EDITORIAL

Contract is a legal instrument through which the contracting parties engage themselves for procuring a product under defined conditions at a price. A contract is broadly divided into two stages. First is the contract formation which primarily involves procurement processes and the second is contract administration which generally involves supervision and overall management of contract execution. A contract can be defined as “Engineering Contract” when it is executed for the Professional Engineering Work as defined in Section 2 (xxv) of PEC Act, 1976 as amended in 2011.

The Contract Administration phase is very significant to ensure quality construction at its stipulated cost & in scheduled time. To achieve this target, the Contract Administrator must have facilitative and proactive approach to guide and supervise the contractor and not wait to punish a contractor when mistakes occur. Preparation of bidding document on a specified format, transparent evaluation and award of contract are the pre-requisite for smooth contract administration which can ensure to minimize the time extension claim and cost claim by the contractor. Now a days scheduling and monitoring of the contract activities from the inception to the project execution with the application of software like Primavera 6 is extremely helpful for regular monitoring and forecast any critical area. A contract shall have the provision of the price adjustment for equitability of contracts and right cost to the contractor for a sustainable quality construction. Timely processing of the payments by the consultant/ employer and making payments to the contractor under the provision of the contract is essential to facilitate timely completion of the project. Finally, the Contract Administration shall focus on reducing the dispute by timely intervention. However, in case the dispute reaches to a stage where the intervention by “The Engineer” will involve then he should be an independent person outside the influence of the contracting parties.

Keeping in view the significance of contracts for construction works, supplies etc. in the economic development of a country. Pakistan Engineering Congress arranged a symposium on the topic of “Contract Management and Administration” On 18th October 2014 in Mashhadi Hall of Congress Headquarter. Engr. Dr.Ch. Mazhar Ali was the Chief Guest. Specialist in “Contracts Formulation” and its “Administration and Management” apprised the participants on the various aspects of contracts in the national & international context and the need for proper preparation of “Contract Documents” in accordance with International standards / national regulation for their effective and timely completion to avoid “Contractual Disputes”, “completion delays” and cost over-runs. A report in this respect is a part of this issue & would give an extended view.

CONTRACT ADMINISTRATION AND MANAGEMENT IN PAKISTAN

BY

ENGR. IFTIKHAR UL HAQ[1]

CONTRACT ADMINISTRATION

A contract is a legally binding agreement between two or more parties. Contract administration focuses on what happens before a contract is signed. Contract administrator's duties as taking control of the way the contract is prepared, analyzed and negotiated. Contract administration may start from issuing a request for proposal to potential contractors / vendors, inviting them to bid on a contract. Once a contractor / vendor is selected, the contract administrator sees the contract to its conclusion, handing it over to the contract manager after the agreement is signed by all parties.

Contract management focuses on what happens after a contract is formed. Contracts management involves deciding what human, financial and technical resources an organization will devote to various initiatives. Thus, a contract manager decides how the organization will ensure that it does what it agreed to do in an agreement with another party and that the other party also fulfills its obligations.

Administrative functions related to dealing with contracts, may be 1) request to bid, 2) evaluating bid, 3) allotment of contract, 4) Implementing contract, 5) measuring completed work, and 6) computing payments.

Types of Contract

Choosing appropriate contract type is essential to successful performance under a contract. The type of contract determines the cost and performance risks which are placed on the contractor. There are two broad contract groups--**fixed price and cost reimbursement**. Within each of these groups, there are various types of contracts which can be used individually or in combination.

Firm Fixed Price Contracts

This type of contract requires the contractor to successfully perform the contract and deliver conforming supplies or services for a price agreed to up front. This type of contract places the most performance and cost risk paid. A firm-fixed price contract is suitable for supplies and services that can be described in sufficient detail to ensure complete understanding of the requirements by both parties and assessment of the inherent risks of performance.

---

[1] Member Executive Council of Pakistan Engineering Congress, Convener Publication Committee

Other Fixed Price Contracts

Within the fixed price contract group, contracts can be awarded with:

- Economic price adjustment factors to allow for industries where costs fluctuate frequently either up or down
- Various incentive types which can be used to reward good performance or to impose provisions to deduct for poor performance
- Price redetermination provisions which permit issuing an order on a fixed price basis and allow for revisiting the reasonableness of that pricing later during the contract performance
- A specified level of effort

Cost Reimbursement Contracts

A cost reimbursement contract allows for payment of all incurred costs, within a predetermined ceiling that can be allocated to the contractor as allowable within cost standards, and reasonable. Therefore, all types of cost reimbursement contracts place the least cost and performance risk on the contractor. They basically only require the contractor to use their "best efforts" to complete the contract. However, this type of contract is required when the uncertainties of performance will not permit a fixed price to be estimated with sufficient accuracy to ensure that a fair and reasonable price is obtained.

Other Types of Contracts

Labor-Hour/Time and Materials - This type of contract pays at fixed rates for services rendered and for materials at cost plus a handling fee.

Letter Contracts - This type of contract is a preliminary instrument which permits a contractor to begin work when all of the contract terms and conditions have not been agreed upon. This type of contract is only used in circumstances of unusual and compelling urgency.

Indefinite Delivery Contracts - There are three different types of indefinite delivery contracts -- definite quantity, indefinite quantity, and requirements. In general, these contracts provide for delivery of goods or services upon the issuance of a delivery or task order as needs arise.

It is generally believed that Contract Management in the public sector in Pakistan is very weak. There are no particular courses run by Universities and Institutions which cover this subject comprehensively. In order to highlight the importance of Contract Administration and Management, Pakistan Engineering Congress arranged a Seminar on “Contract Administration and Management in Pakistan” on 18th October, 2014. Following six papers covering various aspects of Contract Administration and Management will be presented and discussed at the Seminar.

No.	Subject	Author
1.	Contract Administration in Pakistan and FIDIC Rainbow 1999	Engr. Abdul Qayyum
2.	Procurement of Civil Works and Evaluation of Bids	Engr. Ijaz A. Khan
3.	Arbitration	Engr. Balal A. Khawaja
4.	Dispute Resolution	Engr. Nasir Hanif
5.	Regulatory Frameworks for Procurement of Consultancy Services	Engr. Mazhar ul Islam
6.	Role of the Engineer in FIDIC Based Construction Contract	Engr. Mian Abdul Sattar
7.	Claims	Engr. Mushtaq A. Smoore

It is expected that presentation and discussion of these papers will enlighten the Members of the Congress and other participants of the seminar on this important subject.



(From Left) **Engr. Riaz Nazir Tarar**, **Engr**. **Husnain Ahmad** Past President/ Vice-President PEC and **Engr.Dr.Ch.Mazhr Ali**,the Chief Guest



(From Right) **Engr. Husnain Ahmad** Past President/ Vice-President PEC, **Engr. Riaz Nazir Tarar** Chairman Technical Session



(From Right) **Engr. Dr. Ch. Mazhar Ali**,the Chief Guest, **Engr. Syed Mansoob Ali Zaidi**, Secretary (PEC)



Engr.Abdul Qayyum presenting his paper on

"Contract Administration in Pakistan and FIDIC Rainbow 99"



Engr.Mazhar-ul-Islam presenting his paper on **"Regulatory Frameworks for Procurement of Consultancy Services"**



(2nd left) **Engr. Mushtaq A. Smoore** presenting his paper on "Claims" of Contractors etc.



Engr. Balal A. Khawaja presenting his paper on "**Arbitration Act**"



Engr. Mian Abdul Sattar presenting his paper on "**Role of the Engineer in FIDIC Based Construction Contract**"



Engr.Syed Mansoob Ali Zaidi,Secretary (PEC) presenting shield to the Chief Guest, **Engr. Dr. Ch. Mazhar Ali**



Engr.Dr.Izhar-ul-Haq, Vice-Presiden, PEC / Chairman Technical Session being interviewed by the Media



Engr.Dr.Izhar-ul-Haq, Vice-President-PEC / Chairman Technical Session expressing his views on the issues under-discussed at the event



Engr.Syed Mansoob Ali Zaidi, Secretary, Pakistan Engineering Congress conducting the program of the event



(From Right) **Engr.Atiq-ur-Rehman** Director NAB, Lahore & former Member of Executive Council of Congress being interviewed by Media



A seen of Questions / Answers meeting

A Glimpse of the Audience





A Glimpse of the Audience





A Glimpse of the Audience





REHABILITATING DEPLETING FORESTS

By Muhammad Hassain Khan

The Sindh forests department has decided to go for a regeneration of forests in inundated riverine areas. Around 40,000 acres of forest area is likely to submerge in water as a result of the present floods.

The current floods could be boon for Sindh's depleting riverine forests, which are dependent either on flood waters or on fresh suppliers from the Indus.

A significant portion of the forests has been lost and low income communities living in katcha areas cut trees virtually unchecked to use wood as a source of fuel and livelihood.

Officials consider the current flood waters insufficient for submerging the entire riverine forest area, which stretches over 600,000 acres on both sides of the Indus between Guddu and Kotri barrages.

Estimated high flows of 700,000 to 600,000 cusecs downstream in Guddu during floods are needed to reforestation in the riverine areas. But Sindh's barrages are now having low to medium flood levels.

Taking advantage of the current flows, however, the provincial forest authority has decided to go for the regeneration of forests to inundated areas. Around 40,000 acres of riverine forest area is likely to submerge as a result of the present floods.

The drive for the regeneration of forests would cover Raunti, Old Gublo, Keti Shah, Keti Abad, Bagar Ji forests - located between downstream Guddu and upstream Sukkur - and Bhanur, Kundha, Matiari and Miani forests between the Sukkur and Kotri reaches. Similarly, sites of Veeran and Marho riverine forests downstream in Kotri would also be covered.

The process would begin when flood water starts receding from the katcha areas within two weeks. Around 4,000 to 5,000 tonnes of seed of different species would be thrown during mid-abkalani and post-abkalani. About 90 pc of reforestation would take places in mid-abkalani (in the current phase of flood), as only 10 pc is earmarked for post-abkalani (floodwater recedes from katcha areas to reach the sea).

However, the uphill task, according to Sindh Forests Chief Conservator Riaz Wagan, would be the protection of these sites for forest regeneration, as poor local communities encroach these post-flood fertile lands for cultivation. "We face tremendous, political pressure while we try to stop encroachment" he adds.

The forest department's official, website describes riverine forests as the most productive in Sindh for wood material for domestic and commercial use. Experts, however, say from 1979 to 2009, large swatches of Indus basin forests were used for agricultural purposes. During this period, forests depleted at 9 pc per annum.

The forest policy 2005 allowed leasing riverine forest land with the condition that 25 pc of the allotted land would be used by farmers for growing forests and the remaining could be used for crop cultivation. A retired conservator of forests, Ghulam Rasool Keerio however, says the policy's objectives were not achieved due to the forest department's weak oversight, in addition to political influences.

Subsequently, the 25 pc ratio for forest plantation was reduced to 20 pc, "But this policy is followed by 30 pc of lessees as the rest of the 70 pc don't abide by it". Wagan remarked. He added that the forest department faces litigation from lessees at different levels where the leases are withdrawn.

Besides maintaining a natural ecosystem - wildlife, deforestation and vegetation - the riverine forests serve as a natural barrier against river dykes, avert soil erosion and break up the speed of flood water, which do not directly hit main embankments on both sides of the River Indus and minimize the chances of breaches.

Courtesy - Daily Down of 29th September, 2014

CLIMATE REALITIES

By Robert N. Stavins

Cambridge. Mass: World leaders will coverage at Untied Nations headquarters in New York today for a summit meeting on the climate that will set the stage for global negotiations next year to reduce greenhouse gas emissions and the threat of global climate change. Summit is titled "Catalyzing Action", a decidedly hopeful characterization.

I wish I were so hopeful.

It is true that, in theory, we can avoid the worst consequences of climate change with an intensive global effort over the next several decades. But given real-world economic and, in particular, political realities, that seems unlikely.

There are emerging hints of a positive path ahead, but first let's look at the sobering reality. The world is on track to more than double current greenhouse gas concentrations in the atmosphere by the end of the century. This would push up average global temperatures by three to eight degrees Celsius and could mean severe global impacts.

The United Nations has set a goal of keeping global temperatures from rising by no more than two degrees Celsius above pre-industrial levels. Meeting this goal would require a worldwide reduction in greenhouse gas emissions of 40 to 70 percent by mid-century, according to the Intergovernmental Panel on Climate Change. That's an immense challenge.

Three hundred years of economic growth in the industrialized countries has been fueled by the combustion of fossil fuels. We still depend on these. And the large emerging economics of China, India, Brazil, South Korea, Mexico and South Africa are rapidly putting in place new infrastructure that is also dependent on burning fossil fuels.

Two points are important to understand if we're going to he serious about attacking this problem.

One, it will be costly. And two, things become much more challenging when we move from economics to politics.

