-Score	Factor Score
1	GB has disputed legal status in Pakistan	1.787	5
17	Limited financial resources at government disposal to develop hydropower project	1.787	5
32	National grid is incapacitated	1.787	5
8	Cost increases due to delay in the project approval	1.429	4
22	Power evacuation problem due to limited connectivity of national grid	1.429	4
23	Lack of coordination between the different departments	1.429	4
24	Poor load forecasting misread the need for large hydropower	1.429	4

GB region has about 278 identified project sites with a total capacity of 21125 MW [8]. The potential of Gilgit Baltistan is estimated to be around 22,000 MW. GB associated issues include technical limitation and disputed legal status of GB. GB was not considered as sovereign state of Pakistan. GB has not been receiving any share in NFC award.

Gilgit -Baltistan being part of the polemical Kashmir region is also treated as a disputed treaty between Pakistan and India along with Azad Kashmir. Titular rights of GB were given in 2009 via self-governance order signed by the government of that era. But still the legal status of GB is also dubious as it is also linked with matter of Kashmir. Many donors, even China in amid of CPEC, consider it despicable to involve in polemical territory-based projects so are hesitant to fund or donate about projects in GB. It is a failure of government to design a legal framework to handle this titular status ambiguity. Government Debt to GDP ratio is 66.50% with government debt of 20767.90 billion PKR

signifies the limited government resources to develop mega projects on its disposal without aid or loan. Many other countries and funding agencies were funding development projects in Pakistan due to its geopolitical importance and its international relations; United States (30%), World Bank (21%), Japan (14%), K.S.A, Canada and U.A.E [128]. There is a discouraging trend in the aid and loans sanctioned by them due to political reasons. Recently USAID banned 15m$ social sector projects in Pakistan and 350m$ aid to special sector aid to Pakistan. Pakistan will be facing an issue in getting loan even from World Bank too, as it is failing to fulfil the conditions of the International Bank for Reconstruction and Development (IBRD) due to reason that its reserves are getting lower than its three-month import bill. The other wing of the world bank is an International Development Association (IDA), it has limited quota to section a loan or aid for each country (Rana, 2017).Pakistan will be getting a petty share according its quota.

Government organizations/institutions have lethargic attitude. They have been continuously failed to meet the dead lines in different deadlines. In example, Diamer Bhasha dam was planned to be completed by 2023. But delay in different segments has postponed its opening time till 2027. Government was unable to mechanize the financial instruments for project. GOP has been trying to finance through CPEC financing, but it has to drop its bid.

The other discourse building factors are related to the national grid and load forecasting. Unless the privatization process complete both problems are associated with the inefficiency of concerned office. NTDC is responsible for maintaining and up gradation of existing grid transmission network and expansion of grid network. Power is being transferred to all DISCOs by NTDC at 500 KV. Major resource lies in Northern Areas, a single 500 KV grid is located in the Northern Areas, KPK [124]. Efforts made in collaboration with international agencies like JICA and USAID to strengthen the incapacitated limitedly connected national grid are appreciated in this predicament. The transmission and distribution network losses are up-to 17% of power being generated [129]. Therefor Pakistan ranks the top 14th among the list of 131 countries having high losses [130].

The role and responsibility of Central Power Purchase Agency Guarantee Limited (CPPA-G) is to issue and sign power purchase agreement between power developer and

distributer. Hindrances in achieving power purchase agreement (PPA) projects are unable to connect themselves to national grid. All the payments to these developers are issues through CPPA-G. Fewer projects were not connected to National Grid. KP Government claims that 36.6MW Daral Khwar HPP, 17 MW Ranolia HPP and 2.4 MW Machai HPP having total capacity of 56 MW had been facing the problems of non-implementation of power purchase agreements with PESCO resulting in non-connectivity to national grid. There are few more projects having similar issues.

Summary

Analysis of Q-method results helped to identify consensus statements, disagreement statement and to develop four distinct discourses related to hydropower sector of Pakistan. The four discourses included impediments to private sector, contingent cost overrun, lack of coherent planning in hydropower sector of Pakistan and dysfunctional government institutions.

