IEP-SAC JOURNAL

2022-23

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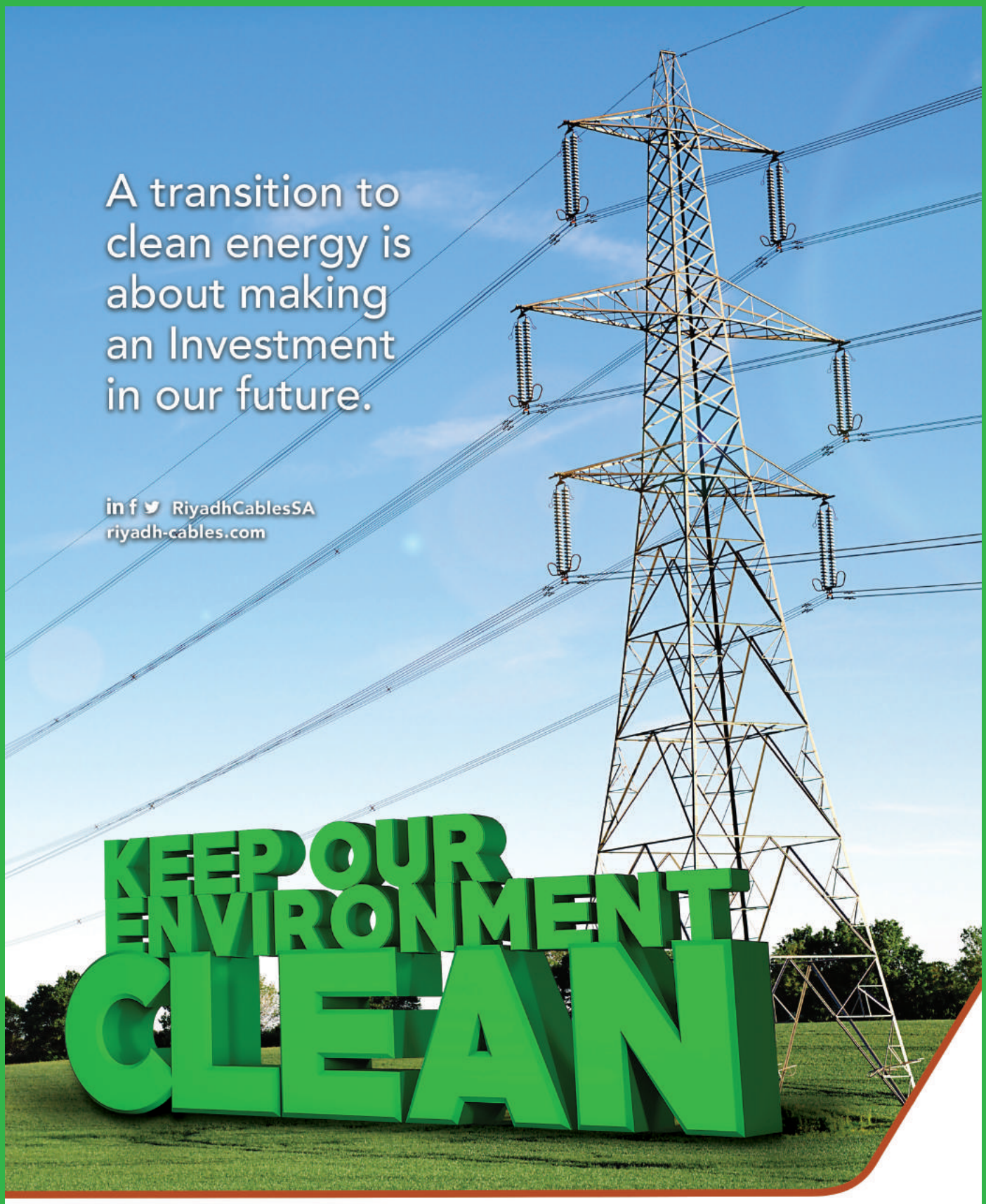

مجموعة كابلات الرياض
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IEP-SAC Journal is published yearly by the Institution of Engineers Pakistan, Saudi Arabian Center (IEP-SAC), Riyadh, and distributed to the engineering community in Saudi Arabia. To promote discussion of issues in the field of engineering and ensure coverage of all responsible points of view, conflicting opinions and views may appear, however, IEP-SAC cannot accept any liability for such views nor for any errors or omissions.

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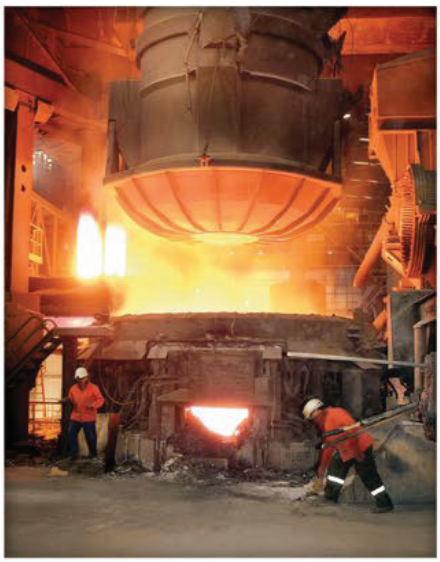

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From the Chairman's Desk

Importance and Reward of Seeking knowledge.

Institution of Engineers Pakistan (IEP) is the leading professional body founded by Qaied-e-Azam Muhammad Ali Jinnah on 20 June 1948 for promoting Engineering, Technology and Scientific knowledge. We as Institution of Engineers Pakistan-Saudi Arabia Center (IEP-SAC) come together and share innovative technical knowledge among fellow engineers in the Kingdom of Saudi Arabia (KSA). My priority as Chairman is to transform IEP-SAC into a vibrant community by taking advantage of the shared strength and new ideas on technical knowledge for the benefit of engineers.

Alhamdulillah, I feel immense pleasure and honor to present the new IEP-SAC Journal 2022-23. Sustaining our legacy from past several years, this journal includes messages from various organizations and personalities, numerous technical papers, annual report by the General Secretary (GS), Eastern region sub-center report, scholarship committee report, pictures of various events in the Central and Eastern region, and the directory of Pakistani Engineers in KSA with recent updates. I urge all Pakistani engineers to come forward, become member of IEP-SAC as well as write technical papers in our journal. Alhamdulillah, we are out of the Covid-19 crises, and this year we have organized our activities as normal way of life.

In September 2022, the IEP-SAC local council entrusted me with the responsibility of being the Chairman of IEP-SAC for the biennial term 2022-2024. The other two office bearers endorsed by the local council are Engr. Muhammad Asim Siddiqui -General Secretary, and Dr. Syed Fakhir Hassni -Joint Secretary. Five convenors of the IEP-SAC standing committees were revamped, whereas the other three past convenors were requested to continue their responsibilities with the same committees. The past Chairmen, Engr. Jaleel Hasan, Engr. Mubashir Hussain Kirmani, and Engr. Syed Muhammad Iqbal Ahmed are requested to play their active role in the committees for the benefit of the engineers and they accepted the request of the new Chairman.

IEP-SAC is providing a platform to all Pakistani engineers in KSA to excel their skills, share knowledge through seminars and technical papers, socialize among engineers along with their families, and help needy meritorious engineering students in Pakistan; all is done under the patronization of Pakistani Embassy. In addition, IEP-SAC is always striving to bring the information and knowledge of the most modern engineering techniques and trends to our fellow Pakistani engineers. Keeping our tradition intact, we had organized a mid-term seminar titled "Machine learning with the role of academia in data science: Challenges and approaches" on 9 December 2022. Dr. Awais Mahmood from King Suad University, Saudi Arabia was the keynote speaker of

the seminar. Also, we organized a family picnic on 10 February 2023 witnessing overwhelming participation of the engineering community wherein prizes were distributed to all the winners of the games for adults, ladies, and children.

We have now planned our annual engineer's convention with technical seminar to be held on Thursday, 4 May 2023, at King Salman Social Centre in Riyadh. Dr. Sohail Munir, Advisor -NEOM, Saudi Arabia, Expert in Digital Transformation, Government Technologies, Cognitive Cities, Emerging Technologies, will visit us from Dubai and deliver a seminar on current issue with the topic "Smart Cities to Cognitive Cities - Trends and Opportunities". We encourage Pakistani Engineers to play their role in the software industry in collaboration with their Saudi counterparts. They can enhance their contribution in the areas of solar energy and wind energy. Nonetheless, IEP-SAC appreciates fellow engineers on your hard work, professionalism, and on your contribution towards the development of Saudi Arabia. In return, fellow engineers enjoy professional stature and earn foreign exchange that is also injected into the economic arteries of Pakistan.

On behalf of IEP-SAC, I would like to express the gratitude to the Custodian of the Two Holy Mosques, King Salman bin Abdul Aziz Al-Saud for their hospitality and cooperation to Pakistani community and engineers. We are thankful to the Prime Minister and Crown prince His Royal Highness Muhammad bin Salman bin Abdul Aziz and his government for the exemplary leadership and vision 2030, and for providing a favorable environment for the professionals to put their engineering skills in practice.

We are grateful to H.E. the Ambassador of Islamic Republic of Pakistan for his support and patronage to IEP-SAC. We appreciate the cooperation of the Embassy of Pakistan and its employees and staff for their unceasing support to us. I extend my attribute and accolade to all my Council Members in Central and Eastern regions for their dedication and commitment to their voluntary services towards IEP-SAC goals and objectives.

We acknowledge support of our sponsors, fellow engineers, Saudi Council of Engineers for their valuable contribution to the success of IEP-SAC. May Allah grant us more energy and strength to serve the engineering community even better.

Finally, I would like to deliver a message in the form of two short hadiths about the importance and reward of seeking knowledge. Narrated Anas bin Malik: that the Messenger of Allah (ﷺ) said: "Who goes out in seeking knowledge, then he is in Allah's cause until he returns." Narrated Abu Hurairah: that the Messenger of Allah (ﷺ) said: "Whoever takes a path upon which to obtain knowledge, Allah makes the path to Paradise easy for him." So, we shall always put our efforts throughout the life to seek knowledge.

Best wishes and kind regards for all

Prof. Rafiq Muhammad Choudhry, Ph.D., PE, M. ASCE
Chairman, IEP-SAC, KSA
Friday 31 March 2023 (1444 Ramadhan 9)

Message from the Charged' Affaires

I wish to congratulate the hardworking and committed team of the Institute of Engineers of Pakistan - Saudi Arabia Chapter (IEP-SAC) for publishing this annual Journal. This Journal contains a lot of useful information for Pakistani professionals who are based in the Kingdom. It also reflects a praiseworthy tradition of sense of community, unity and common purpose among the Pakistani professional community.

Pakistani professionals are playing a major role in the economic growth and development of the Kingdom. Their enterprising attitude and excellence are widely acknowledged both in the public and private circles. Through their competence and dedication, they have not only progressed at the individual level, but have also paved the way for new generation of professionals who are seeking opportunities in the Kingdom. The success of Pakistani professionals and their remarkable reputation is also a source of pride for Pakistan. They are true ambassadors of the country and are extremely valuable asset in our diplomacy.

I would like to take this opportunity to express my appreciation for the community service and philanthropic work that is being done by members of IEP-SAC. By sharing the fruits of their success with others, these professionals are not only doing a religious duty but also exhibiting the fundamental characteristics of our culture such as charity, solidarity and hospitality. I am hopeful that this spirit of brotherhood, kindness and fraternity continue to flourish in the days to come and IEP-SAC will become a role model for other community led organizations.

The Embassy of Pakistan is working diligently to support all community led efforts that are aimed at the welfare, growth and betterment of Pakistanis living in the Kingdom. We will continue to play this role and extend maximum facilitation for all such beneficial projects. I sincerely hope that IEP-SAC will be a productive partner of the Embassy in this national cause. I wish them success in their future endeavours.

Muhammad Zulqarnain Chheena
Charge d' Affaires,
Embassy of the Islamic Republic of Pakistan
Riyadh, Kingdom of Saudi Arabia

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MESSAGE FROM
ENGR. FARHAT ADIL FIE (PAK) PRESIDENT
INSTITUTION OF ENGINEERS PAKISTAN

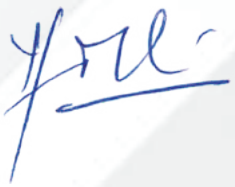
It is a matter of great pleasure and honour that the Institution of Engineers, Pakistan Saudi Arabia Centre (IEP-SAC), an overseas branch of the IEP, is holding the Annual Technical Seminar in Riyadh on 4th May 2023. On this occasion also publishing its annual publication, "The IEP-SAC Journal".

On behalf of the Central Council the Institution of Engineers Pakistan (IEP) and myself, I whole-heartedly congratulate the office bearers including IEP-SAC, as well as the Members of standing committees, for organizing the seminar and publication of the journal. This Journal contains important Articles on current engineering issues and a launch during technical seminars always helps to exchange knowledge and information for the best use of the engineering profession. Furthermore, it builds professional ties among engineers of different nationalities and enables the propagation of a positive image of our country. The IEP-SAC Journal is the real face of IEP and its Members working in Saudi Arabia are not only earning foreign exchange for Pakistan but also delivering their experience and technical expertise to the young engineers back home.

Engineers of every country, whether developed or developing, play a vital role in the nation's prosperity. All nations increasingly rely on engineers who strive hard to remain on top of the cutting edge of economic growth and competitively brace for the prevailing environment of global economic competition. They have an indispensable role to play in improving manufacturing processes and developing efficient sources of the communications technology, transportation infrastructure, and strategic defense systems. We, as Pakistanis, owe a debt of gratitude to our engineers.

I also extend a notable acknowledgment for the Scholarship Awards program helmed by IEP Saudi Arabia Center for engineering students in Public Sector Engineering Universities in Pakistan and Azad Kashmir which deserves an emphatic accolade.

I wish The Institution of Engineers in both Pakistan and Saudi Arabia Centre, a very happy and prosperous future ahead and wish them luck for the successful commencement of this event.



Engr. Farhat Adil FIE (PAK)

President,

The Institution of Engineers, Pakistan

MESSAGE FROM THE SECRETARY GENERAL OF

THE INSTITUTION OF ENGINEERS PAKISTAN

With immense pleasure, the Institution of Engineers, Pakistan (IEP) Saudi Arabia Centre (IEP-SAC) is pleased to announce its Annual Seminar on May 4th, 2023, along with the publication of the Annual Magazine to commemorate this occasion.

Organizing technical seminars and publishing technical journals play a crucial role in facilitating the exchange of technical knowledge and expertise among fellow engineers, making a significant contribution to the dissemination of technical knowledge.

Pakistani engineers working abroad play an invaluable role in the development of Pakistan through their contributions, including foreign remittances and the transfer of the latest technology. Engineers working in Saudi Arabia have the potential to play an even more effective and vital role by adopting new innovations in various engineering fields, such as IT, Agriculture, and Construction industries, for the advancement of Saudi Arabia and Pakistan.

The commendable fundraising efforts of (IEP-SAC), including advertisements and personal contributions from its members, to award scholarships based on merit to needy students in Public Sector Engineering Universities in Pakistan and Azad Kashmir deserve the highest appreciation.

The seminar will undoubtedly contribute to the advancement of engineering knowledge and the welfare of the engineering community working in Saudi Arabia.

I extend my congratulations to the office bearers and members of the organizing committee for the seminar and the publication of the journal, and wish them all the success.

Engr. Amir Zamir Ahmed Khan

Secretary General, The Institution of Engineers, Pakistan

IEPSAC CENTRAL REGION
ANNUAL REPORT FOR 2022-23

We express our heartfelt gratitude to Allah SWT, who bestowed upon us the opportunity to present yet another edition of the IEPSAC annual journal in the year 2023. And it gives me great pleasure to present the annual report of IEPSAC. Throughout the year, we have organized various events and activities that have not only provided our members with opportunities for networking and personal development but have also contributed to the betterment of our community. This annual report is a testament to our collective achievements and serves as a reminder of the milestones we have achieved in the past year.

Here is a summary of the myriad of events that IEPSAC organized and conducted during the year 2022-23.

Annual Seminar – Feb 11, 2022

The Institution of Engineers-Saudi Arabia Center (IEP-SAC) organized an annual technical seminar in Riyadh, Saudi Arabia, on February 11, 2022. The seminar's title was "Hydrogen as an Alternate Fuel for Combined Cycle Power Plants," and Engr. Muhammad Ijaz Umar, Vice President of Acwa Power, was the speaker. He discussed how hydrogen gas can be used as an alternative fuel in power plants, and its potential for reducing carbon dioxide emissions.

The event complied with COVID-19 SOPs, with online participation from a large number of attendees, and some guests listening live at the local hotel. The ceremony started with recitation of Holy Quran. The Chief Guest of the event was Mr. Fayyaz Ahmed Khan, First Secretary of the Pakistani Embassy in Saudi Arabia. Technical Seminar committee convener, Engineer Dr. Rafiq Choudhry presented the introduction of the topic and the Guest speaker. IEP-SAC General Secretary Engr. Asim Siddiqui presented the annual report of the organization. The activities report of IEP-SAC Eastern Region was presented online by the Chairman of Eastern region, Engr. Rizwan Ahmad. Engineer Farooq Iqbal, chairman of the scholarship committee, presented the scholarship report. He said that IEP-SAC has been distributing 96 scholarships in 12 public sector Engineering universities of Pakistan for the last 25 years.

