ALMOHANDIS

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BAHRAIN SOCIETY OF ENGINEERS

A Journey with Engineer Asma Murad:

"The Bahrain Society of Engineers plays a vital role in supporting newly graduated engineers by offering valuable guidance, both in their training and throughout their professional careers."

Phase 1: Street Lighting Retrofit Project using LED Luminaires with Smart Control & Monitoring System.

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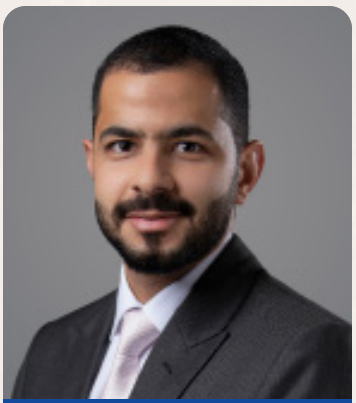

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In this Issue

A Journey with an Engineer

8

Engineer Asma Murad:

"The Bahrain Society of Engineers plays a vital role in supporting newly graduated engineers by offering valuable guidance, both in their training and throughout their professional careers."

Profile

20

Phase 1: Street Lighting Retrofit Project using LED Luminaires with Smart Control & Monitoring System

Articles

Artificial Intelligence and Electrical Engineering: A Revolution in Efficiency and Innovation

Eng. Yosif Al Moamen

Understanding Prime Cost Contracts, PC Rates, and Provisional Sums in Construction

Eng. Hasan Al Zabeel

BSE Youth

Eng. Hamad Ibrahim Badaw

Portrait

Eng. Ali Hasab Lari

Portrait

Students Projects

A single-phase smart distribution board

Induction Motor Noise Analysis with Fault Detection

Design of a Soft Starter for DC Motors" investigates the performance of one method in starting DC motors

Dr. Isa Qamber
Editor-in-Chief

The Bahrain Society of Engineers, while acknowledging the achievements of engineers who have worked on engineering projects in the Kingdom of Bahrain over the years, also pays attention to the activities of young engineers in their workplaces. In this issue, we highlight two young members of the association who have worked in their respective fields, which will be discussed further in the current issue.

This edition features an interview with Engineer Asma Murad, who was appointed Assistant Undersecretary for Sanitation at the Ministry of Works, Municipalities, and Urban Planning in 2016, following a Royal Decree. Her engineering career began as a trainee engineer in 1981 in the Operation and Maintenance Department of the Bahrain Sewerage Project. Notably, Engineer Asma started her engineering journey after graduating from Kuwait University by joining the Ministry of Works, Electricity, and Water. In 1991, Engineer Asma was appointed head of the Engineering Services Department, which specialized in the design and implementation of sanitation systems and surface water management, including electronic data management. In 2004, she transitioned to the private sector but returned to the government sector in 2011 at the request of the Minister of Works, Engineer Issam bin Abdullah Khalaf, to manage planning and sanitation projects. She also has notable achievements in volunteer work through her involvement with the Maternal and Child Care Society. As a member of the editorial board of the Almohandis magazine, and as a member of the Photographers Club at the Fine Arts Society.

The present issue of Almohandis magazine highlights the Electricity and Water Authority's project on street lighting upgrades, focusing on the first phase of the LED street lighting and control system project. The current street lighting network in the Kingdom of Bahrain includes over 150,000 lighting units, including those mounted on poles or walls, connected to more than 3,000 power supply points. The authority is committed to improving the efficiency and sustainability of the street lighting network through its strategy to enhance the quality and reliability of street lighting services. The issue-file discusses the project's key goals, planning stages, implementation, and closure. The project paves the way towards achieving the smart city concept in Bahrain with smart lighting. This means that smart streetlights could be a key component in creating a smart city infrastructure according to international standards and electricity distribution management specifications.

Engineering development encompasses all aspects of life. This initiative aligns with the Bahraini Government's focus, under the leadership of His Royal Highness Prince Salman bin Hamad Al Khalifa, the Crown Prince and Prime Minister, to maximize the use of artificial intelligence programs to enhance sustainable development across various sectors. Therefore, the AI-based urban change detection system was discussed in an introductory seminar organized by the Survey and Land Registration Bureau and the Ministry of Municipalities and Agriculture at the Bahrain Society of Engineers. The seminar was attended by several real estate sector officials, professional associations, and representatives from relevant institutions in both the public and private sectors. The presentation covered an overview of the project, types of observed changes, data used in the system, as well as the system's operation, applications, and beneficiaries. AI-based detection of changes enhances transparency, increases inspection efficiency, and saves effort, time, and costs.

The achievements of chemical engineering over the past century are highlighted in this issue through an article by Dr. Hosni Al-Zubair, a faculty member at the College of Engineering at the University of Bahrain. In this article, Dr. Al-Zubair sheds light on future prospects for chemical engineering achievements. The author

begins by defining the field of chemical engineering and discusses the importance for chemical engineers to plan and strategize industrial processes, maintain a safe environment, conserve energy, and support expanding economies. The author also reviews the growth of petrochemical derivatives during the 1990s and concludes with the achievements of chemical engineers over the past decade, offering hope for future advancements.

Engineer Ibrahim Al-Burshaid discusses the urban change detection system as a pioneering step towards digital transformation in Bahrain. According to Bahrain Economic Vision 2030, the AI-based system for detecting changes and building violations, launched by the Survey and Land Registration Bureau, is considered a groundbreaking initiative. The vast amount of data provided by government platforms and the urban change detection system allows AI to predict future needs of urban areas. This system boosts confidence among local and international investors and supports the national economy to achieve an ambitious vision for a more sustainable and prosperous digital future in the Kingdom.

Engineer Yusuf Al-Muomin discusses artificial intelligence and electrical engineering in this issue. The surge in artificial intelligence is noticeable, and the author highlights its role as a tool reshaping various industries. To improve performance and efficiency, it is essential to integrate electrical systems with AI technologies. The goal of the author's discussion is to use AI for analysis and predicting failures before they occur, which helps in improving the reliability of electrical systems.

The English section of this issue also covers complex construction topics by Engineer Hassan Al-Zubail. The author discusses preliminary cost contracts and actual cost contracts for construction. He addresses provisional sums, which are amounts allocated in the bill of quantities during the pre-contract stage for work that the employer is unsure of will be executed. The author also mentions new measurement rules that need to be considered in relation to provisional sums.

As mentioned at the beginning of this speech, the BSE does not overlook young engineers in their workplaces. It initially featured engineers Hamad Ibrahim Badoo and Ali Hassan Lari. Engineer Hamad Badoo works as the Director of Road Projects and Maintenance at the Ministry of Works, while Engineer Ali Lari is the Executive Director of the Hassan Lari Group.

In this issue's updates, Engineer Abdul Amir Al-Mulla addresses engineers with a poem he authored, highlighting their passion for engineering. To develop themselves, they attend conferences and specialized workshops, with some specialties mentioned in his poem. He also sheds light on what our society aims to provide for its members.

Three projects carried out by the students in the College of Engineering of University of Bahrain and supervised by the academic staff. The first project presents the design and implementation of a single-phase smart distribution board that leverages the capabilities of an Arduino. The Arduino module serves as the central processing unit of the smart distribution board, controlling the operation of the board and facilitating communication with the Arduino Internet of Things cloud. The project's outcome is expected to contribute significantly to the ongoing evolution of distribution boards and set a new standard for residential power distribution systems. The second project is entitled "Induction Motor Noise Analysis with Fault Detection". This project deals with noise which can be the result of two main factors: electrical and mechanical. The project aims to locate electrical motor flaws and therefore solve the noise the motor generates. In addition, the measurements of the current transformer are considered in two different modes (forward and reverse) for each of the three phases. The whole project was dependent on analyzing the data taken from the experimental tests. The Design of a Soft Starter for DC Motors is the third project that investigates the performance of one method in starting DC motors. The project explores one of the most precise and cost-effective techniques for controlling the level of armature current by utilizing the H-bridge circuitry between the armature circuit and the supply voltage. The method will regulate the inrush current, leading to a soft start of the motor in the right and safe manner.

Engineer Asma Murad:

"The Bahrain Society of Engineers plays a vital role in supporting newly graduated engineers by offering valuable guidance, both in their training and throughout their professional careers."