Doing what is necessary to achieve the United Nations' target for reducing emissions would reduce economic growth by about 0.06 percent annually from now through 2100, according to the I.P.C.C. That sounds trivial, but by the end of the century it means a 5 percent loss of worldwide economic activity per year.

And this cost projection assumes optimal conditions - the immediate implementation of a common global price or tax on carbon dioxide emissions, a significant expansion of nuclear power and the advent and wide use of new, low-cast technologies to control emissions and provide cleaner sources of energy.

If the new technologies we hope will be available aren't, like one that would enable the capture and storage of carbon emissions from power plants, the cost estimates more

than double.

Then there are the politics, driven by two fundamental facts.

First, greenhouse gases mix globally in the atmosphere, and so damages are spread worldwide, regardless of where gases are emitted. Any country taking action incurs the costs, but the benefits are distributed globally. So, it is in the economic self-interest of virtually no country to take unilateral action, but each can reap the benefits of any countries that do act.

We're now on track to more than double greenhouse gas concentrations in the atmosphere by the end of the century

This is why international cooperation is essential.

Second, some of these heat-trapping gases - in particular, carbon dioxide - remain in the atmosphere for centuries, so the problem will not be solved immediately. And even the most aggressive efforts will take time to ramp up.

These two realities present fundamental geopolitical challenges.

Reducing greenhouse gas pollution will require the cooperation of at least the 15 countries and one region (the European Union) that together account for about 80 percent of global carbon dioxide emissions. This will mean resolving deep divisions between industrialized nations and developing countries, which argue they should be able to build their economies, just as the West did, without having to reduce or slow the growth of their emissions.

In the United States, the issue is mired in partisan politics, and the outlook is not promising for an effective national climate policy that would encourage carbon-friendly innovation and cost-effective emission reductions by putting a price on carbon emissions, either by taxing them or using a national cap-and-trade system that would make it more expensive to pollute.

Making matters more difficult, climate change is essentially unobservable by the public. On a daily basis, we observe the weather, not the climate. This makes it less likely that public opinion will force action the way it did 50 years ago when black smoke rose from industrial smokestacks, and chemicals and raw sewage were dumped untreated into rivers, famously causing one to catch fire.

Similarly, in China, which leads the world in carbon emissions at 29 percent of the total, the prospect in the near term for a meaningful climate policy appears dim, because of the country's predominant focus on economic growth. China is expected to add the equivalent of a new 500-megawatt coal-fired electric plant every 10 days for the next decade, according to projections by the United States government.

The dispute between the developing and developed world over carbon-emissions reductions has its roots in a series of international agreements in the 1990s, when the industrialized nations alone, but not the large emerging economies, agreed to reduce their greenhouse gas emissions. As a result, since 1990, emissions have been flat or declining in the industrialized world, while increasing rapidly in the large, emerging economies, particularly China.

In the face of current United Nations efforts to develop a promising new approach that would require emissions reductions by all nations, most countries in the developing world continue to insist that these reductions should be made only by industrialized countries.

Despite these obstacles, a developing convergence of interests of the two key emitting countries - China and the United States - offers hope for progress.

China has overtaken the United States as the leading annual carbon dioxide emitter. And China will surpass America as the top cumulative global emitter over the coming decades.

The Chinese government is deeply concerned about worsening local air pollution, which contributed to an estimated 1.2 million premature deaths in 2010. Most actions to improve local air quality will also curb carbon dioxide emissions.

Both countries are moving forward with regional, market-based programs to reduce emissions.

linkage of such systems both within countries and across international borders holds promise as an environmentally effective and cost-effective approach to reducing emissions in coming years.

If the 20th century was the American Century, then leaders in China anticipate (or at least hope) that the 21st century will be the Chinese Century, one of global leadership, not obstruction. In the United States, the hope must be that creative politics and leadership can somehow begin to resolve the debilitating partisan divide that has paralyzed most policy action.

JAPAN'S BULLET TRAIN HITS HALF CENTURY

By Shingo Ito

Omiya: Fifty years ago, the first bullet train pulled out of Tokyo station and hurtled across the countryside, heralding Japan's arrival as a modern economic powerhouse with a transport system soon to become the envy of the world.

Less than two decades after a bitter World War II defeat that left much of the country in ruins, Japan was at the cutting edge with its sleek, airplane-shaped "shinkansen" that glided over great distances of newly-laid track.

"With the start of the shinkansen, we had a feeling that the starving rime would end and Japan would change dramatically", recalled Fumihiro Araki, a former railway engineer.

"The shinkansen aimed to be the world's fastest train, it gave people hope and made Japan look forward", said 73-year-old Araki, now deputy director at the Railway Museum in Omiya, north of Tokyo, where the first engine - named "Hikari" (light) - is housed.

"It was nicknamed the 'super-express' of dreams' and actually gave Japanese people a dream", he added.

The bullet train unveiled on October 1st, 1964 was the centerpiece of Japan's coming out party, which would begin in earnest a week later with the Tokyo Olympics. It proved Japan had caught up with - and even surpassed - other developed countries.

Never mind that its construction had lumbered Japan with huge debts as its runaway budget spiraled out of control, or that public opposition to the project had been fierce.

Celebrated blend of old and new

The shinkansen connected Japan's two major urban centres, Tokyo and Osaka, by way of 66 'i tunnels and 96 bridges at speeds of up 210 kilometers (130 miles) an hour, shortening travel times by a whopping two and a half hours.

That meant a businessman could travel from Tokyo to Osaka and back again in a day, it also lassoed both urban centres for people who wanted to go to concerts or to go shopping in the new "consumer economy.

It also brought top tourist sports like ancient capital of Kyoto much closer, and allowed passengers a majestic view of Mount Fuji as the gleaming new train sped past, simultaneously giving Japan the picture that sums up its celebrated blend of old and new.

The network expanded over the following decades to connect more parts of the mountainous country, and now covers all major population centres on the main island of Honshu and the southern island of Kyushu.

Despite running in an earthquake-prone country, none of the 324 million annual passengers -who travel at speeds of up to 320 kilometers (200 miles) an hour - has ever

died because of a shinkansen derailment or collision, although people have committed suicide by jumping in front of the trains.

Legendary punctuality

The system has almost legendary punctuality lates with the average delay considerably less than a minute.

Climate change threatens world's iconic ecosystems



London: Without better local management, world's most iconic ecosystems are at risk of collapse under climate change, warn researchers.

Protecting places of global environmental importance such as the Great Barrier Reef and the Amazon rainforest from climate change will require reducing pressures like over-fishing, fertiliser pollution and land clearing, they said.

Writing in the journal Science, an international team of researchers warned that localised issues, such as declining water quality from nutrient pollution or deforestation can exacerbate the effects of climatic extremes such as heat waves and droughts.

"We show that managing local pressures can expand the safe operating space" for these ecosystems, they wrote.

"Poor local management makes an ecosystem less tolerant to climate change and erodes its capacity to keep functioning effectively," said the study's lead author Marten Scheffer from the Wageningen University, the Netherlands.

The authors examined three Unesco World Heritage Sites -- Spain's Donana wetlands, the Amazon rainforest and the Great Barrier Reef.

While many ecosystems are important to their local people, these ecosystems have a global importance too, hence their designation as World Heritage Sites. For instance, the Amazon rainforest is a globally important climate regulator.

Like coral reefs, rainforests and wetlands around the world, these sites are all under increasing pressure from both climate change and local threats.

For example, the Donana wetlands in southern Spain are Europe's most important wintering site for waterfowl, hosting over half a million birds and home to numerous unique invertebrate and plant species.

A warming climate could encourage more severe blooms, causing losses of native plants and animals, say the researchers.

"Local managers could lessen this risk and therefore boost the wetlands' climate resilience by reducing nutrient runoff," said co-author Andy Green from the Donana Biological Station.

WELCOME TO NEW MEMBERS

The Executive Council of the Pakistan Engineering Congress approved Membership of the following new members into the Congress fold. The Engineering News Congratulates all of them and welcomes them to Pakistan Engineering Congress.

Members admitted on 29th October 2014.

1. Engr. Dr. Aftab Husnain Azhar
2. Engr. Muhammad Babar Malik
3. Engr. Muhammad Ahsin Bisharat
4. Engr. Mirza Rizwan Shabbir
5. Engr. Hannan Manzoor
6. Engr. Muhammad Ali Turkman
7. Engr. Muhammad Atif Butt
8. Engr. Hassan Hashmi
9. Engr. Lal Din
10. Engr. Umar Sarwar
11. Engr. Muhammad Farooq Sultan
12. Engr. Muhammad Khurram Khalid Malik
13. Engr. Waqar Anwar
14. Engr. Hafiz Muhammad Fiaz Manzoor
15. Engr. Abdul Qadoos
16. Engr. Abdul Jabbar Memon
17. Engr. Ihsan Ullah Khan
18. Engr. Muhammad Ramzan Saeed
19. Engr. Omer Naeem Khan
20. Engr. Muhammad Zia Bin Riaz
21. Engr. Mushrarraf Ahmad Khan
22. Engr. Muhammad Usman
23. Engr. Muhammad Khayyam Ilyas
24. Engr. Muhammad Umer Gill
25. Engr. Atif Aslam
26. Engr. Shoaib Nawaz
27. Engr. Muhammad Asfand Yar
28. Engr. Abdul Ghaffar
29. Engr. Zain Sultan
30. Engr. Muhammad Saad Afzal
31. Engr. Aamer Shahzad Bhutta
32. Engr. Nabeel Ahmad Khan
33. Engr. Wajih Nadeem Qamar
34. Engr. Hamayun Mushtaq
35. Engr. Mubeen Shahid
36. Engr. Rehman Afzal
37. Engr. Abdul Jabbar
38. Engr. Ali Arslan
39. Engr. Gohar Inam
40. Engr. Khubaib Arshad
41. Engr. Hassan Mehmood
42. Engr. Abdul Sattar
43. Engr. Sami Ullah
44. Engr. Farhan Fareed Khan
45. Engr. Muhammad Usman Hassan
46. Engr. Ahsan Rasheed
47. Engr. Muhammad Arif Sharafat Ali
48. Engr. Nasir Javed
49. Engr. Muhammad Saleem
50. Engr. Afshan Kanwal
51. Engr. Ali Amin
52. Engr. Anum Yaseen

COMPUTER COLLGEGE
PAKISTAN ENGINEERING CONGRESS

offers the following

Advance Land Surveying	**Certificate in Construction Management**	**Creo**	**Autocad 2014 (2D+3D)**
Autocad 2014 (2D+3D) (Mechanical)	**Autocad 2014 Civil 3D (Road Calc.)**	**Primavera P6 (R8.3)**	**PRO-E (Pro/Enginner)**
3d Studio Max	**STAAD Pro**	**SAP-2000**	**E-TABS+SAFE**
Geographical Information System/Remote Sensing (GIS/RS)	**Certificate in Office Management (C.O.M)**	**Certificate in ESTIMATION & COSTING**	**SPOKEN ENGLISH**
WEB PAGE DESIGNING	**PROJECT MANAGEMENT LEADING TO PMP**	**MATLAB**	**ANSYS**
CHEMCAD (Process Simulation Software)	**SOLIDCast** (Casting Simulation Software)	**CAESAR II** (Pipe Stree Analysis Software)	**CADWorx** (Plant Design Suite)

PVElite
(Pressure Vessel Design & Analysis Software)

Library
Of
Pakistan Engineering Congress

Pakistan Engineering Congress library is a **"Reference Library"** containing more than 4000 publications (Books +E-Books + Audio + Video etc.).In addition more than
2000 Congress Publications are also available at our Website (www.pecongress.org.pk)



Library Collection

Books Section

Engineering + Computer books are available on relevant shelves according to Dewey decimal classification,
E-books are also available on DVDs

Proceeding Section

- Pakistan Engineering Congress Proceedings
- Institution of Civil Engineers Minutes & Proceedings
- Transactions of the American Society of Civil Engineers
- The New Zealand Society of Civil Engineers
- Burma Engineering Congress
- The Institution of Engineers Australia
- The Engineering Association of Ceylon

PEC Publications Section

- Engineering News
- World Water Day
- World Environment Day
- Proceedings
- Symposium

Journals and Magazines

More than 20 National and International Journals & Magazines are available in Pakistan Engineering Congress Library.

DVDs-CDs Section

Books
Journals
Technical Lectures
PEC Seminar & Conferences
Videos &Pictures

Electronic Resources

Publications of International Organizations
• American Concrete Institution (Journals, Magazines, Standers etc.)
• American Society for testing & material
• American Society of Civil Engineers
• *International Monetary Fund Library*
IMF's periodicals, books, working Papers and studies, and data and statistical tools
http://www.elibrary.imf.org/

Electronic Databases

Higher Education Commission (HEC)
International scholarly literature based on electronic (online) delivery, providing access to high quality, Peer-reviewed Journals, Databases, articles and e-Books
http://www.digitallibrary.edu.pk/pecongress.html

Internet Use,

The Pakistan Engineering Congress library is being transformed with a state-of-the-art digital library with full access to the international digital library through dedicated internet connection.

