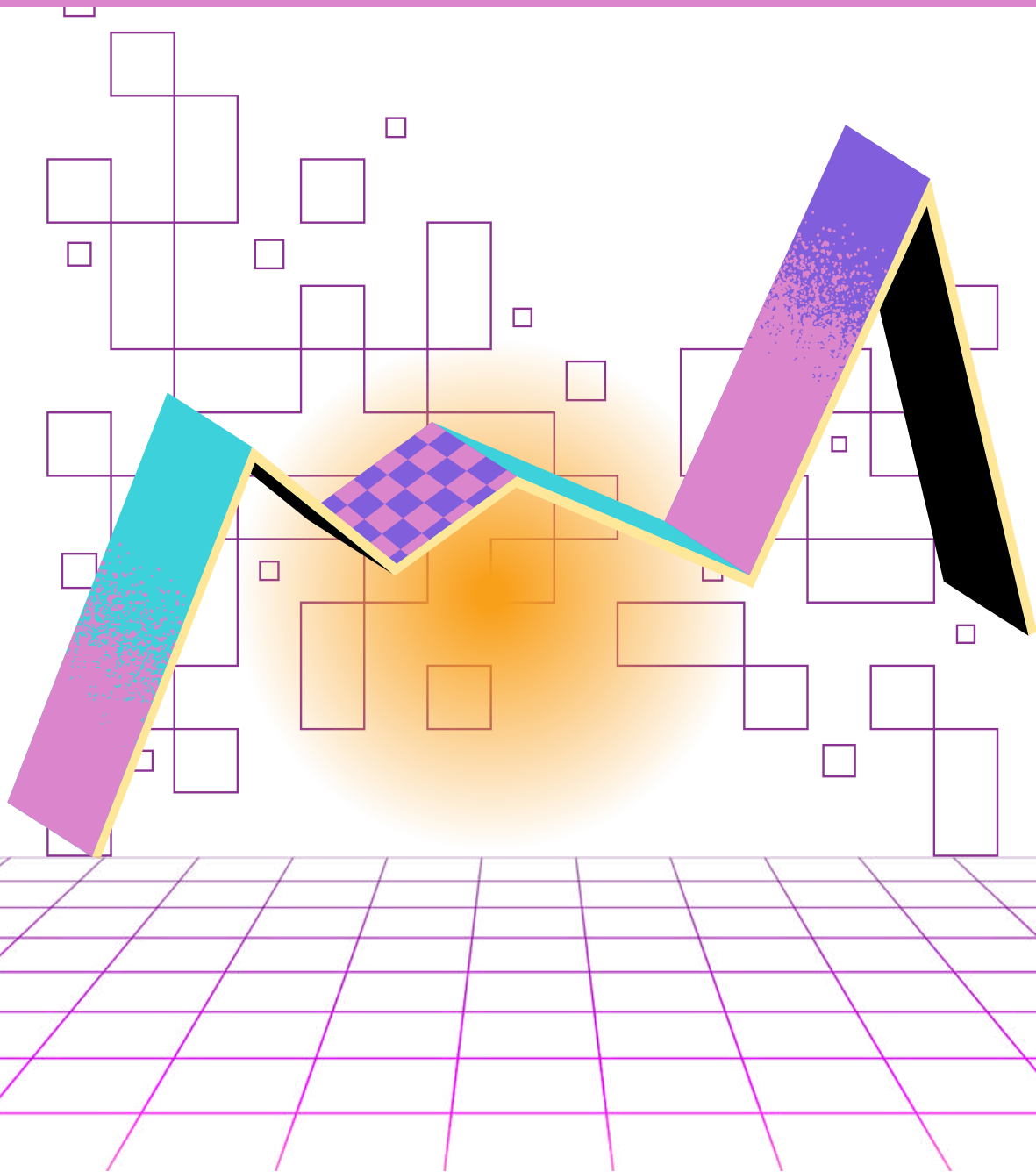


# ELEKTRON

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**SERVING HUMANITY THROUGH  
KNOWLEDGE**

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## **MESSAGE FROM THE VICE CHANCELLOR**

University of Engineering and Technology is an institution which has a history and culture of professional development for its students. In this context, Elektron is playing an important role by providing a platform to scholars for knowledge sharing across various disciplines. Elektron team is working hard to initiate a culture of innovation by inspiring students of science and technology. Only young, innovative minds can lead the country towards prosperity. I extend my best wishes to the Editorial Team for their commendable contribution.

**Prof Dr. Shahid Munir**

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## **MESSAGE FROM THE CHAIRMAN**

The aphorism “publish or perish” asserts the importance of publishing the scholarly work by the faculty and students. The Department of Electrical Engineering, historically, has been highly reputed for its outstanding undergraduate program. It has never been more important to involve undergraduate students in research. To publish the work carried out by under graduates has always been a challenge, due to the lack of availability of proper forum of this purpose, This is no more a limitation due to the introduction of the Elektron magazine. The Elektron team has put an extensive effort to make the idea a realization. The Elektron provides an excellent opportunity to both undergraduate as well as graduate students to publish their work. I believe this initiative will go a long way and will be pivotal in defining the careers of many.

**Prof Dr. Muhammad Asghar Saqib**

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Elektron is a multidisciplinary publication dedicated to making complex research accessible and engaging for a broad audience, especially the matriculation, intermediate, and early year BS students of domains of sciences, pre-engineering and engineering. We aim to bridge the gap between academia and the public through clear explanations, graphical representations, and insightful analyses.

The key objectives of this magazine are,

- **Explaining Research:** The research articles are usually very intensive in usage of complex language, mathematical concepts. For the better understanding of the readers, the research be presented in an easily understandable form, avoiding too complex mathematical forms.
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We encourage the audience, who are science and knowledge enthusiasts, and want to show up as authors, to submit your articles at [elektron.eed@uet.edu.pk](mailto:elektron.eed@uet.edu.pk)

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## سُورَةُ الْحَجِّ

أَفَلَمْ يَسِيرُوا فِي الْأَرْضِ فَتَكُونَ لَهُمْ قُلُوبٌ يَعْقِلُونَ بِهَا أَوْ آذَانٌ  
يَسْمَعُونَ بِهَا فَإِنَّهَا لَا تَعْمَى الْأَبْصَارُ وَلَكِنْ تَعْمَى الْقُلُوبُ الَّتِي  
فِي الصُّدُورِ ﴿٢٦﴾ وَيَسْتَعْجِلُونَكَ بِالْعَذَابِ وَلَنْ يُخْلِفَ اللَّهُ  
وَعْدَهُ وَإِنَّ يَوْمًا عِنْدَ رَبِّكَ كَأَلْفِ سَنَةٍ مِّمَّا تَعُدُّونَ ﴿٢٧﴾

Have they not travelled throughout the land so their hearts may reason, and their ears may listen? Indeed, it is not the eyes that are blind, but it is the hearts in the chests that grow blind. They challenge you 'O Prophet' to hasten the torment. And Allah will never fail in His promise. But a day with your Lord is indeed like a thousand years by your counting.

Al-Quran[22: 46-47]

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# THE POWER OF SOFTWARE INTEGRATION IN TODAY'S DIGITAL LANDSCAPE

## INTRODUCTION

Software integration is at the heart of streamlined operations where businesses can stay competitive, efficient and responsive to the call of their customers in this highly digital world. Simply put, software integration means the linkage of different applications in software for them to work together, so there is easy exchange of data, and higher productivity and more advanced functionality are achieved. Be it an API, middleware, or custom solution integration allows for unique advantages, which help businesses bloom in all this complexity and with technology at its core.