Interviewed and prepared for publication by: Husain Ismail

In this issue of "Al-Muhandis" magazine, we interview a personality of high engineering standing, who excelled in her schools and was sent to study in Beirut, then to Baghdad, then to Basra, to settle in the College of Engineering at Kuwait University, then return and join the engineering sector and start the career ladder, climbing it with her diligence and giving, step by step, to assume the position of Assistant Undersecretary for Sanitary Drainage at the Ministry of Works, Municipalities Affairs and Urban Planning. A little from a lot, and a flood from a drop about this distinguished engineering personality, we get to know her through the pages of "Al-Muhandis" magazine, so welcome to you and to the engineer Asma Murad.

First, readers of "Al-Mohandas" magazine would like to know about the beginnings and upbringing of Engineer Asma Murad in terms of upbringing and education.

My educational beginnings were in government schools from Zubaydah Elementary School in Muharraq to Salmaniya Elementary and Intermediate School, and then I graduated from the Girls' High School in Manama. At that time, the student was given the choice between a literary or scientific specialization, and because of my inclination towards mathematics, I chose the scientific specialization, in which I excelled and was among the top thirty, and I obtained a scholarship from the Ministry of Education.

Connection Project in Salman Port

However, my scholarship to the American University of Beirut faltered due to the civil war and avoiding sending students to Beirut during that period to preserve their safety. The University of Baghdad was chosen as an alternative, and due to the partisan control over admission to Iraqi universities at that time, I was removed from the University of Baghdad (College of Architecture) and sent to the University of Basra, Department of Civil Engineering. At that time, I did not like the living conditions in Basra, and I submitted my papers to the College of Engineering at Kuwait University, which was newly established according to the American system, and I was immediately accepted into the College of Engineering - Civil Engineering Department.

Engineer Asma Murad, what prompted you to choose the engineering major or field and study it, despite the scarcity of women who were interested in this academic major, which at that time was almost exclusive to men?

In the seventies, Bahrain was on the verge of modernity, and our families were pushing us to make choices that were in line with the ambitions of the modern state. The officials at the time supported modern majors, and among the scientific and practical majors were engineering or medicine… Then I remember the mission officer, whose name was Mr. Rashid Selbeekh, advised me to choose engineering, and I chose architecture because of my somewhat artistic inclinations. However, according to the circumstances mentioned above, I chose Civil Engineering because it was closer to architecture.

Nabi Saleh Island Sewage Project 2013

Where did you study engineering and in which specializations?

I obtained a bachelor's degree in Civil Engineering from Kuwait University. I backed out of obtaining a master's degree from America because I believe that engineering is somehow, a practical experience.

After your university studies and graduation, where did you start and work in the engineering sector?

There were many job opportunities, but I chose the Ministry of Public Works, Electricity and Water at the time. Because of the existence of the sewerage system whose networks were being built by foreign and Lebanese consulting companies, some of which I joined to train on preparing and implementing network designs. My choice of the Sanitary Engineering sector was due to my graduation project in this field of civil engineering and my love for the subject of hydraulics, which was part of the curriculum of the College of Civil Engineering.

We look forward through your career in the engineering sector, to know your career progression in the engineering field. What are the jobs that you joined during your career until you reached the position of Assistant Undersecretary?

I started as a trainee engineer in 1981 in the Operation and Maintenance Department of the Bahrain Sewerage Project, and the focus of my training was on operating and protecting the newly built systems by the government.

Al Hamala Station Development Project and Implementation of Sewage Networks

On the first day I joined the work, I was introduced to the facilities of the newly built system, including pumping stations, types of manholes, pipes used and treatment plants, and what equipment is used to operate it in the event of floods or blockages, and how to report any malfunction in the system since it carries foul sewage. Also, how to receive complaints and respond to them in writing after visiting the site, then the importance of saving the data of the system and the used equipment called " As Built" records at that time and ensuring that they were built according to the specifications set by the Strategic Plan for the year 1976. These data were then used in analysis to find solutions to the roots of the problems as well as developing the operation of its facilities. In addition, the tasks of the operation and maintenance departments included preserving their data and taking care of the extensions and connections of homes in terms of quantity and quality, for areas where sewage services began from main lines and drainage networks, following up on treatment plants and their laboratory results, and ensuring the safety of the dual-produced water before discharging it into the sea at that time.

It is worth mentioning here that the head of this department was a British Engineer named (George Lawrence) with a military background, so his interest was focused on protecting the system and operating it accurately and always reminding us that providing services properly is part of maintaining security. Also, as part of our training, we were introduced to the department concerned with the old

Septic Tanks Drainage system, what was later known as surface water, which carried the surplus of the septic tanks and poured it into the sea and the difference between the two devices.

At that time, I was part of the team developing the operation of system and studying the causes of floods in the networks and developing engineering solutions to solve them. At that time, the awareness of the End User was an aspect that could not be ignored, so I was part of the team preparing awareness programs for using the newly build networks and how to protect the system operation to ensure its sustainability and proper operation. My training also included understanding, compiling and translating the terms contained in the texts of the legal articles of the Singaporean and British Sewerage System.

Following up on legal affairs in the Ministry of Justice and forming a committee to draft a law for the sewerage system in the Kingdom of Bahrain in the Arabic language, which took years of revision to prepare the draft and was issued by Law No. (11) at that time. In 1986, the Sewerage and Surface Water Department was formed, and I was part of the Engineering Services Department for the Design of Sewerage and Surface Water, which had two divisions for the design of the sewerage system, one for preparing designs and implementing them by consulting companies and the other from Bahraini and local engineers specialized in preparing the necessary designs for some networks, and here I was chosen to lead this team. In 1991, I was appointed Head of the Engineering Services Department, which was specialized in preserving and designing and implementing the sewerage and surface water system and preserving its data electronically. Among its duties and responsibilities was determining the necessary budgets and providing them to implement the prepared plans.

In 1995, a department was formed to plan and manage sewerage projects. The challenge for the sector was to extend sewerage networks to all areas in Bahrain, especially when people noticed the effectiveness of these services. As a result of urban development in Bahrain, it was necessary to develop the department in terms of capacity. Some Sewage Treatment Plants were built and expanded; also, main lines were built to serve the modern areas.

The success of the first phase of producing tertiary treated water for agricultural uses was also monitored. In 2000, the responsibility of managing the project for the second phase of producing, transporting and distributing treated water was assigned to me by X Minister Engineer (Fahmi Al-Jowder), and managing the team present to supervise the consulting company that was chosen to implement this phase, in addition to my responsibilities as Head of the Department of Planning Sewage Projects without any financial compensation.

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Community Participation

the team present to supervise the consulting company that was chosen to implement this phase, in addition to my responsibilities as Head of the Department of Planning Sewage Projects without any financial compensation.

When the administrative structure of the sewage sector was restructured, no administrative body was appointed responsible for the treated water department. Here, because of special circumstances, my services with the responsible government agencies were terminated in 2004. I moved to the private sector. In 2011, then the Minister of Works, His Excellency Engineer Essam bin Abdullah Khalaf, asked me to join the ministry and assigned me the tasks of the Directorate of Planning and Sanitation Projects.

The tasks of the Directorate of Planning and Sanitation Projects in the Ministry of Works were to contribute to the planning, design and development of sewerage networks and facilities, including pumps and treatment plants, and to develop solutions for the obsolescence of the sewerage system in all its details using modern technologies. The same is the case in developing the production of treated sewage and building its networks in line with urban development and stopping the waste of sewage and converting it to an alternative source of water. It is also the same for developing rainwater networks for areas near the coasts. In addition to planning, monitoring and calculating the budgets

Rehabilitation of pumping stations

and appropriations of the sewerage system and its networks and developing the treated sewage effluent called Treated Sewage Effluent (TSE). In addition to participating in the formulation and implementation of regulations related to controlling environmental pollution from sewage, industrial violations and others.

On April 26, 2016, His Majesty King Hamad bin Isa Al Khalifa, issued Decree No. (28) of 2016 appointing me as Assistant Undersecretary for Sanitary Drainage at the Ministry of Works. During that period, my focus was on ensuring the operation and maintenance of the device and extending the life of the facility as assets that we must preserve. The project plans were to build deep lines and develop the system's facilities to keep pace with the urban development of urban areas and their population increase. In 2020, retired from Ministry of Works.

We also look forward to knowing the most important engineering projects and achievements that Engineer Asma Murad is proud to contribute to and participate in or that she has clear fingerprints in achieving?

