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Public Perception and Cognitive Constraints in Nepal's Renewable Energy Expansion

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ABSTRACT: Nepal possesses significant potential for renewable energy development, yet progress remains slower than expected due to a complex interplay of public perception, cognitive biases, and behavioral limitations. This study explores how psychological factors—such as risk aversion, limited awareness, status quo bias, and misconceptions about cost and reliability—influence public acceptance and engagement with renewable energy initiatives. Through a review of existing literature, stakeholder interviews, and perception-based surveys, the research identifies key cognitive constraints that hinder decision-making, investment willingness, and policy support among consumers, local communities, and institutions.

KEYWORDS: Renewable energy, public perception, Cognitive constraints, Behavioral barriers, Nepal, Energy transition, Cognitive biases, public awareness, Sustainable development, Policy support

I. INTRODUCTION

The Himalayan Mountain region that covers about 15% of the country's land mass, ranges in altitude from about 4800 meters to 8850 meters, and is popular for several high mountain ranges including Sagarmatha, the highest peak of the world. Terai region in the south, the food basket of the country, covers about 17% of the land. The Hilly region in the middle covers about 68%, and presents the highest hydropower potential in the country.

Although Nepal measures less than 250 kilometers from north to south, its elevation ranges from below 100 meters to above 8000 meters from the sea level. This is the greatest altitude change of any country in the world. The large numbers of rivers and lakes and the greatest altitude change are the two main reasons why Nepal is one of the few countries with highest hydropower potential in the world. However, this great potential is challenged by some geographic realities. The most important among them are: the seasonal variation in water flow in rivers, Himalayan. Nepal used to be characterized, for decades, as a poor, underdeveloped, and an agrarian country.

Electricity not only works as the lifeblood of modern living as well as that of all sectors of an economy (industry, agriculture, transportation, information technology, etc.), but also its innovation has shaped major world events, including industrial revolution, world wars, space exploration and computer revolution. Yet, it is very different from various other products traded in the market. It is an essential product (or service) but cannot be seen or touched; It is a perishable product as it cannot be stored economically; It requires networks of wires and transformers to transport to consumers, although it travels at the speed of light, and it takes the path of least resistance.

Hydropower Potential of Nepal:

Various estimates have been made regarding the total hydropower generation potential of Nepal. The previous generation of Nepal's water resource experts used to suggest that Nepal's hydropower potential is the second largest in the world after that of Brazil. More recent surveys, however, have shown that this is not true in absolute terms, but probably true in terms of per capita, and as a percentage of its gross domestic product. Asian Development Bank's (ADB) Country Director in Nepal asserted recently that having over "6000 rivers with a total length of about 45,000 KM, discharging about 220 billion cubic meters of water annually, Nepal has one of the largest hydropower potentials in the region, both per capita and units of its GDP" (Cauchois, 2022). In addition, Nepal's topography that ranges from 119 feet, or 58 meters (Nepalish, 2023) to over 8000 feet from sea level within a span of 120 miles make Nepal one of the most potential countries for hydropower generation (World Atlas, 2024).

Objectives of the Study:

The overall aim of this research is to identify the cognitive problems faced by Nepal's hydropower sector, the most important natural resource of the nation, and explore options to resolve them. This overall aim will be achieved through



various objectives. The key objectives of the research are to:

1. Identify and explain key operational and strategic problems being faced by the hydropower sector of Nepal.
2. Identify key cognitive obstacles that have hindered the growth of the hydropower sector in Nepal.
3. Analyze key operational and strategic problems and explain how they stem from cognitive problems.
4. Measure what percentage of the stakeholders including the general public believe on either side of the cognitive debate.
5. Explore and suggest solutions to the cognitive problems and challenges on the basis of the findings of the research.