## ELIMINATING DATA SILOS FOR INFORMED DECISION-MAKING

No doubt, the most significant advantage of integrating software is the elimination of data silos. This will refer to information being contained in silos-the silos of different systems-allowing access and insight into only an isolated piece of that information. Integrated software solutions help organizations pool data from disparate sources and, through analysis, encourage better decision-making. For instance, an integrated CRM system that interfaces with a marketing automation platform can provide an entire 360-degree view of the interaction with customers and allow companies to structure their message and hence better engage with their customers

## THE ROLE OF AUTOMATION IN ENHANCING EFFICIENCY

Another area where integration stands out is in the aspect of automation. While integration makes it possible to automate repetitive activities by automating routine tasks and reducing human labor, this also decreases the amount of errors. The integration of an e-commerce business's inventory management system with its online storefront and accounting software would update stock levels in real time, process orders accurately, and automatically modify financial records without manual intervention. Efficiency improves, accuracy increases, and reliability is enhanced by not having to waste time and energy on



such matters.

## EXPANDING WITH EASE THROUGH INTEGRATION

Software integration also supports scalability. As businesses expand, so do the requirements for software. Integrating software solutions allows companies to implement new functionalities or widen existing ones without disrupting activity. Scalability is afforded by cloud-based integrations that allow companies to add or remove applications according to changing demands without the large costs of more traditional infrastructure.

## CHALLENGES IN IMPLEMENTING SOFTWARE INTEGRATION

Although the benefits abound, integration of successful software is not easy. Compatibility issues, data security concerns, and high initial costs are some of the major barriers. Still, these challenges can be overcome through careful planning, the use of proper tools for integrating the software, and cooperation with IT partners who have extensive experience in similar situations.

## INTEGRATION AS A STRATEGIC NECESSITY FOR MODERN BUSINESSES

It is about the streamlining of workflows, whether in developing a thorough basis for decision-making or as an actor that induces real innovation. Software integration is not a technical choice anymore but a strategic necessity. The power of integration could unleash new levels of efficiency, agility, and

competitive advantage through companies.

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## AN INVESTIGATION INTO EXCESSIVE SEEPAGE PROBLEMS AT KHANPUR DAM: AN INTEGRATED GEOLOGICAL, GEOPHYSICAL AND GEOTECHNICAL APPROACH

By Maham Ahsan (maanq119@gmail.com), Memona Hanif (memoonabutt77@gmail.com), Hassan Akhtar (akhtarhassan3002@gmail.com), Hafiz M. Awais Rashid (awais.rashid@uet.edu.pk), and Ghulam Mohyuddin Sohail (gmdsohail@uet.edu.pk)

### INTRODUCTION

The Khanpur Dam, completed in 1983 on the Haro River in Khyber Pakhtunkhwa's Haripur District, stands 167 feet high with a storage capacity of 107,076 acre-feet and primarily supports irrigation and municipal needs. The geology of the area majorly consists of limestone which tends to dissolve with water and causes significant seepage through the main dam and its abutments resulting in substantial water loss [1-2]. This study is focused on identifying the subsurface seepage paths, particularly in the left abutment. A 3D geological model is developed to understand subsurface conditions, and SEEP/W software-based modeling is used to evaluate seepage rates at varying reservoir levels. Based on these findings, targeted solutions to mitigate seepage will be recommended.

### METHODOLOGY

In the field, geophysical resistivity surveys were conducted on the left abutment of the dam using the Wenner configuration to assess subsurface water flow paths. Additionally, the orientations of major geological discontinuities were measured at selected locations along the left abutment. A total of seven water samples and two intact rock samples were collected from various field locations for subsequent laboratory analysis. In the laboratory, extended slake durability tests

were conducted, deviating from the standard ASTM D4644-16 procedure. The rock samples were subjected to 30 wetting cycles, each consisting of two 30-minute cycles. Slake durability measurements were taken after every two cycles to monitor progressive changes in the durability of the sample. The rock permeability tests on the collected field samples were performed following ASTM D4525. The water samples were tested for several parameters, including pH (ASTM D1293-18), electrical conductivity (EC) (ASTM D5391), total dissolved solids (TDS) (ASTM D5907), turbidity (ASTM D7315), calcium concentration (ASTM D1126), bicarbonate concentration (ASTM D513), total hardness (ASTM D8192), and sodium and potassium concentrations (ASTM D1428).

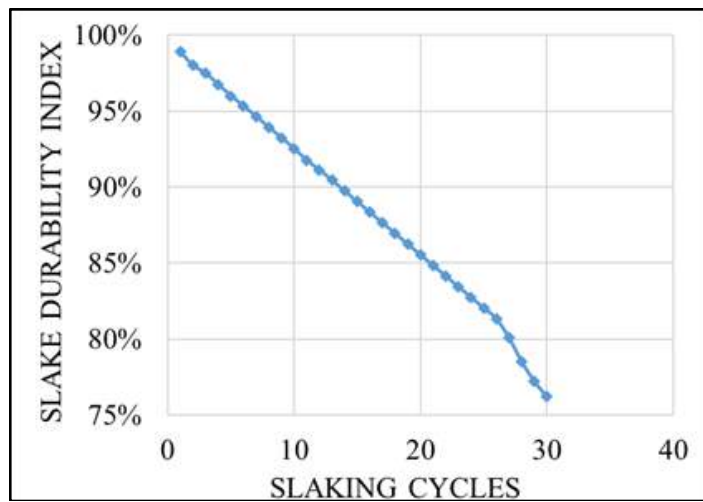
A 3D geological model of the site was developed using a combination of software, including ArcGIS, QGIS, Salome, Python, AutoCAD, and SketchUp. Additionally, a 2D resistivity profile was generated by interpolating resistivity data in Surfer. A SEEP/W model was used to simulate seepage rates at different reservoir levels for both the main dam and the left abutment.

### RESULTS

#### 1. LABORATORY TESTING RESULTS

The results of the extended slake durability test on a representative limestone sample are

presented in Figure 1. After 60 cycles, the cumulative durability index was found to be 76.2%, indicating medium to poor durability. This suggests that the low durability of the limestone, combined with the unfavorable orientation of discontinuities, is likely contributing to excessive seepage through the left abutment. Field measurements of the discontinuities revealed that the major joint sets (Joint set 1: N85W/55NW and Joint set 2: N18W/55SW) are dipping away from the reservoir and into the left abutment, providing a preferential path for water flow. The permeability testing on three intact core samples showed a hydraulic conductivity of 0.00050 m/s. This high value of permeability further exacerbates the seepage problem at the left abutment.



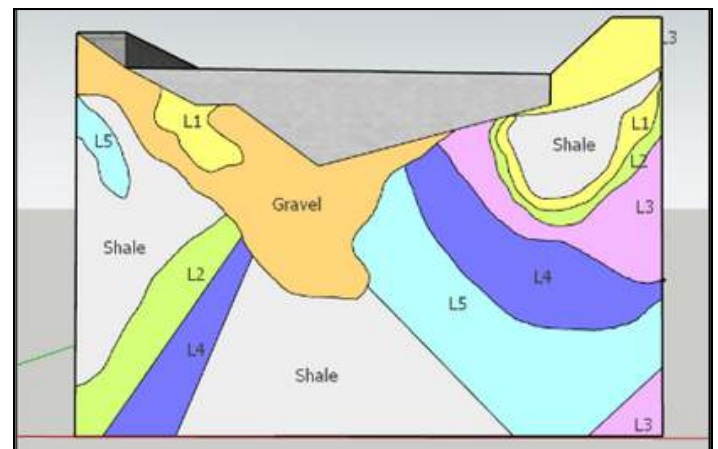
**Figure 1:** Effect of Slaking Cycles on Durability Index

The test results of the water samples are presented in Table 1. It was observed that S-4, S-5, and S-6 show high values of certain parameters which is likely caused by rock dissolution as a result of the interaction of seepage water with the rock mass sample. Sample S-4 exhibits the highest electrical

conductivity (821  $\mu\text{S}/\text{cm}$ ) and elevated calcium concentration (156 mg/L), which suggests active dissolution of calcium-bearing minerals in the rock. The sample S-5 shows a significant calcium concentration (134 mg/L) along with a moderately high EC (678  $\mu\text{S}/\text{cm}$ ), indicating ongoing seepage with partial rock dissolution. Similarly, sample S-6 presents the highest magnesium concentration (64 mg/L) and a relatively high EC (615  $\mu\text{S}/\text{cm}$ ), which is indicative of dissolution involving magnesium-bearing minerals, likely from dolomitic or magnesium-rich rock units. These trends point to ongoing geochemical reactions between the seepage water and the rock materials, contributing to mineral dissolution contributing to enhanced seepage.

