Feasibility Study for Establishing Nepal as a Data Center Hub in South Asia

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Abstract: Increased use of the internet and use of digital technologies in South Asia in recent times have created an increased demand for reliable and sustainable data infrastructure. Through this research, this work examines whether Nepal can become a central hub for data centers in South Asia through analysis of its strategic advantages, which include rich sources of renewable energy, favorable climate, and its location in between China and India. The research design adopted in this research is based upon a case study framework, including site visits and interviews carried with the stakeholders and data centers within Nepal, to assess important factors such as energy efficiency, infrastructure readiness, availability of human capacity, regulatory environments, climate-related hazards, and economic viability. The outcomes of this analysis show that in terms of energy costs, sustainability, and operational efficiency, Nepal holds an advantage, but concurrently highlight seismic hazard issues, relatively small market size, and data accessibility issues. The study concludes that with targeted investment, policy reforms, and regional cooperation, Nepal has the potential to emerge as a data center hub for South Asia.

Keywords— Data Center, Feasibility Study, Digital Infrastructure, ICT Development, Cloud Services

I. Introduction

Nepal's unique geopolitical positioning between China and India, two of Asia's largest economies, presents both opportunities and challenges for economic development [1]. Scholars have analyzed the implications of China's growing influence in Nepal, particularly in the context of Sino-Indian relations and regional security dynamics, highlighting the need to consider the limitations imposed on Nepal's policy options in balancing its relationships with both countries [2]. Nepal's predominantly rural society and status as one of the poorest countries in Asia are further complicated by its landlocked location, rugged terrain, and infrastructural deficits, necessitating tailored solutions for distinct regional divisions based on their specific challenges [3]. Addressing these multifaceted issues requires a comprehensive approach that leverages Nepal's strengths while mitigating its vulnerabilities, enabling the nation to chart a sustainable and prosperous development trajectory.

Nepal's strategic location, coupled with recent advancements in information and communication technology, presents a unique opportunity to establish the country as a data center hub in South Asia. The expansion of ICT infrastructure is considered a milestone for Nepal to improve people's lifestyles [4]. Nepal's progress in adopting e-commerce and digital technologies, albeit gradual, signals a move towards embracing innovation and modern business practices [5]. Factors such as affordable electricity, a relatively cool climate suitable for data center cooling, and the potential for renewable energy sources position Nepal favorably for attracting investment in this sector. Despite having access to electricity, the country's power sector is underperforming, with supply shortages, reliability issues, and restricted access [6]. Nepal could serve as a conduit for data traffic between the two economic giants, offering a neutral and secure location for data storage and processing, leveraging its geographical position to facilitate cross-border digital connectivity. Nepal's growing internet penetration, driven by a burgeoning young population and the expansion of IT companies, further underscores the country's potential as a data center hub.

The purpose of this research report is to evaluate the viability of making Nepal the South Asian hub for data centers. While assessing the initiative's feasibility is the main purpose, the specific objectives include examining the current infrastructure, including the power supply, internet connectivity, and available market as well as location and regulatory requirements.

II. Literature Review

The establishment of data centers in Nepal could bring about substantial economic benefits, including job creation, foreign investment, and technological advancements. The tourism industry which contributes to a large amount of Nepal's economy has the most revenue come from foreign sources[7]. The presence of data centers could also attract other technology-related businesses, fostering a vibrant digital ecosystem and promoting innovation in various sectors. Such initiatives would also help to retain skilled IT professionals within the country, reducing brain drain and bolstering the local economy.

Key factors influencing data center establishment is highlighted with available information on availability of those resources in Nepal.