Need Help,
Have Question?

Send an email to
librarian@pecongress.org.pk
PECongresslibrary@yahoo.com
any time, day or night.
We will do our best to answer you Within 24 hours.

HOW TO DEAL WITH WATER SHORTAGES IN THE COUNTRY

by

AMJAD AGHA

The looming water scarcity in the country is a cause of great concern. The total water availability per capita per year is now less than 1000 cu meters. 50 years ago the quantity available per capita was over 5000 cu meters, and at that time we were water affluent country. The population of West Pakistan in 1950 was about 37.5 million and now it has reached more than 180 million. 1000 cu meter/capita or below are considered water stressed and water deficient countries, which can result in water disputes between various riparians. The water availability is not uniform through the year and most of the water in the rivers flows in the summer season, therefore it is necessary to store surplus *^ water to be used in low flow months. In Pakistan the water scarcity is further compounded since the country has developed very little storage capacity. The present storages are only 10 percent of the total flow, while the world average storages is about 40 percent. Because of lack of storage an average of 30 MAF water goes into the sea. This average is based on post Tarbela flows, and also includes the recent drought years. Thus 20 percent of the already scarce resource is lost since we cannot store it.

IRSA the organization represented by all the four Provinces, which controls the irrigation water distribution in the country has in their recent report warned about lack of sufficient storage and they have urged the Government to even stop all development work in the country for the next some years and invest the available money to create more storage reservoirs.

The related issue is that canal water is being provided to the farms for instance in Punjab at a nominal flat rate of Rs. 135 per acre per annum. The water obtained from tubewells cost about Rs. 3000 per acre per annum. In my discussion with a World Bank representative, he stated that why should any Bank provide money for a water Project in Pakistan, where there is no arrangement for recovering the money spent on water projects. In order to clarify this, in Punjab where 22 million acres are cultivated under canal irrigation, the total revenue assessed as Abiana in a year is only Rs. 2.5 billion, the actual collection was merely Rs. 1.01 billion in 2014, which works out to Rs. 50 per acre per year. When a Farmer has to practically pay nothing for the canal water, this free water is therefore not being used in any efficient manner and a lot of precious asset is being wasted. Similar attitude is noticed in the use of water for municipal and industrial purposes, where no conservation is applied and wastages are increasing.

In order to save the country from the dooming situation, the following actions are absolutely vital:

1. Create storage particularly on the River Indus, so that our storage capacity is increased from 10 percent of the flow to 20 percent in the next 10-15 years. The work on these must start immediately.

2. Increase Abiana to Rs. 1500 per acre per annum, which would still be less than

half of what is spent on Tubewell water. If the farmers will use the water carefully, wastage will be reduced, and better irrigation practice will be introduced, which will result in highest crop intensity. The Irrigation Department revenue will increase, for instance in Punjab it will go up from Rs. 2 billion/year to Rs. 20 billion/year. With this extra money the maintenance of the system will improve, plus free extension service can be provided to small farmers for improving their yield with less water use. Dependence on tubewells will be reduced. This increase in revenue will also attract the international Banks funding for the water sector.

3. The public awareness and attitude towards development and conservation of water for irrigation and other consumptive uses needs to be boosted, media can play an important role in this.

As regards storage of water, a careful decision making on highly urgent basis is essential. Presently three large storage projects are in a stage that their construction can be started. These are Kalabagh Dam (6 MAF storage), Basha Dam (8.1 MAF) and Munda Dam (1.29 MAF). These projects will also provide about 9000 MW of cheap electricity. The construction of these projects has not started due to various impediments, although the Projects are well engineered and very feasible. The merits and impediments for each of these are summarily discussed below:

Kalabagh: It is the most thoroughly engineered project, has been studied by World's top experts, reviewed by top level International Panels of Experts, and thoroughly appraised by the World Bank. The project is located in the middle of load centres, is easy to approach, and no long distance transmission lines are required. It has been ready for construction since mid eighties and international financing from World Bank, Asian Bank etc. can still be easily arranged. However some political interference has come in the way from two Provinces, KPK and Sindh. The KPK objections were that the Kalabagh Dam reservoir will aggravate flooding of important city of Nowshera and the reservoir will displace some population, while they do not see any benefits from the Project. These objections have been thoroughly studied and it has been concluded that Kalabagh reservoir by itself does not cause any threat to Nowshera, since the reservoir elevation is 915 feet, while Nowshera is at elevation 940 feet. It has also been found that even without Kalabagh Dam if the floods of Kabul and Swat river get synchronized flooding of Nowshera does happen. In order to overcome this, it has been proposed that along with Kalabagh, Munda Dam should be built, which will fully control the exiting threat of flooding.

A very important aspect for KPK, which is not being registered is that KPK cannot use their share of water from Indus, since the river is at least 50 feet below the lands in KPK and will require prohibitively expensive pumping to lift it. The Kalabagh Dam will be able to provide a high level outlet from its reservoir and water will reach the lands in KPK through a gravity flow. No other dam on Indus can enable KPK to utilize their entitled share of water. This factor by itself is a great benefit for KPK, therefore /- if properly discussed and understood, the usefulness of the Kalabagh Dam for KPK cannot be over ignored.

The objections of Sindh province are not very clear. Their general feeling is that there is no surplus water in Indus which can be stored. The stated objections are that Kalabagh will hold water and therefore the water flow downstream of Kotri will reduce which will cause environmental damage to the mangroves and the shrimps which breed in

mangroves. The other fear is that low flow below Kotri will cause sea water intrusion and damage lands below Kotri. These objections have also been studied by local as well as international experts and they have concluded that a flow of 8 MAF must go downstream of Kotri every year to meet the environmental requirements. Presently an average of 30 MAF is going downstream of Kotri and goes into the sea. 6 MAF storage at Kalabagh therefore will not create any adverse conditions. There is V^ another objection which is not so much documented, in that the Kalabagh Reservoir is located in another Province which may steal the share of downstream Province. This fear is typical of all downstream riparians and therefore must be addressed. It f\ was for this reason that the Government created the organization IRSA (Indus River System Authority), which has representation from all the Provinces. These senior nominees of each province take a joint decision as to how much water to release for each Province in accordance with their agreed share. This sharing is more critical when the river flows are less than anticipated. It is understood that IRSA in its 22 years of functioning has always worked with consensus and so far there has not been any complaint by Sindh for lesser share of water nor has been referred to Council of Common Interest (CCI).

It appears that if these objections from various Provinces should be discussed at a high level meeting with Prime Minister presiding and a joint decision is taken in the jnterest of the country considering the future scenarios when water shortages will be very painful. Similar effort, as was done in 1992 for Water Accord between the Provinces should produce a good result. Building dams take 6-8 years, therefore *"-the matter cannot be postponed any further.

Basha Dam Another mega Dam Basha is also ready for construction for the last some years. International Consultants have designed the dam and top Panel of Experts have reviewed the design. The dam is very high 272 metre, (892 feet), to be constructed in RCC (Roller Compacted Concrete) and will be the highest RCC dam in the world. No Province has any objection to its construction and GOP is therefore; very keen to start it in preference to Kalabagh Dam. However there are some hurdles in its implementation. Firstly its cost of about 12-14 Billion Dollars is very high and will need good financial support from international funding agencies like World Bank, ADB etc. So far this financial support is not forthcoming, World bank feels that the location of the dam is in a disputed territory therefore they are reluctant to invest. ADB was initially very keen to invest, but are waiting for commitment of funding by other agencies. Chinese Government is also being approached, but their interest in the Project is still unknown. USAID had agreed to help, and they are carrying out independent environment and resettlement validation studies to verify the work already done so that other financing agencies develop more confidence about the Project. Another aspect of the Project which is causing apprehensions, is the far location of the Project. The KKH will need to be repaired and upgraded for approach to the site, where millions of tons of construction material have to be transported. Some 140 km of KKH will have to be rebuilt, since that part of KKH will be submerged in the reservoir. Moreover very long transmission lines in difficult terrain will have to be installed to transmit the electricity. All these issues add to the high cost of the Project. However since it is a good feasible project, with large reservoir must be built. Lets hope the finances can be arranged.

Munda Dam This site on Swat River has been studied for many years. It will be a 213 meter (700 feet) high dam with a storage capacity of 1.29 MAF and power of 800 MW. It was allotted to a private developer who had optimized its design for power production. Subsequently KPK Government objected and demanded that the irrigation and flood control must also be included in the design, which did not suit the . private developer.

The Project was given to WAPDA for its development as a multipurpose dam. The French Development Agency has offered to support the Project, and they have already released some funds for completion of design and tender documents. A commitment from Government to expedite the Project is still awaited.

Further Incentives for Confidence Building

In order to give further incentive for confidence building, it is proposed that a royalty charge of 5 percent be imposed on the revenue from these large Projects. The amount gathered through royalties should be distributed to the affected Province. For instance Kalabagh Dam will produce 10 billion kWh of electricity every year. The revenue from the electricity will be about Rs. 100 billion / year. If 5 percent of this amount i.e. Rs. 5 billion is available every year, Rs. 2 billion out of this can be used for improving the condition of mangroves nurseries, and if considered necessary by Government of Sindh, this money can also be used for building another Barrage downstream of Kotri to dispel threat of sea water intrusion. Rs. 2 billion every year to improve environment and irrigation infrastructure in Sindh will be very useful investment. Similarly the other 3 billion rupees from Kalabagh can be shared by KPK and Punjab for similar environmental mitigation and improvements. Such a royalty will further increase substantially after Basha Dam is built. This type of provision is now used internationally particularly in North Africa for shared projects between the riparians even on country-wise basis.

From the above discussion, it is obvious that Pakistan has to prepare itself for its water security on an urgent basis. The situation of water availability will gradually become even more critical with approaching global warming, when the glacier melting will gradually reduce the inflow in the rivers particularly Indus. The construction of big reservoir to store water which is presently going into the sea is the most important step. It is obvious that the first big reservoir which is the most feasible in all respect is through Kalabagh Dam, whose construction should be started immediately, followed as soon as possible by Basha Dam. No wrongly placed political arguments should hamper the water security of the country. The incentive suggested in the Paper should help in developing consensus. These Projects will also produce large hydropower which make these projects highly economical as well.

SOIL LOSS ESTIMATION FOR RIVER NEELUM BANK EROSION DUE TO FLOOD WAVE

Dr Engr Mazhar Hussain[1]

Abstract

This paper describes soil loss due to flood wave in river Neelum valley in district Muzaffarabad Azad Jammu and Kashmir. A 42 km long Neelum river reach from Nauseri to Muzafarabad is taken for the study. A conservative model universal soil loss equation (USLE) has been adopted to predict soil loss. The study river reach is V-shaped in cross-section and the stream gradient is relatively steep. Meteorological station at Muzaffarabad provides a fair representative estimate for the climatic parameters of the study site. The average annual rainfall of the area is about 1443 mm. In the absence of locally published maps of R values, three different procedures for estimating R from mean annual precipitation (P) are used.Soil loss equation estimates gross sheet and rill erosions and do not account for channel-type erosion. Since 20 – 40% of the total sediment yield results from gully erosion, the contribution of gully erosion should not be overlooked. It is proposed multiplying the annual soil loss by a factor of 1.3 to obtain the gross erosion. On the basis of gross erosion of 32.81 ton per hectare, the Neelum Valley is placed in the high erosion hazard class 4 (10-50 ton per ha per year).

Key Words: Soil loss, USLE, Neelum valley, erosion.

1.0 Introduction

The study of soil erosion and related problems is utmost important for analysis in Water and Land resources Management planning projects. The optimization of water and land resources development in South Asian countries is crucial for survival of 16.5% of world's population. Soil erosion, the removal of soil material by wind and water, is causing serious problems in many parts of Pakistan, particularly in Himalayans. Soil erosion has created many ecological and economic consequences. The effective productive top-soil is removed and the soil productivity deteriorates, landslides and gullies reduce the area of productive land and may damage roads and buildings, the hydrologic regimes of the rivers change and increased sediment loads result in eutrophication and the silting up of reservoirs and irrigation structures.

The most important factors controlling soil erosion are: rainfall, surface runoff, wind, soil, slope, plant cover and absence or presence of conservation measures. In Pakistan, in general, hydrological and metrological information is scarce or difficult to access. This is a constant problem in the development of any research model regarding soil loss.

---

[1] E-mail: maz.civil@gmail.com

Mass movement is an important part of the erosional process, and is often the first stage in the breakdown and transport of weathered materials in mountainous areas. It moves material from higher elevations to lower elevations where other eroding agents such as streams can then pick up the material and move it to even lower elevations.