## 2. 3D SUBSURFACE GEOLOGICAL MODEL

The 3D models of the subsurface geology of the study area are shown in Figure 2. The model shows that there are three different types of limestones in the study area namely nodular limestone (L1 and L4), argillaceous limestone (L2 and L3), and massive limestone (L5).



**Figure 2a:** Main Dam

**Table .1** Physicochemical Properties of Water Samples Collected from Seepage Zones at Khanpur Dam

Sample No.	pH	EC $\mu\text{S}/\text{cm}$	TDS mg/L	Turbidity NTU	Calcium Conc. mg/L	Magnesium Conc. mg/L	Bicarb. Conc. mg/L	Sodium Conc. mg/L	Potassium Conc. mg/L
S-1	6.65	594	260	423	148	15	145	12	31
S-2	6.45	581	261	420	145	23	132	15	27
S-3	7.29	553	265	422	140	10	130	10	21
S-4	7.10	821	262	378	156	32	145	17	32
S-5	6.40	678	254	367	134	27	143	10	26
S-6	7.04	615	275	257	116	64	130	13	24
S-7	7.50	554	274	506	120	50	80	09	22

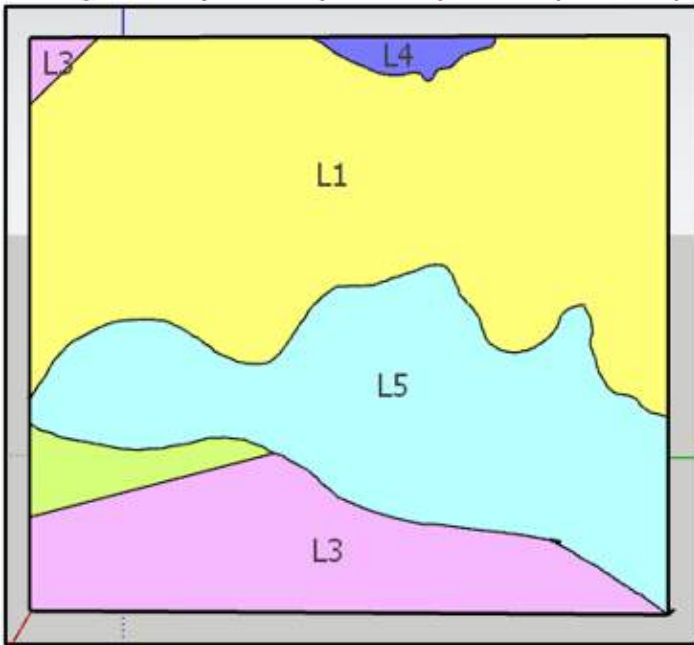


Figure 2b: Left Abutment

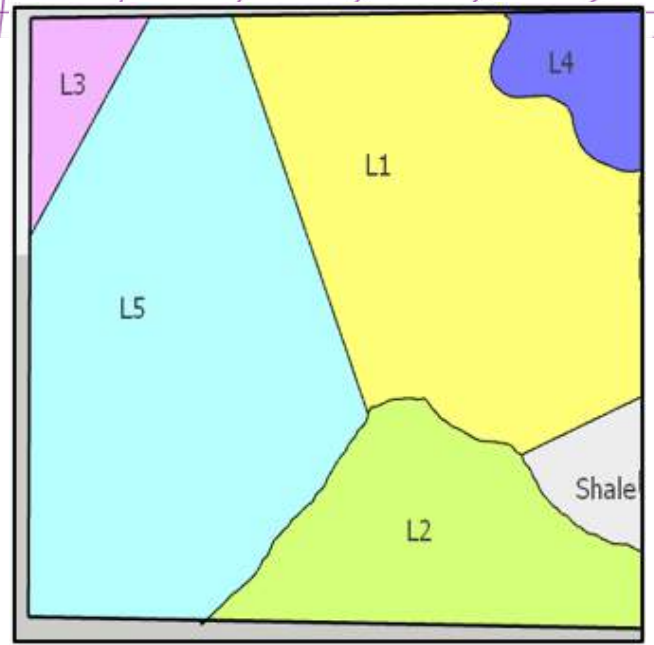


Figure 2c: Right Abutment

### 3. 2D RESISTIVITY PROFILE OF LEFT ABUTMENT

The area near the lower left of the profile (with resistivity values around 20–120 ohm-m) indicates a zone of low resistivity. This suggests the presence of water-saturated materials, which could correspond to a potential seepage path. The gradient and distribution of resistivity suggest that seepage could be occurring in this region, as water saturation would lower resistivity. The higher resistivity areas (yellow to red, with values exceeding 300 ohm-m)

indicate more resistive materials, such as dry soil, rock, or possibly intact dam material. These zones are less likely to be involved in seepage. The circular low-resistivity feature, especially near the bottom-left corner (20–120 ohm-m), seems to suggest a localized flow or seepage path, where water could be escaping from the dam structure or through a permeable layer. The resistivity gradient moving from low to high as we move further right and upwards may indicate a transition from water-saturated to dry or less permeable layers.



Figure 3: Main 2D Resistivity Profile of the Left abutment of Khanpur Dam

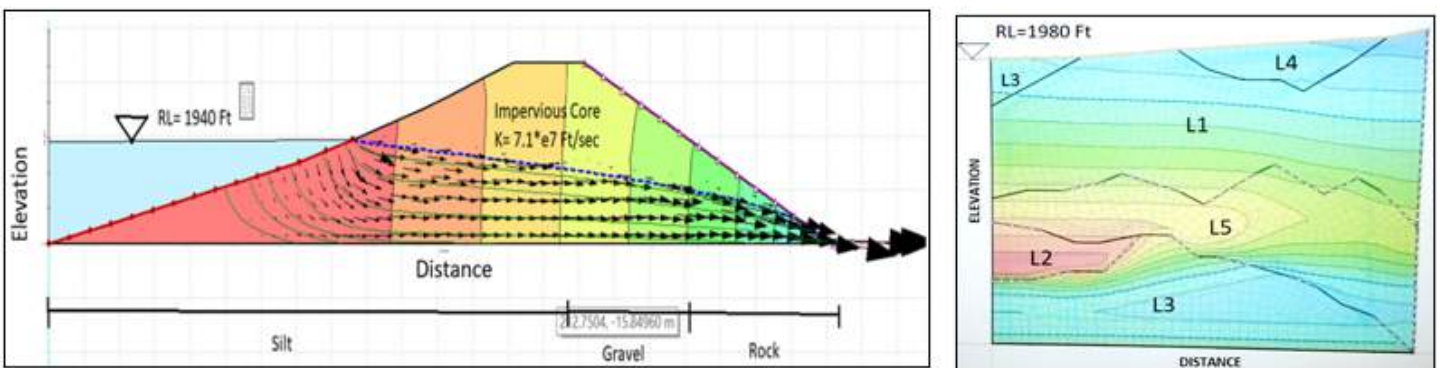


Figure 4: Seepage Analysis of the Khanpur Dam using Seep/W Software (a. Main Dam and b. Left Abutment)

## 5. COMPREHENSIVE MODEL

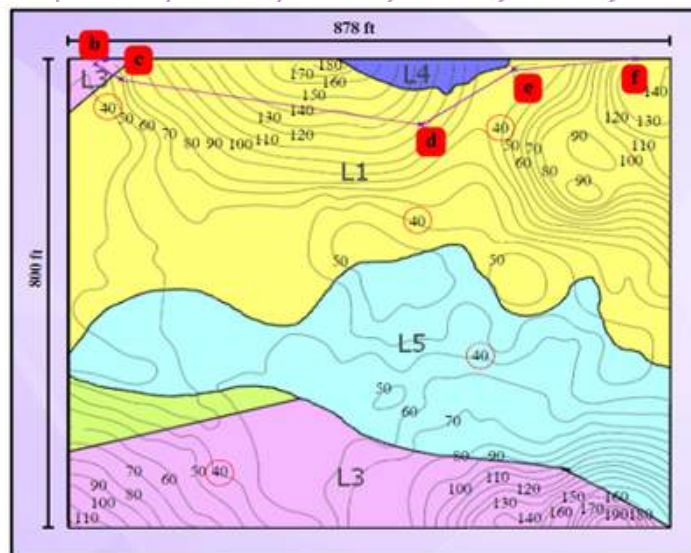
The final subsurface geological model, resistivity profile, and seepage models are integrated and analyzed to produce a comprehensive combined model as shown in Figure 5. The contours in the model indicate the resistivity and the line indicates the path where the survey was performed. The points b, c, d, e, and f indicate the exact survey location.