A. Power Management in Data Centers

Energy-intensive data centers require a minimum of (100 MW to 250 MW) reliable energy source. Nepal's potential as a data center hub in South Asia is significantly supported by its abundant hydropower resources(around 3,157 MW as of July 2024), which provide renewable energy. The government has set a target of generating 28,500 MW of electricity by 2035 [8]. Hydropower capacity not only meets domestic

energy demands but also supports energy exports i.e around 1,000 MW to India Bangladesh, enhancing the feasibility of large-scale data center operations [2]. Advanced power supply technologies, such as three-phase(NRP 175 per unit) current-source rectifiers, further optimize energy efficiency and reduce operational costs for data centers. However, frequent power outages necessitate robust backup power systems, including diesel generators and uninterrupted power supplies (UPS), to ensure operational continuity. The adoption of silicon carbide (SiC) power semiconductors can further reduce power losses, addressing energy efficiency concerns as many data centers currently operate below 50% efficiency [9]. Addressing socio-economic barriers to hydropower trading is critical to align energy exports with domestic needs, ensuring a stable and scalable power supply for data center growth.

B. Energy Sustainability for Data Centers

Hydropower, accounting for approximately 66.54% of total energy consumption, and the significant potential for solar energy, with panel efficiencies ranging from 18–22%, provide a robust foundation for sustainable energy resources. Despite this, the share of renewable energy in Nepal's energy mix declined from 63% in 1998 to 14% in 2015, underscoring the urgent need for policy interventions to enhance sustainability [8]. Investments in Geographic Information Systems (GIS) and multi-criteria decision-making approaches can optimize site selection for renewable energy projects, facilitating resource management and planning [10]. Decentralized renewable systems are critical for rural electrification and achieving Sustainable Development Goal 7 (SDG-7), while waste-to-energy technologies offer innovative solutions for both energy generation and waste management [11]. Addressing socio-technical barriers, such as regulatory challenges and energy poverty, is essential to attract investments and promote the adoption of cleaner energy technologies, thereby supporting sustainable data center operations [12].

C. Human Resources in Data Centers

The data center industry requires skilled professionals across various roles. Data center operators (9–15 for 24/7 operations) manage critical infrastructure, respond to alerts, and perform maintenance. System administrators (2–4) handle server systems, network administration, storage, and virtualization. Network engineers (1–2) design and secure network infrastructure, while security engineers (1–2) focus on implementing security measures and threat response. Facilities engineers (1–2) maintain HVAC, electrical, and fire suppression systems. IT support staff (2–4) provide user support, troubleshoot issues, and offer training.

Strategic investments in education and training are essential to meet these demands. Addressing socio-economic challenges, such as limited rural opportunities [13], and fostering skill development through business incubators, as noted by Li et al. [14], can create a capable workforce. Structured approaches to skill enhancement [15] and task-shifting strategies further improve efficiency, ensuring Nepal's workforce can adapt to evolving technological needs and sustain data center growth.

D. Security and Policy

Robust data management practices are essential, as highlighted by Lv and Yan [16], emphasizing comprehensive security policies to manage risks from integrating heterogeneous data sources. Nepal’s regulatory framework, including the Information Technology Act 2008, Telecommunications Act 2053, and National Cyber Security Strategy, provides a foundation for addressing these challenges. Effective risk management frameworks like ISO 31000, as noted by Andry et al. [17], are critical for maintaining trust and reliability.

Energy efficiency intersects with security, with Olatunde [18] advocating for sustainable practices without compromising integrity. Incident management policies aligned with ISO 27035 standards are vital for resilience against cyber threats, as explored by Poetiray [19]]. Additionally, clear security policies addressing cloud computing challenges, as highlighted by Jensen et al. [20], can bolster trust in Nepal’s data centers and attract investments.

E. Location and Climate

Situated in the Himalayas, Nepal's unique topography, characterized by mountainous terrain, poses both opportunities and challenges for data center infrastructure. Talchabhadel et al. highlight that local terrain interactions with weather systems can lead to extreme events like cloudbursts, which threaten infrastructure stability [21]. Furthermore, climate change exacerbates these challenges. Shrestha et al. project an increase in mean annual temperature by 1.7–3.6°C and precipitation by 11–23% by the end of the 21st century, leading to more severe weather events and potential operational disruptions [22]. Anup and Thapa-Parajuli emphasize the increasing unpredictability of rainfall patterns, which could cause water shortages critical for data center cooling systems [23].