CHAPTER 5

5.1 Conclusion and Recommendations

The pace of hydropower sector has remained slow in Pakistan. This study provides a research-based explanation about the slow paced development. This study represented four distinct discourses about barriers in hydropower using a qualitative approach involving literature review, structured interviews, NVIVO Analysis and analysis based on Q-methodological study.

5.2 Limitations and Future Dimensions of Research

This study neither did focus only on selective projects or nor on any special sector like public sector projects or private sector projects only. The study also tried to include the research input from developer, policy makers, research institutes and other donor agencies too. The study focused on over all hydropower sector of Pakistan.

The study did not compare the power policies of other developing countries to the policy implemented in Pakistan. The intended study should focus on the comparisons of different mechanisms, tariffs plans and incentives being provided in the successful hydropower policies to the policy implemented in Pakistan. The critical successful factors or key performance indicators of different successful policies in the world should be identified. The role and effectiveness of these KPIs/CSFs in other countries should be analyzed in Pakistan. Other than these, certain KPIs/CSF should be set specifically for Pakistan.

A study focusing on successful players in hydropower sector in world should be carried to identify their market structure, policy frameworks, tariff plans, development mechanisms and other such important aspects. The scope of this study should identify the roles these variables in power sector of Pakistan.

The study focused on hydropower only it could not involve other renewable energy resources too. A similar study should be carried out for other renewable energy resources having abundant potential in Pakistan. The research work may also include differences among different renewable energy policies to attract investment in this sector. The research work may identify the reasons of slow paced development solar, wind and other

resources.

Wapda devised a plan to develop hydropower resources and named it WAPDA VISION 2025. The many of projects proposed were not completed as per timeline. A study may be conducted in context to analyze the reasons of failures of not accomplishing specific projects or delay in achieving the enlisted goals of WAPDA Vision by case study of highlighted projects.

5.3 Recommendations

To reinvigorate the hydropower and to tantamount hydropower share in the energy mix and resource utilization by involving the private sector, we suggest below mentioned changing that may have potential for redemption. In amid of CPEC and other economic development in Pakistan, hydropower resource being hefty in potential will add to sustainable development in Pakistan. To enhance the diffusion of private investment in any sector, new business opportunities and their potential of an investment, institutional structure to facilitate the investor, policy frameworks and special fiscal incentives to focus investment in a sector and well structure market is necessarily important. The market structure should encourage the participation of private sector investment by improvement in the ease of doing business index in power sector of Pakistan.

The investment potential in Pakistan is increasing, especially in the power sector. Pakistan has well developed institutional structure, including NEPRA, PPIB and CPPA-G and few others. The addition of a department in the institutional structure, similar to inter provincial coordination (IPC) to enhance the coherence and coordination between provinces, to enhance coordination between different public sector departments concerning the hydropower sector will facilitate the private investor and pace of work progress.

A retrospect of policy development with hydropower sector development narrates the impacts of changing policy framework on project development in private sector. A strong policy framework which could create an increased attraction in power sector not on the cost of economic loss to public sector power resources is needed. A policy framework with modification in electricity market structure having well defined roles and duties of each stakeholder is needed.

To the develop hydropower resources in the public sector, Pakistan government can develop the resources with the help of commercial loans from local banks, international aids and loans. This international part of equity arrangements are controlled by geopolitical reasons and relations. Across border tensions results in issues in getting donation or even loan-based financing from international agencies, organizations and banks. The initial feasibility of project should involve coherence of internal and external political drivers. As the Geo-economics are being a motive to develop the international relations and a cross border economic activity, Pakistan should settle the water issues with cross border countries. If still unable to achieve coherence of political drivers across the border, GOP should focus on projects to counter the aggression as precedent developed from Neelum Jehlum inauguration after Kishanganga issue.

The GOP has a persuasive focus to overcome the performance and productivity crisis in public sector departments. But overcoming the performance crisis in public sector department is not a single day task. There should be redrafting to titular status of the polemical resource territories. The GOP should have active participation and increased accountability in governance, consistency in renewable policies. The regulator should be independent in its functions and activities.