## CONCLUSION

The research effectively addresses seepage at Khanpur Dam by integrating 3D geological modeling, resistivity surveys, and laboratory testing. It was observed that limestone dissolution and joint orientation contribute to high seepage rates. The study's use of Seep/W modeling and comprehensive literature review offers practical recommendations for managing seepage, highlighting the importance of advanced techniques in geotechnical investigations.

## ACKNOWLEDGMENTS

The authors are thankful to the Water and Power Development Authority (WAPDA) for their logistic support in executing this study. The cooperation of Engr. Sohaib Abbasi (XEN Khanpur Dam) is particularly acknowledged. We are also thankful to the Department of



**Figure 5:** Comprehensive Seepage Model of Left Abutment of Khanpur Dam

Geological Engineering, UET Lahore for providing necessary funding and facilitation for successfully completion of this project.

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## GRID-FORMING INVERTERS: BRIDGING BETWEEN RENEWABLE ENERGY SOURCES AND STABILITY

By Sanaullah Baloch (2022msee21@student.uet.edu.pk)

### INTRODUCTION

Grid forming inverter (GFMI) is a new advanced power electronic device used to establish and regulate the frequency and voltage of the power system, establishing a crucial component for the power system, especially for the islanded microgrid. GFMI can be used in the electrical grid connected system or islanded microgrid with the high penetration of renewable energy sources (RES). They set the voltage and frequency as grid reference and provide virtual inertia to the system. As many of the new power grids are penetrated with a large amount of RES, these power grids lack the natural inertia which was provided by the synchronous generators. The lack of inertia can cause the drop of frequency to a level so there will be chances of power blackout [1]. However, the new control strategy of GFMI can balance the voltage, frequency, active power, reactive power and also can mimic the synchronous

generator. GFMI uses three types of control strategies like droop control, virtual inertia control and synchronverter control. GFMI is essential for a high level share of renewable energy and battery energy storage system, as they facilitate the smooth power sharing, allowing the power flow between grid connected and islanded mode, and enhance the frequency stability [2].

### OPERATING PRINCIPLES OF GFMI

GFMI works using control strategies to control real and reactive power flow and ensure proper control of the existing grid. They can provide essential grid services such as:

#### 1. ISLANDED MODE

- Voltage Regulation: GFMI can modulate output voltage to meet specific limits, making the power supply more credible.
- Frequency Control: By varying the active power demands, GFMI may be used in managing the frequency of the power grid, which is important for the systems used in electric circuits.
- Inertia Emulation: GFMI can reflect the inertial response of synchronous generators to mimic a low-pass filter and shield fluctuating load or supply.

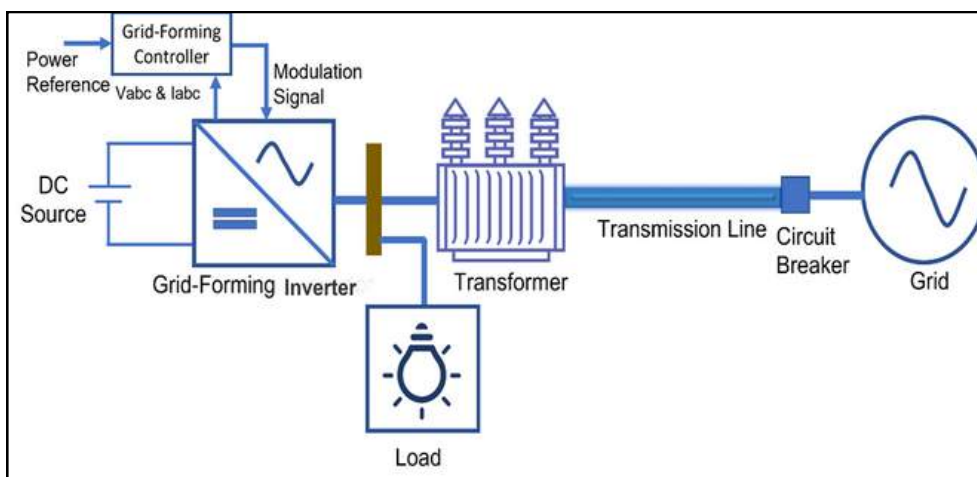


Figure.1 Grid Forming Inverter



- Power Sharing: Balance the power between the distributed energy sources (DES) and parallel inverters

## 2. GRID-CONNECTED MODE

Here grid forming is connected to the power grid and it will stabilize the overall grid system by providing or absorbing active power to/from the power grid to stabilize the frequency of system. So, it can also mimic the synchronous generator by providing virtual inertia to the system. Likewise, it also controls the voltage by providing/absorbing reactive power to/from the power grid.

## 3. TRANSIENT AND FAULT CONDITIONS

It can maintain the grid operation during any transient in the system (like frequency sag and voltage deviation). It protects the grid over the overcurrent while ensuring the grid stability. Provide fast response to the grid in case of any transient which can cause minimal disruption of frequency and voltage.

## 4. INTEGRATION OF RENEWABLE ENERGY SOURCES

As the renewable energy sources are not always providing constant power to the power system so there are chances of power variation in the power system. The GFMLs absorb or inject power from the battery energy source system to maintain the power fluctuation of the power system.

## FUTURE PROSPECTS

Grid-forming inverters may become more

common in the future as the demand for power system stability and resiliency grows. GFMLs are projected to play a significant role in energy markets.

AS the conventional energy sources will be reduced in future so the inertia reduction and power fluctuation will increase to a high level. There the solution of the aforementioned problem by GFMLs and battery energy storage system.

## CONCLUSION

Grid forming inverters offer a novel solution to the developing issues related with the integration of distributed power electronics. As research and development of modern electrical power systems continues, GFMLs are predicted to play an increasingly vital part in today's modern energy grid system, making it more stable, elastic, and sustainable. The transition to a cleaner energy future is no longer an option; with the proper backing of technologies such as GFMLs, it is becoming increasingly unavoidable.

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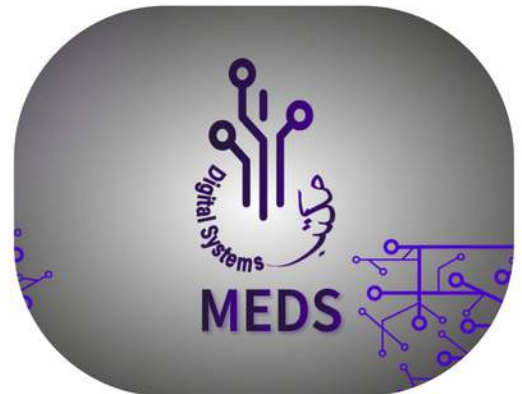
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# ELECTROMAGNETIC INTERFERENCE (EMI) IN MODERN POWER ELECTRONICS

By Sarah Rahman (2024msee31@student.uet.edu.pk)

## INTRODUCTION

Electromagnetic interference (EMI) is critical to ensuring the reliability of modern power electronics, particularly with the advent of wide band-gap (WBG) devices. These devices increase efficiency and compactness of power electronics converter but because of their sharper transitions and faster switching, they also introduce increased EMI, which makes design and international standard compliance difficult. Applications of power electronics, renewable energy, electric vehicles, and aerospace require effective EMI mitigation to avoid performance deterioration and failures.