The most important projects that added another dimension to my experience is the second phase project for the production, transfer and distribution of Treated Sewage Effluent, as I enhanced the use of wastewater in 2017 as an alternative source of water for irrigation and afforestation despite all

Karrana Area Networks Project

the logistical, material and urban challenges. Accordingly, the wastewater sector became in charge of producing another alternative source of water in most of its Treatment Plants.

A line from Sitra wastewater treatment plant was built to transmit the treated effluent produced and used for irrigation and municipality's needs for afforestation purposes in that area. The sector also developed the South Alba treatment plant so that its treated water is suitable for irrigation and afforestation in that area. The Tubli station was expanded to increase the production of treated water and sterilize it using the latest means, as well as dispose of the produced sludge. The necessary conditions were set to build the treatment plant in Salman City so that the production of treated water is suitable for irrigation and afforestation in Salman City Treatment Plant.

Coordination was also made with the Diyar Al Muharraq project to use part of the treated and produced water at the Muharraq station to afforestation the area. I did my best to produce treated sewage effluent and left it to the new administration to build its transmission and distribution lines. I consider using treated water as a vital alternative source to maintain the groundwater level (the right of future generations), to its suitability for agriculture and afforestation, which we need to maintain the environmental balance between land and construction, in addition to the fact that it may open up sources of income for agricultural landowners, and perhaps it can be reused for drinking in the future,

My attendance at the signing of the Tubli Sewage Treatment Plant Expansion Project Agreement (Phase IV), September 4, 2018.

as Singapore did, but as I explained, this system needs firm management. The same is the case with the maintenance of sewage and treated sewage facilities, which require continuous follow-up and monitoring. In 2014, I noticed that there were many complaints received regarding sewage floods.

I took it upon myself to visit some areas in Manama, Muharraq, Hamad Town and some villages and noticed several floods. It turned out that some pumping stations were out of order and there was no plan in place to develop or replace the old pumps. I had to convince the Ministry of Finance of the challenges of the obsolescence of the facilities and allocate budget items for this purpose

I participated in some special conferences and presented three papers about the projects I managed and created a qualitative change in the perception of society or the economy.

How do you describe yourself in the field of volunteer work? Are there volunteer works that bear the mark of Engineer Asma Murad? In social work in general as well as volunteer work in the engineering field?

After graduation, I worked in the volunteer field, whether in charity work and awareness through the Motherhood and Childhood Care Society, and I was concerned with cultural awareness programs for members and children, so we established a children's library and were keen to present plays for children. I also joined the committee for issuing the Engineer magazine affiliated with the Engineers Society. After that, family tasks took on their size from the care that requires dedication and time to balance with work.

In 2010, I joined the Photographers Club at the Fine Arts Society to develop my hobby. I am keen to develop my knowledge and culture to this day.

Tubli Station 4th Expansion Project 2020

In this meeting, we seek to learn about the career of Engineer Asma Murad with the Bahraini Engineers Society. We would like to know when you joined the society. What were your contributions to BSE?

I joined BSE in 1982. At first, I used to borrow some books, then I joined the committee for issuing the Engineer magazine. Then I contributed to some volunteer work from time to time.

What did BSE membership add to Engineer Asma Murad?

Membership in the Society of Engineers played a major role in raising awareness and learning about new projects in the Kingdom of Bahrain, as well as in communication between engineers, whether in the private or public sector. This played a role in caring about the engineering work provided by the engineer on the ground as a witness to his belonging to his engineering world.

How do you evaluate the role played by the Bahrain Society of Engineers in the development of the engineering sector in the Kingdom of Bahrain?

The Society of Engineers has a vital role in embracing the newly graduated engineer and providing him with guidance, whether in his training or professional career. As the role of civil society institutions is to fill the gaps that official institutions may overlook.

What are the most prominent works and achievements that you contributed to during your membership of the association's committees?

The Engineer Magazine Committee was concerned with the general content of the magazine and its production, so we asked for the help of some architects and artists to produce it, such as Engineer Khaled Al-Hashemi and others. I contacted the artist (Dr. Ahmed Baqer) to design the magazine's logo, and then I took the sketch with me to Cairo for implementation, which relied on graceful curves in its implementation.

How does Engineer Asma Murad see the role of the engineering sector in the development and urban renaissance in the Kingdom of Bahrain?

The engineering sector contributed to enhancing the urban renaissance in the Kingdom of Bahrain, whether in the public or private sector, and there was some distinction in the Kingdom of Bahrain, which is its continued growth and sustainable development in line with the urban developments it is going through. In my opinion, it is not correct to compare the Gulf countries and the Kingdom of Bahrain due to several factors, including wealth and population density.

Given Engineer Asma Murad's career in the engineering field, were you primarily influenced by someone else's specialization to enter the field of engineering? Did your engineering specialization affect the educational path of other people?

As I mentioned earlier, my entry into the Faculty of Engineering was a result of the development and economic conditions at that time. My uncle Ali Muhammad Murad was an Architect, and I was impressed by his preparation of engineering drawings and the distribution of spaces in the building. Later, his interest in choosing the materials used in construction, but I chose Civil Engineering, and my interest was in water and sanitation. I encouraged many female engineers to choose the sanitation specialization because it was not desired, especially since the entities that would employ them were very limited, and some of them joined the sanitation sector and some chose the roads or water sector and others.

What is the wisdom that Engineer Asma Murad believes in and works by? And follow its guidance? And why?

There is an Egyptian proverb that says "We planted the roots, then burned the crop." The crop may burn once, but the root remains and can be recovered.

The sustainability of any system requires follow-up and protection to ensure its continuity and development. Since infrastructure services preserve human dignity and enhance their sense of belonging, they need proper operation and continuous maintenance by trained humen. Without them, the effort put into building them will be wasted and there will be no stability in the systems put in place.

With this rich career journey and great engineering experience, what are the most important honors that Engineer Asma Murad has received in her professional life?

I have been honored by many entities, the first of which was the Bahrain Society of Engineers, the Ministry of Works, the Supreme Council for Women, the University of Bahrain, and others that I cannot remember now. I was honored by His Majesty the King in 2019.

Who is the engineer or personality that is a role model for Engineer Asma Murad in her professional career? What distinguishes this personality and makes her a role model?

There are many personalities that I have been influenced by the positive aspects of their personality, the first of which was my English boss who alerted me to pay attention to my hobbies because of their importance in clearing the mind, and the last of which was Engineer Essam Khalaf for his clarity of mind, integrity, and multi-dimensional view in discussing the engineering solutions put in place.

Can you share with the readers of (Al-Mohandas) magazine one or more beautiful influential situations that left an imprint and impact on your engineering personality?

When I first joined the ministry, part of our training to inspect flood sites was to smell the water to make sure whether the flood was due to a leaking water line or a sewage overflow. I would always roll down the window to smell it and then call the ministry's emergency center to do what was necessary. This habit has haunted me to this day, making my friends and family laugh.

At the beginning of distributing treated water, there was some hesitation in using it. One of the farm owners insisted on taking it to a local laboratory, which confirmed to him that this water was cleaner than the well water used and more suitable for agriculture. He was not convinced until after repeating the water quality test several times.

On one of my photography tours, we went to a farm that was supplied with Treated Sewage Effluent. The farm owner hosted us, and we took a tour of his farm and its products. Immediately upon my return, I called one of my acquaintances and encouraged him to buy their agricultural products. He called them to buy melons, and the farm owner responded, "I apologize because the farm's crop has been reserved for a year".

Finally, for the benefit of the new generation of engineers, would you like to say anything to young engineers or those who are about to study engineering?

Engineering sciences require a lot of reading and learning about the experiences of other countries and choosing what is appropriate for their environment. Therefore, I advise engineers to work on developing their responsibilities and experiences every five years.

EWA
هيئة الكهرباء والماء
Electricity & Water Authority

Phase 1: Street Lighting Retrofitting Project Using LED Luminaires and Control & Monitoring System

The Electricity and Water Authority (EWA) is responsible for regulating electric power and water in the Kingdom of Bahrain. It oversees the generation, transmission, and distribution of electric and water utilities. EWA is responsible for maintaining the quality and reliability of those utilities, and for promoting sustainable development and resource conservation.

Furthermore, EWA is responsible for the management, maintenance, and operation of the public street lighting network. It also enhances the development of street lighting infrastructure in collaboration with relevant government and private entities. EWA follows rigorous policies and practices for asset maintenance, planning, installation, operation, and safety of the electricity and streetlights network. EWA effectively manages the balance between utilities' demand and supply, fulfills customer needs, and supports its vision.