In his speech, the chief guest of the event, Mr. Fayaz Ahmed Khan praised IEP-SAC scholarship scheme for Pakistani engineering students and the services it is rendering to the Pakistani engineers' community living in Saudi Arabia. He assured the cooperation of the Embassy for the organization.

IEP-SAC Chairman Engineer Syed Muhammad Iqbal congratulated the Events Committee for organizing a successful seminar and assured to continue the series of such programs.

The Chief Guest of the event inaugurated the new issue of the online journal of IEP-SAC by opening the page of the journal on the computer amid applause.

In the end, an honorary shield was presented to the speaker of the seminar, Engineer Mohammad Ijaz Umar. Apart from this, all the authors who wrote articles in the latest issue of the technical journal were given certificates while certificates of excellence were also distributed among the council members. Engineer Syed Kirmani, a long-time council member of the Center, was presented with an honorary shield for writing article in the annual journal every year for the past 25 years. The event concluded with a group photo and a commemorative shield for the Chief Guest.

Mid Term Seminar – Dec 09, 2022

IEP-SAC held its 61st Technical Seminar on Friday, 9th Dec 2022 at a local hotel in Riyadh. Engr. Dr. Awais Mahmood, Associate Professor at King Saud University, Riyadh gave a presentation on 'Machine Learning with the role of academia in Data Science – Challenges and Approaches'. The seminar moderator was Engr. Asim Siddiqui who presented the agenda of the program after welcoming the Chief guest and seminar participants. The Chief Guest for the occasion was the Ambassador of Pakistan to Saudi Arabia, His Excellency Mr. Ameer Khurram Rathore. The program started with recitation of Holy Quran by Engr. Dr Hafiz Imran, followed by a presentation from the General Secretary, Engr. Asim Siddiqui who briefed the audience about the center's activities and how the center is helping the Pakistani Engineers community in the KSA.

The convener of technical seminar committee, Engr. Mian Abdul Hamid introduced the topic and the speaker of the event. He then invited the speaker, Engr. Dr. Awais Mahmood for his main lecture. Dr. Awais spoke at length about the emerging fields of Data Science and Machine Learning that originated by combining the established theories of Statistics, Mathematics and Computer programming. He elaborated on how Data Science helps to enhance the knowledge of its users to sort through the tremendous amount of data available through various inputs. The presentation was followed by a Q/A session from the audience.

Speaking on the occasion, the Ambassador of Pakistan H.E. Rathore lauded the efforts and services offered by IEPSAC to Pakistani professional engineers working in KSA. In particular, he was deeply impressed by the center's scholarship initiative through which the center is supporting 96 engineering students in 12 public sector universities of Pakistan. The Chairman of IEP-SAC, Dr. Rafiq Choudhry thanked the speaker Dr. Awais for choosing an interesting topic and delivering an informative presentation. He thanked His Excellency, the Ambassador for taking proactive measures for the Pakistani diaspora in the Kingdom and for the continuous patronage by the Embassy for IEP-SAC. He also thanked the Custodian of the two Holy Mosques, King Salman bin Abdulaziz and Crown Prince Mohammad bin Salman for all the facilities extended by the Saudi government to Pakistani engineers working in the public and private sectors.

Shields of appreciation were presented to the guest speaker Dr Awais Mahmood for his excellent presentation and to the Ex-Chairman of IEPSAC, Engr. Syed Muhammad Iqbal. The event ended with a group photo and dinner for all participants.

Annual Family Picnic – Feb 10, 2023

On the 10th of February 2023, the IEPSAC community came together to celebrate their annual family picnic in the scenic venue of Muzahimiyah. A cherished tradition, this yearly event is much anticipated and celebrated by all who attend, as it offers a perfect opportunity to bask in the warm embrace of a relaxing atmosphere and engage in fun-filled activities throughout the day. The organizing committee ensured that there were activities for every age group, keeping families entertained and engaged throughout. The event was graced by the presence of several dignitaries from the Embassy of Pakistan in Saudi Arabia, accompanied by their loved ones.

The children, bubbling with energy, eagerly participated in a variety of games, while the youth relished the chance to burn their energy in competitive games such as cricket, table tennis, and several other exciting group activities. Onlookers were captivated by the spectacle of the cricket tournament, tug of war, and musical chair, cheering on their favorite teams. The Musha'era and Quiz competition were a feast for the soul, as participants were enraptured by the poetic and literary values showcased. A delightful lucky draw session saw several attendees receive prizes, adding to the merriment of the day. The female section, as always, radiated vitality and vigor, with games, performances, riddles, jokes, and enjoyment for all ages. A local caterer, who prepared delicious breakfast and lunch on-site, provided the attendees with sustenance, while tea and snacks were available throughout the day.

IEP-SAC Central Region Elections

The duly approved bye-laws of IEPSAC mandate the election of the Chairman at the end of each biennial term. On the 16th of September 2022, the council carried out the election, which resulted in the election of Engr. Dr Rafiq Choudhry as the Chairman of IEP-SAC for the upcoming biennial term of 2022-24. Engr. Dr Rafiq expressed his gratitude for the council members' trust and confidence in him, and he humbly accepted the nomination. Additionally, he nominated Engr. Asim Siddiqui as the General Secretary, who, in turn, nominated Engr. Dr Fakhir Hasni as the Joint Secretary of the organization. The council wholeheartedly approved the nominations and recognized the nominees' exceptional abilities while promising to provide them with complete support.

The council also expressed their heartfelt gratitude and admiration for the unyielding dedication and indefatigable efforts of Engr. Syed Iqbal, who, for a period of four years, served as the esteemed Chairman of IEPSAC, and contributed immeasurably to the progress and development of the organization.

The tireless efforts and unwavering dedication of the IEPSAC council members have been the cornerstone of the organization's success. Their ceaseless commitment to planning and executing activities throughout the year has ensured that IEPSAC continues to thrive.

It is always prudent for organizations to reflect on their past, analyze their performance, and evaluate their achievements during the year. Such introspection is vital to promote the culture of continuous improvement within the organization. A thriving entity is always open to new ideas and suggestions for growth and development. Therefore, we wholeheartedly welcome your valuable suggestions to enhance our organization and implement innovative ideas.

My heartfelt gratitude goes to all of you for your invaluable contributions to the organization. I would also like to extend my deepest appreciation to the council leadership for their continuous guidance and support. None of this would have been possible without their firm commitment and vision.

In addition, we would like to extend our gratitude to the Custodian of the Two Holy Mosques, King Salman Bin Abdul Aziz, and His Royal Highness, Prince Mohammad Bin Salman Bin Abdul Aziz for their unwavering support to the Pakistani community in KSA. Their benevolent leadership and steadfast commitment to the community have been a source of inspiration for all of us.

Warmest regards,

Mohammad Asim Siddiqui

General Secretary, IEPSAC Central region

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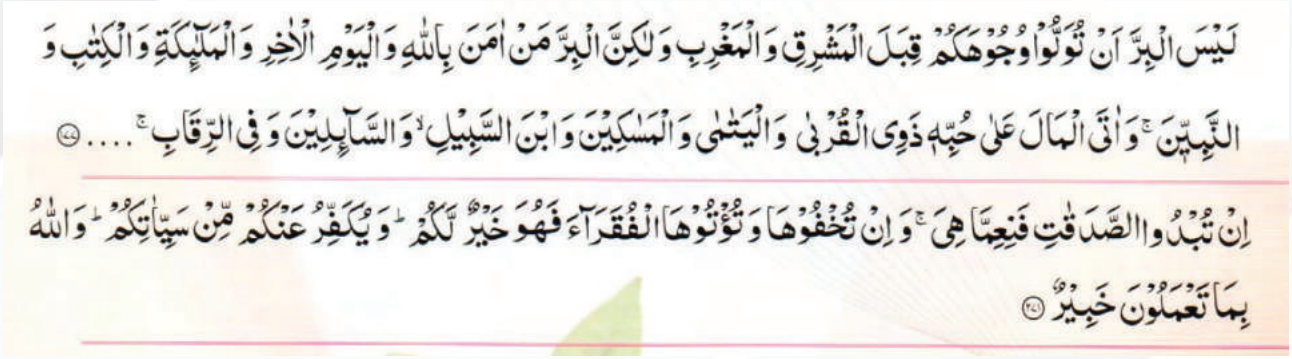
IEP-SAC AWARDS & SCHOLARSHIPS COMMITTEE


لَيْسَ الْبِرَّ اَنْ تُوَلُّوْا وُجُوْهَكُمْ قِبَلَ الْمَشْرِقِ وَالْمَغْرِبِ وَلٰكِنَّ الْبِرَّ مَنْ اٰمَنَ بِاللّٰهِ وَالْيَوْمِ الْاٰخِرِ وَالْمَلٰٓئِكَةِ وَالْكِتٰبِ وَ
النَّبِيّٖنَ ۚ وَاٰتَى الْمَالَ عَلٰى حُبِّهٖ ذَوِي الْقُرْبٰى وَالْيَتٰمٰى وَالْمَسٰكِيْنَ وَابْنَ السَّبِيْلِ ۙ وَالسَّآئِلِيْنَ وَفِي الرِّقَابِ ۚ ....۞
اِنْ تُبْدُوا الصَّدَقٰتِ فَنِعِمَّا هِيَ ۚ وَاِنْ تُخْفُوْهَا وَتُؤْتُوْهَا الْفُقَرَآءَ فَهُوَ خَيْرٌ لَّكُمْ ۚ وَيُكَفِّرُ عَنْكُمْ مِّنْ سَيِّاٰتِكُمْ ۚ وَاللّٰهُ
بِمَا تَعْمَلُوْنَ خَبِيْرٌ ۞

"But Al-Birr (righteousness, piety) is the quality of one who believes in Allah, and the Last Day, and the Angels, and the Book, and the Prophets and distributes his wealth, in spite of love for it, to the kinsfolk, and to the orphans, and to the needy, and to the wayfarer, and to those who ask, and to the ransom of prisoners." (Al-Baqarah-177)

"If you disclose your (acts of) charity, it is well, but if you conceal it, and give it those (really) in need, that is better for you; it will remove from you some of your (stains of) sins and Allah is well acquainted with what you do." (Al-Baqarah-271)

The Engineer plays an important role in the development of any country and build a better world. IEP-SAC, Saudi Arabian chapter of The Institute of Engineers Pakistan under the patronage of the Embassy of Islamic Republic of Pakistan in Saudi Arabia along with other technical and social activities is also playing its role in supporting Engineering education in Pakistan.

By the grace of Allah the Almighty, the IEP-SAC scholarship program for needy and academically sound students in the Engineering Universities and Colleges of Pakistan was launched 26 years ago in the year 1996. With the joint efforts of IEP-SAC, Local Council members, and others, it has been expanding ever since and presently 96 students from the below listed 12 public-sector universities and colleges are benefiting from this program.

1. University of Engineering and Technology, Lahore
2. University of Engineering and Technology, Taxila
3. University College of Engineering and Technology (Bahauddin Zakariya University), Multan
4. Institute of Chemical Engineering and Technology (University of the Punjab), Lahore
5. Dawood University of Engineering and Technology, Karachi
6. NED University of Engineering and Technology, Karachi

7. Mehran University of Engineering and Technology, Jamshoro
8. Quaid-e-Awam University of Engineering Sciences and Technology, Nawabshah
9. NWFP University of Engineering and Technology, Peshawar
10. Baluchistan University of Engineering and Technology, Khuzdar
11. Mirpur University of Science and Technology, Mirpur (AJ&K)
12. Khawaja Fareed University of Engineering and Information Technology, Rahim Yar Khan

As can be noted from the list, this scholarship program serves all the four provinces of the Islamic Republic of Pakistan and the State of Azad Jammu and Kashmir. The rules and regulations, selection criteria and application forms can be accessed and printed from IEPSAC website. By the blessings of Allah the Almighty, 23 batches of the scholarships have been completed so far and 24th batch was launched in January 2022, benefiting meritorious and needy students from this scholarship program who will serve the humanity and our homeland after graduation.

The continuity of IEP-SAC scholarship program has not only been maintained during last 26 years, but it has also been expanding gradually with the help of financial contributions from various philanthropists, individuals, and organizations in Saudi Arabia. I take the opportunity to offer the readers of these lines in general and the Pakistani community and engineers in particular to join hands with us in this noble and just cause. It is a great service to the Engineering community in Pakistan. It is my humble request to all to put our maximum efforts in contributing and expanding the scholarship program to the needy and deserving engineering students in Pakistan.

Your suggestions to improve this noble cause further will be most welcomed. Please do not hesitate to contact any of the members of IEP-SAC Awards and Scholarships Committee or Local Council for any suggestion or information.

Arch. Farooq Iqbal, Convener

IEP-SAC Awards and Scholarships Committee

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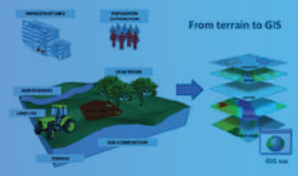

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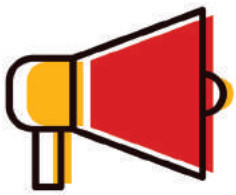

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See page 149 for the Membership Form

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CENTRAL REGION

Midterm Seminar

SCENES FROM IEP-SAC Activities

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Midterm Seminar











SCENES FROM IEP–SAC Activities

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Annual Seminar 2022









SCENES FROM IEP-SAC Activities

CENTRAL REGION

Annual Seminar 2022

SCENES FROM IEP–SAC **Activities**

CENTRAL REGION

Annual Family picnic




















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Engr. Mohammad Asim Siddiq	General Secretary
Engr. Dr. Fakhir Hasani	Joint Secretary

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Engr. Mian Hamid	Convener
Engr. Syed Iqbal	Co-Convener
Engr. Dr. Fakhir Hasani	Member
Engr. S. M. H. Kirmani	Member

Publication Committee	
Name of LC Member	**Role**
Engr. Dr. Awais Mahmood	Convener
Engr. Naveed Ahmad	Co-Convener
Engr. Riaz Ahmad	Member

Events Committee	
Name of LC Member	**Role**
Engr. Riaz Ahmad	Convener
Engr. Dr. Awais Mahmood	Co-Convener
Engr. Farhan Yazdani	Member
Arch. Farooq Iqbal	Member
Engr. Ijaz Akhtar	Member

Scholarship Committee	
Name of LC Member	**Role**
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Engr. Ijaz Akhtar	Co-Convener
Engr. Dr. Fakhir Hasani	Member

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Name of LC Member	**Role**
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Engr. Ijaz Akhtar	Co-Convener

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Engr. Mohammad Yousuf Ismail	Member
Engr. Jaleel Hassan	Member

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Engr. Mohammad Yousuf Ismail	Member
Engr. Abdul Qadir Akbani	Eastern Province

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Name of LC Member	**Role**
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Dr. Hafiz Imran	Co-Convener
Engr. Dr. Fakhir Hasani	Member
Engr. Mian Hamid	Member

Message from Chairman IEP -SAC
(Eastern Region)

We strive to come together and share current innovative knowledge among engineers of all nationalities around us. We engage and take advantage of all to share and benefit from each other's strengths and new ideas purely on a technical basis to serve our communities.

After a tough period facing corona pandemic, life has progressively come to normal. By Following the governmental directives, IEP-EP gradually commenced its physical meetings and activities in 2022.

Major activity at beginning of this year was meeting & discussion with the newly appointed Ambassador of Pakistan "HE. Ameer Khurram Rathore" where multiple issues were discussed for the best interest of the engineering community and Pakistan.

IEP-EP honored its long-serving council member Engr. Sami Uddin Chughtai decided to leave KSA after 24 years to Canada in June 2022. Engr Chughtai was the convener of the membership committee.

On request from the Embassy of Pakistan, a technical team was formed to collaborate with TEVTA Pakistan. The aim was to target USD 815 Billion worth of new projects that have been announced in Saudi Arabia which are not limited to engineering or construction sectors and should be targeted to have our maximum share. Our target is to identify the skills and courses required to be introduced in Pakistani institutes under TEVTA so that persons with the right knowledge can join Saudi Market.

Mankind has been harvesting wind energy for the past millennium. Technological advancements in the modern era are now commonplace and wind energy harvesting is no exception. We conducted a hybrid webinar on wind energy potential, its availability and assessment, and global & regional wind power statistics including KSA and Pakistan to promote awareness on the topic. The webinar was presented by Dr. Farooq Saeed of Imam Abdulrahman bin Faisal University, Dammam. A graduate of the University of Illinois, USA, he holds 9 US patents, has authored 100+ peer-reviewed publications, and is a senior consultant for the design of wind turbine/energy systems for a Canadian company.

The brief is as under:

"Wind Energy & The Regional Outlook" by Engr. Farooq Saeed, Dr

The discussion focus was on the topic of wind energy, and its history through the ages leading to the technological advancements in the modern era. A brief introduction to the basics of wind power highlighted key parameters that are essential for harnessing maximum energy from the wind. The seminar covered topics to help promote awareness among the public and promote knowledge about wind energy, and global and regional wind power statistics.

The eastern province sub-center is actively fulfilling its roles and responsibilities to establish and promote excellent relationships and interactions among its members and other professionals. We provide opportunities for the exchange of engineering and scientific information and organize technical visits, research studies, conferences, seminars, and workshops on engineering subjects.