With little academic emphasis, weak infrastructure, and negligible industry-based awareness, Pakistan falls behind developed nations in the education and research of EMI hence creating a substantial disconnect between theoretical understanding and practical abilities.

## CHALLENGES IN EMI EDUCATION AND RESEARCH IN PAKISTAN

In Pakistan most universities do not have EMI and power electronics courses, let alone state-of-the-art labs that are necessary for practical training. Although theoretical ideas are frequently covered in more general power electronics or electromagnetics courses, they rarely get the attention they demand. Students find it difficult to relate theoretical information to real-world applications when they are not exposed to EMI testing equipment or real-

world situations. However, University of Engineering and Technology (UET) is serving as a leader in introducing the EMI in Power electronics converters as a field and course. Through exercises designed to develop critical thinking and analytical abilities, the university provides students with a comprehensive knowledge in the core concepts in the mentioned domain.

However, the absence of cutting-edge testing facilities and practical laboratories severely restricts the educational process and students find it challenging to completely understand and use advanced EMI reduction strategies. Some of the commonly used terminologies include common-mode (CM) and differential-mode (DM) noise, line impedance stabilization networks (LISNs), EMI receivers, and impedance analyzers. However, the lack of practical instruction often limits students' understanding and application of these concepts.

Although it is a positive start to include EMI as a specialist field in the power electronics curriculum, integrating practical training backed by sufficient infrastructure is extremely necessary to close the gap between theoretical understanding and real-world application

## GLOBAL EXAMPLES OF EMI EDUCATION

Pakistan ought to seek inspiration from other countries that have successfully implemented EMI education through a combination of specialized academic programs and state-of-

the-art laboratories.

## **1. EUROPE: UNIVERSITY OF L'AQUILA, ITALY**

In Europe, the University of L'Aquila in Italy has emerged as a leader in EMI education. The university developed a comprehensive EMC course supported by a grant from the IEEE EMC Society [1]. The course combines rigorous theoretical training with hands-on experiments in cutting-edge facilities. Students participate in real-world EMI mitigation projects and learn to utilize advanced simulation tools based on the Partial Element Equivalent Circuit (PEEC) [1] method, providing a strong foundation in EMI control and design. Graduates from the program have excelled in telecommunications and defense sectors, particularly in the Abruzzi district.

## **2. ASIA: HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY, CHINA**

For Asia, Huazhong University of Science and Technology in China is a well-known institution for EMI education. The university established an advanced EMC program, focusing on both theoretical knowledge and real-world applications through university grant program [1]. Students perform detailed practical experiments using state-of-the-art spectrum analyzer, and calibrated antennas. The program also involves projects like designing power supplies that meet EMI standards, that will prepare graduates to deal with EMI challenges in industries including consumer electronics to power systems [1].

## **3. AMERICA: MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY, USA**

In the United States, the Missouri University of Science and Technology established significant partnership with Center for Electromagnetic Compatibility (CEMC) [2] to initiate EMI education. Utilizing the aid of state-of-the-art laboratories equipment [3] like as EMI receivers, spectrum analyzers and vector network analyzers [3]. A notable aspect is the integration of predictive modeling and simulation, into lab tasks, in which students design, test and verify EMI mitigation techniques to ensure they are prepared for job after graduation.

These universities have made progress through incorporating industry collaborations, investing in state-of-the-art laboratories, and optimizing

their curricula to meet real-world requirements.

## **BRIDGING THE GAP: LESSONS FOR PAKISTAN**

Pakistan can employ similar strategies to excel and compete with the rest of the world by developing a strong theoretical background, establishing partnerships with local and international businesses, equipping laboratories with state-of-the-art technology, and developing practical, hands-on training programs to bridge the knowledge gap.

## **INDUSTRY AND ACADEMIC COLLABORATION: A PATH FORWARD**

Pakistan's industries, particularly in the field of power electronics, renewable energy and telecommunication should start focusing on developing state-of-the-art products, and solutions. Such research work and developed solutions definitely need exposure of researchers to issues like electromagnetic compatibility, interference and compliance. Understanding of them is not only highly crucial but serves as a baseline to make/produce a product which can capture international audience. This necessitates highly skilled power electronics engineers, university-based curriculum and hands-on laboratory settings and arrangements thus enabling the country with professionals proficient in measurement, testing, and mitigating techniques.

In order to have this advancement, the first and foremost step can be taken by government of Pakistan. It can help create regulations, and mandate compliance of any electronics product with internationally accepted standards. This will lead to awareness amongst general consumers leading to demand of standard compliant solutions with detailed information about its safety, protection, performance, efficiency, and other operational indicators.

Public awareness will push the industries and academia to sit together on a table and decide upcoming streams of education, courses to be launched and laboratories to be developed. Having initiated this, the faculty can develop laboratories with required tools which can be procured with the financial support of the industries involved. At the beginning, components, tools and equipment can be borrowed/exchanged or rented to develop

baseline education and training; later-on resulting in procurement of more expensive, but sophisticated and sensitive equipment. The process will also develop competition amongst students, industries and different universities hence resulting in improved overall culture and demand.

## **GOVT'S ROLE AND FUTURE ADVANCEMENT**

Government can also take some financial initiatives by sponsoring and financing a couple of state-of-the-art laboratories across a few large cities of the country, which can help organize trainings, seminars, awareness campaigns, and thus will pave the path for future research grants and high-quality research. A far future product of this initiative will be Pakistan's engineer's being fully

equipped with EMI related tools and techniques, design of EMI compliant products which can make our economy sky-rocket by delivering electronics-based products to the local as well as international market. Pakistan can eventually become leader of the region in terms of EMI and EMC knowledge.

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# Super Earth GEL Powder

Ground Enhancement Material (GEM)

الیکٹریکل ارتھ کا بہترین کیمیکل



## **SEMINAR ON: SUSTAINABLE DEVELOPMENT GOALS, GENDER AND WELL-BEING: CREATING SAFER WORKPLACES**

Celebrating anti-bullying week - 2024, Dr. Mehvish Riaz, Chairperson, Department of Humanities, Social Sciences and Modern Languages, conducted a seminar titled, 'Sustainable Development Goals, Gender and Well-being: Creating Safer Workplaces' for the undergraduate students at the Department of Electrical Engineering, UET Lahore. She shared how the Sustainable Development Goals (SDGs), which address issues including poverty, inequality, climate change, and injustice, are the roadmap for achieving a better and more sustainable future for all. She emphasized the importance of community service, volunteering, innovation, and prevention as measures to achieve sustainable development goals. In addition, she emphasized how measures against bullying and harassment at workplaces are crucial to enhance productivity. She asserted that in order to create psychologically safer workplaces, administrators and employees must receive a mandatory training in human rights and workplace well-being. In addition to screening their documentaries related to SDGs and well-being, students performed a few activities and shared their experiences and solutions.

Dr. Mehvish Riaz is an Associate Professor and the Chairperson of the Department of Humanities, Social Sciences, and Modern Languages at UET, Lahore.  
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# INDEPENDENT POWER PRODUCERS (IPPS): A STRANGLEHOLD OR AN OPPORTUNITY TO SALVAGE THE POWER SECTOR

By Muhammad Muneeb Ud Din (muhammad.muneeb@ntdc.com.pk)

## ABSTRACT

In the early 1990s, government was facing severe issue to meet the growing electricity demand. In response to these challenges, Power Generation Policy of 1994 was introduced which encouraged private sector investment in power generation. As it was open for both local and international investors, policy offered attractive guarantee against electricity bills and currency fluctuations to attract foreign investment. Large number of companies established in Pakistan till 2000s. In effect, the shortage of electricity supply was overcome but high power tariff emerged as new challenge to government. In last few year Pakistan is paying more attention to energy mix, integrating alternative sources of energy that are more ecofriendly. However, IPPs still play significant role in power sector infrastructure development and also causing expansion of circular debt. Consumers now a days shifted to their independent electricity generation using cheap solar technology available in market. Due to reduced demand on national grid, the surplus generation with capacity payments are causing overburden on basket value of tariff. Power Purchase Agreement need to be revised and special package should be introduced for consumers to uplift the consumption from grid and in result helping to compress the volume of circular debt.