The current street lighting network in Bahrain comprises over 150,000 luminaires, both pole-mounted and wall-mounted, connected to more than 3,000 points of supply. These lights consume energy equivalent to 34.8 MWh of operation. While about 10% of the luminaires utilize LED technology, the majority still use High Pressure Sodium (HPS) lamps.

Strategic Objective:

EWA is committed to enhancing the efficiency and sustainability of the street lighting network by replacing conventional HPS lamps (Figure 1) with advanced LED lights (Figure 2). LED technology offers numerous benefits over HPS lamps, including lower energy consumption, extended lifespan, superior color quality, and a reduced carbon footprint. By adopting LED technology, EWA can achieve energy savings of 50% and reduce maintenance costs by 50%, while improving the quality and reliability of the street lighting service.

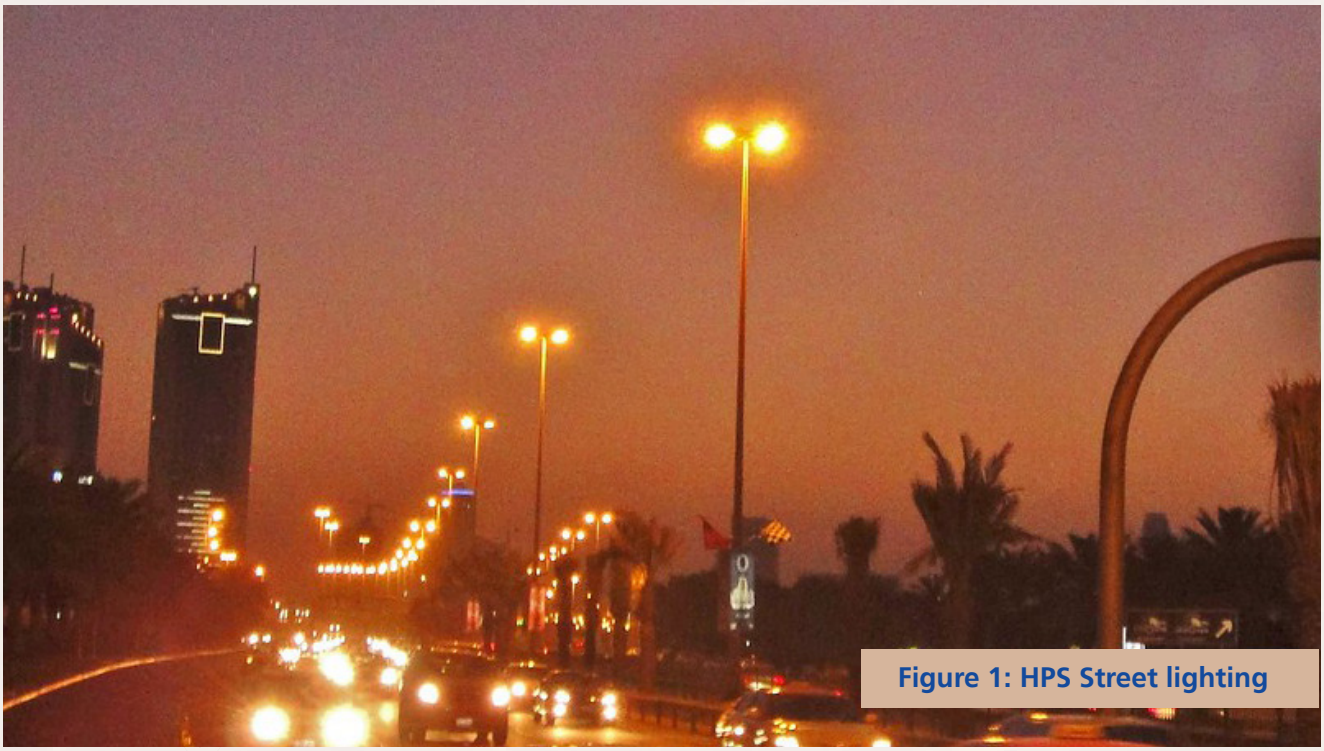


Figure 1: HPS Street lighting

Figure 2: LED Street lighting

Project Background:

The Electricity Distribution Directorate (EDD) in EWA aims to cooperate with a private Concessionaire who will upgrade the existing HPS streetlights to LED luminaires and incorporate Smart Lighting Control System including but not limited to wireless NEMA smart nodes, gateways, and street lighting Control & Monitoring System (CMS) in the Kingdom of Bahrain. The project will follow Energy Performance-Based Contracting approach where the payments are linked to the Energy savings schemes achieved. The Concessionaire will oversee the installation, operation, and maintenance of the project while EDD's

team shall follow up and supervise every stage of the project to ensure the proper implementation of it within the scheduled time frame.

The most important objectives of the project:

Location	* Muharraq Governorate (Figure 3). * Sheikh Isa Bin Salman Causeway & Highway (Figure 4). * Sheikh Khalifa Bin Salman Causeway & Highway (Figure 4).
Energy Consumption	Minimum 50% Reduction annually.
Billing	Minimum 50% Reduction annually.
Carbon Emissions	7,810 metric tons reduction annually.

Project General Objectives:

• Upgrade the existing street lighting system by replacing around 30,000 HPS luminaires with LED luminaires that meet the international standards and specifications for quality, efficiency, and reliability.

• Ensure the quality, safety and accountability of the Concessionaire and the LED luminaires throughout the project lifecycle, by establishing clear roles and responsibilities, contractual obligations, risk management strategies and dispute resolution mechanisms.

• Achieve significant energy savings and cost reductions for the street lighting systems.

• Align with the objectives of the National Energy Efficiency Action Plan (NEEAP) by enhancing the street lighting system in a way that benefits the environment, society, and economy. The project will help reduce greenhouse gases emissions, improve public safety and security, and invigorate local businesses.

• Monitor and evaluate the project using appropriate indicators and methods to ensure high performance and impacts of the LED luminaires are verified and reported transparently.

• Involve and engage the relevant stakeholders in the project design, implementation, and evaluation, such as the Roads Planning and Design Directorate (RPDD) & Maintenance Directorate, General Directorate of Traffic, Municipalities, and other interested parties.

• Serve as a reference for upgrading the entire existing lighting network in the next phases, using quantitative and qualitative measures of energy savings, performance, and user satisfaction.

• Achieve a high level of reliability and performance for the LED Streetlight Systems by exceeding 98% availability throughout the Project contract period.

Figure 3: Geographical Scope (Muharraq Governorate)

Figure 4: Geographical Scope (Highways)

Implementation Process:

1. Planning Stage:

The planning stage is done by a special team of Bahraini engineers and technicians who studied the project's aspects to determine the impact of implementing it. After proving that it is indeed worthy of the investment as mentioned above in this article, the team shall create a detailed action plan to elaborate on the roles of both the Concessionaire and EDD. Added to that, this document shall contain the entire project's information along with the instructions to the bidders who will partake in the project's tender in which the winner bidder will be assigned as the official Concessionaire of this project.

2- Execution Stage:

The Concessionaire shall submit their implementation plan along with the time schedules and the technical details of the equipment to be used in the project. EWA shall review and approve all the submitted documents before proceeding with the implementation. Moreover, EWA shall schedule meetings with the Concessionaire throughout the entirety of the project's timeline to oversee and review the implementation process to ensure that it follows EDD's specifications and the safety regulations, and to fix any rising issues.

In addition, EWA shall have the right to access and evaluate the Concessionaire ongoing project by establishing Critical Success Factors (CSF) and Key Performance Indicators (KPI) if it is necessary.

Figure 5: Smart NEMA node installed on LED luminaire (The control device in smart street lighting).

3- Closing Stage:

At this ending stage, EWA and the Concessionaire will have multiple meetings to finish and close the contract. On the other hand, the Concessionaire have to submit Cadastral As-Built drawings with all details including street lighting poles' coordinated positions, along with the full access to the monitoring system.

Towards a Smart City:

This project paves the pathway towards achieving the concept of a Smart City in the Kingdom of Bahrain. A Smart City is the concept that refers to the integration of advanced technologies and data-driven solutions to improve the quality of life. It leverages the power of information and communication technologies to enhance various aspects of urban living including infrastructure, transportation, energy, public services, and governance. The primary goal of a smart city is to utilize technology and data to create a more connected, responsive, and sustainable urban environment. By collecting and analyzing data from various sources, a smart city can gain insights into the functioning of its systems and make informed decisions to optimize resources allocation, reduce waste, and improve services and security.