We appreciate the support of our sponsors, fellow engineers, local industries, the Saudi Council of engineers, and the Jordanian Engineers Association for their valuable contribution to our success.

Finally, we thank Allah (swt) for providing us with resources, energy, and opportunities to serve our engineering community.

Rizwan Ahmed,

Chairman,

IEP-SAC-EP

1- Eid Milan Party & Desert Camping

IEP-EP arranged Eid Milan Party for its council members and families. Another similar event was arranged outdoor at state of art Desert Camp by the Social events committee. Such events give chance not only to families to gather & meet but at the same time provide a refreshing ambiance to council members out of their professional busy schedule. Members enjoyed outdoor and indoor games, BBQ, bonfires with a traditional touch of Saudi Arabia.

2- Farewell Party for Engr. Sami Uddin Chughtai

IEP-EP honored its long-serving council member Engr. Sami Uddin Chughtai decided to leave KSA after 24 years to Canada in June 2022.

He was the convenor of the IEP-EP membership committee and an active part of other committees as well. Engr. Chughtai's efforts for IEP-EP as well as for Pakistani Community would not be forgotten. His most significant contribution was the employment of Pakistani engineers in various organizations.

3- Lecture at KFUPM

IEP- EP council member Engr. Munawar Zaman delivered a lecture to undergraduate students at King Fahad University of Petroleum and Minerals on Cost Estimation and Cost Control on project sites.

The lecture was part of the seminar committee's goal of disseminating knowledge to university students and engineers at large.




Collaboration between Tevta, IEP-SAC-EP & **Pak Embassy(Eastern Region)**

On request from the Embassy of Pakistan, a technical team was formed to collaborate with TEVTA Pakistan containing selected council members Engr. Mohammed Abrar Shami, Itlaque Ahmed Khan, Nabeel Pervaiz Malik, Mohammed Munawar, Ahmed Raza.

The representation from TEVTA was by Mr. Muaaz Saleem and Mr. Ubaid Ur Rehman. Mr. Sohail Babar (CWA) from Pakistan Embassy coordinated all sessions to provide necessary data and information to TEVTA.

Some important highlights from this joint effort are as below:

1. CWA shared embassy focus on manpower export from Pakistan which has resulted in excellent progress regarding labor/semi-skilled/skilled manpower. The manpower exported till June 2022 was 172,000 whereas the target is to increase it to 400,000 by Dec 2022 against 152,000 for the full year 2021.
2. CWA also emphasized that USD 815 Billion worth of new projects have been announced in Saudi Arabia which are not limited to engineering or construction sectors and should be targeted to have our maximum share.
3. NAVTEC (Federal body for certification and diplomas) and TEVTA (Provincial Bodies) have been asked to align their courses towards future requirements.
4. TEVTA is handling this as of now 23 trades while IEP has suggested that a total of 342 trades needed to be addressed. IEP explained the need to concentrate on high-paid trades like Rigger level 1, environmentalists, HSE officers, Quality officers etc.
5. IEP explained the need for improving the certifications, enhancing presentation skills, basic English language & understanding, etc.
6. IEP Team presented a list showing high-level data of Technology/Course outlines and brief contents.
7. TEVTA showed their deep interest to get input from IEP, especially fairly paid trades, its curriculum, certification bodies, the expected number of slots/jobs for



such trades, etc.

8. TEVTA explained that NAVTTC and TAKAMUL are collaborating on a skill verification program and have assessment centers across the country. They conduct paid assessment tests based on 60% practical with 40% theory and certify labor upon clearance.
9. IEP highlighted the English language/communication skills issue with the manpower. TEVTA said our focus is a local industry, that's why most teaching is in the local language. They are working on total curriculum design and will focus on communications skills as well.
10. CWA closed the discussion with comments that they will work closely with TEVTA to bridge the gap between TEVTA & NAVTTC. He also requested IEP support to identify as many skills as required for the Saudi market which will help them train the labor force back in Pakistan. As of now, TAKAMUL has identified 23 technologies only.
11. CWA will continue working with TEVTA, NAVTEC, and TAKAMAL to bridge the gaps.

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A CFD study of fluid flow and heat transfer in spacer filled feed channels of membrane distillation modules

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Abstract

Membrane distillation is an emerging technology in the field of desalination. It has the advantage that it can be operated in isolation in the remote areas using solar energy. The technology has the added advantages of being environment friendly, harmless to the ecological system and does not require extensive pre-treatment of raw feed water. Research in the area is currently in the direction of making this technology commercially competitive to the existing membrane filtration technologies such as reverse osmosis, micro and nano-filtration. Recent studies have shown that one possible way of achieving the desired goals is through improvements in the design of the membrane distillation module. Feed spacer is an important element of the spiral wound membrane module. It creates micro flow channels between adjacent membrane layers and provide strength to the module. In the modern scientific era computational fluid dynamics (CFD) has emerged as a useful tool for flow visualization and design optimization studies. In this research work CFD is used to model the flow and heat transfer inside the spacer. Parametric study is carried out for three spacer designs and temperature polarization coefficients are calculated to identify suitable spacers for membrane distillation. A numerical correlation for Nusselt number is obtained from the simulation results obtained through this work.

Introduction

Desalination of sea water in the Kingdom of Saudi Arabia is largely done through multi-stage flash (MSF), multi-effect distillation (MED), membrane processes such as reverse osmosis (RO) and membrane filtration (MF). These technologies have become quite matured over the years and have been used extensively for desalting water. Due to the growing population and a correspondingly higher demand of potable water in the Kingdom, the available water resources often get brackish or contaminated. Furthermore, the water supply system using these big plants which run on fossil energies is not always an economically and ecologically

feasible solution. The costs further increase when the inland regions are not connected to the main supply system and have to be supplied through trucks or some other means.

Membrane distillation (MD) technology has the advantage that it can also be operated in isolation in remote areas without depending on fossil fuels. However, significant research is required to make MD as an acceptable technology and it still remains an emerging technology for desalination. The driving force in a MD process is the vapour pressure of water across the membrane, rather than the total pressure. The MD membranes are hydrophobic in nature (i.e. they allow only water vapour to pass and no liquid water) and are made from materials such polyvinylidene difluoride (PVDF), Teflon (TF) and polypropylene (PP). The vapour pressure gradient is created by heating the source water, thus increasing its vapour pressure. The major energy requirement comes from low grade thermal energy such as solar or waste heat. A fraction of the hot fluid evaporates, flows through the porous membrane due to vapour pressure (or temperature) difference and then condenses on the low temperature side.

A membrane distillation process may be one of the following four types as shown in Fig. 1:

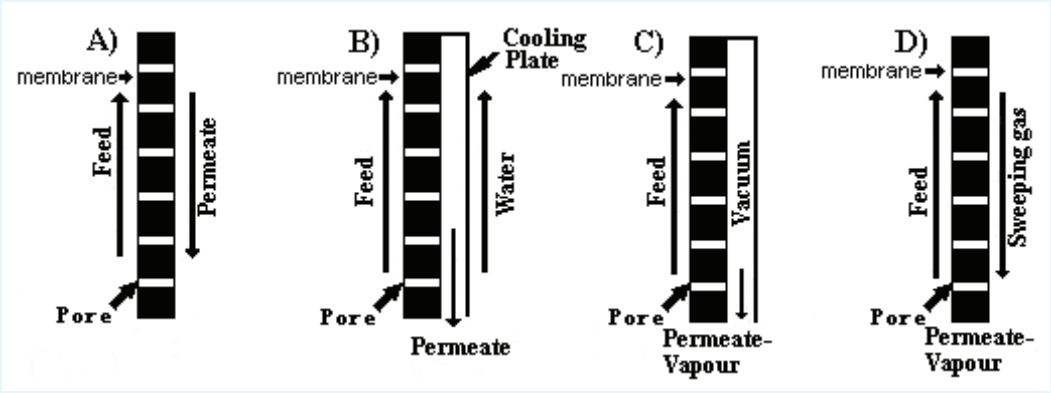

Figure 1: Configurations of various MD Systems [7]

A. **Direct-Contact Membrane Distillation** (DCMD). The cool condensing solution directly contacts the membrane and flows counter current to the raw water. This is the simplest configuration. It is best suited for applications such as desalination and concentration of aqueous solutions (e.g., juice concentrates).

B. **Air-Gap Membrane Distillation** (AGMD). An air-gap followed by a cool surface. The air-gap configuration is the most general and can be used for any application.

C. **Vacuum Membrane Distillation** (VMD). A vacuum is used to pull the water vapour out of the system. Useful when volatiles are being removed from an aqueous solution.

D. **Sweep-Gas Membrane Distillation** (SGMD). A sweep gas pulls the water vapour and/or volatiles out of the system. Useful when volatiles are being removed from an aqueous solution.

A MD system offers several advantages such as it produces high quality distillate by completely rejecting almost all ions and macro molecules. The water can be distilled at relatively low temperatures and pressures. Low grade thermal energy such as solar and waste heat can be used to heat water and does not require extensive pre-treatment as in the case of pressure-based membrane water treatment. Membrane distillation is one research area that still needs to be explored further. With renewed interest in alternative clean energy technol-.ogies such as solar energy, MD shows promise to become a very competitive technology in future

Literature Review

Although the MD process has been known for almost 50 years but not much success could be achieved primarily due to non-availability of high quality hydrophobic membranes. The reported water fluxes were low as compared to RO and hence the technology lost its acceptance after only enjoying few years in the spotlight in the 1960's. Interest in MD technology was renewed in the 1980's as new membrane manufacturing techniques had become available that could produce high porosity-low thickness membranes at much lesser costs. Improvements in module design and a better understanding of the process itself also contributed to renewed interest in the technology thus making it competitive with RO and other MF technologies. Lawson and Lloyd [1] provided a very good review of the MD technology and discussed its advantages over existing technologies. Bier and Plantikow [2] fabricated and tested a solar-powered desalination system with energy storage using membrane distillation. Distillate flow output from this system was in the range of 40-85 litres/hour with a vacuum flat plate collector area of approximately 51 m^2. Koshikowski et al. [3] fabricated a solar based MD system with 6 m^2 of collector area without thermal storage producing 120-160 litres of water per day. Srisurichan et al. [4] experimentally studied fouling mechanism in a DCMD process. The experiments were conducted on a PVDF membrane with a pore size of 0.22μm. Several models were considered to predict the fouling behaviour and it was found that the 'Cake filtration model' fitted the data well while the fluxes on both sides of the membrane were best represented by the 'Molecular diffusion model'. Criscuoli et al. [5] studied the energy requirements in DCMD and VMD processes using a 0.2μm thick PP membrane. They reported that VMD performed better than the DCMD and the cross-flow design resulted to be the most efficient design for obtaining high fluxes with moderate energy consumptions.

The University of Texas at El Paso carried out a project on solar and waste heat desalination by membrane distillation and published a report [6] highlighting the main features of the project. The greatest success they achieved was that they operated their system at a hot side temperature as low as 13°C, the flux per unit temperature drop was only reduced about 50 percent compared to the flux at higher temperatures. The main problem encountered was the wetting of the membrane. Pressure spikes or lack of temperature gradient lead to wetting of some pores and subsequent decline in distillate quality. They further observed that leakage rate through wetted pores was proportional to pressure drop. If the hot water passing through the membrane module were kept near atmospheric pressure, the rate of leakage through wetted pores would be reduced to near zero. This would ensure high distillate quality even when water begins to penetrate the membrane pores. The Water Quality Research Australia (WQRA) studied membrane distillation of brine wastes and published a very comprehensive report [7] in which they demonstrated that MD has the following advantages over other membranes processes:

- It produces very high-quality distillate. In most circumstances salt rejections of 99-100% are achievable.
- Water can be distilled at relatively low temperatures (i.e. 5 to 80°C). As the driving force for MD is temperature difference, very low feed temperatures can produce reasonably high rates of product water and may be more practical considering the nature of some water impurities (e.g. scaling issues at high temperature).
- Low-grade heat such as industrial waste heat, solar or desalination waste heat may be used.
- The feed water does not require extensive pre-treatment that is typically required for pressure-based membrane processes.

Despite benefits of the membrane distillation a phenomenon that limits its effectiveness is temperature polarization. Temperature polarization exists due to the fact that the temperature difference across the membrane surfaces ($T_{m1} - T_{m2}$) is lower than the difference of the bulk fluid stream temperatures ($T_{b1} - T_{b2}$) as shown in Fig. 2.

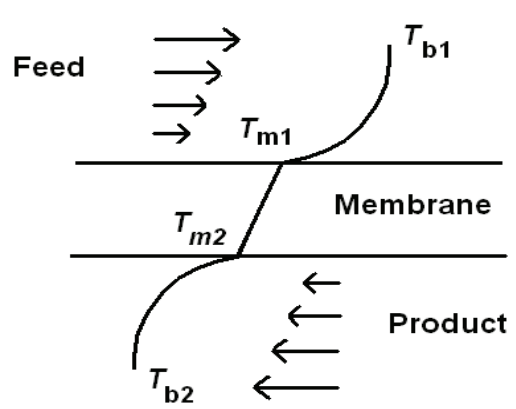

Figure 2: Temperature variation in DCMD process

This reduces the driving force for vapor permeation. In many MD modules net-type spacers are used which separate the membrane layers. In addition, spacers also disrupt the thermal boundary layer thereby increasing the heat transfer rates and in-turn enhance the permeate flux. Various studies have been done to investigate the effect of spacers on the membrane performance. Martínez et al. [8, 9] studied the influence of three different types namely, open separator, coarse screen separator and fine screen separator. It was found that the presence of screen separators introduce turbulence due to formation of eddies and wakes, causing a reduction in temperature polarization and enhancing the permeate flux. The study also showed that coarse separator was best among three configurations. In another work Martínez et al. [10] found that increase in feed circulation rates cause a significant increase in the heat transfer coefficient values in MD. Phattaranawik et al. [11] carried out experiments for DCMD. Product flux enhancement of around 31 – 41 % was noticed when spacers were used in the

membrane channels. In another paper [12], the same authors considered different spacers and identified an optimal spacer with a void fraction of 0.6 and a hydrodynamic angle of 90°. Chernyshov et al. [13] tested spacers with round and twisted filaments in AGMD process. The spacers of round filaments with flow attack angle of 45° and twisted filaments with an angle of 30° resulted in highest fluxes. Computational fluid dynamics (CFD) has also been applied to study the membrane distillation modules. Xu et al. [14] simulated the temperature and mass flux profiles in AGMD. The results showed that temperature polarization phenomena can be reduced by increasing feed Reynolds number. Alklaibi and Lior [15] performed simulations for three different spacer arrangements: zigzag spacer, non-central suspended and central suspended. The three arrangements were compared on the basis of spacer effectiveness defined as ratio of the permeate fluxes with and without spacer. The central suspended spacer resulted in highest spacer effectiveness. Cipollina et al. [16] conducted 3D simulation for spacer-filled MD channels and demonstrated that the presence of spacers considerably improve the temperature polarization. In this paper, the effect of spacer filament thickness and filament spacing on fluid flow and heat transfer is investigated using CFD. The objective of this work is to show that appropriate spacer dimensions are crucial for reducing temperature polarization and thus to improve the heat transfer characteristics of membrane systems.

Mathematical and CFD models

The CFD modeling in this work is carried out for hot side (channel) of membrane distillation module. The spacer-filled channel contains number of cells and flow becomes repeating after first few cells. It is thus suitable to restrict the computational domain to single cell composed of two filaments as shown in Fig. 3.

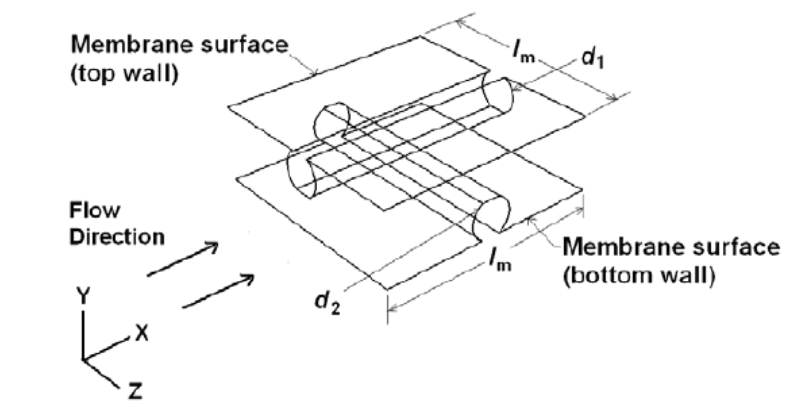

Figure 3: Computational domain for spacer-filled channels

This procedure allows modeling fully developed flow region in the membrane channel and also reduces the computational time and space. Periodic boundary conditions are used at the opposite vertical faces in *x*-direction. The vertical faces in *z*-direction are symmetric and mass flow rate is specified in the *x*-direction. No-permeation and no-slip conditions are assumed at the channel walls. Bulk temperature is 57°C whereas constant heat flux (q_w) of 20 kW/m^2 is

imposed on the top and bottom walls for all the simulations. The above values of temperature and heat flux are among the typical conditions commonly encountered in membrane distillation process.

The governing equations are continuity, momentum and energy equations which are solved using CFD code ANSYS-FLUENT. QUICK scheme is used for discretization of momentum equations whereas Power Law scheme is used for energy equation. Pressure-velocity coupling is made through SIMPLEC algorithm. The fluid used is water which is assumed to be of constant density and thermal conductivity whereas viscosity varied with temperature. Three types of spacers are considered in this paper. The dimensions of each are listed in Table 1.