## HISTORICAL BACKGROUND

In the early years of Pakistan, the power sector

was a state-owned enterprise and dependent entirely on WAPDA. WAPDA is vertically integrated organization established in 1958 which is responsible for efficient and sustainable management of water and power resources in Pakistan. Hydro power generation was main source of electrical energy at that time. During 1970s, Pakistan had decided nationalization of all power generations in country and as a result government took control of all private electricity generation plants, and the energy sector become integrated under public-sector monopolies. WAPDA was sole responsible for managing all electricity generation, transmission, and distribution in the country.

## IPPS

The term IPP in Pakistan refers to “Independent Power Producers”. These are privately owned entities that generate electricity and sell it to the national grid or directly to large consumers. The concept of IPPs was introduced in Pakistan in the early 1990s to address the country's growing energy deficit and to attract private investment in the power sector. IPPs play a significant role in the country's electricity generation, especially since Pakistan has faced chronic energy shortages. They enhance the electricity supply by generating power through sources like thermal, hydropower, and renewable sources. Following are types of IPPs

- Thermal IPPs: Generate electricity primarily using fossil fuels such as oil, coal, or gas.



- Hydroelectric IPPs: Small to medium-sized hydroelectric plants.
- Renewable IPPs: Solar, wind, and other renewable sources.

While IPPs have helped alleviate some of the energy shortfall, issues like fuel price volatility, inefficiencies in distribution, and financial instability in the power sector remain ongoing challenges. In recent years, the government has been trying to make balance between investment of private sector through IPPs and manage issues related to operation and maintenance of IPPs that have plagued the power sector.

## POWER POLICIES

The 1990s decade has significant importance in shifting Pakistan's power sector in new direction with the introduction of Independent Power Producers (IPPs). Government was facing energy shortages in that era where authorities recognized the need for private/foreign investment in the power sector. The IPP Policy of 1994 was introduced to attract private sector involvement in power generation. Under this policy, private companies were allowed to set up power plants doing long-term contracts with the government. In Power Policy 1995, a framework for IPPs was set up by offering attractive terms and conditions such as guaranteed purchase agreements and foreign exchange protection to IPPs. Many private-sector power plants were set up under this policy which significantly increased the generation capacity of Pakistan. Consequently, circular debt began to emerge because of high power tariff provided by government to IPPs. Government faced criticism for providing such tariff which were seen as financially unsustainable because as the government struggled with paying IPPs.

Then 2002 Power Policy was introduced which focused on privatization, deregulation, and reform of the energy sector. Government started privatization of various state-owned power assets, including distribution companies (DISCOs) and WAPDA's assets. These assets were split into separate entities for generation, transmission, and distribution. This policy included provisions for Public-Private Partnerships (PPP) in power sector encouraging the establishment of new power projects, particularly those based on natural gas, oil, and coal. NEPRA (National Electric Power

Regulatory Authority) was given more power to regulate tariffs and monitor performance.

The Energy Policy of 2013 was developed to address the country's worsening energy crisis, improving efficiency, and increasing energy access. The policy targeting sectoral reforms, recognized the importance of the energy mix and committed to develop renewable energy sources. A target of 5% by 2015 and aimed for 10% by 2025 was set for renewables portion.

Supply-demand mismatches, circular debt, and inefficiencies in the sector were persistent issues faced by government. The National Electricity Policy 2021 was made to bring long-term structural reforms to the power sector. This policy escalated the target to 30% for electricity generation from renewable sources by 2030. In addition to focusing on subsidies for lower-income consumers, it brought attention to the problem of tariff modifications that should reflect the true production cost.

The future of Pakistan's power sector will depend on successfully implementing these reforms, expanding renewable energy sources, addressing circular debt, and improving energy efficiency across the board.

## ISSUES/BOTTLENECKS

With the passage of time, electricity demand continued to grow with the growth of country's population. However, inefficiencies in the state-run system began to emerge, leading to higher costs, lower performance, and a lack of investment in new infrastructure. After the failure of nationalization policies, Pakistan began to recognize the need for private sector involvement to improve efficiency in power generation and distribution. However, the power sector continued to be largely controlled by state-owned entities like WAPDA. Pakistan continued to rely on thermal power generation (oil and gas) and began importing natural gas to fuel thermal plants. Following issues are highlighted

- **Circular Debt Crisis:** Circular debt refers to the growing debt when distribution companies do not have enough revenue to pay for the electricity they buy from IPPs and end up defaulting on payments, which creates a cycle of debt.
- **High Electricity Tariffs and Subsidies:** IPPs, particularly thermal ones, have been contracted at high power purchase prices leading to concerns about their impact on

- the consumer. These tariffs are often subsidized by the government, but the subsidies are unsustainable and put pressure on the country's finances. High power tariffs have led to electricity bills that are unaffordable for a significant portion of the population, which worsens the poverty situation and causes social unrest.
- **Fuel Dependency and Price Volatility:** The volatility in global fuel prices has a direct impact on the cost of electricity. When global oil and gas prices spike, electricity production costs rise, which can lead to higher tariffs for consumers and a heavier burden on the government. The cost of importing fuel for power generation is also a major financial burden for the country.
- **Inefficiencies in Power Distribution and Transmission:** The losses, both technical and non-technical (e.g., theft), increase the cost of electricity and lead to a situation where consumers often experience power outages.
- **Poor Infrastructure:** The outdated and inefficient transmission network is unable to handle the growing demand for electricity.
- **Political Influence on Power Sector Decisions:** Inconsistent policy decisions, delayed reforms, and disputes over contract terms undermine investor confidence and complicate long-term planning.
- **Environmental and Social Issues:** Thermal plants contribute to air pollution and greenhouse gas emissions, which add to the environmental challenges in the country.
- **Underutilization of Renewable Energy:** The focus of IPPs has historically been on thermal power due to the higher and more predictable returns while Pakistan has significant potential for solar, wind, and hydropower energy and private investment in renewable sector has been limited.
- **Lack of Transparency:** Negotiations between the government and IPPs are opaque, which results in contracts that are unaccountable for and encourages corruption and erodes public confidence.
- **Inadequate Long-Term Planning/Mismatch between Demand and Supply:** While renewable energy sources have not been fully established,
  - overcapacity has been created as an effect of excessive investment in thermal resources.
  - **Domestic Solarization:** In past few years, huge number of domestic consumers shifted towards their independent electricity generation by installing PV modules. The average annual growth rate for electricity demand reduced from 5.4% to 4% causing surplus installed capacity.

## WAY FORWARD

IPP-related issues in Pakistan necessitate a thorough, multifaceted strategy that addresses the operational and structural difficulties faced by power industry. The following are some crucial measures that might improve IPP operations and the energy industry overall:

- **Review Power Purchase Agreements (PPAs):** The government should engage in a comprehensive review of existing PPAs with IPPs to ensure that they reflect realistic costs and market conditions. In some cases, renegotiation of these agreements could help reduce tariffs, especially in high-cost thermal plants.
- **Industrial Supportive Package:** The government should encourage industrial load by offering special packages/discounts that can motivate local industry to consume more energy.
- **Improving Payment Mechanisms:** The government must work to streamline payments from distribution companies (DISCOs) to IPPs.
- **Debt Restructuring:** A comprehensive restructuring of the circular debt could be considered, where the government takes on a portion of the outstanding debt and restructures the remaining amount to be repaid over a longer period. This could be coupled with efforts to reduce new debt accumulation.
- **Reducing Power Losses:** Improving the collection efficiency of DISCOs, and reducing technical and non-technical losses (e.g., electricity theft), can ensure that revenues are collected and more funds are available to pay IPPs. This could be improved by better metering systems and stricter enforcement against theft like adopting smart meters, advanced metering infrastructure (AMI), and improving billing accuracy resulting in enhanced revenue