Nepal's diverse geographical regions also exhibit varied climatic risks. Karki et al. report that lowland areas like the Terai experience rising precipitation extremes and flooding risks, whereas mountainous regions face droughts and landslides due to shifting weather patterns [24]. Such variability necessitates strategic site selection for data centers to enhance resilience. Moreover, Karki et al. stress that the socio-economic impacts of climate change, such as food insecurity in rural communities, could indirectly affect the labor market and operational costs for data centers [25]. Nepal’s location offers advantages such as natural cooling and renewable energy potential, but addressing climatic risks through robust infrastructure and adaptive strategies remains critical.

F. Financial Considerations

The establishment of Nepal as a data center hub in South Asia necessitates a thorough evaluation of financial considerations, including investment, operational costs, and return on investment. Dahal emphasizes the positive correlation between foreign direct investment (FDI) and economic growth in Nepal, indicating that increased FDI could provide the financial foundation required for data center development [26]. Nepal’s potential to attract international financial markets is vital for securing the substantial capital required for such infrastructure, which ranges from approximately 500 million to 2 billion NPR for setup, encompassing power systems, cooling equipment, and security measures.

Yu notes that financial integration in center-periphery economies can stabilize access to capital, reducing risks from local economic fluctuations [27]. Operational costs, such as energy and labor, play a significant role in financial sustainability, with annual human resource expenses

estimated at 50 million to 150 million NPR, covering salaries and benefits for essential personnel like data center operators and engineers. Wu et al. highlight that advanced cooling technologies can enhance operational efficiency, reducing long-term costs [28].

Additionally, Acharya underscores the importance of investing in human capital, as a skilled workforce contributes to operational efficiency and innovation, further boosting financial performance [29]. Nepal's reliance on renewable energy, particularly hydropower, offers a cost-effective solution to minimize energy expenses. This aligns with Pohl's insights on integrating financial sustainability into data center operations [30]. Land costs, ranging between 100 million and 500 million NPR depending on location and proximity to power sources, further influence the financial dynamics of developing data centers.

As seen in the review, studies on data centers in other countries included detailed requirements and analyses. However, there is a lack of data specific to Nepal; There is no proper secondary data about the power requirement and cost of operating data centre in Nepal. Data about the human resource availability is also lacking along with data on market saturation and location feasibility.

Thus, despite the comprehensive coverage of the literature, several research gaps persist. Specially the limited availability and reliability of secondary data sources related to the feasibility of establishing data centres in Nepal.

III. Methodology

This case study and feasibility study research investigates the potential of Nepal as a data center hub in the South Asian continent. The approach is suitable for the complex interplay of social, technical, and economic factors that shape the development of this developing sector. Major aspects of the Nepalese data center landscape investigated include existing infrastructure, operational practices, the regulatory environment, and market potential.

Primary data collection was performed at the site visit to Datahub Pvt. Ltd., the largest private data center in Nepal. It involved direct observation and a semi-structured interview with a senior officer. Detailed field notes were taken after thorough observation.

Transcripts from interviews were analyzed, and significant statements regarding infrastructure, efficiency, compliance, and market potential were identified and categorized into broader themes. Field notes from observations of physical infrastructure, environmental conditions, and logistics were also analyzed systematically.

Triangulation of interview and observation data enabled comprehensive analysis that underlined strengths and challenges of the data center and gave a nuanced understanding of its potential in Nepal.

Ethical considerations were priortized throughout the research process. Informed consent was sought from the participants in advance, explaining the purpose of the study, freedom to withdraw from the interview at any time, and how their data would be used. Data were anonymized to let the privacy of the participant and sensitive information remain confidential.