1.1 MATERIAL AND METHODS

1.1.1 Study area

The project lies in district Muzaffarabad (AJ&K). River Neelum valleys have a typical V cross-section and the stream gradient is relatively steep (Fig. 1). In all stages of stream erosion, by far the most erosion occurs during times of flood, when more and faster-moving water is available to carry a larger sediment load. In such processes, it is not the water alone that erodes: suspended abrasive particles, pebbles and boulders can also act erosively as they traverse a surface.

1.1.2 Data collection

Muzaffarabad is the nearest meteorological station which is operated and maintained by the Pakistan Meteorological Department (PMD). Meteorological station at Muzaffarabad provides a fair representative estimate for the climatic parameters of the study site. The meteorological station is located at 340 22‟N and 730 29‟E at a height of 702 mean above sea level (masl). The prominent climate parameters of Muzaffarabad are described in following sections.

1.1.3 Temperature

The climate of the project is very similar to that of the sub-mountainous tracts of Rawalpindi and Hazara districts. It is fairly hot in summer and cold in winter. June and July are the hottest months and the temperature rises to more than 101 'F (38.3'C). The temperature during winter seldom falls below the freezing point. The river in the valley flows between elevations 580 and 1000 masl and the climate in the area is comparatively warm. The surrounding mountains rise to more than 1500 masl above the valley floor and have a cool and brazen climate.

Muzaffarabad city is located at 760 masl at the confluence of Neelum and Jhelum rivers (Dornel). It is surrounded by fairly high mountains, most of which remain covered with snow during the winter. The weather records at Muzaffarabad give a fairly good idea of temperature and humidity expected in the project area.

The maximum temperature during summer months varies between 58'F (14.4°C) and 98'F (36.7'C), the summer season mean being 80°F (26.7°C). The minimum temperature during winter varies between 37°F (3°C) and 72°F (22.2°C) which gives a mean of 55°F (30.5°C).

1.1.4 Precipitation

Mean monthly rainfall recorded at Muzaffarabad and the numbers of rainy days are given in Table-1.The average annual rainfall of the area is about 1443 mm. The maximum rainfall occurs during the months of July, August and September, which is about 20 % of the annual rainfall. Precipitation in the study area is characterized by the monsoon season. Winter rains generally occur during the months of January, February and March. April, May, October and November are normally the months of least

precipitation.

1.1.5 Method for computing soil loss

The most commonly used model for predicting soil loss from water erosion is the Universal Soil Loss Equation (USLE; Wischmeier & Smith 1978) which estimates the average annual soil loss, E,

Annual soil loss, E = R.K.LS.C.P (eq.1)

Where:

R: This is the rainfall erosivity index, based on mean annual EI30. If E is in foot-tons per acre and I30 is in inches per hour, R = EI30/100, R is in American units. If E is in MJ ha-1 and I30 is in mmh-1, R is in metric units.

K: This is the soil erodibility index defined as mean annual soil loss per unit of R for a standard condition of bare soil, recently tilled up-and-down slope with no conservation practice and on a slope of 5° and 22 m length. K can be defined for a unit of both American and metric R. Wherever possible, K should be based on measured values. Nomograph for computing the K value (metric units) of soil erodibility for use in the Universal Soil Loss Equation (after Wischmeier et al. 1971) is shown in Fig. 2. Divide values by 0.13 to obtain K values in the original American units

LS: The factors of slope length (L) and slope steepness (S) can be combined in a single index,which expresses the ratio of soil loss under a given slope steepness and slope length to the soil loss from the standard condition of a 5° slope, 22 m long, for which LS = 1.0. The appropriate value can be obtained from Nomograph (Wischmeier & Smith 1978) or from the equation:

$$LS = \left(\frac{x}{22.13}\right)^{n} \left(0.065 + 0.045S + 0.0065S^{2}\right)$$

where x is the slope length (m) and s is the slope gradient in per cent. The value of n varies according to the slope steepness.

C: The crop management factor represents the ratio of soil loss under a given crop to that from bare soil. Since soil loss varies with the erosivity and the morphology of the plant cover, it is necessary to take account of changes in these during the year in arriving at an annual value. For arable farming, the year is divided into periods corresponding to different stages of crop growth. For a given crop, separate ratio values are obtained for each period from tables summarizing data collected over many years by the United States Natural Resources ConservationService at their experimental stations (Wischmeier & Smith 1978). The values vary not only with the crop but also, for a single crop, with yield, plant density and the nature of the previous crop. The individual values for each period are weighted according to the percentage of the mean annual R value falling in that period. The weighted values are then summed to give the annual C value. This method allows C factor values to be determined for the crop rotations and management practices found in the USA. For other countries, detailed information for calculating the C factor in this way does not always exist and it may be more appropriate to use average annual values. Table-2 gives typical

ranges of values for different crops and management systems.

P: Values for the erosion-control practice factor are obtained from tables of the ratio of soil loss where the practice is applied to the soil loss where it is not. With no erosion-control practice, P = 1.0. Values cover contouring and contour strip-cropping and vary with the slope steepness (Table 3).Where diversion terracing is adopted, the value for contouring is used for the P factor and the LS factor is adjusted for the slope length represented by the horizontal spacing between the terraces. This method is not appropriate for bench terracing, for which values of P for different types have been established from research in Taiwan (Chan 1981).

1.2 CALCULATION OF SOIL LOSS

1.2.1 Estimating R (Rainfall erosion index)

In the absence of locally published maps of R values, three different procedures for estimating R from mean annual precipitation (P) are used.

Method 1

Mean annual precipitation (P) = 1443 mm

From Roose (1975), mean annual rainfall

erosion index (R) in American units = 0.5 P

= 0.5 x1443

= 721.5

Conversion to Mgmmha-1h-1 = 721.5x 17.3

= 12,481.95

Method 2

From Morgan (1974), mean annual erosivity = 9.28 P - 8,838

= (9.28 x1443) - 8838

= 4,553.04 Jm-2

= 45.53 Mgha-1

Multiply by I30 (use 75mmh-1; maximum value = 45.53x 75

recommended by Wischmeier and Smith (1978)

= 3,414.75

Method 3

From Foster et al. (1981), mean annual EI30 = 0.276 P x I30

(kg.m.mm)(m2h-1)

= 0.276 x1443x 75

= 29,870.1

Divide by 100 to convert to Mgmmha-1h-1 = 298.70

Best estimate: discard result from Method 3, which is rather low.

Take average value of Methods 1 and 2: = 7948.35

1.2.2 Estimating K (Soil erodibility index)

From Whitmore and Burnham (1969), the soils have a 43% clay, 8% silt, 9% fine sand and 40% coarse sand content; organic content is about 3%.

Using the Nomograph (Fig. 2), gives a first approximation K value = 0.04

1.2.3 Estimating LS (Slope factor)

For slope length (l) and slope steepness (s) in meters and percent respectively,

LS = (l / 22)0.5 (0.065 + 0.045s + 0.0065s2)

With contour bunds at 15m spacing, l = 15m and s = 12%

LS = (15 / 22)0.5 (0.065 + (0.045 x 12) + (0.0065 x 122))

LS = 0.82571 X 1.541

LS = 1.272

1.2.4 Estimating C (Crop management factor)

According to Table 2, the C value for maize ranges between 0.2 and 0.9, depending on the productivity. For many tropical farming conditions, C for maize lies between 0.4 and 0.9 (Roose 1975), depending on the cover. During the three-month period from seeding to harvest, the cover is likely to vary from 9 to 45 per cent in the first month, from 55 to 93 per cent in the second month, and from 45 to 57 per cent in the third month. Therefore, we might assume C values of 0.9, 0.4 and 0.7 for the three respective months.

Maize can be planted at any time of year in Neelum Valley but assume planting after the April rains, allowing growth, ripening and harvesting in June and July. Land is under dense secondary growth prior to planting (assume C = 0.001) and allowed to revert to the same after harvest (C = 0.1).

Of the mean annual precipitation, 32 per cent falls between January and April inclusive, 10 per cent in May, 6 per cent in June, 7 per cent in July and 45 per cent between August and December. Assuming that erosivity is directly related to precipitation amount, these values scan be used to describe the distribution of the R factor

throughout the year.

From the above information, the following table is constructed.

Months	C Value	Adjusted Factor (% R value)	Weighted R value
January to April	0.0201	0.32	0.0032
May	0.9	0.10	0.09
June	0.4	0.06	0.024
July	0.7	0.07	0.049
August December	0.1	0.45	0.045
Total			0.20832

C-factor for the year = 0.208

1.2.5 Estimating P (Erosion-control practice factor)

From Table 3, P value for contour bunds = 0.3

Soil loss estimation

Mean annual soil loss = R .K .LS .C .P

= 7948.35x 0.04x 1.272x 0.208 x 0.3

= 25.24 tha-1

The soil loss equations estimate gross sheet and rill erosions and do not account for channel-type erosion (gully, valley trenches, stream bank, and road bank erosions. Since 20 –40% of the total sediment yield results from gully erosion (Bali et al., 1972, Piest, et al, 1975), the contribution of gully erosion should not be overlooked. It is proposed multiplying the annual soil loss by a factor of 1.3 to obtain the gross erosion. On the basis of gross erosion, the Neelum Valley is placed in the high erosion hazard class 4 (10-50 ton/ha/year), (Table 4).

Gross erosion = 1.3 x 25.24 t ha-1

= 32.81 t ha-1

1.3 Results and discussions

1. USLE is normally used to predict mean annual loss. USLE was derived from and tested on data from experimental stations in the USA, which, when combined, represent over 10,000 years of record, it is widely accepted as reliable.

2. Soil erosion cannot be adequately described merely by multiplying together six

factor values.There is considerable interdependence between the variables. Some of these are considered. For instance, rainfall influences the R and C factors and terracing the L and P factors.

3. The soil loss equation estimates gross sheet and rill erosions and do not account for channel-type erosion(gully, valley trenches, stream bank, and road bank erosions).

4. In the absence of locally published maps of R values, three different procedures for estimating R from mean annual precipitation (P) are used.

5. Based on the value of gross erosion, Neelum Catchment is placed in the high erosion hazard class 4 i.e. (10 – 50 ton/ha/yr).

6. The soil erosion rate is generally expressed in units of mass or volume of eroded soil per unit area per g, unit of time. According to young (1969), erosion rates under natural conditions range between 0.045 to 0.450 tonnes/ha per year, for areas with moderate, respectively steep relief. For agricultural land erosion rates from 45 to 450 tonnes/ha per year are classified as accelerated erosion.

1.4 Conclusions and recommendations

1. The River Neelum catchment has steep slope which lead to occurring the great amount of soil erosion in this valley. This generates sediment transport problems.

2. Not all the soil loss on the slopes is delivered to the river; generally deposition takes place at various locations in the watershed. The eroded soil that is transported to, and passes a certain point along the stream channel in a certain period is important for reservoir design.

3. An accurate assessment of soil erosion / land degradation is not straight forward. A detailed survey is required to achieve more realistic value of soil erosion.

1.5 REFERENCES

1. Wischmeier, W.H. and Smith, D.D. 1978. Predicting rainfall erosion losses.USDA Agricultural Research Service Handbook 537.

2. Wischmeier, W.H., Johnson, C.B. and Cross, B.V. 1971. A, soil erodibility nomograph for farmland and construction sites. Journal of Soil and Water Conservation 26: 189–93.

3 Chan, C.C. 1981a. Evaluation of soil loss factors on cultivated slope lands of Taiwan. Food and Fertilizer Technology Center Taipei, Technical Bulletin 55.

4. Roose, E.J. 1975. Erosion etruissellement en Afriquedel'ouest: vingtannées de mesures en petites parcelles expérimentales. ORSTOM, Adiopodoumé, Ivory Coast.

5 Morgan, R.P.C. 1974. Estimating regional variations insoil erosion hazard in Peninsular Malaysia. Malayan Nature Journal 28: 94–106.

6 Foster, G.R., Lane, L.J., Nowlin, J.D., Laflen, J.M. and Young, R.A. 1981. Estimating erosion and sediment yield on field-sized areas. Transactions of the AmericanSociety of Agricultural Engineers 24: 1253–63.

7 Whitmore, T.C. and Burnham, C.P. 1969. The altitudinal sequence of forests and soils on granite near Kuala Lumpur. Malayan Nature Journal 22: 99–118.