Smart street lighting is a key component that can contribute to the development of a smart city. Other than enhanced energy efficiency due to the use of LED, and operational cost and billing reduction as mentioned earlier, the ability to monitor and control the streetlights using a centralized management system allows the authorities to have a real-time visibility into the status and performance of each streetlight. The authorities will be able to schedule on/off times and adjust the lighting levels to increased visibility, making public spaces safer for pedestrians and drivers. In addition, to detect faulty lights more efficiently, hence, issues can be identified and addressed promptly, optimizing the life span of the lighting infrastructure.

Smart streetlights can serve as a foundational element for establishing connectivity infrastructure in a smart city. They can be equipped with wireless communication technologies like Wi-Fi or cellular networks, creating a network of connected devices across the urban landscape. This connectivity infrastructure enables residents, businesses, and city services to access the Internet, connect IoT devices, and utilize smart applications, fostering a digitally connected ecosystem. Added to that, smart streetlights can act as data collection points, housing various sensors that gather valuable information

about the urban environment. For example, they can monitor traffic flow, air quality, temperature, humidity, and noise levels. This data can be aggregated, analyzed, and used to gain insights into the city's operations and make informed decisions for urban planning and traffic management.

By implementing smart street lighting, cities can achieve energy efficiency, cost savings, improved safety, and enhanced data-driven decision-making. These benefits contribute to the overall transformation of a city into a smart city, where technology and data (Figure 5) are leveraged to create a more sustainable, efficient, and livable urban environment.

This project signifies the commencement of EWA's visionary goal to modernize the entire streetlight network in Bahrain with high-efficiency, state-of-the-art technology and trends in the streetlight industry. This project will also serve as a valuable learning experience for the second phase, which will cover the whole Kingdom of Bahrain.

Challenges:

This large scaled project is set to be implemented on two of the major highways in the Kingdom, as well as the entire Muharraq governorate, these areas are highly active and often suffers a high density of traffic. In order to accomplish the project within the required time frame, a proper execution plan must be set in cooperation with the local authorities to organize the traffic flow throughout the project's installation and maintenance periods, to ensure the smoothness of the traffic and avoid jams and accidents as much as possible.

Role of the Bahraini Engineer:

This project is initiated, planned, implemented and supervised by a team of specialized and experienced Bahraini Engineers and Technicians. Their main goal is to elevate the quality level of services provided by EWA to all citizens in the Kingdom of Bahrain according to the international standards and EDD's specifications, while ensuring to follow the safety procedures to protect EWA's workers on site, and EWA's assets. This is achieved by:

- Studying the compatibility of the equipment and technology to be used in the project with the current electricity distribution network and the service conditions in the kingdom.

- Overseeing the tendering process and carefully reviewing all the bidders offers to choose the best one in terms of eligibility and suitability to be in par with the kingdom's strategic goals.

- Setting up regular meetings to review and check the project progress, and to make sure that the work schedule is in phase with the project base line plan.

- Supervising every stage of the project and prepare periodic reports to monitor the implementation and performance of the system, and take the necessary actions in case of the occurrence of any issue.

- Reviewing all the observations and results of the entire project to set up the plan for the next phase with improved efficiency

Artificial Intelligence and Electrical Engineering: A Revolution in Efficiency and Innovation

Eng. Yusuf Al Moamen, Managing Director, Watt Me Electrical Services.

Figure1: AI technology

Figure 2: System Data

Introduction

In an increasingly technology-dependent world, artificial intelligence (AI) stands out as one of the most transformative tools reshaping various industries, including electrical engineering. Integrating AI technologies into electrical systems opens up vast opportunities for improving efficiency, performance, cost reduction, and safety (Figure 1). In this article, we will explore how AI can revolutionize electrical engineering and the significant benefits that can be achieved through this integration.

Big Data Analysis

Data (Figure 2) is the backbone of any modern system, and the ability to analyze vast amounts of data quickly and efficiently is one of AI's greatest advantages. In electrical engineering, AI can be used to analyze operational and performance data to detect patterns and identify potential issues before they occur. This type of analysis helps enhance system performance and reduce downtime.

Predictive Maintenance

Predictive maintenance is one of the most practical applications of AI in electrical engineering. By analyzing performance data, AI can predict

potential failures and send maintenance alerts before issues arise. This approach reduces the costs associated with unplanned maintenance and improves system reliability.

Electrical System Design

AI can play a crucial role in optimizing the design of electrical systems (Figure 3). By simulating different scenarios and analyzing performance, AI systems can provide recommendations to improve the design of electrical networks and load distribution more effectively. This optimization can lead to reduced energy loss and increased operational efficiency.

Energy Management

Optimizing energy management is one of the standout benefits of using AI in electrical systems. AI can enhance energy consumption by analyzing patterns and offering recommendations to improve resource use. For example, AI can manage electrical loads during peak energy cost times, helping to reduce costs.

Automation and Control

Automation is a classic application of AI, and in electrical engineering, it can be used to improve automatic control systems in industrial facilities and smart buildings. AI can enhance the accuracy and efficiency of control systems, reducing human errors and increasing operational safety.

Security and Protection

AI can play a critical role in enhancing security and protection in electrical systems. Through continuous monitoring and data analysis, AI systems can detect threats and security issues early and respond quickly, reducing the risk of cyberattacks and malfunctions.

Education and Training

AI can also be a powerful tool in improving education and training in electrical engineering. AI technologies can develop advanced training programs that help engineers enhance their skills

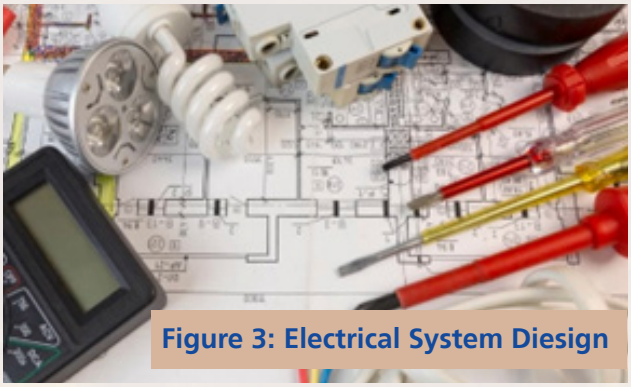


Figure 3: Electrical System Diesign

Figure 4: Modern technology

and knowledge of modern technology (Figure 4), improving their ability to handle advanced systems.

Smart Grid Design

Smart grids are the future of electricity distribution, and AI can play a significant role in designing and improving the performance of these grids. By analyzing data and managing demand and energy distribution more effectively, smart grids can enhance efficiency, reduce losses, and achieve higher stability in energy supply.

Conclusion

Integrating AI into electrical engineering is not just a future trend; it is a reality that significantly enhances efficiency, performance, and reliability. By using AI technologies in data analysis, predictive maintenance, system design, energy management, automation and control, security and protection, education and training, and smart grid design, substantial improvements can be achieved, contributing to the advancement of this vital field. The future of electrical engineering looks promising, thanks to the rapid developments in AI technologies.

Understanding Prime Cost Contracts, PC Rates, and Provisional Sums in Construction Contracts

Eng. Hasan Al Zabeel, MRICS, MAIQS, MCIArb, FIDIC CCM.

Figure 1: Prime Cost

In the complex world of construction, understanding the intricacies of different contract types and cost elements is essential for successful project management. Among these, the concepts of Prime Costs, Prime Cost Contracts and Provisional Sums play a pivotal role, particularly in ensuring expenditure transparency and flexibility during the project execution phase. This article explores these concepts, their applications, and the relevant considerations in the context of construction projects..

Prime Cost and Prime Cost Contracts

Prime Cost (Figure 1) generally refers to the sum of direct costs associated with construction work, including materials, plant, equipment, and labor. These costs are integral to calculating the overall expenses involved in a project. In a Prime Cost Contract, the method of payment is based on covering these direct actual costs (labor, plant, material) plus an additional fee, which may be fixed or variable as a percentage. This fee represents overhead and profit.

Prime Cost Contracts are particularly useful for projects where immediate commencement of work is necessary, even if the design information is incomplete. For instance, repair works on a vital facility may require such a contract to expedite the process. This type of contract ensures that the employer covers all necessary expenses while providing a clear structure for contractor compensation (Figure 2).