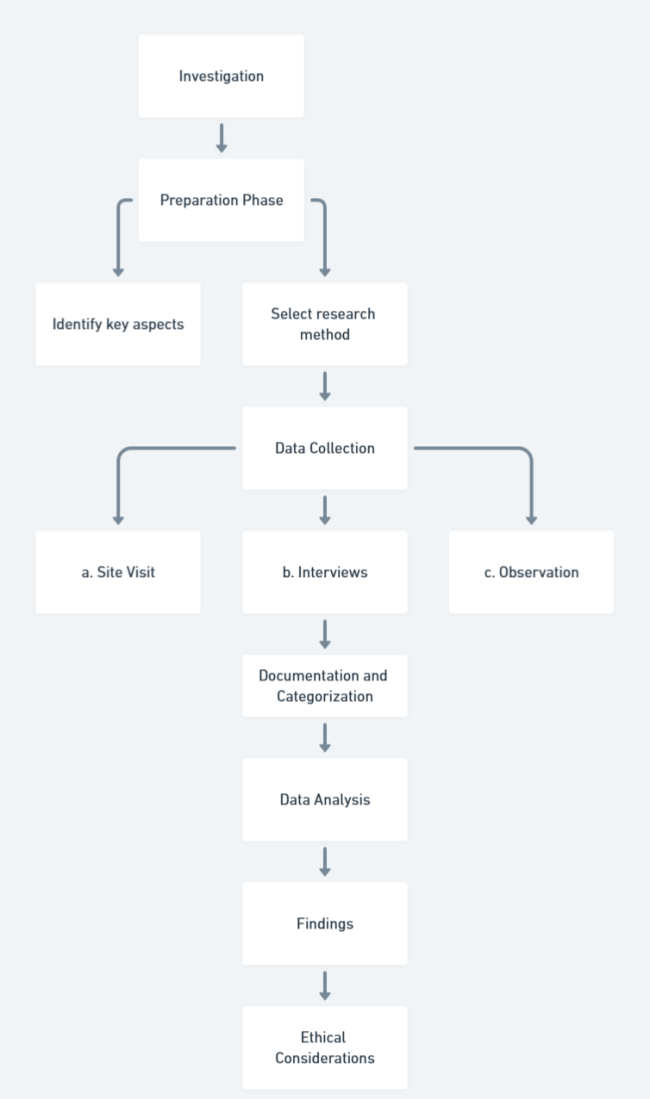

Fig. 1. Methodology Flow Chart

IV. Result and Discussion

To get firsthand information and data we visited Nepal's largest private data center Datahub Pvt. Ltd. And the following were our findings

The data center houses the servers of Nepal Stock Exchange TMS and most of the brokers of Nepal's only stock exchange as well as servers of most of the commercial banks of Nepal as well as payment portals and digital wallets like E-Sewa, Khalti etc. The company provides cloud services as well as IAS (Infrastructure as a Service) for private companies to house their servers.

Capacity: Currently the data center has a total capacity of 100 racks, each capable of housing 42 servers,as well as a backup data center with 35 racks with same capacity. An additional 18 rack capacity facility is being built. The servers have 1 tb to 4 tb of storage each.

Backup Database: The company has a DR (Disaster Recovery) data center in Butwal, located approximately 265 kilometers from the DC, which offers disaster recovery in case of catastrophic events. This geographic separation significantly reduces the risk of both facilities being affected

simultaneously by natural disasters. The location is chosen considering the seismicity and flood hazard.

Power: The major component that determines the cost of maintenance of a data center is power, specifically electricity consumption. For Datahub Private Limited, the average power consumption is 480 units (KW). In Nepal, the total cost for one unit of 3-phase electricity operating 24 hours a day over 30 days is calculated as 480 units * NRs 11.00 per unit * 24 hours * 30 days,

480 units NRs11.00 per unit* 24 hrs* 30 days=NRs 3,801,600*

Comparatively, in India, the total cost for the same power consumption, accounting for 4141 INR per hour for 480 units of 3-phase electricity, is calculated at 4141 * 24 hours * 30 days * 1.6,

*4141 * 24 hours * 30 days * 1.6= NRs 4,770,432*

१२ थी-फेज तल्लो भोल्टेज (४०० भोल्ट)