II. LITERATURE REVIEW

A Brief History of Hydropower Development in Nepal

Nepal established its first hydropower plant in 1911, just 29 years after hydropower technology was invented in 1882 by James Francis in the United Kingdom (Nunez, 2019). Pharping Hydropower Station is Nepal's first hydropower plant and only the second hydropower plant in South Asia (New Business Age, 2021). The first hydropower plant established in South Asia is Sidrapong Hydel Power Station that was set up in Darjeeling, India in 1897 (The Darjeeling Chronicle, 2019). Since then, various achievements have been made towards exploiting Nepal's hydropower potential, although the process has been rather slow and difficult. The history of hydropower development in Nepal can be explained in various phases or eras as follows:

Constitutional Monarchy Era (1990-2008): During the 17 years of this era, significant achievements have been made in the area of hydropower development, although this period witnessed the decade long Maoist insurgency that created unfavorable situations for development activities. Enactment of Nepal Electricity Act 2049, significant expansion in the generation and distribution of electricity, allowing the private sector to invest in hydro projects and the Mahakali Treaty between Nepal and India are major developments of this era. During this period 24 new hydropower projects with a total capacity of 475 MW were completed (NEA Publications, 2023). Several transmission lines and substations were also constructed in this era.

Current Era (2008 to Present): Constitutional monarchy was abolished in BS 2065 (2008 AD) by a vote in the parliament. With the termination of the monarchy, Nepal became a federal republic. This brought great enthusiasm as well as very high expectations for quick transformation and prosperity both at the people's and political parties' levels. Political parties wanted to make the best use of hydropower potential to bring a quick economic transformation in the country. For example, the government of Pushpa Kamal Dahal (8/2008/4/2009) expressed a commitment, through an annual budget, to generate 10,000 MW of electricity within ten years (Hydro Review, 2008). After him the government of Madhav Kumar Nepal (5/2009-2/201) issued a plan to produce 20,000 MW within twenty years (Bhusal, 2010). Subsequently, the various ministers of energy, water resources, and irrigation also put forward various ambitious plans (Barsha Man Pun/2018 AD, 10,000 MW (Onlinekhabar, 2018); Pampha Bhusal, 15000 MW (Khabar Hub. 2021).

While these appear like plans put forward without adequate research and analysis, they show the interest and commitment of political leadership as well as the recognition of the importance of hydropower in Nepal's development. These announcements also encouraged the private sector, both local and international, and widened the outlook of experts and managers.

Currently Operating Hydropower Projects:

About 572 hydropower projects are currently operating in Nepal, which have the accumulated generation capacity of 2991 MW (2024). These projects are owned by NEA, NEA subsidiaries and IPPs (Independent Power Producers). Among the currently operating projects, NEA owned projects have a generation capacity of 583 MW, and NEA subsidiary owned projects have a generation capacity of 493 MW. The total generation capacity of projects owned by independent power producers is 1915 MW. As such, the private sector has surpassed the NEA and its subsidiaries in the hydropower generation capacity. The data of the past few years shows that the generation capacity of NEA projects has remained almost stagnant, but that of both NEA subsidiaries and IPPs owned projects has increased steadily. This is partly because NEA develops new projects mostly through its subsidiaries.



III. RESEARCH METHODOLOGY

3.1. Research Design

Quantitative research techniques were also used to measure which side of the cognitive argument was more popular among the key stakeholders and the general public. This information was expected to be useful while designing policies and programs that need to address unfounded perceptions regarding the development of the hydropower sector. Literature review, as discussed above, was also a major source of information needed to achieve several of the objectives of this study. The various elements of the research design that were used during this research are elaborated below.

3.2. Nature and Types of Data:

Based on the objectives of this study, both qualitative and quantitative data were collected. Qualitative information, particularly the non-numerical data was collected through one-to-one, in-depth interviews, and quantitative data was collected by administering a questionnaire. In addition to the above primary data, secondary data, both numeric and non-numeric, were also collected through review of relevant literature.

3.3 Organization and Analysis of Data:

Data collected from in-depth interviews and questionnaires was cleaned, coded, organized and analyzed. The data was cleaned for any ambiguity or for any incomplete responses. SPSS software was used to analyze the data, and hence questionnaires were coded before feeding the data into SPSS software. Queries were set up as per predetermined data tables as well as statistical results sought such as averages, deviation and percentages. Results have been presented in tables with totals, averages and percentages. These statistical results were analyzed and interpreted in the contexts of the objectives of the study. The statistical results were also discussed from various points of views and implications were drawn.