Table 1: Spacer dimensions

Spacer name	l_m	d_1	d_2	d_h
A	3	0.5	0.5	1.25
B	2	0.5	0.5	1.00
C	3	0.6	0.4	1.25

To compare the above spacers, the values of temperature polarization index φ are computed. The temperature polarization index is defined as:

$$\varphi = \frac{T_b}{T_m} \tag{1}$$

where T_b and T_m are temperatures respectively of bulk fluid and at the membrane surface. A lower value of φ means less temperature gradient in the channel and the better it is.

The temperature polarization indices are obtained at different Reynolds number (Re_{ch}) defined as [17]:

$$Re_{ch} = \frac{u_{av} d_h}{\nu} \tag{2}$$

$$d_h = \frac{\text{Volume of flow channel}}{\text{Wetted surface}} \tag{3}$$

The values of Nusselt number and Prandtl number are also determined for comparison of present results with

ones available in literature. These dimensionless numbers are defined as:

$$Nu = \frac{hd_h}{k} \quad (4)$$

$$h = \frac{q_w}{T_b - T_m} \quad (5)$$

$$Pr = \frac{\mu C_p}{k} \quad (6)$$

The results are compared with correlation given in Eq. 7 which was originally used for mass transfer in spacer-filled channels [18]. Due to heat and mass transfer analogy this relation however can be extended for membrane distillation with reasonable accuracy [11].

$$Nu = 0.664 Re_{ch}^{0.5} Pr^{0.33} \left(\frac{d_h}{l_m} \right)^{0.5} \quad (7)$$

Results and Discussion

Previous CFD studies have shown for pressure driven membrane processes such as ultrafiltration and reverse osmosis that feed spacers greatly alter flow and concentration patterns. Therefore, proper selection of feed spacer geometry is essential for enhancing heat transfer in membrane distillation process and is investigated in this work. To obtain the velocity and temperature profiles at different Reynolds number the grid is fine enough so that the results become independent of grid. For example, spacer A is tested at 100,000 and 250,000 cells. The difference of temperature polarization index and pressure drop at Reynolds number of 150 is found to be less than 1 %. The temperature contours overlapped with vector plot in Fig. 4 show the effect of spacer type and Reynolds number. It is observed that temperature values at two planes $l_m/2$ and $l_m/8$ (from top filament) are higher in the upper portion as fluid moves above the bottom filament. In the lower portion, a relatively low temperature region exists where flow recirculation takes place. In Fig. 4b where the Reynolds number is reduced to 50 for spacer A, the flow recirculation is found to be of shorter length as evident from the direction of velocity vectors. A comparison of temperature profiles at two planes shows that temperature values are uniform and higher on the symmetric plane ($l_m/2$ from top filament). On the plane near the top filament (Fig. 4b) the temperatures are lower indicating a higher degree of temperature polarization that is undesirable. Spacer B shows similarity with spacer A in terms of temperature patterns at Re_{ch} = 150 (Fig. 4c). The zones of high/low temperature polarization

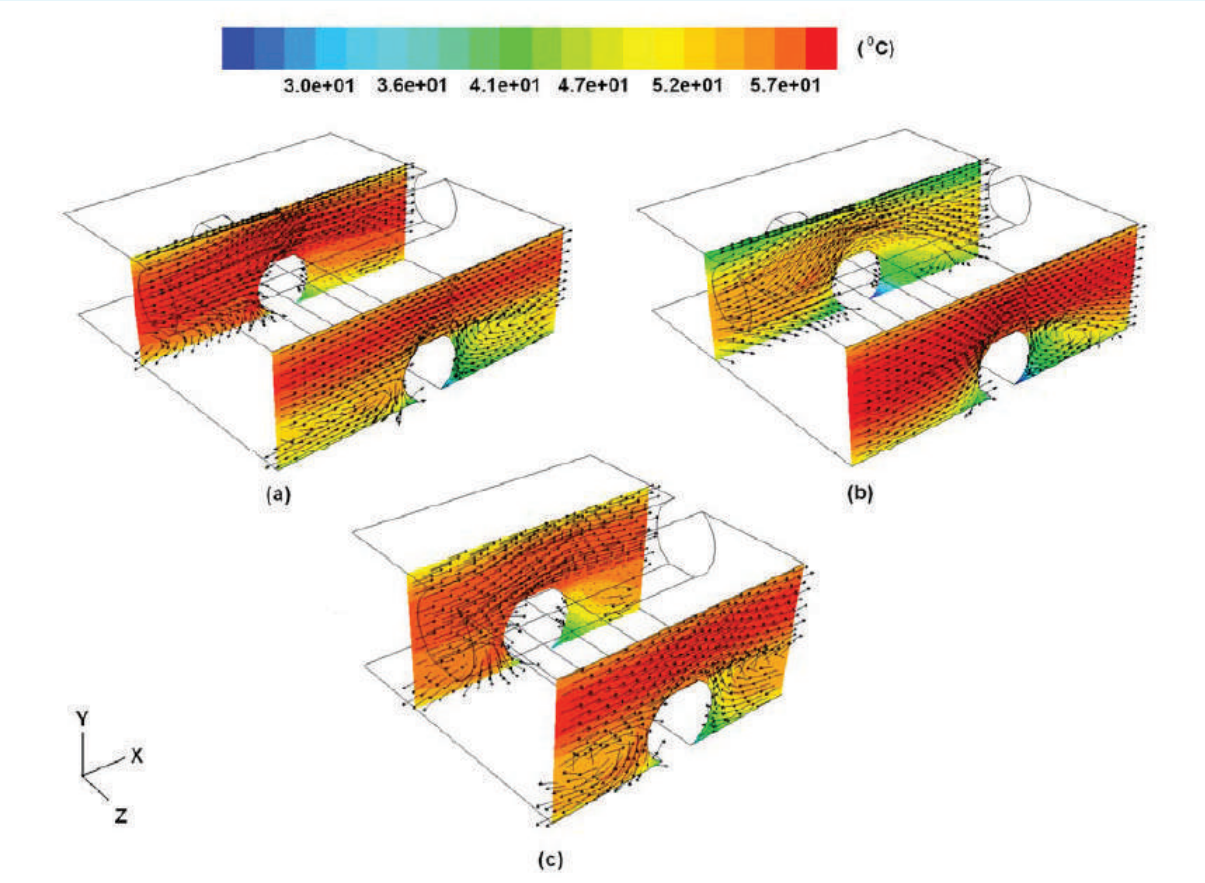

Figure 4: Temperature contours and velocity vector plots for (a) spacer A, Re_{ch} = 150 (b) spacer A, Re_{ch} = 50 (c) spacer B, Re_{ch} = 150

indices φ can be seen from contours in Fig. 4. For all cases it is found that region very near the top and bottom filaments at the membrane surfaces have high φ values (more obvious in Fig. 4b) implying lower values of heat transfer coefficient. This region thus will yield low vapor fluxes and will also be susceptible to fouling. Best distribution of φ at top surface is noticed with spacer A at *Re*ch = 150 as values are closer to 1 on a major portion. The behavior of spacer C is not shown here (in Fig. 4) but from its contours it is noticed that the distribution is similar to spacer A except the magnitude of φ indices is higher. The results shown in Figs. 3 and 4 are at a Prandtl number of 3.7. The membrane distillation process however can be used for variety of applications like fruit juices concentration and blood purification [1] which leads to significantly different Prandtl number values. The effect of Prandtl number is thus also investigated for spacers A and B at a Reynolds number of 100. Fig. 5 shows temperature

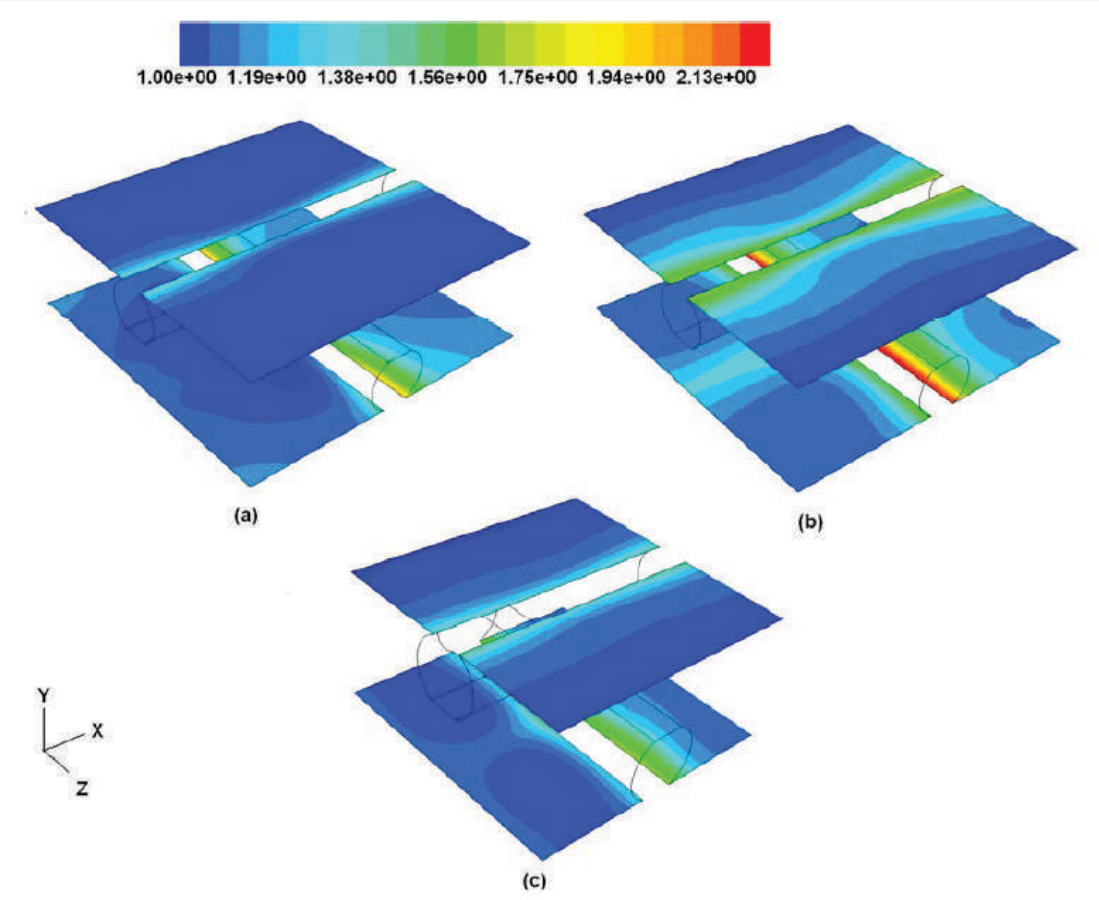

Figure 5: Temperature polarization index for (a) spacer A, Re_{ch} = 150 (b) spacer A, Re_{ch} = 50 (c) spacer B, Re_{ch} = 150

polarization contours for spacer B at two different Prandtl numbers. From the color map ranges it is clear that numerical values of temperature polarization index are much higher at low much higher at low Prandtl numbers whereas the distribution of φ over the membrane surface is qualitatively the same. On the bottom wall however the higher φ indices spread over a major portion at lower Prandtl number of 0.75 (Fig. 6a). The average temperature polarization indices

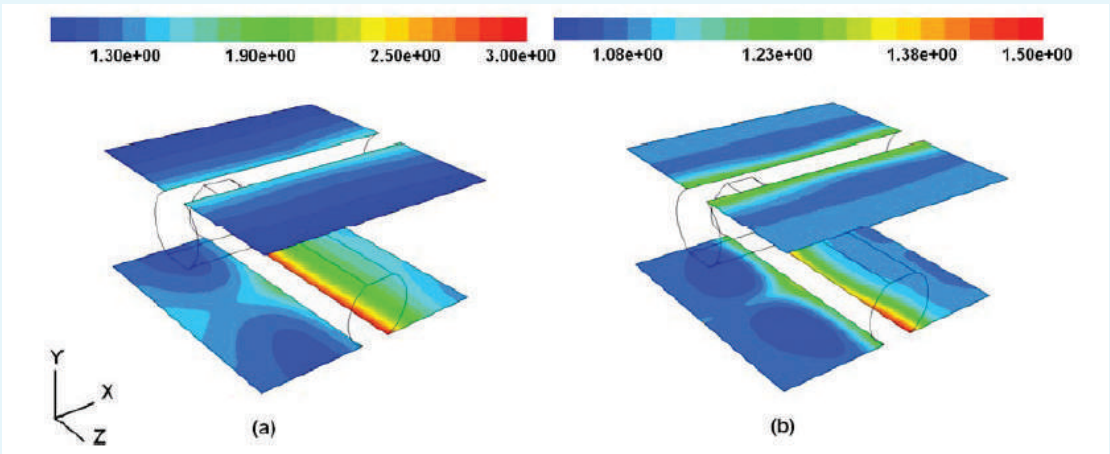

Figure 6: Temperature polarization index values for spacer B at (a) Pr = 0.75 (b) Pr = 18.2, spacer B, Re_{ch} = 100

are calculated and shown in Fig. 7 as a function of Reynolds and Prantdl numbers. For the spacers considered, as anticipated the temperature polarization decrease with increase in Reynolds number and Prandtl number. A comparison of spacers show that highest φ is obtained for spacer C. Spacer A has inferior heat transfer characteristics (or higher φ) when compared to spacer B at a Reynolds number of 50 whereas at higher Reynolds number of 150 the performance of spacer A becomes better. Though spacers A and B yield more or less same heat transfer rates but spacer A can be assumed to be superior as it has higher void fraction (or hydraulic diameter) and results in less pressure drop in comparison to spacer B. Separate calculations for top and bottom surfaces indicate that on top surface φ is relatively lower (5 – 10 %). The numerical results of this work are compared with experimental correlation (Eq. 7). The comparison of spacers A and C with this correlation is shown in Fig. 8a while of spacer B is shown in Fig. 8b since it has a different hydraulic diameter. The plots in Fig. 8 indicate that for most of the cases the agreement is acceptable.

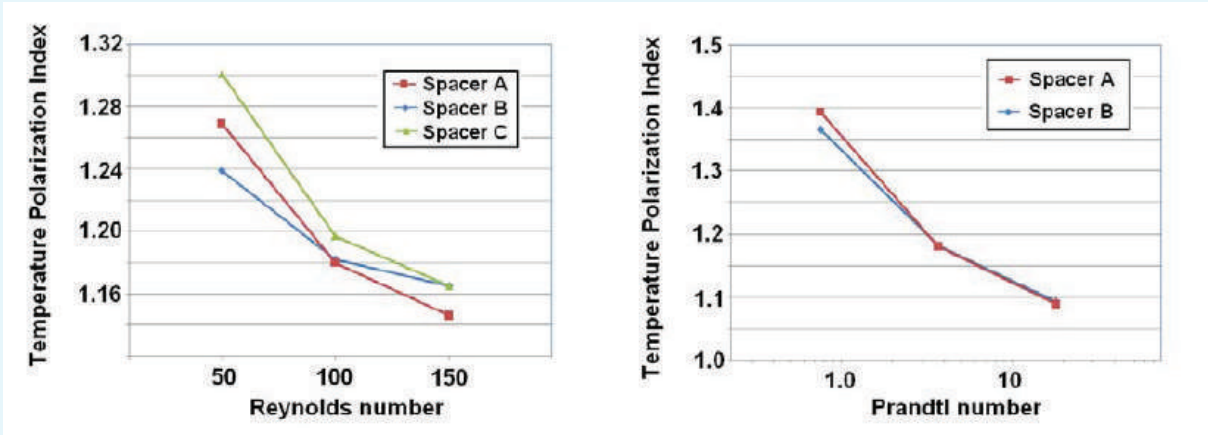

Figure 7: Effect of Reynolds number and Prandtl number

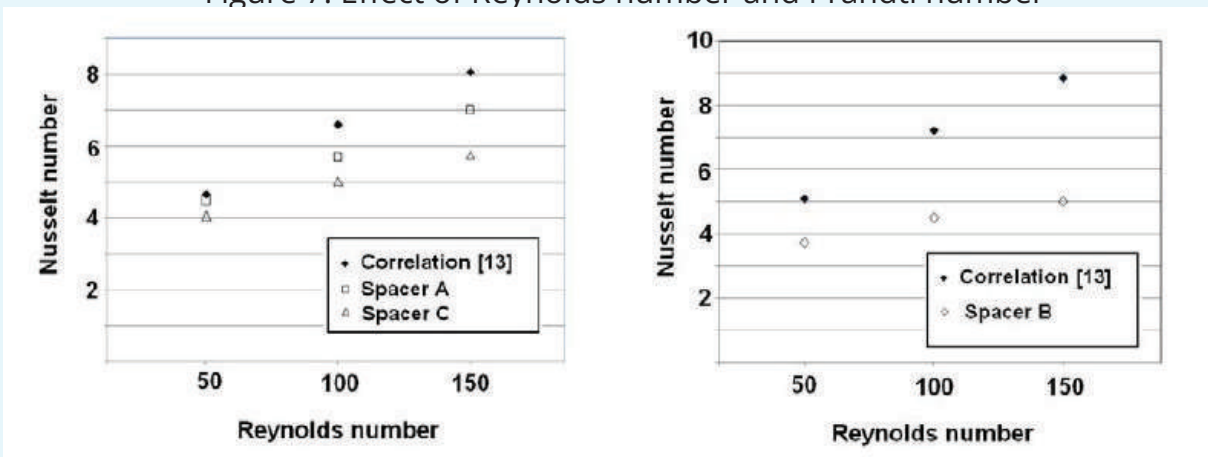

Figure 8: Comparison of CFD results with experimental correlation

From the results in this work a correlation (Eq. 8) is also developed for predicting heat transfer rates in membrane distillation channels. For the test conditions considered in this paper the maximum deviation with this relation is below 30 %.

$$Nu = 0.9 Re_{ch}^{0.33} Pr^{0.23} \quad (8)$$

Conclusions

CFD Modeling is carried out for temperature profiles and heat transfer rates in spacer-filled membrane distillation modules. The results show that magnitude as well as distribution of temperature polarization index depends on spacer type, Reynolds number and Prandtl number. The temperature polarization index is seen to be comparatively higher in the lower portion where flow recirculation takes place. For all cases the stagnant region near the spacer filament is a zone of lowest heat transfer. Spacer with a spacing of 3 mm and equal top and bottom filament thicknesses is found to be more suitable among the spacers considered in this study.