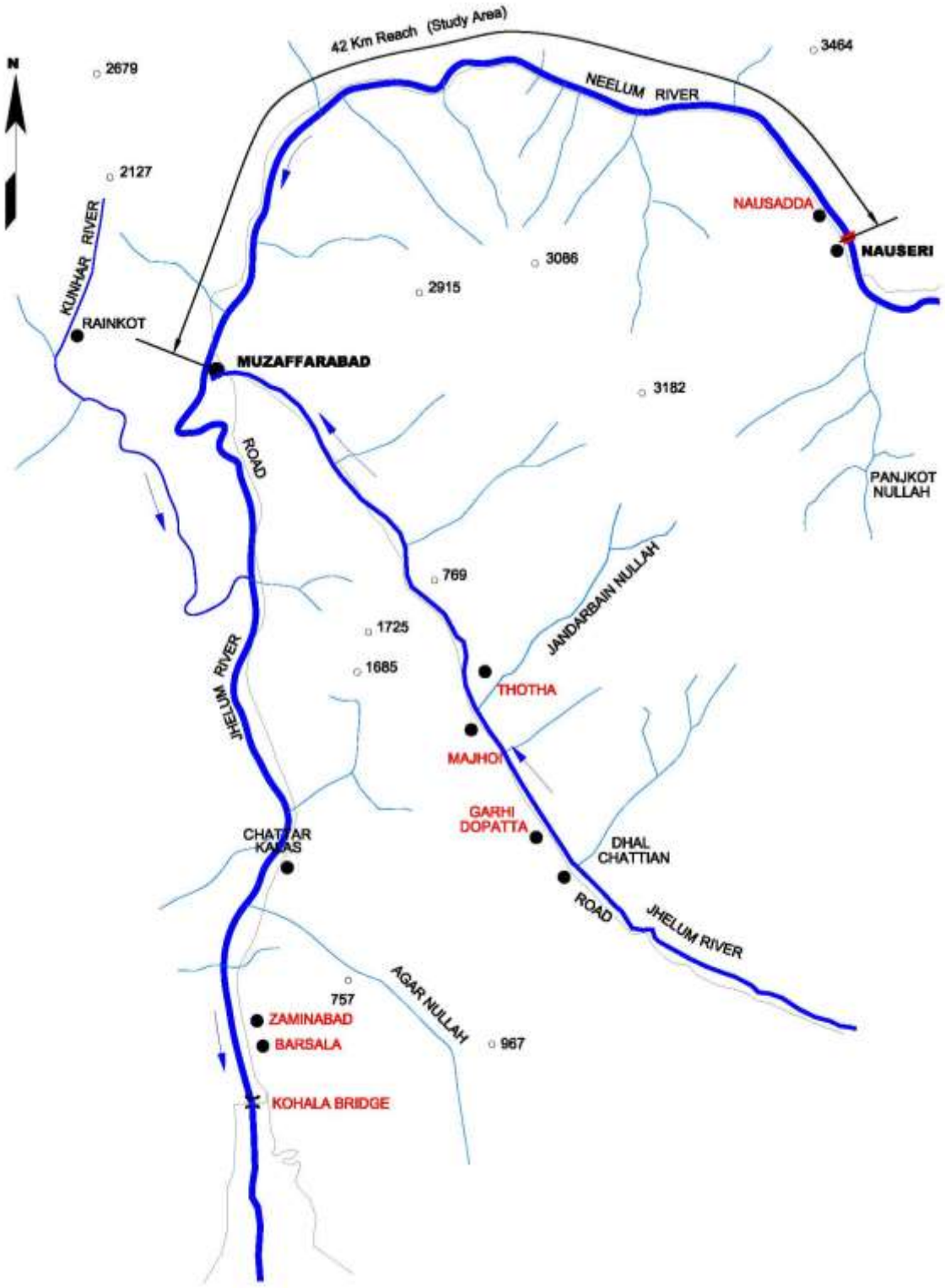


Fig 1: Study area river Neelum

Table-1: Mean Monthly Rainfall

Month	Mean Monthly Rainfall (mm)
January	109
February	144
March	158
April	105
May	73
June	113
July	277
August	199
September	114
October	42
November	39
December	70
Annual	1443

Source: Pakistan Meteorological Department, 2012

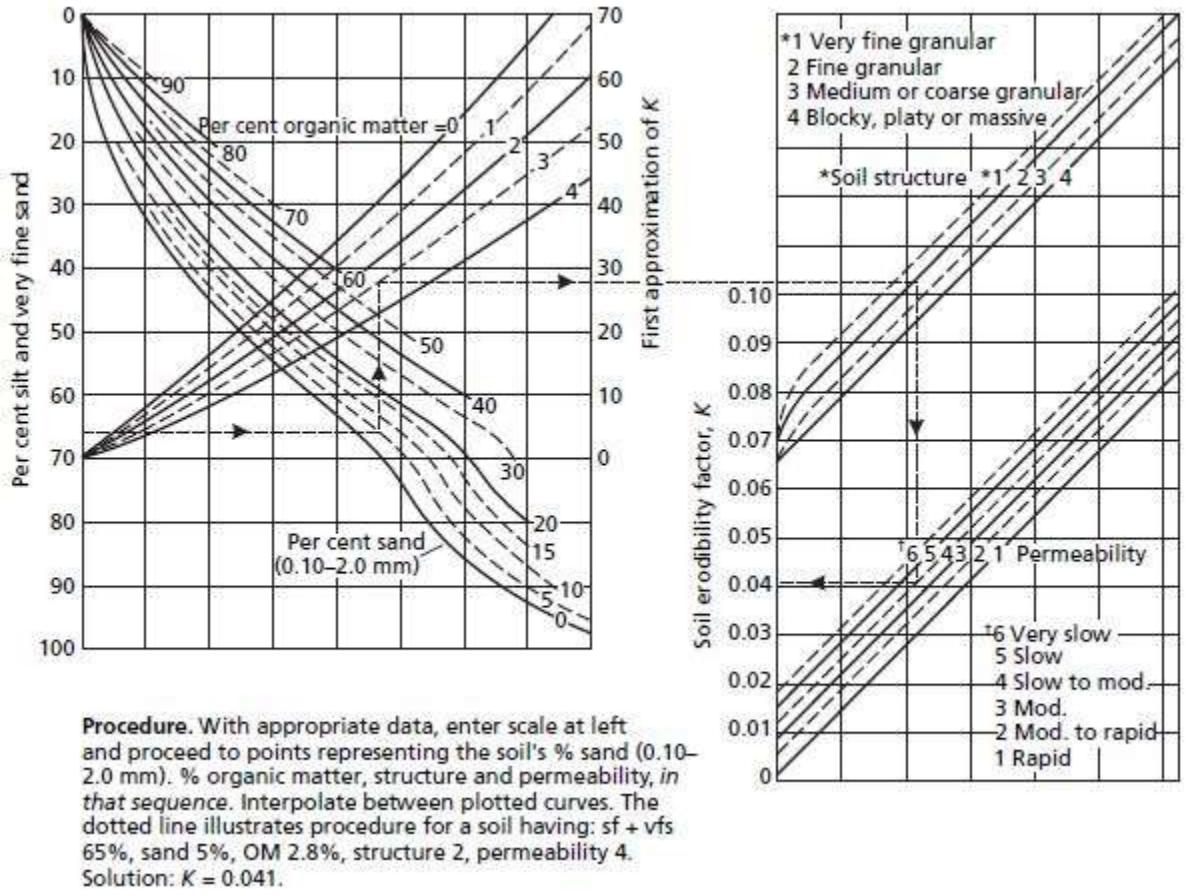


Fig. 2: Nomograph for computing the K value (metric units) of soil erodibility for use in the Universal Soil Loss Equation (after Wischmeier et al. 1971)

Table-2: C-factor values for the Universal Soil Loss Equation

Practice	Average annual C-factor
Bare Soil	1.00
Forest or dense shrub, high mulch crops	0.001
Savanna or prairie grass in good condition	0.01
Over grazed savanna or prairie grass	0.10
Maize, sorghum or millet; high productivity; conventional tillage	0.20-0.55
Maize, sorghum or millet; low productivity; conventional tillage	0.50-0.90
Maize, sorghum or millet; high productivity; chisel ploughing into residue	0.12-0.20
Maize, sorghum or millet; low productivity; chisel ploughing into residue	0.30-0.45
Maise, sorghum or millet; high productivity; no or minimum tillage	0.02-0.10
Cotton	0.40-0.070
Meadow grass	0.01-0.025
Soya beans	0.20-0.50
Wheat	0.10-0.40
Rice	0.10-0.20
Groundnuts	0.30-0.80
Palm trees, coffee, cocoa with cover crops	0.10-0.30
Pineapple on contour; residue removed	0.10-0.40
Pineapple on contour; with surface residue	0.01
Potatoes; rows downslope	0.20-0.50

Cowpeas	0.30-0.40
Strawberries; with weed cover	0.27
Pomegranate; with weed cover	0.08
Pomegranate; clean-weeded	0.56
Ethiopian tef	0.25
Sugar cane	0.13-0.40
Yams	0.40-0.50
Pigeon peas	0.60-0.70
Mungbean	0.04
Chilli	0.33
Coffee: after first harvest	0.05
Plantains: after establishment	0.05-0.10
Papaya	0.21

Source: after Wischmeier and Smith (1978), Roose (1977) Singh et al. (1981), El-Swaify et al. (1982), Hurni (1987), Hashim and Wong (1988).

Table-3: P-factor values for the Universal Soil Loss Equation

Erosion-control practice	P-factor value
Contouring: 0-1° slope	0.60*
Contouring: 2-5° slope	0.50*
Contouring: 6-7° slope	0.60*
Contouring: 8-9° slope	0.70*
Contouring: 10-11° slope	0.80*
Contouring: 12-14° slope	0.90*
Level bench terrace	0.14
Reverse-slope bench terrace	0.05
Outward-sloping bench terrace	0.35
Level retention bench terrace	0.01
Tied ridging	0.10-0.20

* Use 50% of the value for contour bunds or if contour strip cropping is practiced.

Source: after Wischmeier and Smith(1978), Roose (1977), Chan (1981a).

Table-4: Coding system for soil erosion appraisal in the field

Code	Class	Erosion rate ( )	Indicators
1	Very slight	<2	No evidence of compaction or crusting of the soil no wash marks or scour features; no splash pedestals or exposure of tree roots; over 70% plant cover (ground and canopy).
2	Slight	2-5	Some crusting of soil surface; localized wash but no or minor scouring; …… every 50-100m small splash pedestals, 1-5mm depth, where stones or exposed trees protect underlying soil, occupying not more than 10% of the area; soil level slightly higher on up slope or windward sides of plants and boulders; 30-70% plant cover.
3	Moderate	5-10	Wash marks; discontinuous …….. spaced every 20-50m; splash pedestals and exposed tree roots mark level of former surface, soil mounds protected by vegetation, all to depths of 5-10 mm and occupying not more than 10% of the area; slight to moderate surface crusting; 30-70% plant cover; slight risk of pollution problems downstream if slopes discharge straight into water courses.
4	High	10-50	Connected and continuous network of ……. Every 5-10 m or gullies spaced every 50-100m; tree root exposure, splash pedestals and soil mounds to depths of 10-50 mm occupying not more than 10% of the areas; crusting of the surface over large areas; less than 30% plant cover; danger of pollution and sedimentation problems downstream.
5	Severe	50-100	Continuous network of ……. Every 2-5m or gullies every 20m; tree root exposure, splash pedestals and soil mounds to depths of 50-100 mm covering more than 10% of the area; splays of coarse material; bare soil; siltation of water bodies; damage to roads by erosion and sedimentation.
6	Very severe	100-500	Continuous network of channels with gullies every 5-10 m; surrounding soil heavily crusted; severe siltation, pollution and eutrophication problems; bare soil.
7	Catastrophic	>500	Extensive network of ….. and gullies; large gullies (>100m^2) severe damage from erosion and sedimentation on-site and downstream.

Source: after Morgan et al. (2004)

Development of Road Safety Parameters and Comparison of Pakistan with other countries being United Kingdom as Reference

Prof. Dr. Tanvir Iqbal Qayyum[1]

Engr. Faizan Ahmad[2]

Engr. Imtiaz Ahmad and Engr. Rao Zaka[3]

ABSTRACT

Road safety is an important issue specifically for developing countries. The road safety level of a country is mainly expressed by the number of its fatalities per year, and actually depends upon various road safety parameters. This research paper develops and compares road safety parameters of various countries. The parameters are Population, Land Area, Population Density, Road Length, Paved Road % age, Road Density, Total Number of Registered Vehicles, Motor Vehicles (per 1000 people), Motor Vehicles (per km of road length), Reported Number of Traffic Deaths, Estimated Traffic Deaths per 100,000 Population and Fatality Rate (per 10,000 population).

United Kingdom (UK) was taken as a reference and road safety parameters of selected countries were calculated in proportion/compared to UK. Countries selected were regionally classified into two groups i.e. Low Income and Low Motorized Economies and High Income and High Motorized Economies. The countries examined in this research paper were Pakistan, India, Bangladesh, United Kingdom, Japan, USA and UAE.

The Fatality Rate (per 10,000 vehicles) on the Pakistan's road network remains among the highest in the selected countries i.e. about 12 times greater than UK despite the fact that Pakistan's registered vehicles are only 22% of UK. Thus for a safer community the traffic system in Pakistan needs a balanced approach, considering behavior of drivers, vehicles, roads, environment and enforcement, to identify road safety issues and to have a prolong solutions.