IV. ANALYSIS AND FINDINGS

Clear understanding of these inter-relationships between the problems will help to identify and implement effective measures that address not only the cognitive problems but also the policy and strategic concerns, and technical and operational problems. Nepal's Hydropower sector will progress rapidly as it has in neighboring countries such as India, China and Bhutan only when the cognitive obstacles as the main sources of other problems are clearly understood and addressed. However, before presenting and analyzing data pertinent to various study objectives, this chapter describes below the key characteristics of the actual sample population; discusses how data quality was ensured; and explains the conceptual framework of the study.

4.1. Sample Characteristics

Primary data was collected through Key Informant Interviews (KII) and a questionnaire survey (QS). The KII was administered to current and previous government officers who worked in the ministry of Water, electricity and irrigation; selected leaders of several political parties, private sector producers of electricity and bankers, senior staff of NEA and known experts of hydropower of Nepal. These experts, **46 in total**, were almost entirely male and over 40 years of age. Most of them had masters and PhD degrees followed by a few with Bachelor's degrees. None were below undergrad degree.

4.2. Cognitive Problems Being Faced by the Sector

Key Informant Interviews and deeper probing revealed that several stakeholders and opinion leaders had technical and practical differences in understanding, defining and resolving some of the most pressing problems of the hydropower sector. These differences or disagreements were not just due to professional and political biases or due to their vested interests; instead, they were the results of their deep beliefs and commitments of the stakeholders. For example, some stakeholders clearly believed that Nepal's hydropower has no future without closely cooperating with India, others believed working with India was losing control over Nepal's most precious natural resource forever - a suicide. Similarly, there were experts and policy makers who believed that the best way of utilizing Nepal's hydropower resources was by building small, ROR projects run by communities. There were other groups of experts and policy makers who held the opposite view; they believed in building large projects and selling hydropower to neighboring countries. This group believed in production optimization over so-called resource protection. Still another group of experts, investors and policy makers believed in something in between.



4.3. Cognitive Problems and Stakeholders' Affiliation

Building on the outcomes of the KII, a survey was designed to validate and measure the cognitive debates related to critical issues and significant problems being faced by the hydropower sector. The survey was administered with a much larger sample size to validate the cognitive problems that were pointed out by the KII interviews. The survey was administered to 398 respondents comprising ten different stakeholders and opinion leaders. To measure the stakeholder affiliation regarding different cognitive problems the study rated 50 related statements on a Likert Scale. The study identified eight cognitive problems for deeper analysis. These cognitive problems were selected because they were most frequently mentioned in the KII interviews. To measure stakeholders' opinions and beliefs on each cognitive problem a number of statements, also referred to as items, were developed, and a Likert scale was designed for each of them. Nearly half of these statements were designed as positive and the other half as negative statements to gather respondent opinions from both perspectives. For example, in case of the cognitive problem #1, whether to emphasize on small and micro projects with ROR and PROR models or to emphasize on large and storage projects, three statements were designed as "emphasis should be placed on large projects" and other three statements were designed as "emphasis should be placed on small, ROR and PROR projects".

Future research areas.

While this study identified and analyzed several key cognitive problems and issues related to Nepal's hydropower sector, the study also highlighted the fact that there may be other cognitive problems hindering the growth of this sector. Since this is a pioneering study in this area, more research should be done to identify and measure other cognitive problems, if any. The respondents of the Key Informant Interviews also suggested that there should be other similar cognitive problems which should be identified and analyzed. The study also highlighted the fact that the current and new cognitive problems should be studied and analyzed in further depth with a lot more items or statements. The number of items/statements can be increased by exploring and identifying more justifications to support either side of the cognitive debate.

V. CONCLUSION

In the case of several cognitive debates, the research found that the opinions of the key stakeholders are sharply divided. This division in opinions magnifies when the data is analyzed by the stakeholder groups. At the same time, a significant number of respondents remained neutral on several of the cognitive debates suggesting that a significant number of people and opinion leaders do not fully understand or comprehend the issues. The sharp division as well as neutrality can only be resolved through educational programs such as seminars, discussion forums and public discourses on these debates.

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