Prime Cost Sum (PC Sum) or PC Rate

The terms Prime Cost Sum, PC Sum, and PC Rate are used interchangeably to denote the same concept. The Royal Institution of Chartered Surveyors (RICS) New Rules of Measurement (NRM2) describes a Prime Cost Sum as "a sum of money included in a unit rate to be expended on materials or goods from suppliers." It typically involves a supply-only rate for materials or goods whose exact quality is not predetermined. For example, the supply rate for ceramic floor tiles might be $20 per square meter.

Figure 2: Conditions of Contracts

The primary purpose of using PC rates is to control material costs while allowing bidders to focus solely on installation pricing. This approach enables employers to analyze bids consistently, facilitating a straightforward comparison of installation costs.

FIDIC Standard Forms of Contracts and PC Rates

In the Middle East the use of Provisional Cost (PC) Rates is common. However, there is often ambiguity in the contractual procedures for adjusting PC Rates in the event of a rise or fall after the final materials have been selected by the Employer. This procedure is not explicitly outlined in either the 1999 or 2017 Fédération Internationale Des Ingénieurs-Conseils (FIDIC) forms of contracts.

FIDIC deliberately avoids referencing a specific standard method of measurement, such as NRM (New Rules of Measurement by RICS) or POMI (Principles of Measurement International), to ensure that the Standard Forms of Contract remain international and not tied to any specific standard or professional institution. By doing so, FIDIC aims to maintain flexibility and adaptability across various project types. However, users of FIDIC contracts may still choose to refer to a particular standard method of measurement in the Contract Data.

The FIDIC Red Book (both 2017 and 1999 versions) specifies in sub-clause 12.2 that the method of measurement should be stated in the Contract Data. If not stated, it should follow the Bill of Quantities (BOQ) and/or Schedules. Therefore, defining procedures related to PC rates in the BOQ Preamble during the pre-contract phase is crucial to prevent disputes during the construction phase.

The BOQ Preamble should clarify the standard method of measurement used and outline the rules for measurement, including costs' inclusions and exclusions.

Figure 3: Perform Work and Construction Stage

Provisional Sums

Provisional Sums are amounts allocated in the Bill of Quantities (BOQ) during the pre-contract phase for works the employer is unsure will be executed during the construction stage (Figure 3). This uncertainty can arise due to various reasons, such as incomplete design information, uncertain funding, complex work that cannot be priced, or the employer's desire for flexibility.

During the construction stage, if the employer decides to perform work for which a Provisional Sum was allocated in the contract, the Engineer (who serves as the Contract Administrator in FIDIC's Contracts) issues an instruction (Engineer Instruction) to the Main Contractor or the Nominated Subcontractor(s) to carry out these works. This occurs after agreeing on the amount of the works with the contractor, and the Contract Price is adjusted accordingly to reflect this change.

FIDIC defines it as "a sum specified in the Contract by the Employer as a Provisional Sum, for the execution of any part of the Works or for the supply of Plant, Materials, or services under Sub-Clause: Provisional Sums"

Provisional Sums refers to Sub-Clause 13.5 in the 1999 edition and Sub-Clause 13.4 in the 2017 edition. The procedure is similar in both versions.

It states that the Provisional Sum can be expended only by the Engineer through an Engineer's Instruction, which can include: (1) Variation by instruction to the Contractor, and/or (2) Instructing the Contractor to procure works, materials, services, or a combination thereof from Nominated Sub-Contractor(s).

NRM2 and Provisional Sums

The RICS NRM2: Detailed measurement for building works categorizes Provisional Sums into two types: Defined Provisional Sums and Undefined Provisional Sums.

In accordance with NRM2, a Provisional sum is "a sum of money set aside to carry out work that cannot be fully described and given in quantified items in accordance with the tabulated rules of measurement. A provisional sum should be identified as either defined or undefined"

Defined Provisional Sum A sum provided for work that is not completely designed but for which the following information is provided:

- the nature and construction of the work and,

• a statement of how and where the work is fixed to the building, and what other work should be fixed, and

• a quantity or quantities that indicate the scope and extent of the work, and

• any specific limitations, etc. identified.

If the above information cannot be provided, then it is considered an Undefined Provisional Sum.

NRM2 defined the Undefined Provisional Sum as "a sum provided for work that is not completely designed, but for which the information required for a defined provisional sum cannot be provided"

Figure 4: Construction Project and Project Management

Example of a defined Provisional Sum is constructing a 4-star boutique hotel with 40 keys (rooms/suits) using a typical concrete structure frame, adjacent to Airport terminal 1 over a land of 3000 square meters, including MEP, and excluding FF&E.

Example of an Undefined Provisional Sum is constructing a 4-star hotel next to the Airport, without mentioning or knowing being able to specify more details.

In conclusion, it is important to avoid allocating Provisional Sums simply to expedite the start of a project due to insufficient design information. Such actions can lead to significantly undesirable impacts on project costs and schedules, potentially disrupting other contractors' timelines, causing resequencing of activities, and delaying key milestones.

A thorough understanding of Prime Cost Contracts, Provisional Sums, and PC rates is crucial for effectively managing construction projects from both commercial and contractual perspectives. These elements provide cost flexibility and control, ensuring all parties have a clear understanding of the project's financial aspects. As construction projects grow more complex, mastering these concepts will become increasingly essential for engineers and project managers, whether representing the Employer or the Contractor (Figure 4).

References:

1. FIDIC Red Book 1999
2. FIDIC Red Book 2017
3. RICS New Rules of Measurement 2 (NRM2): Detailed measurement for building works" 2nd edition October 2021.

Eng. Hamad Ebrahim Badaw

Director of Roads Projects and Maintenance Directorate, Ministry of Works

Portrait

A civil Engineer specializing in the roads and bridges construction field, with experience in project management, and thrives on seeking new challenges in order to expand his skillset and acquire new knowledge continually.

- B.Sc. in Civil Engineering, University of Bahrain, 2015.
- Site Engineer, G.P.Zachariades Group, Apr – Nov 2016.
- Civil Engineer, (December 2016 – May 2022) at the Ministry of Works
- Head, Bridge & Flyover Projects, Ministry of Works Dec 2016 – 2024).
- Director of Roads Projects and Maintenance Department, a position to which he was appointed on August 6, 2024.

Responsibilities:

- Supervising all aspects of developing the road network in the Kingdom of Bahrain through implementing strategic projects and working on their maintenance and operation to ensure sustainability.
- Working on developing project implementation programs to establish and maintain a wide network of roads, bridges, tunnels and road-related assets

Major projects involved on:

Al Fateh Highway Upgrade,

- Bahrain Airport Access improvement Stage 1 & 2.

Professional Awards:

- Best Idea Award, Government Innovation Competition (FIKRA), 2021.

Photo at top of page: His Excellency Eng. Essam bin Abdullah Khalaf, former Minister of Works, Municipalities and Urban Planning, during an inspection of a road project, and Eng. Hamad Badaw is shown giving an explanation of the project's developments.

Arch. Ali Hasan Lari

Executive Director at Hassan Lari Group

Portrait

Registered architect in Bahrain and New York, PMP, LEED GA, engineering arbitrator and member in various international professional organizations and advisory committees.

• Bachelor of Science in Architecture from Georgia Institute of Technology, currently completing Executive MBA from HEC Paris.

Responsibilities:

• Leads Hassan Lari Group real estate development sector, including project conceptualization and feasibility and thereon contract, project, and design management; and sits on the company's Board of Directors.

• Certified engineering arbitrator from GCCCAC.

• Juror of graduation projects for various universities.

Major projects involved on:

• 30 storey office tower in Water Garden City, Bahrain.

• Benefit corporate headquarters in Al Seef, Bahrain.

• Al Razi Orthopedic Hospital, Kuwait.

• Kuwait Cancer Center, Kuwait.

• Hongqiao Vanke Center, Hongqiao, China.