PROBLEM DEFINED

Roads are integral part of the transport system. Now a days governments of all countries in the world are building more and more roads for their economic, industrial and tourism development. As far as usage of roads is concerned, the "Road Safety" is one of the nation's most important issue.The road safety level of a country is mainly

---

[1] Dean Faculty of Civil Engineering, Imperial University Lahore.

[2] Junior highway Engineer, Asif Ali Associates, DHA Phase 1, Lahore.

[3] Graduates, Department of Transportation Engineering and Management, University of Engineering and Technology, Lahore.

expressed by the number of road fatalities per year which depends upon various road safety parameters. Throughout the world, roads are bustling with cars, buses, trucks, motorcycles, mopeds and other types of two- and three-wheelers. By making the transportation of goods and people faster and more efficient, these vehicles support economic and social development of the countries. But while motorized travel provides many benefits, it also do serious harm unless safety is made a priority. According to World Health Organization (2013), approximately 1.24 million people die every year on the roads, and another 20 to 50 million sustain non-fatal injuries as a result of road traffic crashes. These injuries and deaths have an immeasurable impact on the families affected, whose lives are often changed irrevocably by these tragedies, and on the communities in which these people lived and worked.

Road safety aims to reduce the harm (deaths, injuries, and property damage) resulting from crashes of vehicles traveling on roads.The users of a road include pedestrians, bicyclists, motorists and passengers.Road safety strategies focus upon the prevention of serious injury and death crashes. Safe road traffic is an indisputable requirement all over the world whose demand is increasing day by day.Road traffic safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. Although the standards of road safety measures are almost the same but their implementation from country to country is different. Some countries have come a long way from primitive road safety measures and are constantly moving towards their betterment keeping them abreast of all the developments around them while some others are still behind or lacking. This degree of implementation is one of the major causes of road accidents on a global platform.

Batool*et a*l. 2012 compared some countries of high economies with high motorization with low economies of low motorization, based on few general and basic road safety parameters i.e. populations, income, vehicles and road crash deaths etc. United Kingdom has flourished tremendously in reducing its traffic casualties over the past years despite having a high multitude of registered vehicles, therefore, was taken as reference for comparison with other countries.

In this research paper, authors have developed/calculated several Road Safety Parameters and compared different countries of Low Income Low Motorized and High Income High Motorized countries with United Kingdom as Reference/Unit Country, and on the basis of Developed Road Safety Parameters.

DATA COLLECTION, COMPARISON AND DISCUSSION

The road safety level of each country or group of countries is expressed by the number of road fatalities and casualties per year. The basic road safety parameters which are usually examined of the countries are the population, the total number of registered vehicles, road length, total number of deaths and Casualties etc. The Basic Road Parameters examined in this research paper were Population, GNI per capita (US dollars), Land area (sq. km), Road Length (km), Number of Registered Vehicles and Reported Number of Traffic Deaths. The Developed and Calculated Road Safety Parameters by authors were Population Density (people per sq. km of land area), %age Paved Road, Road Density (km of road length per sq. km of land area), Motor Vehicles (per 1000 people), Motor Vehicles (per km of road), Estimated Traffic Deaths per 100,000 population and Fatality Rate (per 10,000 population). The values of the Basic and the Developed Road Safety Parameters are given in Table-1.

Quantitative research methodology has been adopted for the analysis and comparison. In the Table-1, Countries were divided into two categories i.e. Low Income Low Motorization Countries and High Income High Motorization Countries. Low Income/motorization countries included Pakistan, India and Bangladesh whereas High Income/motorization countries included Japan, United Kingdom, United States of America and United Arab Emirates. United Kingdom was taken as a reference model and as Unity for comparison. Every parameter of all the countries were compared to United Kingdom using ratios. All the data collected was taken for year 2010 due to limitation of resources and available data. World Health Organization (2013) and Data Bank Indicators (2010) were used as sources of essential information.

Table 1: Development of Road Safety Parameters and their Country Comparison with respect to United Kingdom

Serial No.	Road Safety Parameters	Year	Classifications						
			Low Income and Low Motorized Economies			High Income and Highly Motorized Economies			
			Pakistan	India	Bangladesh	United Kingdom	Japan	USA	UAE
1.	Population	2010	173,149,306 (2.75)	1,205,624,648 (19.2)	151,125,475 (2.4)	62,747,868 (1)	127,450,459 (2.03)	309,326,225 (4.92)	8,441,537 (0.13)
2.	GNI per capita in US dollars	2010	1050 (0.027)	1260 (0.03)	700 (0.01)	38140 (1)	42050 (1.1)	47350 (1.24)	39640 (1.03)
3.	Land Area (sq. km)	2010	770880 (3.18)	2973190 (12.28)	130171 (0.53)	241930 (1)	364500 (1.50)	9147420 (37.8)	83600 (0.34)
4.	Population Density (people per sq. km of land area)	2010	224.61 (0.86)	405.4 (1.56)	1160.97 (4.47)	259.3 (1)	349.6 (1.34)	33.81 (0.13)	100.97 (0.38)
5.	Road Length (km)	2010	262567 (0.62)	4690342 (11.17)	22726 (0.05)	419671 (1)	339038 (0.8)	6561643 (15.63)	4080 (0.009)
6.	Paved Road % (in comparison to UK)	2010	72.5 (0.725)	53.1 (0.531)	N/A	100 (1)	80.9 (0.809)	100 (1)	100 (1)
7.	Road Density (km of road per sq. km of land area)	2010	0.34 (0.196)	1.57 (0.90)	N/A	1.73 (1)	0.93 (0.53)	0.71 (0.41)	0.049 (0.028)

Serial No.	Road Safety Parameters	Year	Classifications						
			Low Income and Low Motorized Economies			High Income and Highly Motorized Economies			
			Pakistan	India	Bangladesh	United Kingdom	Japan	USA	UAE
8.	Number of Registered Vehicles	2010	7853022 (0.22)	114952000 (3.2)	1624862 (0.04)	35170629 (1)	89871000 (2.62)	258957542 (7.36)	2260000 (0.064)
9.	Motor Vehicles (per 1000 people in)	2010	45.35 (0.08)	95.3 (0.17)	10.75 (0.019)	560.5 (1)	705.1 (1.25)	837.1 (1.49)	267.72 (0.47)
10.	Motor Vehicles (per km of road)	2010	29.9 (0.35)	24.5 (0.29)	71.4 (0.85)	83.8 (1)	265 (3.16)	39.4 (0.47)	N/A
11.	Reported No of Road Traffic Deaths	2010	5192 (2.72)	133938 (70.3)	2958 (1.55)	1905 (1)	7309 (3.83)	33808 (17.74)	826 (0.43)
12.	Estimated Road Traffic Deaths per 100,000 population	2010	3 (0.98)	11.11 (3.65)	1.96 (1.55)	3.04 (1)	5.73 (1.88)	10.93 (3.59)	9.78 (3.21)
13.	Fatality Rate (per 10,000 vehicle)	2010	6.61 (12.24)	11.65 (21.58)	18.2 (33.71)	0.54 (1)	0.81 (1.51)	1.31 (2.42)	3.65 (6.77)

Note: Each Parameter Quantity of UK is taken as reference unit i.e. as 1, the compared values of other countries are given in ().

The Road Safety Parameters indicated in Table 1 delineated the fact that the conditions of road safety in Pakistan are not up to the mark. A general quantitative analysis depicted that the Population of Pakistan is about 2.75 times as that of UK, and Land Area of Pakistan is 3.18 times of the UK, therefore as a result Population Density of Pakistan is less than that of UK. i.e. almost 86% of the UK, which is a positive aspect in regards of road safety. Since the population of Pakistan is relatively greater than UK, so more numbers .of registered vehicles should be present but this is highly unlikely.

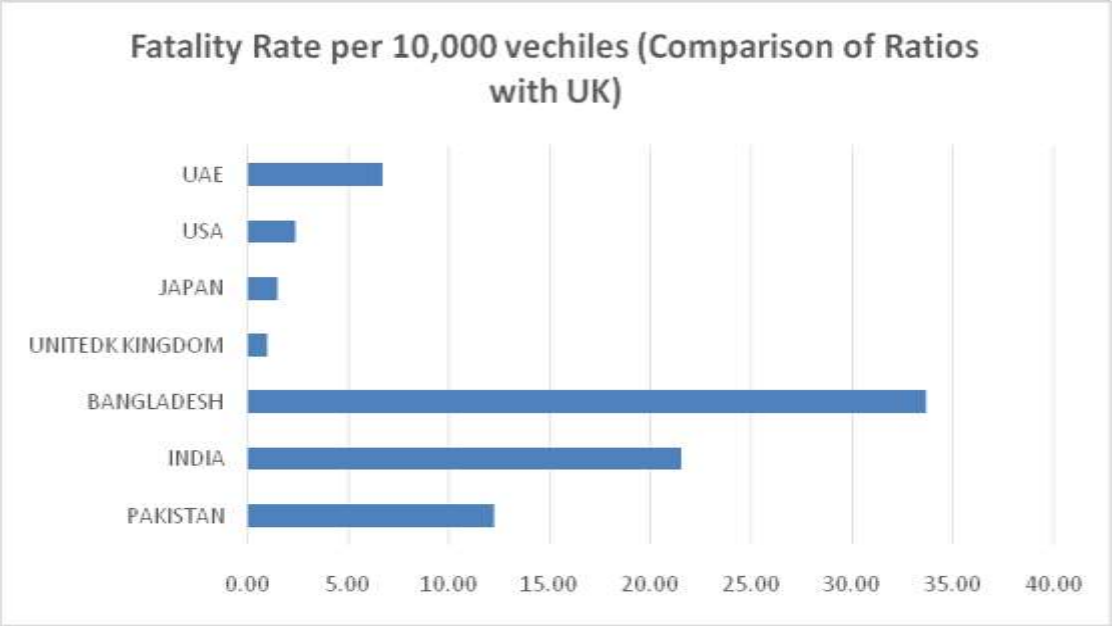


Figure 1: Fatality Rate per 10,000 vehicles (Comparison of Ratios with UK being 1)

Figure 1 shows a graphical view of the most important road safety parameter in this research paper i.e. Fatality Rate (per 10,000 vehicles), The Fatality Rate (per 10,000 vehicles) on the Pakistan's road network remains among the 3rd highest in the selected countries in Table1, and is about 12 times greater than that of UK, despite the fact that Pakistan's Numbers of Registered Vehicles are only 22%of UK and Motor Vehicle (per km of road) of Pakistan are also only 35% that of UK.

Greater Road Density means more length of road per sq. km of land area, but in case of Pakistan, the land area is greater than UK but still the road density of Pakistan is extremely less as compared to the selected countries, except UAE. This means that much land area in Pakistan is not covered with roads. If land area is high and road density is less, this means that road network is scarce in comparison to total land area. Furthermore along with the scarce road length, the paved percentage of Pakistan's road network is also less as compared to that of the UK. A very alarming finding for Pakistan authorities is that the Motor Vehicle (per 1000 people in) of Pakistan is extremely less (only 8%) as compared to that of the UK but overall the Fatality Rate (per 10,000 vehicle) is 12 times greater than UK. Thus it clearly needs dire improvements, modifications and need a more systematic approach to reach substantial safety results. Similarly the Fatality Rate (per 10,000 vehicles) on the India's and Bangladesh's roads network is about 22 and 34 times respectively greater than that of the UK.Thus in the terms of statistics India and Bangladesh are also lagging in context of road safety. India has the highest number of Reported Number of Traffic Deaths, primarily may be due to its highest population. The High Income and Highly Motorized Economies like Japan

and USA, the Fatality Rates(per 10,000 vehicle) respectively are 1.5 and 2.4 only. This means that road safety in Pakistan as compared with developed countries is at a very crucial and critical stage.

CONCLUSION

The research paper statistically concludes that low income with low motorized countries especially Pakistan is in dire need of road safety improvements. The statistics clearly portray that the present scenario of road safety is not up to the mark. Such kind of road safety research should be initiated at national level to identify road safety issues and to have a prolonged remedy solutions. The low income developing countries should adopt road safety methodologies employed by the developed countries after necessary modification in keeping with Domestic conditions.

REFERENCES

Batool Z. , Oliver Carsten & Ann Jopson (2012), *Road Safety Issues in Pakistan, A Case Study in Lahore*, Institute for Transport Studies, Transportation Planning and Technology, University of Leeds, Leeds, United Kingdom.

Data World Bank Indicators 2010 http://data.worldbank.org/indicator Assessed Date: 3/3/14

Road Transport Japan

http://www.ajtpweb.org/statistics/japan/road-transport-japanAssessed Date: 3/3/14

World Bank Road Safety (2013) http://www.worldbank.org/transport/roads/safety.html Assessed date: 22/3/14

World Health Organization (2013), *Global Status Report on Road Safety*, pp. 1, 244-302.