क्र. सं.	किलोवाट-घण्टाः युनिट (मासिक)	१० के.भि.ए. सम्म			१० के.भि.ए. भन्दा माथि		
		मासिक न्यूनतम शुल्क (रु)	इनर्जी शुल्क (रू. प्रति किलोवाट-घण्टाः युनिट)		मासिक न्यूनतम शुल्क (रु)	इनर्जी शुल्क (रू. प्रति किलोवाट-घण्टाः युनिट)	
			आषाढदेखि कार्तिकसम्म	मङ्सिरदेखि जेष्ठसम्म		आषाढदेखि कार्तिकसम्म	मङ्सिरदेखि जेष्ठसम्म
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Fig. 2. Cost of 3-Phase electricity in Nepal (source: NEA)

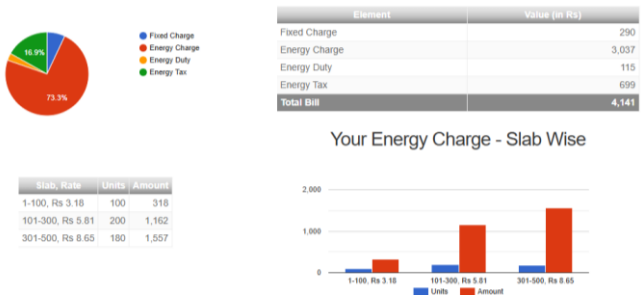


Fig. 3. Electricity Charge Calculation for 480 KW in India, Mumbai

Human Resource and Equipment: For the establishment of the DataHub Pvt. Ltd. in 2012 the company had contracted a Singaporean company. The Human Resource as well as Equipment both were imported. In the initial years, the company had to rely of foreign workforce for maintenance and error handling. Now, 12 years later they are adding new facilities and expanding database without foreign human resource. The company now has following employees. All the employees are from Nepal.

Designation	**No. of Employees**
Power Department	8
IT Department	12
Sales and Marketing	12
Electrical Engineers	4

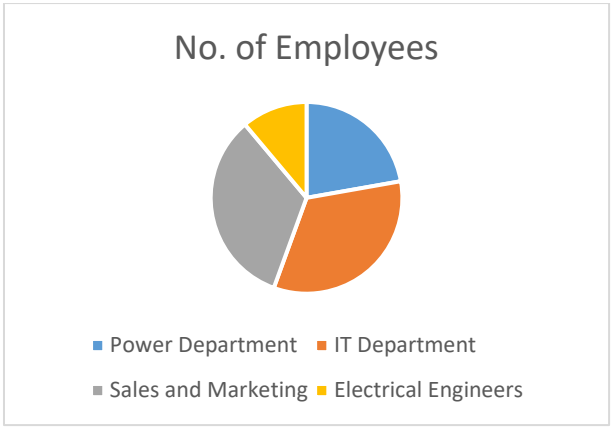


Fig. 4. Employee Chart of DataHub Pvt. Ltd as of 2024

Location: The only issue (location wise) for establishment of data center in Nepal is seismicity of Nepal. It can be overcome by construction of proper infrastructure and maintaining proper Data Recoveries'.

Market Saturation: Nepal is a very small market in terms of data generation. We can see the population density of South Asia in Fig.5. Nepal has a small population so establishing data center targeting Nepal's market alone will not suffice for large database. Thus, the data center targeting whole South Asia is to be considered.