Professional Awards:

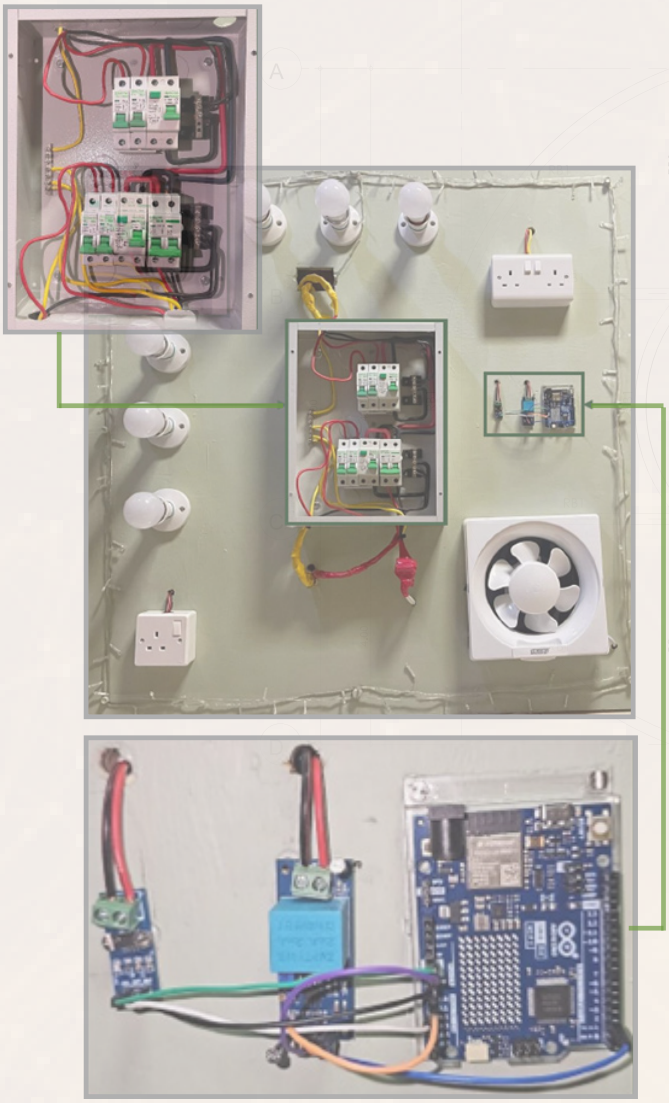
• 1st place in design and build studio graduation project, Georgia Institute of Technology.

Photo at top of page: Arch. Ali Lari with the Benefit headquarters construction project team upon completion of work

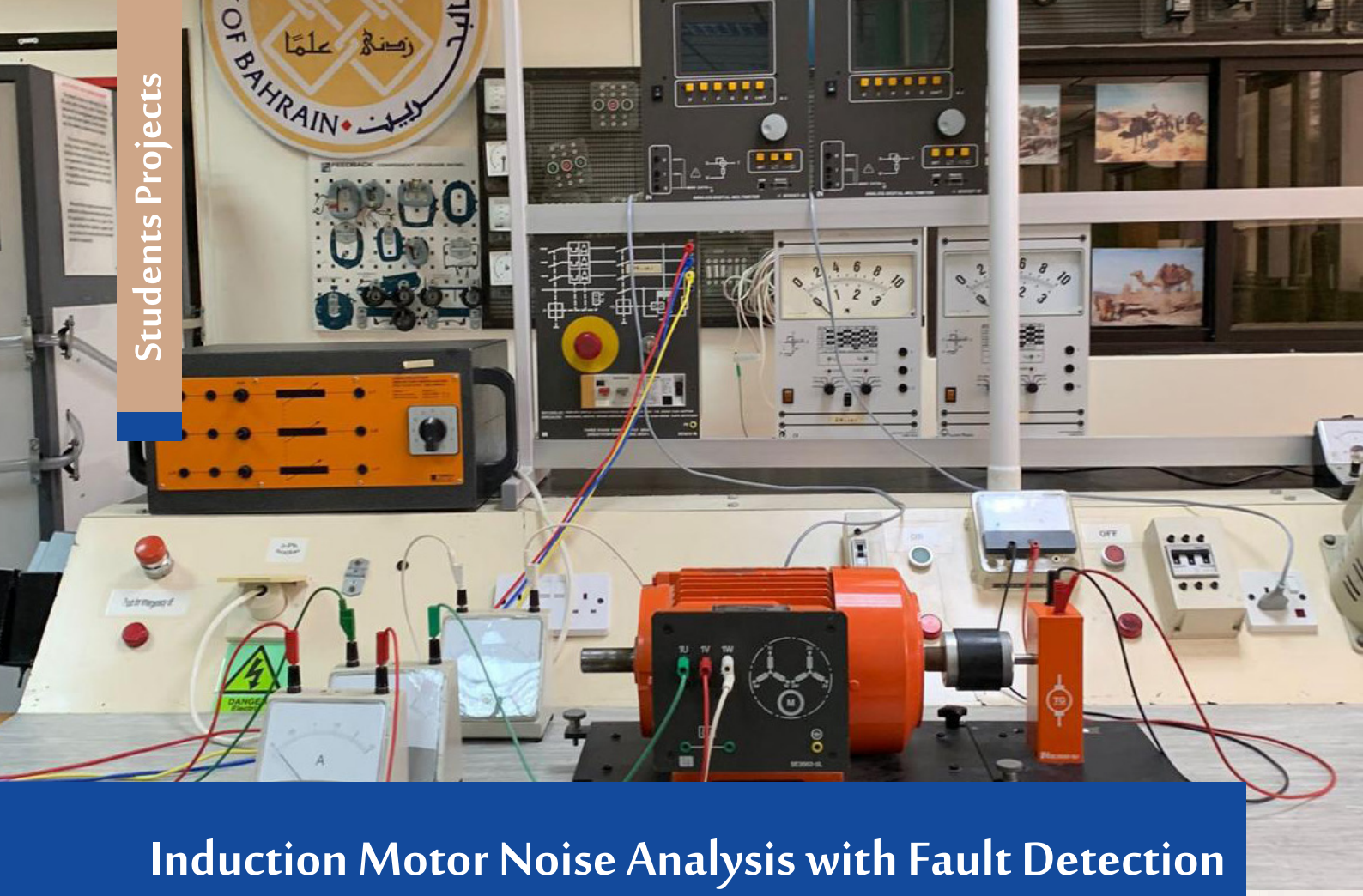
Design and implementation of a single-phase smart distribution board

Student Aqeela Alawi Sayed Mohsen Al-Alawi.
Supervised by: Dr. Ali Sayed Al-Mousawi, Associate Professor in the Department of Electrical and Electronic Engineering at the University of Bahrain.

Student Aqeela Alawi Sayed Mohsen Al-Alawi, under the supervision of Dr. Ali Sayed Al-Mousawi, Associate Professor in the Department of Electrical and Electronic Engineering at the University of Bahrain, presents the design and implementation of a single-phase smart distribution board that leverages the capabilities of an Arduino UNO R4 Wi-Fi module, a ZMPT101B voltage sensor, and an ACS712 current sensor to enhance the safety, efficiency, and adaptability of electrical power distribution in residential settings. The Arduino UNO R4 Wi-Fi module serves as the central processing unit of the smart distribution board, controlling the operation of the board and facilitating communication with the Arduino IoT cloud. The Wi-Fi module enables the distribution board to connect to the internet, transforming it from a traditional power distribution system into a smart, connected device that can be monitored and controlled remotely. The ZMPT101B voltage sensor and the ACS712 current sensor



are critical components of the smart distribution board. They continuously monitor the voltage and current flowing through each circuit, providing real-time data on the electrical parameters of the system. This data is crucial for identifying potential issues such as over currents or voltage spikes that could damage electrical appliances or cause electrical fires. The collected data is transmitted to the Arduino IoT cloud via the Arduino UNO R4 Wi-Fi module. The Arduino IoT cloud provides a user-friendly interface for monitoring the electrical parameters of the system in real-time. It also allows for remote control of the distribution board, enabling users to switch circuits on and off from anywhere in the world. Furthermore, the Arduino IoT cloud can send alerts to users when it detects potential issues, allowing for quick intervention and resolution. Overall, this project represents a significant advancement in the field of electrical power distribution. By integrating advanced sensors, smart technologies, and cloud connectivity into a single-phase distribution board, it transforms the board from a simple power distribution system into a sophisticated, intelligent device that ensures efficient and reliable power distribution while offering unprecedented levels of control and convenience to users. The project's outcome is expected to contribute significantly to the ongoing evolution of distribution boards and set a new standard for residential power distribution systems.