List of Symbols

Cp	specific heat (J/kg·°C)
d_1	top filament thickness (mm)
d_2	bottom filament thickness (mm)
d_h	hydraulic diameter (mm)
h	heat transfer coefficient (W/m^2·°C)
k	thermal conductivity (W/m·°C)
l_m	mesh length (mm)
Nu	Nusselt number
Pr	Prandtl number
q_w	heat flux (W/m^2)
Re_{ch}	Reynolds number
T_b	bulk temperature (°C)
T_m	temperature at membrane surface (°C)
u_{av}	average velocity (m/s)
μ	viscosity (kg/m·s)
v	kinematic viscosity (m^2/s)
φ	temperature polarization index

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Success

- Action is the foundational key to all success. **(Pablo Picasso)**
- In order to succeed, your desire for success should be greater than your fear of failure. **(Bill Cosby)**
- Always be yourself, express yourself, have faith in yourself, do not go out and look for a successful personality and duplicate it. **(Bruce Lee)**
- A successful man is one who can lay a firm foundation with the bricks others have thrown at him. **(David Brinkley)**
- Success is not final, failure is not fatal: it is the courage to continue that counts. **(Winston Churchill)**
- Try not to become a man of success, but rather try to become a man of value. **(Albert Einstein)**
- Always bear in mind that your own resolution to succeed is more important than any other. **(Abraham Lincoln)**
- Coming together is a beginning; keeping together is progress; working together is success. **(Henry Ford)**
- Strive not to be a success, but rather to be of value. **(Albert Einstein)**
- I've failed over and over and over again in my life and that is why I succeed. (Michael Jordan)
- All you need is ignorance and confidence and the success is sure. **(Mark Twain)**
- Success is a lousy teacher. It seduces smart people into thinking they can't lose. **(Bill Gates)**
- I don't know the key to success, but the key to failure is trying to please everybody.**(Bill Cosby)**
- Develop success from failures. Discouragement and failure are two of the surest stepping stones to success. **(Dale Carnegie)**
- The difference between a successful person and others is not a lack of strength, not a lack of knowledge, but rather a lack of will. **(Vince Lombardi)**

2022 Flood in Pakistan:

Climate catastrophes, causes, impacts and mitigation of disaster.

(Engr. S.M.H.Kirmani :Former Chairman of IEP-SAC, Vice-President in Saudi Technical Ltd. Riyadh)

Abstract:

United Nation's Secretary General Mr. Antonio Guterres stated that ," Pakistan is awash in suffering. The Pakistani people are facing a monsoon on steroids, the relentless impact of epochal levels of rain and flooding. This climate catastrophe has killed thousands of people, with many more injured. Millions are homeless, schools and health facilities have been destroyed ,livelihoods are shattered and critical infrastructure wiped out."

Pakistan is vulnerable and most affected by adverse impact of climate change. This study examines the impact of climate change on Pakistan during the year 2022 resulting into an unprecedented heat wave and drought in summer followed by the abnormal rains and floods during monsoon season. This study also provides recommendations to control the flood, beneficial utilization of flood water and to mitigate the post-flood negative impacts. In August 2022, the province of Sindh and Baluchistan received with 784% and 500% respectively more rainfall than average (1). Impact of abnormal melting of glaciers, non-availability of dams for storage of rain water has aggravated the effect on life and property.

While flood water is gradually receding, the stagnant contaminated water is causing several health risks for inhabitants. (2).

INTRODUCTION

Floods are among the most frequent natural disaster that cause greater economic losses and difficulties to human activities. About 90% of the damages caused by natural disaster (excluding draughts) are caused by floods and associated water flows. The social and economic cost of floods have risen in recent decades and the trend is continuing to rise if necessary action is not taken.

The summer rainfall in Pakistan is generally during the period of July to September. Monsoons from the bay of Bangal are the main source of these rains. The Indian ocean is one of the fastest warming ocean in the world, Warming by an average of 1°C (1.8° F). The rise in the sea surface temperature is believed to increase monsoon fall {4}. In addition, southern Pakistan experienced back to back heat waves in the month of May and June which were record Setting and themselves made more likely by climate change. These effects created a strong thermal low that brought heavier rains than usual. These heat waves also triggered glacial flooding in Gilgit-Baltistan {5}.

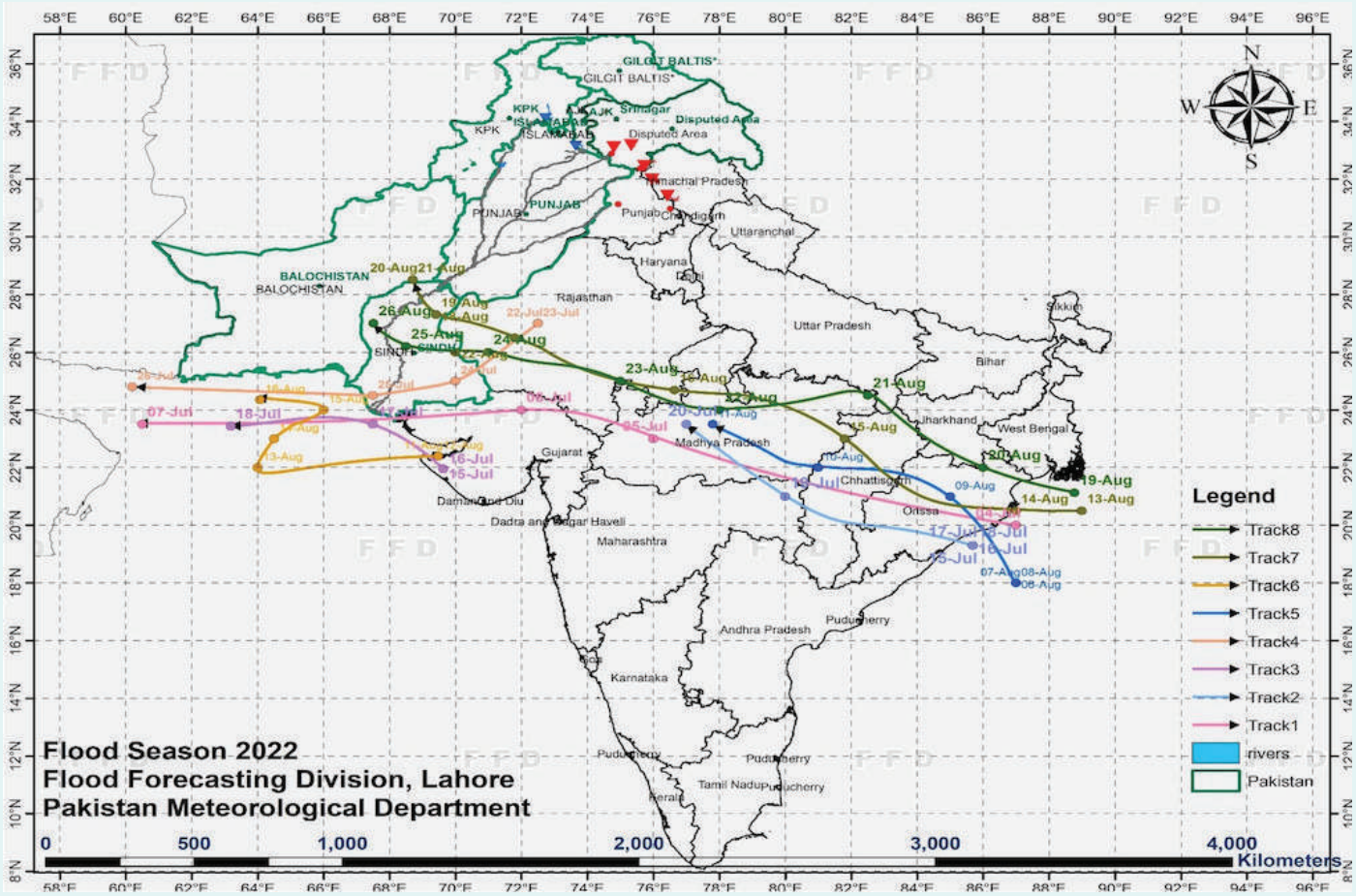
The years of 2010, 2011, 2012, 2013, 2020 and 2022 witnessed the worst flood in the history of Pakistan damaging crops, infrastructure, significant loss of human life and livestock, while

causing an unimaginable and prolonged suffering amongst the affected population. Over the month of June to August 2020, Pakistan received nearly 190% more rain than its 30 year average. The southern provinces of Sindh and Baluchistan were the worst affected receiving 726% and 590% of their normal August rainfall respectively {6}. It is reported that floods covered one third of the country land and is estimated to have caused a loss of more than USD 30 billion.

CAUSES OF FLOODS:

Flooding occurs when lakes, riverbeds, soil and vegetation cannot absorb all the water. Water then escapes from land in quantities that cannot be transported into the channels of streams or retained in natural ponds, lakes and manmade reservoirs. River flooding is usually caused by heavy rains, sometimes by snow melting. Rapid flooding with little or no advance warning is called a sudden flood. Sudden floods usually result from heavy rains.

Pakistan's flooding of 2022 was mainly caused by prolonged rainfall that hit the country in a series of "Monsoonal Depression". This depression, the regions of low pressure, travel from bay of Bangal over the Indo-Gangetic plains, causing rainfall over the eastern upper Indus basin. Pakistan was affected by eight depressions in the summer of 2022. While these depression usually travel towards the north of the country over the monsoon season, all eight tracks moved over the southern provinces of Sindh and Baluchistan this year, drawing heavy rainfall over southern Pakistan {6}.



Dr. Fahad Saeed, the regional lead for South Asia and Middle East, at "Climate Analytics" pointed out that the heat wave over March and April, which was made 30 times more likely by climate change, "brought the depression from the bay of Bangal towards the southern provinces of Pakistan." {6}.

Although Pakistan remains significantly low on the global C02 emission list, yet the effects of the global warming have reached Pakistan in a sweeping manner {7}. The issue that the industrialized countries failed to realize that environment does not belong to a single country and when one country damages the ozone layer, the entire world pay the prize for that. The year 2022 was such year for Pakistan when the effects of the climate change brought heavy rainfall resulting in major loss of lives, damages to infrastructure and massive economic losses estimated to USD30 billion. {8}.

The NASA issued satellite imagery on the flood situation in Pakistan 2022, which is given in figure 1.

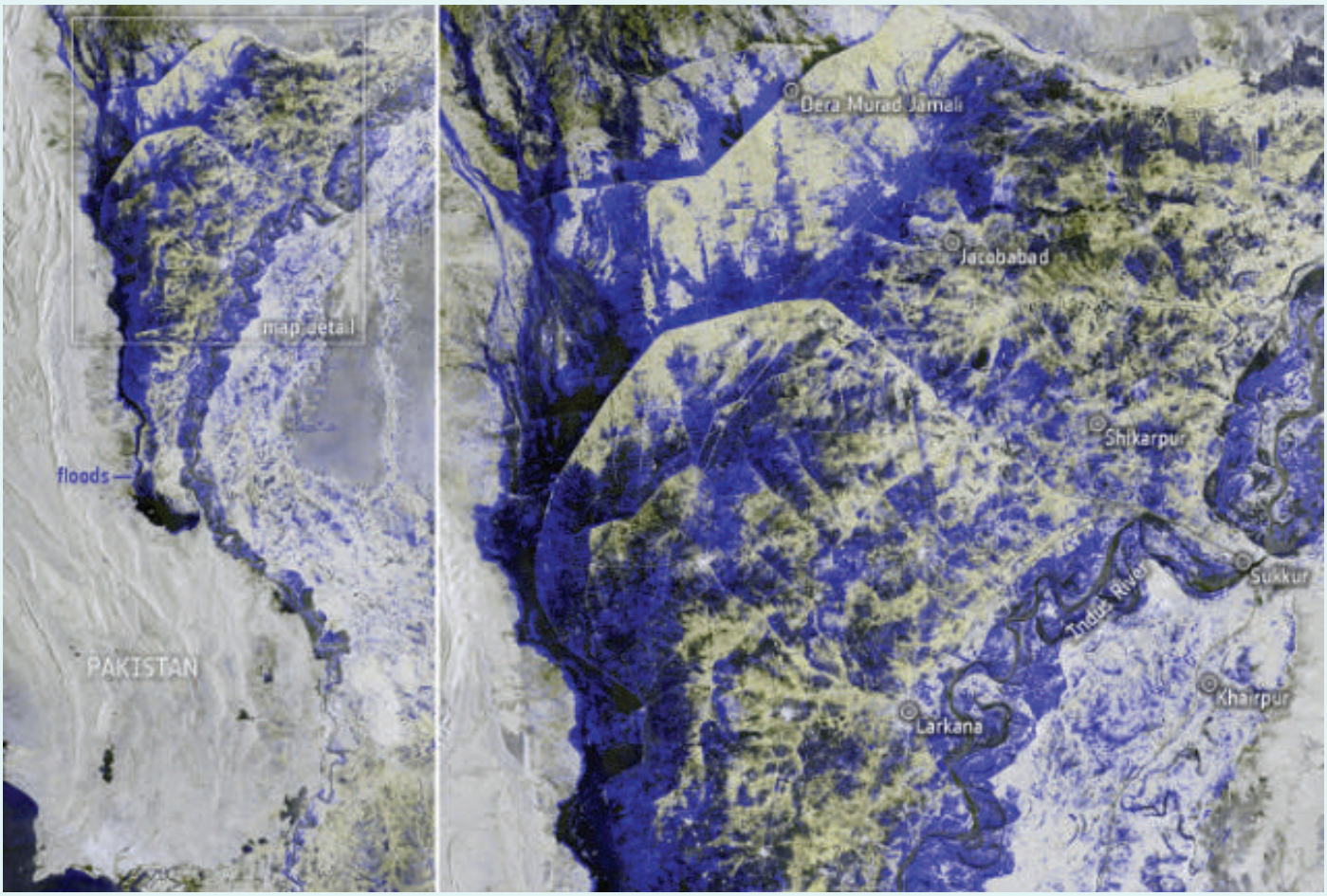


Fig.1: NASA issued satellite imagery on flood situation in Pakistan, 2022.

"One third of the country is literally under water, a catastrophe of unknown precedent"(9). Another factor in the flooding is melting from country's 7000 Glaciers in hottest summer during April-May. Glaciers melting water coupled with the unexpected and unprecedented large scale depression system from the Arabian sea, resulted in the historic runoff that could not

be contained by the mighty Indus River, nor by the massive network of dams and reservoirs across the tributaries.

The intense rainfall was also driven in part by a “La Nina event” (6) , which caused warmer than average sea surface temperature in the eastern ocean, providing additional moisture to feed the monsoon depression, according to the study.

Reverberating Impacts:

2022 “Monsoon on Steroids” or “Monster monsoons” has caused serious damages to life, property and overall economy of Pakistan. Briefly it is estimated as follows:

1. Total area of standing flood waters peaked between July and August was approximately 84,952 Sq.km (10).
2. Over 2 million hectares of bumper crops and Fruit gardens have been lost. (6), costing about USD 2.3 billion.
3. The flood affected over 33 million people in Pakistan (11)
4. 1,739 people died including 647 children. An additional 12,867 were injured (11).
5. Over 1400 clinics and hospital facilities have been partially or completely damaged in Sindh and Baluchistan (12)
6. 1,164,270 livestock have been killed.
7. 897,014 houses were destroyed and another 1,391,467 were damaged (11).
8. Over 22000 schools were damaged or destroyed (13)
9. 13,115 kilometres of roads and 439 bridges are destroyed which obstructed access across flood affected area. (11).
10. Ten dams and several reservoirs have been destroyed or breached (12)
11. Fifty villages have been submerged (12)

Fig 2. Flood disaster in 2022 in Pakistan: more than 30 million people are displaced.

Damages, loss and needs:

- Total damage is estimated at USD: 14.9 billion.
- Total loss is estimated at USD: 15.2 billion
- Total needs is estimated at USD: 16.3 billion

The most suffered sectors include: Housing, Agriculture, Food, Livestock, Transport and communication.