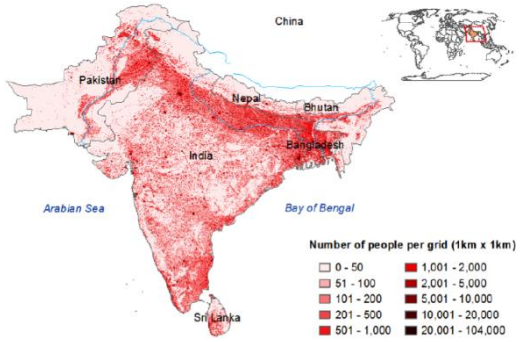
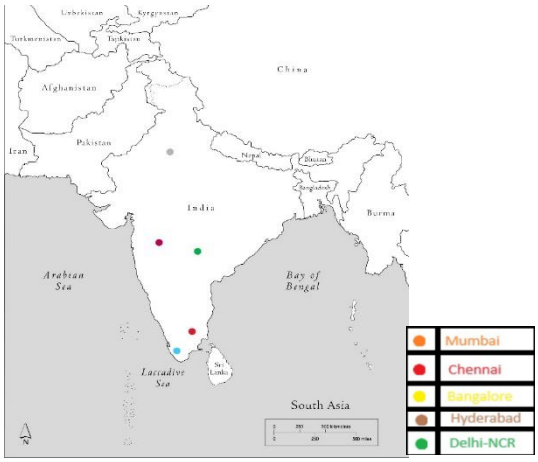


Fig. 5. Population Density of South Asia



Locations of Largest Data centers in South Asia

Distance and Latency: Propagation Delay is the time it takes for a signal to travel from the sender to the receiver. It is determined by the speed of light in the transmission medium (fiber optics, copper wire, etc.) and the physical distance between the two points. Since the speed of light is finite (approximately 300,000 kilometers per second in a vacuum, and about 200,000 kilometers per second in fiber optic cables), longer distances result in greater propagation delays.

$$Delay = distance(d)/speed\ of\ light\ in\ medium\ (s) \quad (1)$$

Thus Data centers are usually established near populated established near populated cities and not very remote areas, Datahub Nepal is also thus situated at the heart of capital city.

V. Conclusion

To answer the question simply "Yes, it is possible to establish Nepal as Data Centre of South Asia.". Nepal's potential as a competitive data center hub for South Asia is demonstrated by our research, which was bolstered by an in-depth visit to DataHub Pvt. Ltd., the country's largest private data center. The main conclusions supporting this statement are listed below:

Cost and Power Efficiency: At Nepal's electricity prices, DataHub Pvt. Ltd.'s monthly operating costs come to about (NPR 3,801,600) due to its average power use of 480 kW. Nepal has a cost advantage because this price is far less than similar prices in India (NPR 4,770,432). Thus, 20% cheaper. In addition, Nepal's use of renewable hydropower guarantees sustainability, and its milder climate lowers cooling costs, which boosts operational effectiveness even further.

Redundancy and Capacity: DataHub Pvt. Ltd. can now support 100 racks, each of which has 42 server slots, and more facilities are being built. By using geographic separation to reduce the risks of natural disasters, a Disaster Recovery (DR) center in Butwal, 265 kilometers away, guarantees company continuity.

Human Resource Development: After 12 years of depending on outside knowledge, DataHub Pvt. Ltd. has developed a skilled, entirely Nepali workforce with 36 experts in electrical, power, IT, and sales engineering. This change demonstrates Nepal's increasing ability to fund and maintain high-tech enterprises.

Strategic Location and Latency: When placing a data center, physical distance-related propagation delay is a crucial factor. The Kathmandu location of DataHub Pvt. Ltd. keeps access to South Asian markets while reducing latency for domestic operations. Enhancements to the region's infrastructure, including better fiber-optic networks, can maximize connectivity even further.

Market Opportunities: Although Nepal's population limits its domestic market, the country is positioned as a viable data hub due to its ability to service the larger South Asian area. The dense population and growing digitization of South Asia present numerous prospects for regional data services.

Infrastructure and Seismic Resilience: Despite Nepal's seismicity, risks can be reduced with appropriate infrastructure design, disaster recovery plans, and adherence to international best practices. One excellent step in resolving these risks is DataHub Pvt. Ltd. 's disaster recovery center in Butwal.

In conclusion, Nepal is a strong contender to become a data center hub in South Asia because to its many benefits, including cost effectiveness and renewable energy supplies. To achieve this goal, it will be essential to address issues with connection, seismic resilience, and infrastructure. Government, business sector, and international players working together to unlock Nepal's potential and help meet South Asia's fast expanding data demands in addition to its own internal needs.

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