Annexure-A

Questionnaire for Unstructured interview

This is a purely research-based questionnaire. All the information provided will be used for academic purposes and will not be shared with any other institution.

1. How do you see a present energy shortfall in Pakistan?
2. What are major stakeholders in hydropower exploitation?
3. What are economic factors that influence the hydropower sector in Pakistan?
4. What are social barriers that have been observed in previous projects?
5. What do you say that we are having enough technology to exploit our resources?
6. What are legal barriers that projects or stakeholders have to face during execution of projects?
7. What are environmental barriers that projects or stakeholders have to face during execution of projects?
8. What do you suggest enhancing the share of hydropower in our energy mix in Pakistan?

Annexure-B

Q Statements

1. Gilgit-Baltistan has disputed legal status in Pakistan
2. Project management issues during the implementation of projects
3. Risk involved in contract termination with the government
4. Bidding procedure for hydropower project is complicated and time taking
5. Less budget is allocated to hydropower projects
6. Bureaucratic involvement influences technical decisions
7. Project delays due to financial interests of the officials
8. Cost increases due to delay in the project approval
9. Increase in the project cost due to compensation of the environmental damages
10. Hydro projects create a negative downstream effect
11. Construction of hydro projects causes hydrological damage
12. Risks with private investment due to fluctuations in exchange rate
13. Risks involved with private investment due to state expropriation
14. Structure of electricity market discouraged the involvement of private investors
15. Promotion of thermal based IPPs by giving them special incentives
16. Fear of investors regarding the nationalization of projects
17. Limited financial resources at government disposal to develop hydropower project
18. Weak institutional structure to involve private investors in the hydropower projects
19. Lack of local technical expertise to handle the mega hydro power projects
20. Earth quakes and floods in past slowed process of development
21. Lack of social immobilization and involvement in project planning and execution create social opposition
22. Power evacuation problem due to limited connectivity of national grid in remote areas
23. Lack of coordination between the different departments
24. Poor load forecasting misread the need for large hydropower projects
25. Indus Water Treaty reduced the right to use water of certain rivers for hydropower
26. Inflation rate is unpredictable in Pakistan
27. Politicians were involved in business of IPPs
28. Environmental protection agencies of provinces create delay in issuing NOC
29. CPPA-G created a delay to issue Power Purchase Agreements (PPAs) to small projects
30. Provinces were unable to provide the sovereign guarantees for the projects
31. Lack of control on river flows due to existence of river origins in other countries
32. National grid is incapacitated
33. Weak mechanism to handle the disputes between developers and governments
34. Less special financial incentives for the hydropower sector

35. Government did not prioritize hydropower development
36. Financial losses in power sector due to the issue of circular debt
37. Private investor reservation regarding long time required to recover the capital from hydropower projects
38. Weak industrial set up for manufacturing of equipment
39. Weak accountability mechanism to counter corruption
40. Political consensus was not developed on hydropower projects
41. Lack of proper planning in hydropower sector
42. WAPDA lacked officials having experience in hydropower development
43. Real time data was not available for [6]few rivers in KPK
44. WAPDA did not properly invested in R&D of hydropower sector
45. Projects delayed due to land acquisition and resettlement issues
46. Delay in issue of payments to the contractor delayed the projects
47. Law and order situation in country is stringent
48. Project delays due to nepotistic interests of the officials
49. Law for land acquisition is outdated
50. Political instability impeded the growth
    Poor performance level in public offices
51. Improper planning of WAPDA to achieve its vision 2025
52. On site health and safety issues were observed
53. Project areas lacks a lot of infrastructures and other basic utilities
54. Political exploitation of local community on projects impacts
55. Dissatisfaction of investors on tariff determination process
56. Unpredictable taxation system
57. International companies restricted their activities due to terrorism issue in project area (KPK and GB)
58. Weak hydropower policies were unable to attract private investor
59. Problems in getting loan or aid due to lobbing in international agencies

Annexure -1