Sindh and Baluchistan have since seen outbreaks of conditions including cholera, Malaria and Skin Infections. By early Sept.2022 more than 6.4 million people were in dire need of humanitarian aid. UNICEF warns that over 3 million children are at risk of malnutrition and water borne diseases. It may take years to rebuild over 22000 schools that have been fully or partly destroyed. (12).

Immediate Needs:

Current needs identified by national NGOs include: {14}

- Basic food staples.
- Nutritional supplements for children.
- Clean drinking water
- Hygiene and Sanitation kits
- Medicine
- Temporary healthcare facilities
- Blankets, tarpaulins and disaster mitigation activities
- Long term needs include education support kits, psychological and healthcare support, livelihood, rebuilding and disaster mitigation activities.

National NGOs actively participated for Flood relief:

In addition to Government and UN response about 90 National NGOs have provided humanitarian assistance. Following is the list of some prominent national NGOs, those provided prompt and effective flood relief. {15}

- Al-Khidmat Foundation
- Edhi Foundation
- Akhwat Foundation
- Transparent Hands
- HANDS Pakistan

In addition to providing urgent flood relief in affected area, including food supply, shelters, medical aid, Hygiene and Sanitation Kits, Clean Drinking Water with the help of more than 50 ,000 volunteers equipped with boats and vehicles and lifesaving equipment, Alkhidmat has started "Tameer-e-Watan" rehabilitation program including reconstructing and repairing of houses, schools, mosques along with supporting more than three thousand orphanage and water projects in flood hit areas. {15}

Flood Control:

Flood control refers to all methods used to reduced or prevent the damaging effects of flood water. Some common techniques used for flood control are:

- Installation of Rock Beams
- Rock Rip-Raps

- Sand bags
- Maintenance of normal slopes with vegetation or application of soil cements on steeper slopes and constructions or expansion of drainage.
- Construction of dykes, dams, reservoirs or holding tanks to store extra water during flood period.

The Engineering works that can prevent and mitigate the effects of floods are as follows:

1. Acceleration of out flows: On highways, the implantation of steel pipes should take water by gravity away from the road to catchment basins.
2. Detention/Retention: Construction of large underground water tanks to store the flood water.
3. Flow deviation: Drill several water wells down into aquifer and inject water. This stored water can be used for future irrigation. Attention is required to prevent silt and organic matter from the flood water do not block the flow in the aquifer. Natural infiltration ponds in such areas could be a better solution.
4. Mandatory placement of permeable drainage floors in huge courtyards of parking lots.
5. Using drains and Gutters around all houses to divert rain water to reservoir or disposal area.
6. Rectification of rivers and streams, construction of dams and canals in large rivers like Indus that extend their containment basins.
7. Implementation of Civil defence system that should be able to at least warn people and have a scheme to remove them from houses in case of emergency.

Flood Management:

In order to deal with flood risk, it is essential that prevention and precaution measures are adopted to avoid catastrophic events. The Preliminary environmental impact assessment of flood is an important instrument for the formulation of Civil defence plans as it is used to access, predict and prevent future economic and social damages resulting from flood.

For Pakistan, in order to ensure improvements in risk reduction, use of remote sensing and GIs (Geographic Information System) technologies is conjunction with the flood management and its interrelationship to flood hazard assessment and Planning is required. Improving the accuracy of forecasting system specially along the Indus River, using time series data augmentation is recommended. {17}

Education and Training is a particular requirement for population generally located within the flood plans. Early warning system and scientific information should be produced in a clear and concise manner, so that the average person is easily able to understand it.

Pakistan's lack of climate adaptability entails a loss of investment and human lives. Such loss can be avoided or reduced by factoring in climate information into the decision making

process.

Beneficial Utilization of Flood Water:

Beneficial utilization of flood water needs top priority in Pakistan which is already facing water scarcity for domestic and agricultural use.

The infrastructures including dams, reservoirs, embankments and flood walls have been the traditional response to managing flood risk. However, one of the most important ecological process is, "The connection between rivers and flood plains". This connection is what makes river-flood pain system among the most productive and diverse ecosystem on the planet. This is called "Green Infrastructure" {18}. This technique not only provided primary benefit of flood risk reduction, but also support a diverse range of other benefits.

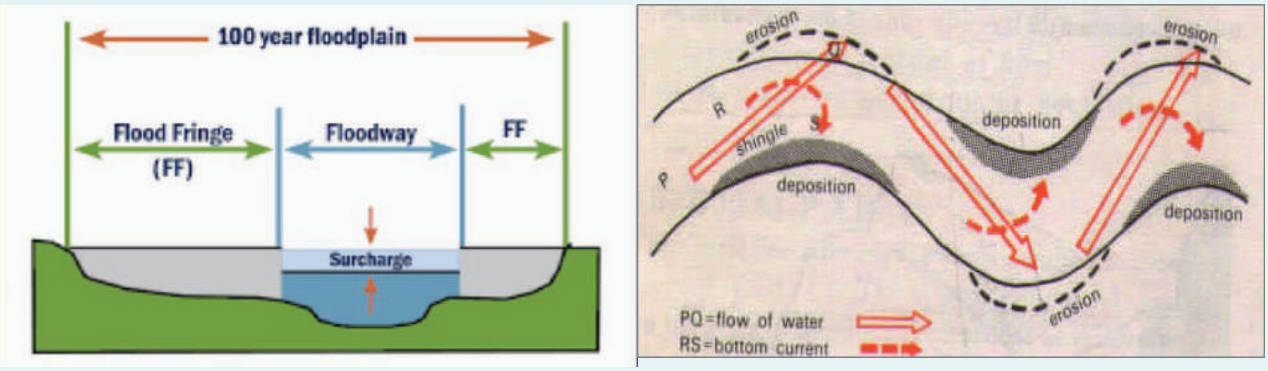


Fig 3. Concept of diversion and floodplains

It should be noted that decision making is a process of analysis and choice of several alternatives available with due consideration of chronicle floods of 2010, 2013, 2020 & 2022 in Pakistan, it's impact and runoff of large volume of water. It could be the most effective flood management to integrate the "Green" infrastructure (Flood ways and back water area) with engineered infrastructure (Dams & Levees). This model of water management infrastructure provides the opportunity for greater environmental sustainability allowing large volume of water to be stored and conveyed through the backwater areas and flood ways likely provided greater environmental benefits.

Conclusion:

Pakistan is vulnerable and most affected by adverse impacts of climate change despite the fact that Pakistan has least share in greenhouse emission. Unfortunately the industrialized countries failed to realize that environment does not belong to a single country and when one country damages the ozone layers, the entire world pay the price for that.

In July-August 2022, the effect of climate change resulted in heavy rainfall in Sindh and Baluchistan. As a result of this unprecedented heavy rainfall Pakistan suffered major losses of lives, damages to infrastructure over 2 million hectares of bumper crops and fruit gardens have been lost. About 84,952 sq.km agricultural fields were devastated. The most affected sectors

include: Housing, Agriculture, Live Stocks, Transport, Schools, Hospitals, Dams and Reservoirs.

UNICEF has warned that over 3 million Pakistani children are at high risk of malnutrition and water born diseases. The massive economic losses are estimated as more than USD 30 billion.

The correction and prevention measure to minimize flood damage are classified to their nature into structural and non-structural measures. The structural measures comprise the Engineering work. Intensive measure includes:

- Acceleration of outflow
- Flow retardation: Dams, Reservoirs
- Flow deviation: Tunnels of deviation and channels of deviation.

Non Structural measures may be grouped as follows:

- Action to regulate land use and occupation.
- Environmental education focussed on the control of diffuse pollution, erosion and waste
- Flood warning and forecasting system, using remote sensing and GIS (Geographic Information System) technologies is conjunction with flood management and it's interrelationship to flood hazard assessment and planning.

Beneficial utilization of flood water should be the top priority of Pakistan's flood management policy noting that Pakistan is already facing water scarcity for domestic and agriculture use.

Several alternate options have been discussed in this article but the integration of the "Green infrastructure" with engineered infrastructure provides better opportunity for greater environmental sustainability allowing large volume of water to be stored and used subsequently. Finally, it is worth mentioning that flood effected area in Pakistan is still in dire need of humanitarian aid, The author of this article request all Pakistan expatriates to come forward and help their countrymen, women and children by donating to this noble cause through one of their choice of national NGO.

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Risk Management in the **Construction Industry**

by: Professor Rafiq Muhammad Choudhry

Abstract

Risk management is a relatively modern field in the construction industry, but it is gaining prominence gradually due to increased construction activity and competitiveness. This is a survey-based study of risk management in the construction industry of Pakistan. It reports the findings of the importance of risks, their current management techniques, the existing status of risk management systems of the organizations, and barriers to effective risk management from the perspective of key stakeholders. The analysis of the results reveals that: financial and economic factors followed by quality are the most important risks and the industry generally tries to avoid or transfers these risks. Results indicated that the risk management system and practices of most of the organizations are reactive, semi-permanent, informal, and unstructured with non-existent and limited committed resources to deal with risks. The results of interviews indicate that there is awareness about risk management and a desire to learn from past mistakes. The study concludes that the major barriers to effective risk management are the lack of a formal risk management system, and the lack of a mechanism for joint risk management by the parties. Insights and discussions are given in the analysis, which are valuable to planners, project managers, supervisors, and other stakeholders. This work can be utilized in exploring mechanisms for joint risk management by prospective stakeholders.

Keywords: Construction industry; Risk management; Risk management techniques; Joint risk management; Stakeholder.

1.0 Introduction

Since risk management is relatively new to the construction industry of Pakistan it has rarely been researched as a subject. Nonetheless, risk management is being practiced in the financial sector. A study was carried out by Masood and Choudhry (2010), but its scope was limited to perceptions of contractors about risk factors; however, many project risks cannot be controlled by a single party (Tang et al. 2007). Risk is a complex phenomenon that has physical, monetary, cultural, and social dimensions (Loosemore et al. 2006: p.1). The consequences of risk events go well beyond the direct physical harm to financial or physical assets, people, or ecosystems. The effects include the way a society operates, and people think (Loosemore et al. 2006). The objectives of project risk management are to increase the probability and impact of positive events and decrease the probability and impact of events adverse to the project (PMI 2021). Avoiding project risks altogether is not desirable, especially if these risks can be turned into opportunities by proactive identification, risk analysis, timely response, and effective monitoring. Risk management is considered a vital tool in the management of projects (Wood and Ellis 2003) and is becoming an essential part of the decision-making process (Kangari 1995). As pointed out by Flanagan and Norman (1999), there are generally four flawed approaches to tackle the risks on a construction project:

1. The ostrich approach is the one in which one buries his head in the sand against all odds assuming that the crisis is self-destructive, and he will sail through it.
2. The brute force approach is one in which one assumes that he can force the outcomes as he desires or can change the course at will, which is generally a false assumption.
3. The umbrella approach is the one in which every risk event is managed by a costly risk premium.
4. The intuitive approach is the one in which it is presumed that all these processes of identification, analysis and control measures are futile efforts, and one should trust his gut feelings or intuition.

Researchers (Loosemore et al. 2006; Smith et al. 2006; PMI 2021; Jaafari 2001; Berends 2000; Standards Association of Australia 2004; Flanagan and Norman 1999) have investigated several risk management techniques; however, all these techniques may not be applicable in local environments. Risks and opportunities do not respect disciplinary boundaries and occur over the entire life cycle of a project (Loosemore et al. 2006). Any system designed and implemented must reflect the life cycle approach, from inception to demolition, or even beyond. From this perspective, risk management gets precedence over project management as the former rarely recognizes the life cycle approach. In companies, the project management methodology that has been adopted does not readily accommodate the increasing requirements for risk management. As a result, many projects are not set up to manage risk (Smith et al. 2006). An efficient risk management system must be more dynamic in nature than the risk itself. Otherwise, chances are that it may not integrate well into the organizational culture and other company practices. Any system, regardless

of the diligence and care taken in its preparation and implementation, may not achieve its objective when first implemented and will require constant calibration. This requires leadership, patience, guidance, time, and resources on the part of management.

It is becoming increasingly important to adopt a joint risk management strategy by all stakeholders to achieve the intended project objectives (Loosemore et al. 2006). Unfortunately, stakeholders may have different, even competing, project objectives. Joint risk management will ensure that project objectives are more transparent and can be achieved in an efficient way. As pointed out by Baldry (1998), conflicts among project participants can contribute to project failure as well as technical deficiencies. Chapman (1997) indicated that clients and contractors necessarily have different objectives, but a contract which leads to confrontation is perhaps the biggest single risk that most projects encounter. To mitigate risks due to misalignments between project participants, many researchers have suggested the use of such strategies as partnering, alliances, and relationship contracts that adopt a cooperative philosophy to seek congruence in objectives (Tang et al. 2004). Rahman and Kumaraswamy (2004, 2002a, b) concluded that the construction industry is moving towards joint risk management by the application of partnering principles. Tang et al. (2006) revealed the important role of partnering in enhancing risk management and indicated that partnering helps participants to share added information through the improvement of open communication. Such communication facilitates optimum decision making to reduce lost opportunities when dealing with project risks.

The construction industry of Pakistan is to grow 7% in 2022 following a 2.9% growth in 2021 (Research and Market, 2022). The construction industry presents both opportunities and challenges. With a population of over 230 million in 2022, Pakistan has the world's fifth largest population and with a projected annual growth rate of 1.8 percent it will become the fourth largest nation on earth in terms of population by 2050 (FBS 2010). There was a shortage of an estimated 10 million housing units in 2022 (PIDE 2022). While housing represents only a portion of construction industry, there are huge investment opportunities in the infrastructure of the country which include: infrastructure, dams, irrigation, power, oil and gas, tourism, and industry. Competitive bidding, generally practiced in the public sector of Pakistan, may slow the process of identifying risks dynamically due to increased chances of bid rejection. Effective risk management provides a competitive edge in the bidding process of construction projects and increases chances of meeting key project objectives in an efficient way. Construction project risks, if not managed properly, can lead to failure in achieving the desired project objectives, resulting in increased costs, time delays, lack of quality and issues related to functionality of facilities. There is a requirement to consider the perceptions of key stakeholders (client, consultant, and contractor) to establish a ranking of risks facing the construction industry. This can lead to techniques to manage these risks and to identify barriers to effective risk management. These can help to explore mechanisms for joint risk management in the construction industry of Pakistan.

The main objective of this paper is to identify and prioritize common risks, management techniques to address those risks, the status of the implementation of risk management systems in organizations and barriers to effective risk management in the construction industry. The aim is to help stakeholders to take stock of their ongoing and future projects, with a focus on important risks, their management techniques, and barriers to effective implementation

of risk management systems. These issues were examined in this study, along with remedial measures that might be necessary. This research makes a unique contribution by categorizing important risks, describing relevant risk management techniques, and identifying barriers to effective risk management in the industry.

2.0 Methodology

This study reports the findings of the questionnaire survey and interviews of key participants in the construction industry of Pakistan. The research questionnaire was unique to the Pakistan construction industry and was an adaptation of the instrument used by Tang et al. (2007).

2.1 Questionnaire and survey

From the literature review a questionnaire was prepared and a pilot survey was conducted to check the applicability of the questionnaire in the local environment in Pakistan. Ten questionnaires were presented to academia and industry experts representing different organizations: universities (3), clients (2), consultants (2) and contractors (3), followed by interviews with each participant. Each of the respondents had more than ten years of experience in their respective fields. Interviews were conducted face to face, ensuring a 100 per cent response rate. The questionnaire was amended by incorporating feedback of the experts to suit the local environments of the construction industry. The final questionnaire had an introduction of the respondent covering their name, qualifications, experience in construction industry, organization, appointment, and the group which they represent (client, consultant, and contractor). This was followed by four sections: importance of risks; application of risk management techniques; status of risk management systems; and barriers to risk management. In first section, 20 major risks were identified, of which 13 were adopted from Tang et al. (2007) and the remainder were incorporated from the input of experts in the pilot survey. In the second section, 16 different techniques were identified, of which 11 were adopted from Tang et al. (2007) and the remaining were adopted from input of the experts in the pilot survey. The third section had two questions pertaining to the status of the risk management system of the respective organization. In the fourth section 10 barriers to risk management were identified, of which 6 were adopted from Tang et al. (2007) and the remainder were taken from Loosemore et al. (2006) and from the feedback obtained in the pilot survey. Finally, each questionnaire incorporated a five-point Likert-type scale facilitating statistical analysis of the information.

Consultants and contractors for the survey were chosen from company registrations maintained by the Pakistan Engineering Council (PEC). Respondents were divided into three main groups, namely clients, consultants, and contractors. A total of 105 questionnaires were distributed, of which 80 (76 percent) responses were returned for analysis. The geographic distribution of respondents was follows: 12 (Karachi), 20 (Lahore) and 48 (Rawalpindi / Islamabad). This included 32 consultants, 28 clients, and 20 contractors. All respondents were initially contacted by telephone or e-mail. The fieldwork approach was used to distribute and collect the questionnaires, followed by an interview. Seventy percent of the respondents had 10 or more years of experience and the remainder had 3-10 years of experience in

the construction industry. With the geographical dispersion of the respondents, their size variations, industrial development contribution and extensive experience of respondents in a variety of construction projects, the data collected was extensive and is presumed to be representative of the construction industry. The Statistical Package for Social Science (SPSS) was used to analyze collected data.