- collection.
- **Implement Cost-Reflective Tariffs:** Over time, the government should work toward eliminating blanket subsidies and moving toward cost-reflective tariffs, where the price of electricity better matches the cost of generation. This could lead to more efficient energy consumption and encourage investments in cheaper, renewable energy sources.
- **Modernizing the Power Sector:** Implementing smart grid systems can enable real-time monitoring of electricity supply and demand, improve system reliability, and enhance load management. It also helps in better integration of renewable energy and provides advanced solutions to reduce technical losses.
- **Decentralized Power Generation:** Encourage decentralized or distributed generation systems, to reduce pressure on the national grid and lower transmission losses.
- **Regulatory and Institutional Reforms:** To better regulate the electricity industry, NEPRA should be given more authority. This would allow it to supervise tariff setting, guarantee adherence to environmental laws, and mediate conflicts between IPPs and the government. It would also be helpful to approve power purchase agreements with more transparency.
- **Public-Private Partnership (PPP) Models:** Develop public-private partnership (PPP) models to encourage private investment in power generation, particularly for renewable energy projects. These models could offer risk-sharing mechanisms and long-term guarantees that provide both financial security for investors and affordable electricity for consumers.
- **Carbon Trading:** Explore more carbon credit mechanisms in which IPPs are using greener technologies. It could provide financial incentives for clean power generation.
- **Promote Demand-Side Management/Peak Shaving:** Implement demand-side management (DSM) programs in which consumers are encouraged to lower their electricity usage during peak hours. This will help to balance supply and demand without additional capacity required only for small duration.

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# PODCAST;

## TUNE IN; SPEAK OUT! POWER OF PODCASTS

By Sadia Gondal (sadiagondal@uet.edu.pk)

The world speaks English, and now more than ever, effective communication is key to unlocking opportunities. But how do you bridge the gap between textbook knowledge and fluent conversation? The answer is in your pocket – or, more accurately, in your earbuds. Podcasts offer a dynamic and engaging way to dramatically improve your spoken English competency. Unlike traditional language learning methods, podcasts provide accessible exposure to authentic spoken language. You'll hear speakers conversing naturally so that you are well-prepared for real-world interactions. This constant exposure helps you to understand and use language comfortably with natural flow.

### WHY PODCASTS WORK WONDERS

Podcasts are a rich source of authentic language input for developing comprehension and fluency. Unlike scripted dialogues, podcasts capture spontaneity and nuances of real conversations. Podcasts encourage active listening skills with auditory cues and context to understand the message. This focused listening sharpens listeners' ability to process spoken English in real-time. Whether you're interested in business, technology, culture, or storytelling, there's a podcast for you. This allows you to learn vocabulary and expressions relevant to your interests, making the learning process more enjoyable and effective. Learn on your commute, while exercising, or even while doing chores. Podcasts add continuous and effective language practice to your daily routine without any hassle.

Research consistently demonstrates the positive impact of listening to podcasts on language building skills. Field (2008) argues that increased exposure to a variety of spoken English through media, including podcasts, significantly enhances listening comprehension, a foundational skill for spoken fluency. Learners develop a better understanding of different accents, speech rhythms, and colloquialisms, preparing them for diverse communication situations. Vandergrift (2007) highlights the importance of metacognitive strategies in listening comprehension, emphasizing that podcasts allow learners to develop self-regulatory skills like planning, monitoring, and evaluating their understanding. Listeners can pause, rewind, and relisten, enabling them to actively engage with the content and deepen their comprehension. Chang and Read (2006) found that learners who regularly listened to audio materials, such as podcasts, demonstrated significant improvements in pronunciation, particularly in areas like intonation and stress patterns. Exposure to native speakers' voices helped learners internalize accurate pronunciation models, leading to more natural and intelligible speech. Lin and Compton (2015) explored the use of podcasts for developing oral fluency and found that learners who utilized podcasts for shadowing (repeating after the speaker) and summarizing activities exhibited noticeable improvements in their speaking fluency and accuracy. This active engagement with the audio content facilitated a deeper level of language processing and production.

### TURNING PODCASTS INTO POWER TOOLS

Don't just passively listen!

Maximize your learning by:

- Shadowing: Repeat phrases and sentences aloud to copy speaker's pronunciation and intonation.
- Summarizing: After each segment, try to summarize what you've heard in your own words.
- Vocabulary Building: Keep a notebook handy to jot down new words and phrases.
- Discussion: Talk about what you've learned with a friend or language partner.

## PODCAST RECOMMENDATIONS

- Voice of America - Learning English: (<https://learningenglish.voanews.com/>) Offers news and features at a slower pace with clear pronunciation.
- The English We Speak (BBC): (<https://www.bbc.co.uk/programmes/p02pc9zn/episodes/downloads>) Short episodes explaining common idioms and phrases.
- TED Talks Daily: (<https://www.ted.com/podcasts>) Inspiring talks on various subjects from experts worldwide.

## CONCLUSION

In today's world, the ability to communicate confidently in English is a valuable asset. So, tune in, immerse yourself in podcasts, and watch your communication skills soar. The world is waiting to hear what you have to say.

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## **BIM-DRIVEN INNOVATION IN CONSTRUCTION: ENHANCING SCHEDULING, COST-CONTROL, SUSTAINABILITY AND COLLABORATION**

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### **ABSTRACT**

This article reviews the revolutionary effects of Building Information Modeling (BIM) and its combination with artificial intelligence (AI) in contemporary buildings construction. It emphasizes for improved scheduling, cost management, and stakeholder cooperation in real-time, using 4D and 5D BIM software. Improved project visualization, clash detection, and simpler procedures that increase productivity and reduce delays are some of the main advantages. Additionally, the combination of BIM and Life Cycle Assessments (LCA) encourages sustainable building by reducing environmental effects and maximizing energy efficiency. Issues like skill gaps and data interoperability are discussed, highlighting how the synergy between BIM and AI can potentially transform project management and promote environmentally responsible construction practices.

### **BIM UTILIZATION FOR SCHEDULING AND COST CONTROL**

Building Information Modeling (BIM) transforms conventional building construction procedures by improving project scheduling and cost estimation. It facilitates effective resource planning and budget management by allowing the integration of 3D models with time and cost data.

BIM enhances project scheduling and cost estimation, improving efficiency in managing time and financial resources [1]. 4D BIM integrates time into the 3D BIM model, enabling construction sequencing and scheduling visualization. It helps plan, detect clashes, and simulate construction progress over time, improving efficiency and reducing delays. 5D BIM integrates cost data with 3D and 4D models, providing dynamic cost estimation and management tools. It emphasizes cost visualization, real-time budget adjustments, and precise financial planning throughout the construction lifecycle [2].

Through 4D and 5D BIM, construction projects benefit from enhanced timelines, effective cost management, and reduced delays, ensuring successful project delivery and financial control.

### **ENHANCED COLLABORATION AMONG STAKEHOLDERS**

BIM enhances collaboration by centralizing data and offering shared digital models. This approach advances communication, minimizes misunderstandings, and aligns all participants, including architects, engineers, and contractors, toward shared project objectives.

4D and 5D BIM are used to streamline the entire project lifecycle, from planning to execution. It helps in real-time progress tracking, cost control, and efficient resource

management, driving better coordination among stakeholders [2]. BIM facilitates seamless collaboration among architects, engineers, and stakeholders, improving decision-making and detecting design errors early in complex construction projects [3]. BIM facilitates real-time collaboration and centralized information sharing among architects, engineers, contractors, and other stakeholders. This improves decision-making, reduces misunderstandings, and minimizes project conflicts for better outcomes. Through shared digital models, BIM improves communication and coordination between construction players, leading to better decision-making and streamlined project workflows [4]. By improving workflows and facilitating real-time information sharing, BIM enhances coordination, reduces errors, and supports more integrated project execution.

### **INTEGRATING BIM AND AI FOR SMART CONSTRUCTION COST MANAGEMENT**

The combination of BIM and AI provides smart cost management solutions by utilizing predictive analytics, optimizing materials, and allowing real-time cost tracking to improve budget efficiency and reduce risks.