WATER SCARCITY ISSUE AND SOLUTION FOR PAKISTAN

By

Engr. M. P. Aftab

Abstract

Existing Water Resources are meager and diminishing rapidly. These must be conserved through better planning and implementation. Priority should be given to save unused water. This necessities construction of storage structures, recharge of aquifers, treatment of municipal and industrial wastewaters and it's reuse for beneficial purposes, etc to reduce stress on available water resources. Suchprojects would enhance irrigation supply and power generation thus reducing the deficit between demand and supply.

Introduction

Pakistan is blessed with plenty of water resources in the following forms:

(i) Surface water

(ii) Ground water

Surface water is available in rivers/streams/nullahs generated from snow melt runoff from the mountains in the northern areas flowing downstream to plains in the south of the country.

Rainfall runoffs add to the surface water.

Ground water is the infiltration of surface water through permeable soil/strata in the region.

Water Resources are renewable. It is estimated that overall water resources availability to world population was at 2,961 cubic meters (cu.m) per capita in the year 2000which is reduced to 1,420 cu.m per capita in the year 2005. It was 1,299 cu.m per capita in the year 1996-97 and declined to 1,100 cu.m per capita in the year 2004-2005. Pakistan will be a ''High Stress Country' since water resource availability is gradually declining tothe critical figure of 1,000 cu.m per capita.

Situation is likely to become worse due to rapid growing population, expanding urbanization and increased industrialization in the country. It may be noted that 36% of groundwater is saline causing water logging and salinity problems.

Present Water Resources Utilization

Out of 169,384 billion cu.m withdrawn in the year 2000, 96% was used for irrigation purpose in the country leaving 2% for domestic and 2% for industrial uses.

Current population of Pakistan is estimated to 187,343,000 in 2011 (Ref: 2)

Area under irrigation is 181,000 sq. km. requiring 48 billion cu.mof water.

It is well established fact that significant volume of unutilized surface water (mainlyflood water) isdischarged into Arabian Sea.

In Pakistan, only 80% of the population has access to piped water supply, although that does not mean clean drinking water supplies as well, and around 11% of rural population is beneficiary of this facility. Access to water is now reported to have risen to 92% i.e. 96% of urban population (36% of population) with 57% house connections and 89% of rural (64% of population) with 15% with house connections in the year 2010.

It is estimated that present water demand for domestic and industrial uses is approximately 3,032 million gallons per day (mgd) whereas the available water for the purpose is about 2,369mgd. Thus there is net shortage of 22% of total water requirement.

Based on the population growth and water uses for different categories (urban and rural) the water requirements for the year 2025 are estimated to be 7,340mgd.

The water supply systems in the urban centers of Pakistan are based on either the utilization of surface water or the ground water abstraction through tube wells. The cities which depend on surface water for their drinking water needs, includes among others the Federal Capital Islamabad, Karachi and Hyderabad whereas water supply for Lahore and Peshawar, Faisalabad, Quetta and Abbottabad are mostly dependent on the groundwater source. Nevertheless, excessive mining of groundwater is known to be taking place in major cities like Quetta. Despite a lowering water table, the overall annual growth of electric tube wells has been indicated to be 6.7% and diesel tube wells to be around 7.4%

Almost all the cities face moderate to acute shortage of water. Whereas the situation in Lahore and Peshawar can be considered somewhat satisfactory(due to comparatively rich aquifer), the cities of Karachi, Islamabad, Quetta and Abbottabad are facing acute shortage of water since gap between available water supply and demand is increasing day by day.

The scarcity of fresh water has forced the people to use the polluted water for growing and washing vegetables. The cumulative effect of these problems causes a high incidence of water borne diseases and degradation of environment. Flushing flows occur for a few weeks each year and only add pollution to the receiving bodies of water.some of which already could not support life. Increasing pollution and salt water intrusion threaten country's water resources.

Due to limited resources of water, there is a dire need for conservation of water resources or development of new sources and reuse of treated wastewater also.

Storage of Water / Proposed/Under –Construction Dams

Following are the proposed and under-construction dams ranked as large dams exceeding 15 meters (49 feet) in height as per International Commission on Large Dams:

Baluchistan	7
GilgitBaltistan	4
Federally Administered Areas	1
Khyber Pakhtunkhwa	8
Punjab	2
Sindh	2

Table below shows details of the above listed province wise proposed and under-

construction dams. These dams are going to enhance overall storage capacities of reservoirs and allow more releases from these reservoirs for increased irrigation water and/or power generation.

BALUCHISTAN	GILGIT BALTISTAN	FATA (FEDERALLY ADMINISTERD AREAS)	KHYBER PAKHTUNKHWA	PUNJAB	SIND
1. Garuk Dam (Proposed) 2. Pelar Dam (Proposed) 3. Winder Dam (Proposed) 4. Hingal Dam (Proposed) 5. Sukleji Dam (U/C) 6. Naulong Dam (U/C) 7. Darawat Dam (Completed)	1. Diamer-Basha Dam(U/C) 2. Bungi Dam (U/C) 3. Satpara Dam (Completed) 4. Dasu Dam (U/C)	1. KhurramTangi Dam (Proposed)	1. AllaiKhwar Dam 2. Bara Dam (U/C) 3. Changuz Dam (U/C) 4. Khan Khwar Dam 5. Maunda Dam (U/C) 6. Tanda Dam 7. Warsak Dam 8. Kalam Dam (U/C	1. Akhori Dam (U/C) 2. Kalabagh Dam (Proposed)	1. Darawat Dam (U/C) 2. NaiGaj Dam

Pakistan's Irrigation system is known to be the largest system in the world. This comprises barrages, canals, water courses, etc. Since canals and water courses are unlined /earthen, water losses are tremendous. It may contribute to recharge of the existing groundwater resource to some extent in certain areas but may also add to existing water logging and salinity problem in other areas.

By far most of the water is used for irrigated agriculture, emphasizing the particular significance of agriculture in the country. This sector contributes about 25% of Pakistan's GDP (2000-2001).

Water is essential for power generation in Pakistan since 29% is generated through hydropower.

Conclusions

(i) Master planning of water resources requires updating on priority basis.

(ii) Water Resources are already meager and diminishing rapidly. These must be conserved through better planning and implementation. Priority should be given to save unused water being discharged into Arabian Sea.

(iii) Construction of new large dams is necessary. In this regard, Kalabagh Dam is the only technically viable option at this time. A huge investment has already been made on design, bid invitation /construction documents but greater efforts are required for political consensus. This project would enhance irrigation supply and power generation thus reducing the deficit between demand and supply.

(iv) Basha Dam will be for power and irrigation purpose but in initial stage of investigations so far. Diversion of Karakurram highway is going to be a major project in itself. This is going to be a long term project for its implementation.

(v) Lining of irrigation canals is required to conserve water for increased irrigation areas and reducing water logging and salinity problem in the plain areas.

(vi) Reuse of municipal and industrial treated wastewater must be considered for recharge of aquifers, agricultural irrigation, landscape areas, etcas is being practiced in other countries.

References

1. **Aftab M.P, Reuse of Treated Wastewater for Karachi in Pakistan,** Conference Papers, Water Middle East International Exhibition and Conference for Water Technology (2003), Bahrain Convention & Exhibition Bureau and Nuemberg Global Affairs.
2. KirmaniSMH, **Waste Management Issues and Solutions**,IEP-SAC Journal 2012-13.
3. Waterinfo.net.pk.

Causes of delay and cost overrun in construction projects of Pakistan

Saad Farooq, Usman Javaid, Jawad Iqbal, Zubair ur Rehman Ansari

Graduate Students, Department of Civil Engineering, University of Engineering and Technology Lahore, Pakistan

Abstract

The research is aimed to identify and rank critical causes of delay and cost overrun in construction projects. The scope was limited to public sector projects of Pakistan and involved 17 employers, 21 consultants and 27 contractors. Through a survey questionnaire it was found that 1-non-availability of funds, 2-Delay in progress payment, 3-poor site management and supervision by the contractor and 4-improper planning are most critical for in budget and timely completion. It was also concluded that all parties are unanimous in the ranking. They believe that construction phase and general causes are most critical and require careful planning. The findings will serve as guide for technical people and as information for the taxpayers.

Keywords: Delay in construction, Cost overrun, Pakistan construction industry

1. Introduction

A successful project is completed in time and within the allocated budget. Good quality management is necessary for the timely completion of a project. The management of four main resources of a construction project; machinery, manpower, money and materials; is very crucial for the success of a project. Latest techniques and tools also play an important role in the efficient management of a project. Poor management and indifference to latest tools and techniques result in delay and cost overrun.

For a construction project, within the budget and early completion is rarely achieved, as construction is a very unique process in which the work is complex and the projects are diverse. The construction industry of developing countries is prone to these problems and Pakistan is no exception.

For Pakistan, construction industry is fundamental for infrastructure development, serving as foundation for other industries. The level of construction work is an economic indicator of a country. In Pakistan, construction industry constitutes around 2.4 percent of GDP [13]. Almost 3.3 million people were employed in construction sector in FY08 and the number for rural areas (2.2 million) is twice that of urban areas (1.1 million). Moreover, construction sector is also strongly associated with the growth in a number of manufacturing industries including cement, metals, glass, paints, etc. [13].

The delays in work and the cost overruns can inflict serious damages to the industry. They augment the already frail condition of this industry. Most of the projects seem to be lagging behind in schedule and breaking the limit of planned budget. These causes of delay and cost overrun, if not identified hinder the prosperity, which will subsequently affect the economy of the nation. Moreover, the governmental policies are not supportive. Registration fees, professional tax, withholding tax and other taxes are

discouraging for the smaller and weak companies. If these processes are not made efficient, results can be in the form of shrinking of construction activities.

2. Literature Review

Immense research has been carried out on this topic internationally but in Pakistan it has not been given the adequate consideration. An extensive literature review has been carried out for this research. Numerous texts and journals were consulted. The top rated causes have been selected from various research papers and with the help of discussion with professionals working in field. Summary of previous studies of the causes of delay and cost overrun in construction projects is presented in Table 2.1.

Table 2.1 Previous Studies

Sr. no.	Phase Of Project	Major Causes of Delay and Cost Overrun	Previously Identified by
1	Objective/ Employer's Perspective	-	-
2	Feasibility & Conceptual Planning	-	-
3	Design and Engineering	Poor design	(Momani, 2000) [7]
		Delay in reviewing and approving design documents by owner	(Sadi A. Assaf, 2006)[2], (Abdalla M. Odeh, 2002) [8]
4	Planning and Scheduling	Improper planning	(Abdalla M. Odeh, 2002) [8] (Sadi A. Assaf, 2006) [2], (Murlai Sambasivan, 2007) [1], (G. Sweis, 2008) [5]
		Inadequate managerial skills	(Kumaraswamy, 1997) [10], (K.C. Iyer, 2005) [4]
5	Tendering	Types of project bidding and award	(Sadi A. Assaf, 2006) [2]
		Contract management	(Abdalla M. Odeh, 2002) [8], (Yaw Frimpong, 2003) [3]
		Contract modification	(Chabota Kaliba, 2009) [6]
		Deficiencies in cost estimates prepared	(Yaw Frimpong, 2003) [3]
6	Mobilization and Procurement	Preparation before construction	(Bent Flyvbjerg, 2004) [9]
		Material procurement	(Yaw Frimpong, 2003)[3], (Mohan R. Manavazhi, 2002)[12]
		Material supplier fault	(Mohan R. Manavazhi, 2002) [12]
7	Construction	Change orders	(Momani, 2000) [7], (Abdalla M. Odeh, 2002) [8], (Kumaraswamy, 1997)[10], (G. Sweis, 2008) [5]
		Weather condition	(Momani, 2000) [7], (G. Sweis, 2008) [5], (Yaw Frimpong, 2003) [3],(Long Le-Hoai, 2008) [11]
		Site condition	(Momani, 2000) [7]
		Shortage of labour	(Sadi A. Assaf, 2006) [2], (G. Sweis, 2008) [5]
		Delay in progress payment by owner	(Sadi A. Assaf, 2006) [2],(Abdalla M. Odeh, 2002) [8], (Murlai Sambasivan, 2007) [1], (Chabota Kaliba, 2009)[6], (Yaw Frimpong, 2003) [3],(Long Le-Hoai, 2008) [11]
		Unqualified work force	(Sadi A. Assaf, 2006) [2]
		Poor site management and supervision	(Abdalla M. Odeh, 2002)[8], (Kumaraswamy, 1997) [10], (Murlai Sambasivan, 2007) [1],(Long Le-Hoai, 2008) [11]
		Improper control over site resource allocation	(Kumaraswamy, 1997)[10]

		Inadequate contractor experience	(Kumaraswamy, 1997) [10],(Murlai Sambasivan, 2007) [1]
		Unforeseen ground condition	(Kumaraswamy, 1997) [10]
		Subcontractors	(Murlai Sambasivan, 2007) [1]
		Shortage in material	(Murlai Sambasivan, 2007) [1]
		Understanding operational difficulties by the owner engineer	(K.C. Iyer, 2005) [4]
		Coordination ability and rapport of project manager with other contractors at site	(K.C. Iyer, 2005) [4]
		Coordination ability and rapport of project manager with top management	(K.C. Iyer, 2005) [4]
		Inflation	(Yaw Frimpong, 2003) [3]
		Non-availability of crushers at queries	(Mohan R. Manavazhi, 2002) [12]
		Transportation delays	(Mohan R. Manavazhi, 2002) [12]
8	Project Handover	-	-
	General Causes	Sluggishness in decision making	(Bent Flyvbjerg, 2004) [9]
		Financial difficulties	(Chabota Kaliba, 2009)[6], (G. Sweis, 2008)[5]
		Economic problems	(Chabota Kaliba, 2009)[6]
		Stubborn attitude of project manager and project participants	(K.C. Iyer, 2005) [4]
		Governmental regulations	(Mohan R. Manavazhi, 2002) [12]

3. Research Scope and Objectives

The research focuses on construction projects of all scales in Pakistan. Scope involves all three parties of the project namely employer, consultant and contractor. Survey responses include public agencies, private companies and semi-government organizations. Ranking of the causes that lead to delay and cost overrun has been carried out from all three parties of the project.