3.0 Analysis and Results

The study regarded the level 0.05 as being statistically significant and 0.01 being highly significant.

3.1 Importance of Risk Factors

Respondents were requested to provide responses regarding the importance of 20 risks affecting the construction industry on a Likert scale 1 to 5; where 1 represented "insignificant risk" and 5 represented "catastrophic risk". The overall rankings of the risks based on their means is a follows: financial factors (mean = 4.31), economic factors (mean = 4.18), quality (mean = 4.15), premature failure of facility (mean = 4.01), lack of planning and management (mean = 3.99), change in design / scope of work (mean = 3.84), corruption (mean = 3.74), claims and disputes (mean = 3.60), inadequate/incorrect design (mean = 3.58), quantity variations (mean = 3.20), unforeseen site conditions (mean = 3.16), delay in supply of drawings (mean = 2.91), political and social factors (mean = 2.61), conflict in contract documents (mean = 2.59), safety (mean = 2.54), feasibility of construction methods (mean = 2.53), insufficient technology/ skills/techniques (mean = 2.38), poor coordination/cooperation/relationship among key stake holders (mean = 2.36), non implementation of standard bidding/contract documents (mean = 1.99) and force majeure (mean = 1.94).

Interviews revealed that financial and economic factors; capital supply, cash flows, interest rates and inflation are major concerns. Whereas capital supply and cash flows are internal to an organization, interest rates and inflation are external in nature and or primarily governed by government policies. Interest rates are high in Pakistan. Political and social factors, including the law-and-order situation, get precedence.

Clients, consultants, and contractors, have similar perceptions on 14 of the 20 risks and differ on the remaining 6 risks as revealed by the Kruskal-Wallis Test. Perceptions are significantly different about financial factors ($p < 0.001$), economic factors ($p = 0.003$), quality ($p = 0.024$), lack of planning and management ($p = 0.004$), corruption ($p = 0.031$), inadequate/ incorrect design ($p < 0.001$). Results show that financial and economic factors have been given relatively lower rankings by consultants (mean = 3.88 and mean = 3.81 respectively) mainly because these risks are generally distributed among clients and contractors. It is suspected that consultants give greater importance to those risks that involve their fundamental responsibility, e.g., economic design of facilities. Quality was given a relatively low ranking by contractors (mean = 3.75) but clients and consultants gave this a considerably higher ranking. Lack of planning and management was ranked lower by consultants (mean = 3.59) mainly because this risk is largely the responsibility of the client and contractor unless the consultant is awarded the management contract. Corruption was ranked slightly higher by the clients (mean = 4.07), and interviews revealed that clients have a general perception that it is unethical for substandard work of the contractor to be approved by a consultant. Inadequate/incorrect

design was ranked much higher by consultants (mean = 4.06) probably because providing adequate and correct design is considered the fundamental responsibility of the consultant. Most of the works related to alterations, revisions, amendments, cost overruns, time delays and disputes are also associated with the design. Safety was ranked 18th by clients and 12th by contractors; signifying that clients do not consider safety to be a primary responsibility. Safety-related incidents and associated risks are transferred to the contractors. Additionally, the overall low ranking of safety (15th) also points towards the greater issues of labor laws, their implementation, and the general difficulty of the construction laborers.

Results reveal that there is a strong positive correlation between the risk ranking of clients, consultants, and contractors, which is statistically significant. Although groups differ from each other on the perception of six of twenty risks, they all agree on risk ranking of each other. The statistical and interview results signify the willingness of the groups for joint risk management mechanism to address these risks collaboratively provided a standard contract/bidding document of the Pakistan Engineering Council or Federation Internationale Des Ingenieurs Conseils (FIDIC) are implemented on public sector construction contracts.

3.2 Risk Management Techniques

Risk Identifications Techniques: Respondents were asked to identify the frequency of usage of five risk identification techniques on the scale of 1 to 5; where 1 represented "Never used", and 5 represented "Always used". An overall mean ranking of risk identification techniques was computed for each group (see Table 1). Consulting experts (mean = 3.49) is the most frequently used technique to identify risks, followed by industry information (mean = 3.01), checklists (mean = 2.66), risk review meetings (mean = 2.53) and brain storming (mean = 1.36). The perceptions of the various groups do not differ significantly except for the technique of consulting experts (p = .023). It is ranked low (mean = 3.13) by consultants and high by contractors (mean = 3.85) probably because consultants possess in-house expertise. On the other hand, contractors with more limited expertise, consult experts more frequently for guidance. This is due to the difference in level of in-house expertise available to consultants versus clients and contractors. Interviews revealed that the various techniques are employed unsystematically, without any documentation. Most parties rely on personal experience and information extracted from printed and electronic media. The respondents were not very familiar with proactive and reactive risk identification techniques and their utility.

Table 1. Ranking of Risk Identification Techniques

Technique	Overall		Client		Consultant		Contractor	
	M	R	M	R	M	R	M	R
Consulting experts	3.49	1	3.64	1	3.13	2	3.85	1
Industry information	3.01	2	3.04	2	3.16	1	2.75	2
Checklists	2.66	3	2.68	4	2.72	3	2.55	4
Risk review meetings	2.53	4	2.61	3	2.34	4	2.70	3
Brain storming	1.36	5	1.36	5	1.31	5	1.45	5

Note: M = Mean; R = Rank

Risk Analysis Techniques: Respondents were asked to identify the frequency of usage of risk analysis techniques on the scale of 1 to 5; where 1 represented "Never used" and 5 represented "Always used". An overall ranking of risk analysis techniques based on means (see Table 2) is: Qualitative (mean = 2.20), Semi quantitative (mean = 1.23) and Quantitative (mean = 1.11). The low mean values signify that analysis is seldom utilized for already identified risks and these groups are not very familiar with their utility. The interviews revealed that there is hardly any process of documentation of risks analyzed by any process by any group and is best regarded as an informal and trivial effort. Additionally, the use of computers and risk analysis software is seldom utilized in conjunction with project management software e.g., MS Project and Primavera, even though project managers do recognize their utility. The advanced techniques for quantitative risk analysis, for example sensitivity testing, expected monetary values (EMV) and risk adjusted discount rate (RADR), are seldom employed. An added issue is the availability of reliable data for quantitative risk analysis, as most of the organizations do not have an appropriate system, expertise, or capacity to record data of ongoing and completed construction projects.

Table 2. Ranking of Risk Analysis Techniques

Technique	Overall		Client		Consultant		Contractor	
	M	R	M	R	M	R	M	R
Qualitative	2.20	1	2.14	1	2.13	1	2.40	1
Semi quantitative	1.23	2	1.21	2	1.19	2	1.30	2
Quantitative	1.11	3	1.07	3	1.16	3	1.10	3

Note: M = Mean; R = Rank

Risk Response Techniques: Respondents were asked to identify the frequency of usage of 6 risk response techniques on the scale of 1 to 5; where 1 represents "Never used", and 5 represents "Always used". The overall mean ranking of response techniques is to avoid the risk (mean = 4.18), transfer the risk completely (mean = 4.08), reduce the likelihood of occurrence (mean = 3.89), reduce the consequences (mean = 3.81), risk sharing (mean = 3.59) and retain the risk completely (mean = 3.59). The results are presented in Table 3. "Avoiding the risks", at the top of the ranking, suggests losing considerable amount of business opportunities due to an over-cautious attitude. Organizations make money and increase their worth by taking risks. It is desirable to make informed decisions and take those opportunities which can be managed effectively and to avoid those risks which are beyond organizational resources. Making informed decisions not only requires experience and professional judgment but also knowledge of the risk management process. Essentially, risk management is decision making (Kliem and Ludin 1997). Nevertheless, risk management is regarded as a function of the quality of a decision. Whether a decision is good or bad is largely decided by the quality of information obtained by the decision maker. Information is the main source in the steps of risk identification and analysis (Tang et al. 2007).

The investigation of the ranking of risk response techniques suggests that the construction industry is far beyond the process of risk sharing (ranked 5th) and mostly relies on transferring the risk (ranked 2nd). Interviews revealed that insurance, a means of transferring risk, is only utilized in public sector contracts where it is a contractual obligation. There are no principles that are followed in transferring the risk to a business partner as suggested by Loosemore et al. (2006). Neither is the business partner made fully aware of the risks being taken nor do they have the necessary capacity and resources to manage it effectively.

Table 3. Ranking of Risk Response Techniques

Technique	Overall		Client		Consultant		Contractor	
	M	R	M	R	M	R	M	R
Avoid the risk	4.18	1	4.07	2	4.41	1	3.95	3
Transfer the Risk Completely	4.08	2	4.11	1	4.09	2	4.00	2
Reduce the Likelihood of Occurrence	3.89	3	3.89	3	3.72	4	4.15	1
Reduce the Consequences	3.81	4	3.86	4	3.84	3	3.70	5
Risk Sharing	3.59	5	3.64	6	3.53	5	3.60	6
Retain the Risk Completely	3.55	6	3.79	5	3.19	6	3.80	4

Note: M = Mean; R = Rank

Risk monitoring techniques: Respondents were asked to identify the frequency of usage of risk monitoring techniques on the scale of 1 to 5; where 1 represents "Never used", and 5 represents "Always used". Incident investigation (mean = 3.44) is mostly used for risk monitoring followed by risk audit/inspection (mean = 1.25). The results are presented in Table 4. Interviews revealed that most of the respondents had little knowledge of risk audits/inspections and even incident investigation is not conducted from a risk management point of view but more on allocating the responsibility. The results of investigations are intended to protect organizations from any defamation, litigation and/or loss.

Table 4. Ranking of Risk Monitoring Techniques

Technique	Overall		Client		Consultant		Contractor	
	M	R	M	R	M	R	M	R
Incident investigation	3.44	1	3.32	1	3.47	1	3.55	1
Risk audit / Inspection	1.25	2	1.25	2	1.22	2	1.30	2

Note: M = Mean; R = Rank

3.3 Maturity Level of Risk Management System

In investigating the status of the risk management system, respondents were required to answer two questions on a Likert scale 1 to 5. For the first question, 1 represents "Strongly informal" and 5 represents "Strongly formal" and for the second question, 1 represents "Strongly disagree" and 5 represents "Strongly agree". These questions were included to establish the status of the risk management system of organizations by understanding the general perceptions about the present formality and adequacy level of their risk management system (see Table 5). The results show that the perceptions of contractors (mean = 2.75) about the formality level of their organization's risk management system are comparatively better than that of clients (mean = 2.61) and consultants (mean = 2.47). While generally low, the perceptions of clients (mean = 2.32) are comparatively better about the adequacy of their organization's risk management system than that of contractors (mean = 2.20). Most of the clients represent public sector organizations and although they place formality level of their organizations comparatively lower than contractors, they are more satisfied with its adequacy. Contractors typically represent the private sector and have a slightly better perception of their risk management system than clients, but they still feel it is inadequate. As the contract forms the basis for the allocation or distribution of risks between client and contractor, clients in the public sector typically use standard contract documents. Hence clients are more confident about the adequacy of their risk management system as far as risk distribution is concerned; Contractors work with different types of client organizations while entering into different type of contracts and feel inadequacy of their risk management system. The single most important influence on any project is whether it is carried out by the public or private sector organization (Smith et al. 2006). Interviews revealed that the overall risk maturity level of the respondent organizations can best be described as between level 1 and level 2. Whereas the highest level is 4, only 2 to 3 percent of the organizations claimed to attain it when measured according to the risk management maturity level audit tool of the Project Management Institute (PMI). The risk management system and practices of most of the surveyed organizations are reactive, semi permanent, informal, and unstructured with little or no committed resources to deal with risks. Nonetheless, there is awareness about risks and a desire to learn from past mistakes.

Table 5. Status of Risk Management System

Questions	Overall	Client	Consultant	Contractor
Formally you place your organization's risk management system at what level?	2.59	2.61	2.47	2.75
You consider your organization's risk management system as adequate?	2.33	2.32	2.41	2.20

3.4 Barriers to Risk Management

Respondents were asked to identify the most important barriers to risk management on a Likert scale where, 1 represents "Strongly disagree" and 5 represents "Strongly agree". The overall ranking of barriers to risk management is: lack of formal risk management system (mean = 4.06), lack of joint risk management system by parties (mean = 3.89), shortage of knowledge/techniques (mean = 3.80), complexity (mean = 3.64), reactive rather than proactive (mean = 3.54), centralized rather than decentralized (mean = 3.44), risk analysis rather than risk identification (mean = 3.20), periodic rather than continuous (mean = 3.04), lack of historical data for risk trend analysis (mean = 2.99) and lack of risk consciousness (mean = 2.95). The results are presented in Table 6. Interviews with the respondents revealed that most had a vague idea of the aim and purpose of implementing an effective risk management system. They believed the motivation behind implementing an effective risk management system is to avert unfavorable consequences of risk events rather than adding value. It is appropriate to use the term "Investment in risk management" rather than "Cost of risk management".

Lack of a formal risk management system is overall ranked first (mean = 4.06). Interviews revealed that although organizations practice risk management at some level, with varying degrees of expertise, it is mostly unorganized, unsystematic, inconsistent, personalized, and informal. The result is that risks may be overlooked and unmanaged. Author suggests that risk management is best practiced in the presence of a clear aim, sound policies and best practices, like any other managerial activity. In the absence of such policies and practices, the organizations are at the mercy of the capabilities of its employees and their experiences. Risk management is compromised in the event a valued employee leaves the organization. The system needs to be mature enough to absorb such shocks by performing adequately with or without the replacement of the leaving employee.

The lack of a joint risk management system received an overall rank of second (mean = 3.89) and interviews revealed that the construction industry is not very familiar with the term "joint risk management". Loosemore et al. (2006) revealed that a "chain is only as strong as its weakest link", hence risks cannot be managed without managing the risks arising from the supply chain, e.g., from construction suppliers to contractors/subcontractors. It is the contract that distributes risks between the client and the contractor, and this distribution is often more favorable to the client. The contract should preferably follow the principle of distributing the risks to the party in a best position to manage it. If it can be best managed jointly by two or more parties, then the contract should specify such terms and conditions. Negating this will result in disputes which is detrimental to construction project objectives. Interviews reveal that most of the standard contract documents implemented in the public sector are inclined towards the clients and allocates most of the risks to the contractors or subcontractors. This aspect needs further investigation.

Shortage of knowledge/techniques is overall ranked third (mean = 3.80) and the results of interviews revealed that although respondents were familiar of risks and their generic sources, there is a clear deficiency concerning the knowledge and techniques to manage them appropriately. No respondent organization had a dedicated risk manager and most of the project managers were not much familiar with the principles of risk management. Interviews

showed that most of the project managers consider risk management to involve complex techniques and procedures. Nonetheless, an effective system needs to be simple both in understanding and implementation. A complicated system will only replace the existing risks with new forms of risks.

Reactive rather than proactive is overall ranked fifth (mean = 3.54) and interview participants revealed that many of the project managers were under the impression that they are practicing risk management, whereas, in essence they are practicing crisis management. Risk management is proactive while crisis management is reactive in nature. Crisis management entails the loss of initiative and the loss of opportunities. The construction industry may be capable of implementing crisis management, but it is still beyond the boundaries of effective risk management.

Centralized rather than decentralized is overall ranked sixth (mean = 3.44) and interviews revealed that most of the construction firms are in the private sector and are owned by individuals. The lack in a corporate culture has a heavy influence in their operations, as company operations are guided by the personal uniqueness of the individuals in the organization. These firms are aware of the issue and have graded this barrier slightly higher (mean = 3.60) than clients (mean = 3.32) and consultants (mean = 3.44). Loosemore et al. (2006) reveals that a centralized system is generally less responsive, results in delays and overtakes the capabilities of its workers. Risk management is to be decentralized with easy-to-use tools and techniques in the field. Essential to effective risk management is affective communication; from top to bottom and bottom to top.

Table 6. Ranking of Barriers to Risk Management

Barriers	Overall		Client		Consultant		Contractor	
	M	R	M	R	M	R	M	R
Lack of formal risk management system	4.06	1	4.18	1	4.13	1	3.80	3
Lack of joint risk management system by parties	3.89	2	3.89	2	3.88	3	3.90	2
Shortage of knowledge / techniques	3.80	3	3.39	5	3.91	2	4.20	1
Complexity	3.64	4	3.68	3	3.53	5	3.75	4
Reactive rather than proactive	3.54	5	3.50	4	3.59	4	3.50	6
Centralized rather than decentralized	3.44	6	3.32	6	3.44	6	3.60	5
Risk analysis rather than risk identification	3.20	7	3.14	8	3.13	7	3.40	7
Periodic rather than continuous	3.04	8	3.11	9	2.81	10	3.30	8
Lack of historical data for risk trend analysis	2.99	9	3.21	7	2.84	9	2.90	10
Lack of risk consciousness	2.95	10	2.71	10	3.00	8	3.20	9

Note: M = Mean; R = Rank

4.0 Conclusions

The survey reveals many aspects of risk management practices besides providing guidelines to stakeholders about the importance of risks and their generic sources in the construction industry. Results provide an opportunity for planners, project managers, supervisors, and other key project members to take stock of their ongoing and future projects in the light of risk management techniques highlighted in the study. Some of the reported results are as follows:

1. The ten most important project risks in order of priority are: financial factors, economic factors, quality, premature failure of facility, lack of planning and management, change in design/scope of work, corruption, claims and disputes, inadequate/incorrect design, and quantity variations.