BIM and AI integration improves cost estimation, budgeting, and real-time cost tracking. By using AI for predictive cost analysis, material optimization, and labor allocation, cost efficiency can improve throughout the project lifecycle. AI uses past cost data from BIM to accurately estimate materials, labor, and equipment costs. This improves budget planning and helps avoid financial risks [5].

BIM and AI collaboration enhances construction projects through improved budgeting, resource efficiency, and cost-effective decision-making throughout the project lifecycle.

### **CHALLENGES AND OPPORTUNITIES IN PROJECT MANAGEMENT THROUGH BIM-AI INTEGRATION**

While BIM-AI integration offers significant advantages, it also encounters challenges such as data interoperability and the necessity for professionals to upskill. Tackling these challenges is crucial for realizing the full potential of this technology.

BIM and AI address project management issues

including resource allocation, real-time decision-making, and stakeholder communication. It also identifies challenges like data interoperability and skill gaps while proposing solutions like standardized frameworks and enhanced collaboration [5]. AI technologies, such as machine learning and deep learning, are useful for handling large amounts of data. They help make better decisions, increase efficiency, improve safety, and support sustainable construction practices [6].

By addressing these challenges, BIM-AI integration can transform project management, providing greater efficiency, better decision-making, and more sustainable construction practices.

### **THE ROLE OF BIM IN ENVIRONMENTAL LIFE CYCLE ASSESSMENTS: ADVANCING SUSTAINABLE PRACTICES IN CONSTRUCTION**

BIM integrates with Life Cycle Assessment (LCA) tools to assess the environmental impacts of materials and processes, leading to more eco-friendly construction practices.

BIM integrates with LCA tools to evaluate the environmental impacts of materials and processes, streamlining sustainable construction practices and reducing carbon footprints [3].

BIM, in synergy with LCA, fosters data-driven sustainability strategies, minimizing carbon footprints and encouraging environmentally friendly construction solutions.

### **BIM AS A TOOL FOR ENHANCING SUSTAINABLE CONSTRUCTION**

BIM enhances sustainability by optimizing material use, reducing waste, and integrating green technologies throughout the building lifecycle.

BIM facilitates the integration of sustainable practices throughout the entire lifecycle of a building, from planning to demolition. Incorporating green technologies and efficient maintenance strategies leads to long-term cost savings and significant environmental benefits [7]. BIM enhances sustainable construction by optimizing material use, reducing waste, and enabling comprehensive lifecycle assessments. These processes help minimize environmental impact and promote eco-friendly building

practices [7].

BIM fosters long-term environmental and economic advantages in construction projects by encouraging resource-efficient designs and maintenance practices.

## **APPLICATIONS OF BIM FOR ENERGY EFFICIENCY IN HIGH-RISE BUILDING DESIGN**

BIM optimizes energy performance by analyzing building designs and operational parameters, which contributes to sustainable high-rise developments.

By examining important elements including building envelope designs, ventilation systems, and occupant behaviors, BIM improves energy performance. It makes it possible to choose components and arrangements that enhance insulation and reduce energy loss via the building envelope. By optimizing airflow distribution for ventilation, BIM preserves indoor air quality while lowering dependency on energy-intensive HVAC systems. It also incorporates smart systems that adapt in real time, reduces waste, and model occupant consumption patterns to forecast energy demands. BIM guarantees that high-rise buildings are both ecologically friendly and energy-efficient by coordinating design, systems, and user behavior [3].

BIM guarantees that high-rise structures are economical and ecologically conscious by integrating energy-efficient solutions.

## **IMPROVED PROJECT VISUALIZATION AND SIMULATION**

With the help of BIM's advanced 3D modeling and simulation features, stakeholders can see designs and construction timelines and see possible problems early.

With the help of BIM's advanced 3D modeling and simulation tools, stakeholders can efficiently plan construction sequences and visualize designs. These features lessen mistakes and delays by assisting in the early detection of design conflicts. BIM facilitates decision-making and collaboration by bringing stakeholders together with a common understanding of the project. Additionally, it streamlines the construction process by optimizing operations. In the end, BIM guarantees improved project results and increased productivity [3].

By decreasing errors, enhancing workflows, and

encouraging well-informed decision-making, these tools expedite project execution.

## **CLASH DETECTION AND ERROR REDUCTION**

By identifying any design conflicts before construction starts, BIM's clash detection features can save time and money.

By modeling and evaluating project models before construction, BIM enables the early identification of design disputes. By being proactive, mistakes that can result in expensive rework or delays during the building process are reduced. BIM guarantees a more efficient construction process by addressing conflicts beforehand, which lowers interruptions and boosts productivity. By upholding greater standards of accuracy and cooperation throughout the project, it also improves quality management [4].

BIM guarantees better overall results and more seamless project implementation by lowering errors and improving quality control.

## **CONCLUSION**

In conclusion, the construction industry is evolving due to the integration of Building Information Modeling (BIM) with advanced technologies such as artificial intelligence (AI). These innovations enhance scheduling, cost control, collaboration, and sustainability. By utilizing 4D and 5D BIM, projects benefit from better resource allocation, reduced errors, and increased efficiency. Additionally, techniques like energy optimization and life cycle assessments demonstrate how BIM can promote environmentally friendly practices and address current challenges in construction. By bridging skill gaps and overcoming interoperability issues, BIM paves the way for smarter, more sustainable, and resilient infrastructure development. This opens the door to a future in construction characterized by efficiency and innovation.

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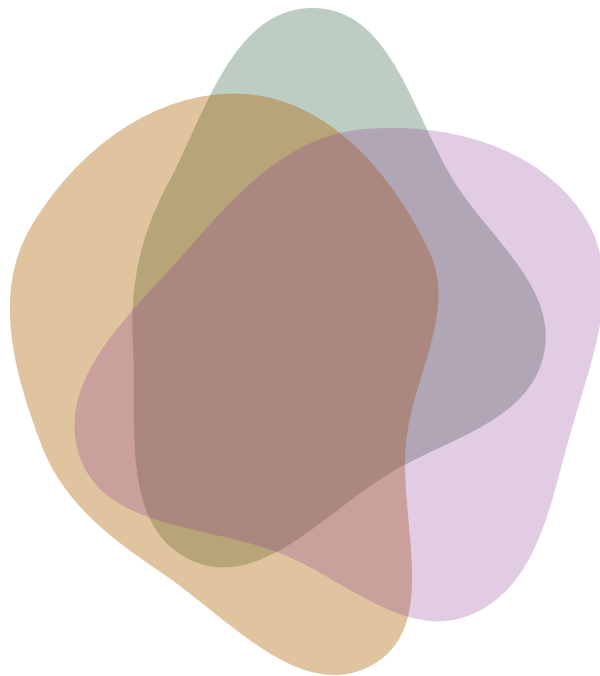
سُورَةُ الْمَعَارِجِ  
بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

سَأَلَ سَائِلٌ بِعَذَابٍ وَاقِعٍ ﴿١﴾ لِلْكَافِرِينَ لَيْسَ لَهُ دَافِعٌ ﴿٢﴾ مِّنَ اللَّهِ ذِي الْمَعَارِجِ ﴿٣﴾ تَعْرُجُ الْمَلَائِكَةُ وَالرُّوحُ إِلَيْهِ فِي يَوْمٍ كَانَ  
مِقْدَارُهُ خَمْسِينَ أَلْفَ سَنَةٍ ﴿٤﴾ فَاصْبِرْ صَبْرًا جَمِيلًا ﴿٥﴾ إِنَّهُمْ  
يَرَوْنَهُ بَعِيدًا ﴿٦﴾ وَنَرَاهُ قَرِيبًا ﴿٧﴾

A challenger has demanded a punishment bound to come for the disbelievers—to be averted by none—from Allah, Lord of pathways of 'heavenly' ascent, 'through which' the angels and the 'holy' spirit<sup>1</sup> will ascend to Him on a Day fifty thousand years in length. So endure 'this denial, O Prophet,' with beautiful patience. They truly see this 'Day' as impossible, but We see it as inevitable.

Al-Quran[70: 1-7]





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