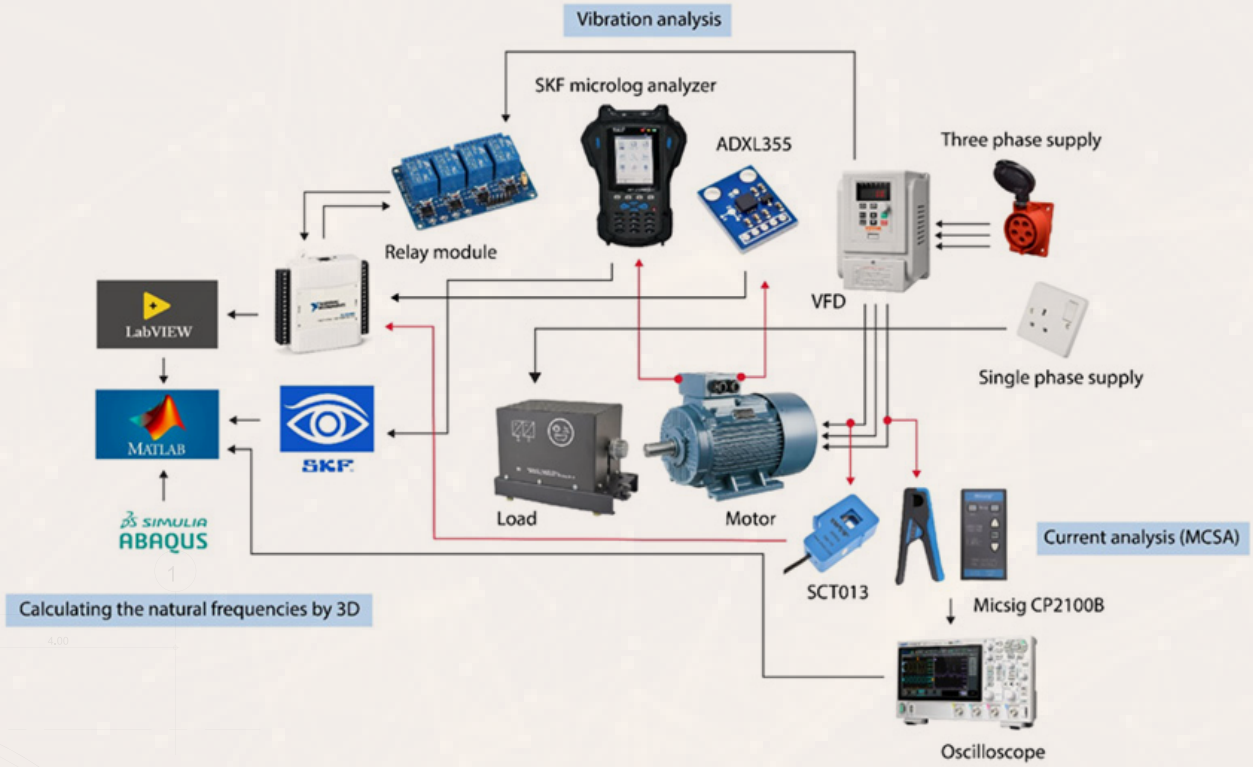
Induction Motor Noise Analysis with Fault Detection

Students: Zainab Hameed, Zainab Almatrook, and Salman Mohammed.
Supervised by: Dr. Salwa Baserrah, Department of Electrical and Electronics Engineering, University of Bahrain.

Three students Zainab Hameed, Zainab Almatrook, and Salman Mohammed carried out the BSc project study entitled "Induction Motor Noise Analysis with Fault Detection" which supervised by Dr. Salwa Baserrah the assistant professor in University of Bahrain department of Electrical and Electronics Engineering department.

This project deals with noise which can be the result of two main factors: electrical and mechanical. Throughout the whole project we couldn't neglect the mechanical factors as it plays a major part in calculating the frequencies resulting the noise. So, by adding fault detection test on the motor first, to determine wither the motor has any faults that might result in additional noise we were able to predict any noise added to the other made by the electrical factors.

To achieve that we used multiple mechanical tools, such as: the SKF frequency analyser and abaqus program to calculate the natural frequencies as well as the vibration in all three axis (x-axis, y-axis, z-axis). We also used current transformers (SCT103) and another current transformer with a wider range (Micsig CP2100B)



as well as vibration sensors (ADXL335). To pinpoint the faults that we have in the motor we had to use assigned formulas for fault detection; after calculating them we compared the frequencies we found with the graphs we plotted using MATLAB program. We were able to identify two types of faults one of them that we already have in our motor. Which played a part in the noise made by the motor.

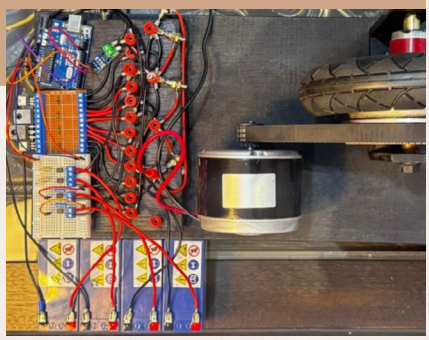
This study aims to locate electrical motor flaws and therefore solve the noise the motor generates. Data on motor vibration at five distinct speeds—1470, 1998, 2015, 2650, and 2890 RPM—will be collected in order to achieve this. in addition to the measurements of the current transformer in two different modes (forward and reverse) for each of the three phases (U, V, and W). To help collect the readings, LabVIEW and the motor are interfaced with the use of three DACs. In order to collect accurate data, we developed many applications. We were able to determine the frequencies that were causing issues and, as a result, the noise by comparing their FFTs. It will be selected using MATLAB/SIMULINK, after which it will be filtered out (canceled)

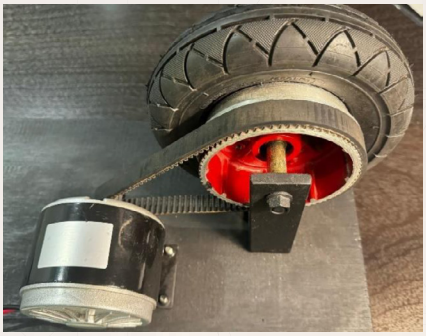
To ensure the success of this project we used multiple devices to compare the results and make sure that it's the same (two current transformers with different ranges [small range, wide range]) and (two devices for frequency analyzing [one with small range, the other is takes the readings more accurately]). The whole project was dependent on analyzing the data taken from the experimental tests taken.

Design of a Soft Starter for DC Motors" investigates the performance of one method in starting DC motors

Students: Mohammed Bucheeri and Abdulla Talha.
Supervised by: Dr. Maamar Taleb, Department of Electrical and Electronics Engineering, University of Bahrain.

The study entitled "Design of a Soft Starter for DC Motors" investigates the performance of one method in starting DC motors. The study carried out by both students Mohammed Bucheeri and Abdulla Talha which supervised by Dr. Maamar Taleb the associate professor in the University of Bahrain (Department of Electrical and Electronics Engineering), where several methods and approaches are employed to regulate the armature current while DC motors are being started. These include the use of a variable resistance between the armature circuit and the supply DC voltage by gradually decreasing the resistance in a way that will lead to an increase in the supply DC voltage during the starting condition, or implementing a control system that can be utilized in limiting the inrush current with the aid of power electronics circuits. In this project, we explore one of the most precise and cost-effective techniques for controlling the level of armature current and that is by utilizing the H-bridge circuitry between the armature circuit and the supply voltage. This method will regulate the inrush current, leading to a soft start of the motor in the right and safe manner. Soft starting of DC motors can reduce the mechanical stress on the motor and the associated equipment attached to it which will result in extending the lifespan of the equipment and reducing rewinding costs. The present project involves soft starting a DC motor by using a current sensor as feedback between the armature circuit and the supply DC voltage. An Arduino (a hardware microcontroller) has been used to respond to the current sensor readings, leading to control of four MOSFET's gate pulses of an H-bridge circuitry once the motor is started.





The H-bridge circuit will make use of semiconductor devices such as MOSFETs and diodes and that can be justified by their capabilities in providing rapid response to our proposed control system. In this project, a soft starter of a DC motor has been implemented by using first MATLAB/SIMULINK simulations and later by in a practical implementation to ensure real and reliable performance of the proposed soft starter.

In the presence of
H.E. Dr. Mohamed bin Mubarak Bin Daina
Minister of Oil and Environment
Special Envoy for Climate Affairs
Kingdom of Bahrain

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