2. Construction industry often consults experts (mean = 3.49) for risk identification and seldom carries out quantitative risk analysis (mean = 1.11). The construction industry often avoids risks (mean = 4.18) and sometimes shares risks (mean = 3.59). Additionally, it sometimes carries out incident investigations (mean = 3.44) mainly for allocating the responsibility and not for monitoring the risks.

3. The overall risk maturity level of surveyed organizations was categorized between level 1 and level 2 against the highest level of 4. Only 2 to 3 percent of the organizations claim to attain it close to the level 4 when measured according to the risk management maturity level audit tool.

4. The risk management system and practices of most of the organizations are reactive, semi permanent, informal, and unstructured with little or no committed resources to deal with risks. There is barely any process of documentation of the risk management process by all parties and is characterized as an informal and trivial effort.

5. The main barrier to implementing an effective risk management system is the lack of a formal risk management system followed by the lack of mechanisms for joint risk management by the parties. Shortage of knowledge/techniques is overall ranked third whereas the parties are familiar of risks and their generic sources but lack an awareness

of risk management techniques.

Financial and economic factors are the most important risks faced by the construction industry followed by quality. A systematic risk management approach needs to be adopted in the construction industry to mitigate the adverse impacts of these risks, individually and collectively on the construction project. The usage and applicability of risk management techniques need to be adopted in the local environment. Systematic improvement in the risk maturity level of the local organizations must take place especially with the increase in risk management knowledge. The identified main barriers to effective risk management are the lack of the availability of a formal risk management system and lack of joint risk management. There is need to improve joint risk management by the parties, especially its contractual aspects in local environments. Finally, the risk management standards for industries are required to be developed.

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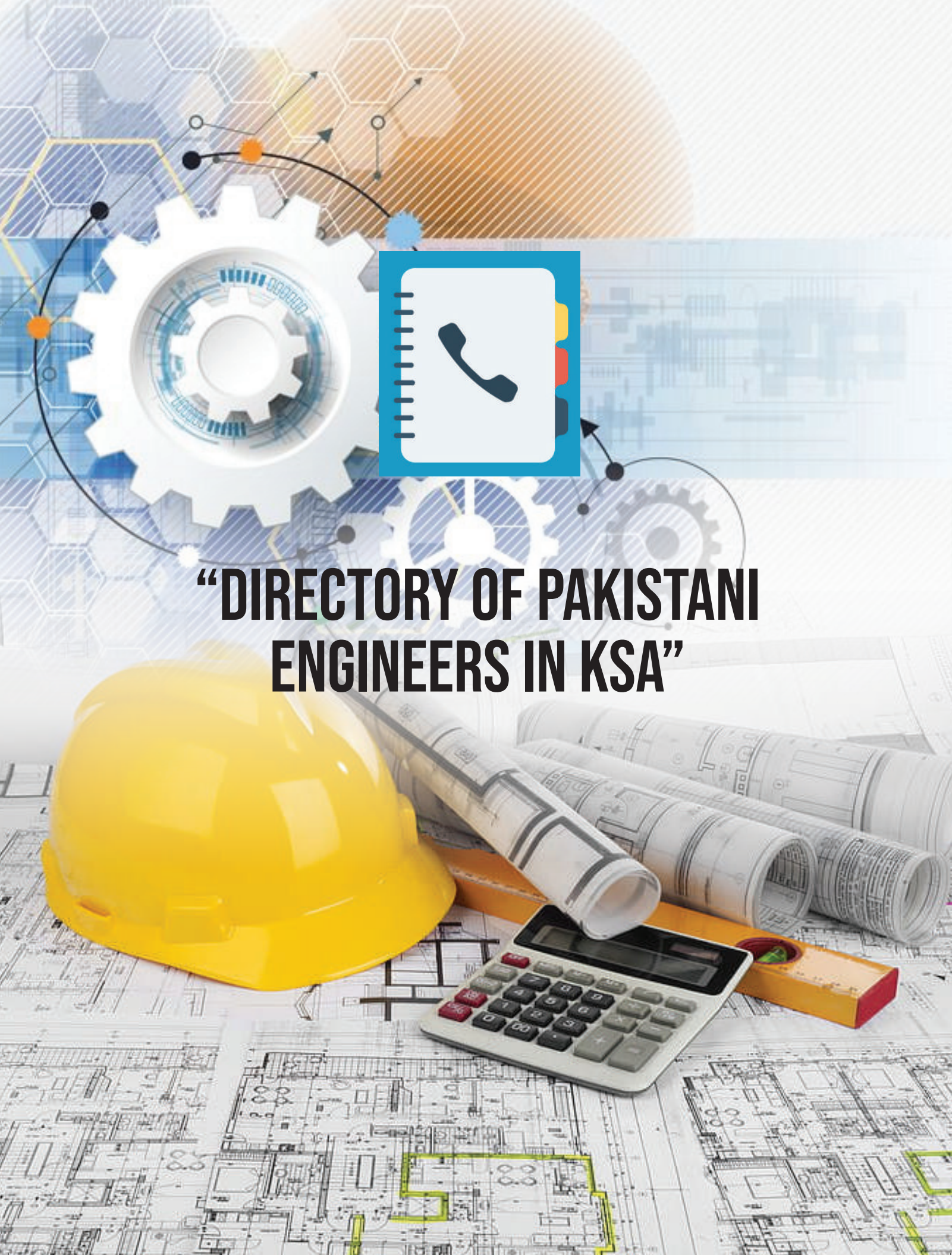

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Population explosion in Pakistan

Pakistan is the fifth most populous country in the world with a population of over 220 million, and it is estimated that by 2050, the country's population will reach 400 million. The rapid growth of Pakistan's population has resulted in numerous challenges and problems, including poverty, unemployment, food and water scarcity, and lack of infrastructure.

One of the primary reasons for Pakistan's population explosion is the lack of awareness and education. A large number of people in rural areas and low-income communities have limited access to healthcare facilities. As a result, the fertility rate in Pakistan is 3.6 births per woman, which is one of the highest in the world.

The impact of population explosion in Pakistan is evident in several ways. The high population density has resulted in a strain on natural resources, including water and agricultural land, leading to food insecurity and malnutrition. Additionally, the high number of people has resulted in an increase in pollution levels, which has had a detrimental effect on the environment and public health.

Furthermore, the rapid increase in population has also led to an increase in unemployment and poverty levels. The government is struggling to provide jobs and basic amenities to its citizens, which has led to a rise in crime and social unrest.

In conclusion, population explosion is a significant problem in Pakistan that requires immediate attention and action. The government needs to implement effective policies and increase awareness among masses. Additionally, education and awareness campaigns should be launched to help people understand the negative impacts of population growth on their lives and the environment. Only through concerted efforts can we hope to overcome this challenge and ensure a better future for Pakistan.

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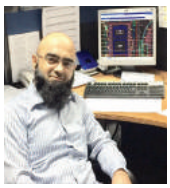

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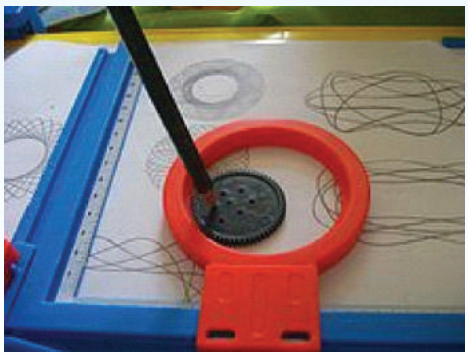
Spirograph



Spirograph is a geometric drawing toy that produces mathematical roulette curves of the variety technically known as hypotrochoidsand epitrochoids. It was developed by British engineer Denys Fisher and first sold in 1965.

The mathematician Bruno Abakanowicz invented the spirograph between 1881 and 1900. It was used for calculating an area delimited by curves.[1] Drawing toys based on gears have been around since at least 1908, when The Marvelous Wondergraph was advertised in the Sears catalog.[2][3] An article describing how to make a Wondergraph drawing machine appeared in the Boys Mechanic publication in 1913.[4] The Spirograph itself was developed by the British engineer Denys Fisher, who exhibited at the 1965 Nuremberg International Toy Fair. It was subsequently produced by his company. US distribution rights were acquired by Kenner, Inc., which introduced it to the United States market in 1966 and promoted it as a creative children's toy.

The original US-released Spirograph consisted of two different-sized plastic rings, with gear teeth on both the inside and outside of their circumferences. They were pinned to a cardboard backing with pins, and any of several provided gearwheels, which had holes provided for a ballpoint pen to extend through them to an underlying paper writing surface. It could be spun around to make geometric shapes on the underlying paper medium. Later, the Super-Spirograph consisted of a set of plastic gears and other interlocking shape-segments such as rings, triangles, or straight bars. It has several sizes of gears and shapes, and all edges have teeth to engage any other piece. For instance, smaller gears fit inside the larger rings, but also can engage the outside of the rings in such a fashion that they rotate around the inside or along the outside edge of the rings.

A Spirograph is formed by rolling a circle inside or outside of another circle. The pen is placed at any point on the rolling circle. If the radius of fixed circle is R, the radius of moving circle is r, and the offset of the pen point in the moving circle is O, then the equation of the resulting curve is defined by:

$$x = (R+r)*\cos(t) - (r+O)*\cos(((R+r)/r)*t)$$

$$y = (R+r)*\sin(t) - (r+O)*\sin(((R+r)/r)*t)$$

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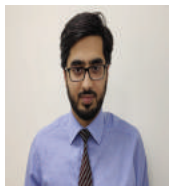

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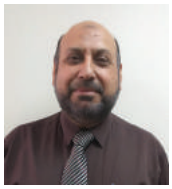

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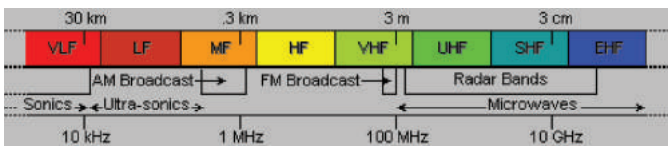
The RF Spectrum -- An Overview

The term Radio Frequency (RF or rf) refers to the electromagnetic field that is generated when an alternating current is input to an antenna. This field, also called an RF field or radio wave, can be used for wireless broadcasting and communications over a significant portion of the electromagnetic radiation spectrum -- from about 9 kilohertz (kHz) to thousands of gigahertz (GHz). This portion is referred to as the RF Spectrum. As the frequency is increased beyond the RF spectrum, electromagnetic energy takes the form of infrared (IR), visible light, ultraviolet (UV), X rays, and gamma rays.

Many types of wireless devices make use of RF fields -- radio, television, cordless and cellular telephones, satellite communication systems, and many measuring and instrumentation systems used in manufacturing. Some wireless devices, such as remote control boxes and cordless mice, operate at IR or visible light frequencies. The RF spectrum is divided into several ranges, or bands. Each of these bands, other than the lowest frequency segment, represents an increase of frequency corresponding to an order of magnitude (power of ten). The chart below depicts the eight bands in the RF spectrum, showing frequency and bandwidth ranges.



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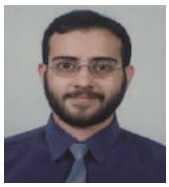

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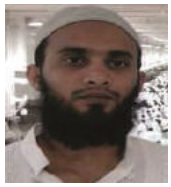

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Murphy' Laws

Murphy's Law ("If anything can go wrong, it will") was born at Edwards Air Force Base in 1949 at North Base. It was named after Capt. Edward A. Murphy, an engineer working on Air Force Project MX981, (a project) designed to see how much sudden deceleration a person can stand in a crash. One day, after finding that a transducer was wired wrong, he cursed the technician responsible and said, "If there is any way to do it wrong, he'll find it." The contractor's project manager kept a list of "laws" and added this one, which he called Murphy's Law.

- Nothing is as easy as it looks.
- Everything takes longer than you think.
- Anything that can go wrong will go wrong.
- If there is a possibility of several things going wrong, the one that will cause the most damage will be the one to go wrong.
- If anything simply cannot go wrong, it will anyway.
- If you perceive that there are four possible ways in which a procedure can go wrong, and circumvent these, then a fifth way, unprepared for, will promptly develop.
- Left to themselves, things tend to go from bad to worse.
- If everything seems to be going well, you have obviously overlooked something.
- Nature always sides with the hidden flaw.
- It is impossible to make anything foolproof because fools are so ingenious.
- Whenever you set out to do something, something else must be done first.
- Every solution breeds new problems.
- The legibility of a copy is inversely proportional to its importance.
- Things get worse under pressure.
- Everything goes wrong all at once.
- When there is a very long road upon which there is a one-way bridge placed at random, and there are only two cars on that road, it follows that: (1) the two cars are going in opposite directions, and (2) they will always meet at the bridge.
- Matter will be damaged in direct proportion to its value

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ChatGPT

by ChatGPT

ChatGPT is a large language model developed by OpenAI, based on the GPT-3.5 architecture. It is designed to process and understand human language in a way that allows it to engage in conversation with humans, just like a real person would. ChatGPT has been trained on an enormous amount of text data, making it capable of generating human-like responses to a wide range of queries and topics.

One of the most impressive features of ChatGPT is its ability to understand context. It can analyze the meaning of previous messages in a conversation to provide more accurate and relevant responses. This is achieved through a technique called transformer neural networks, which enable ChatGPT to build a contextual representation of a conversation.

The training data used to develop ChatGPT includes everything from books and articles to social media posts and online forums. This vast amount of text data has allowed the model to develop an extensive knowledge base covering a broad range of topics. It can answer questions about history, science, literature, and much more, making it a valuable resource for anyone seeking information.

Another key feature of ChatGPT is its ability to generate creative and original responses. It can write stories, poems, and even compose music based on input from the user. This is achieved through a process called natural language generation, which involves using the model's knowledge base to create new and unique content.

The potential applications of ChatGPT are vast and varied. It can be used in customer service chatbots, virtual assistants, and educational tools. It can also be used to improve language translation and natural language processing technologies. In the future, ChatGPT may even be used to help develop more advanced AI systems that can understand and interact with humans more naturally.

Despite its many impressive capabilities, ChatGPT is not without limitations. One of the most significant challenges is ensuring that it doesn't perpetuate bias or harmful stereotypes. Like any machine learning model, ChatGPT's responses are only as good as the data it has been trained on. If the training data contains biased or harmful content, ChatGPT may reproduce those biases in its responses. This is a challenge that must be carefully managed to ensure that the model is used in a way that promotes equity and fairness.

In conclusion, ChatGPT is a remarkable achievement in the field of natural language processing. It has the potential to revolutionize the way we interact with computers and AI systems, making them more intuitive and human-like. With further development and refinement, ChatGPT may one day become a ubiquitous part of our daily lives, helping us to learn, communicate, and create in ways we never thought possible.

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Maths Interesting Facts

- The word 'mathematics' comes from the Greek máthēma, which means learning, study, science.
- What comes after a million, billion and trillion? A quadrillion, quintillion, sextillion, septillion, octillion, nonillion, decillion and undecillion.
- Different names for the number 0 include zero, nought, naught, nil, zilch and zip.
- Zero (0) is the only number which can not be represented by Roman numerals.
- The name 'zero' derives from the Arabic word sifr which also gave us the English word 'cipher' meaning 'a secret way of writing' .
- Do you know the magic of no. nine (9)? Multiply any number with nine (9) and then sum all individual digits of the result (product) to make it single digit, the sum of all these individual digits would always be nine (9).
- Here is an interesting trick to check divisibility of any number by number 3.A number is divisible by three if the sum of its digits is divisible by three (3).
- The = sign ("equals sign") was invented by 16th Century Welsh mathematician Robert Recorde, who was fed up with writing "is equal to" in his equations.
- Googol (meaning & origin of Google brand) is the term used for a number 1 followed by 100 zeros and that it was used by a nine-year old, Milton Sirotta, in 1940.
- Abacus is considered the origin of the calculator.
- Have you ever noticed that the opposite sides a die always add up to seven (7).
- 12,345,678,987,654,321 is the product of 111,111,111 x 111,111,111. Notice the sequence of the numbers 1 to 9 and back to 1.
- Plus (+) and Minus (-) sign symbols were used as early as 1489 A.D.
- An icosagon is a shape with 20 sides.
- Trigonometry is the study of the relationship between the angles of triangles and their sides.
- If you add up the numbers 1-100 consecutively (1+2+3+4+5...) the total is 5050.
- 2 and 5 are the only primes that end in 2 or 5.
- From 0 to 1,000, the letter "A" only appears in 1,000 ("one thousand").
- A 'jiffy' is an actual unit of time for 1/100th of a second.
- 'FOUR' is the only number in the English language that is spelt with the same number of letters as the number itself
- 40 when written "forty" is the only number with letters in alphabetical order, while "one" is the only one with letters in reverse order.
- In a group of 23 people, at least two have the same birthday with the probability greater than 1/2 .
- If there are 50 students in a class then it's virtually certain that two will share the same birthday..

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    College & University _____
11. Professional Training & _____
    Names of Organizations _____
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13. Practical Experience:

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2.					
3.					
4.					
5.					

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☐ Chartered Engineers ☐ Fellow ☐ Member ☐ Associate ☐ Affiliate ☐ Subscriber

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Applicant's Signature

Proposer's Name (in block letters)	Signature	Date	Class of Membership

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