Main objectives are

- To study and evaluate the causes which lead towards time and cost overrun in construction projects of Pakistan.
- To classify and rank the identified causes corresponding to their response.
- To give recommendations to the parties of the project for the elimination or minimization of critical causes.

4. Methodology

After extensive literature review and discussion with experienced personnel working in construction industry total 62 causes leading to delay and cost overrun were filtered. These filtered causes were distributed in common phases of construction project as illustrated in table 4.1 and presented in a questionnaire for data collection.

The questionnaire was divided into 3 parts i.e. general information, ranking of causes and comments. First part included the data about the respondent; second part included the causes with an ordinal scale ranging from 1 to 10 while third part consists of two open ended questions about the research credibility.

Out of the 62, five common causes were assembled in a separate group named “General Causes”.

Table 4.1 Common construction phases

Phase #	Phase Name	Number of causes
P-1	Objective/ Employer’s Perspective	1
P-2	Feasibility & Conceptual Planning	5
P-3	Design and Engineering	4
P-4	Planning and Scheduling	3
P-5	Tendering	6
P-6	Mobilization and Procurement	8
P-7	Construction	25
P-8	Project Handover	5

	General Causes	5
	∑=	62

With correction of minor errors during pilot testing the final questionnaire was prepared for data collection. List of registered contractors and consultants was collected from Pakistan Engineering Council (PEC). For employers, no proper data was available so only well-known and approachable employers were surveyed. These organizations were randomly surveyed and data was collected from Employers (17), Contractors (27), and Consultants (21) during a time of about 7 months. Total sixty-six samples were distributed out of which one incomplete sample was rejected giving a total response rate of 98%.

Computer softwares including Statistical Package for Social Sciences (SPSS) 17.0 and Microsoft Excel 2010 were used for the analysis of data.

4.1 Ranking

Ranking of causes was done using universally accepted formula of relative importance index.

$$RII = \frac{\sum i * f}{A * N} \qquad \textbf{Equation 4.1}$$

Here

RII = Relative importance index

i = scale value

f = frequency corresponding to scale value

A = highest scale value i.e. 10 in this case

N = total number of respondents i.e. total frequency in this case

4.2 Hypothesis

For the development of hypothesis the scope of the study was limited to only top twenty causes that were ranked using relative importance index (RII).

Since all the parties of the project were involved in the study so a hypothesis was developed to check the variance of the response of the parties for the same cause. The hypothesis was

- Hypothesis 1 (H1): “There is no association and difference between party of the project and ranking of cause.”

The respondents were divided into different categories depending upon their experience in construction industry. So, to check the variation of opinions between the respondents based on the completed projects, another hypothesis was developed as follows

- Hypothesis 2 (H2): “There is no association and difference between previous completed projects (PCPs) and ranking of cause.”

In a similar way two more hypothesis were developed to facilitate the above hypothesis. These are as follows

- Hypothesis 3 (H3): “There is no association and difference between education level of respondent and ranking of cause.”

- Hypothesis 4 (H4): “There is no association and difference between Experience of the respondent and ranking of cause.”

4.3 Statistical analysis

Unlike previous researchers, two flow charts were developed for statistical analysis. For the identification of relation or association between two variables Chi-square test was used as shown in Fig. 4.1.

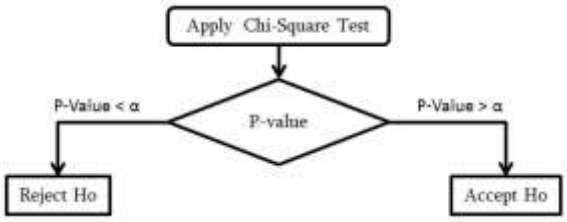


Figure 4.1 Association checking flow chart

The data was then checked for normalization as shown in Fig. 4.2.

A test named Kolmogorov-Smirnov test was used for this purpose. Based on the results of this test a non-parametric test named Kruskal-Wallis H test was applied to check the degree of agreement for the ranking of cause. The major advantage of this test is its capability of comparing three or more than three variables at the same time.

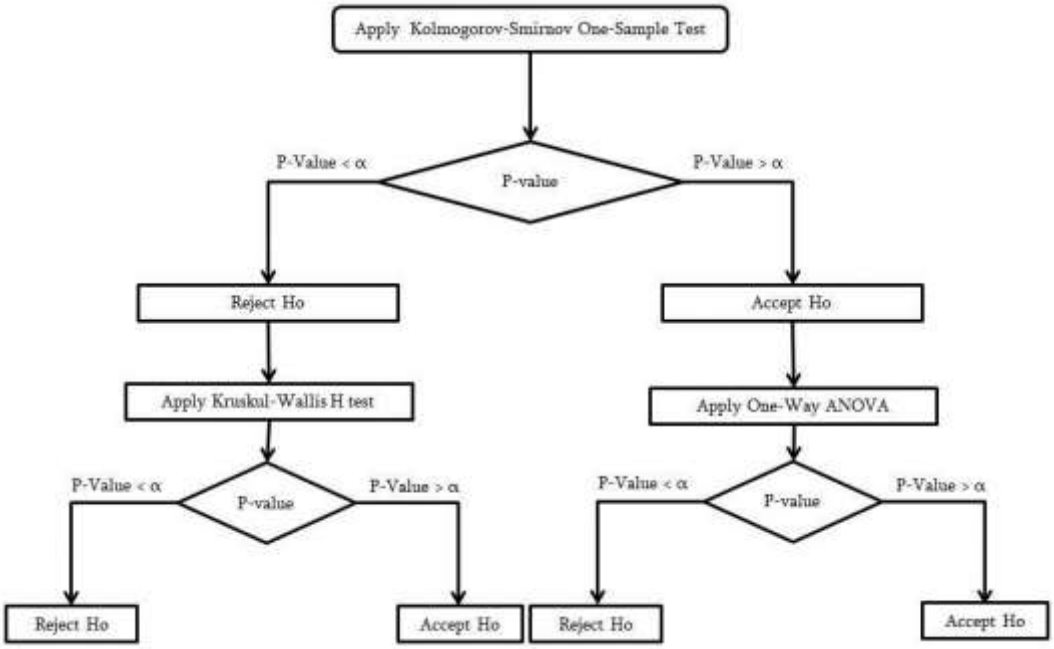


Figure 4.2 Difference checking flow chart

5. Results and discussion

The analysis was done on all the 62 causes but for the purpose of better understanding only top 20 causes were filtered for detailed discussion.

5.1. Demographic data

All the three parties were involved in data collection. The partywise distribution of sample collection is shown in Fig. 5.1 in a form of pie chart.

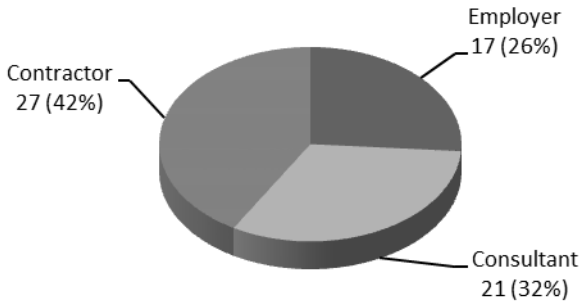


Figure 5.1 Samples

The demographic data of the respondents is tabulatedin table 5.1.

The table 5.1 shows that the previous completed projects have a percentage of 43.1% corresponding to the scale value of “More than 15” which means that the respondents must have faced the variability of different conditions during project life cycle.

In education level the high percentages of Bachelor and Master shows that the respondents were more educated.

Table 5.1 Demographic data

	CATEGORY	FREQUENCY	PERCENTAGE
Previous Completed Projects		15	23.1
	5-10	13	20
	10-15	9	13.8
	More than 15	28	43.1
Education Level	an DAE	2	3.1
	DAE	4	6.2
	Bachelor Degree	35	53.8
	Master Degree	21	32.3
	Doctoral Degree	3	4.6
Experience	n 2 years	4	6.2
	2-5 years	7	10.8
	6-10 years	11	16.9
	11-15 years	8	12.3
	16-20 years	9	13.8
	More than 20 years	26	40

Regarding experience the high percentage of 40% corresponding to the scale value of "More than 20 year" clearly elaborates that the respondents were highly experienced.

Descriptive statistics: Different statistical parameters were calculated for top 20 causes and presented in a tabular form in table 5.2.

Ranking of causes: All the causes were ranked using equation 4.1 and are presented in Fig. 5.2 in the form of bar chart.

The top four causes i.e. Non-availability of funds during fiscal year, Delay in progress payment, Poor site management and supervision by the contractor and Delayed decision making process by top management are having RII values greater than 0.8 which is the high severity range. Among these four causes, first three are from construction phase while fourth one is from general causes.

Table 5.2 Descriptive Statistics

Phase	Cause	Mean	Median	Mode	Range	Variance	Standard Deviation

P-1: Objective/ Employer's Perspective	Vague conception of demand	6	6	5	9	7	2.58
P-2: Feasibility and Conceptual Planning	Delay in land acquisition	7	8	10	9	6	2.54
	Inadequate topographic survey data	6	6	5	8	6	2.47
	Slow government processing	8	8	10	9	5	2.20
	Delay in geotechnical studies	6	5	3	9	8	2.89
	Social and cultural barriers	5	5	3	9	5	2.20
P-3: Design and Engineering	Delay in preparation of design documents	7	7	8	8	6	2.52
	Technical inability of consultant	7	7	9	9	7	2.61
	Ambiguous and unrealistic specifications	7	8	8	9	7	2.60
	Past experience of consultant of similar project	7	8	9	9	8	2.83
P-4: Planning and Scheduling	In efficient project planning	8	9	10	7	6	2.38
	Lack of risk management	7	7	7	9	5	2.24
	Unrealistic project completion time	8	8	10	8	4	2.10
P-5: Tendering	Type of construction contract (BOT, Turnkey, construction only etc.)	6	6	1	9	8	2.83
	Type of project bidding	6	6	7	9	8	2.81
	Inaccurate and erroneous estimation of quantities	7	8	8	9	6	2.42
	Award of contract to lowest bidder	6	7	9	9	8	2.79
	Fraudulent practices. kickbacks and corruption	8	8	10	9	7	2.73
	Long period between design and time of bidding/tendering	7	8	8	9	6	2.43
P-6: Mobilization and Procurement	Difficulty in access to site due to rough terrain	6	6	5	9	6	2.35
	Permits and regulations (No objection certificates, NOCs) from government agencies	6	6	8	9	6	2.46
	Delay in site mobilization	6	6	8	9	5	2.30
	Shifting of existing public services or utilities	7	8	8	9	7	2.66
	Transportation of material	6	6	7	9	6	2.53

Delayed shipment of imported material	7	7	9	9	6	2.41
Improper planning for procurement of material	7	8	10	9	6	2.40
Damage of material (during storage)	5	5	3	9	6	2.41
Delay in material delivery	7	7	8	9	6	2.46
Fluctuation in price of raw material	7	8	8	9	6	2.44
Unstable cost of manufactured material	7	7	7	9	5	2.28
Shortage of construction material	6	6	9	9	6	2.40
Low quality of material	7	7	8	8	6	2.51
Financial inadequacy of contractor	8	9	10	9	5	2.33
Delay in availability of structural drawings	7	7	10	7	5	2.32
Traffic control and regulation problem	5	5	3	9	5	2.29
Old construction practices	6	6	5	9	5	2.21
Deficiency of skilled labour	7	7	8	8	5	2.15
Non availability of labour during harvesting season	6	6	9	9	6	2.52
Accidents during construction	5	5	3	9	6	2.54
Equipment breakdown	6	6	5	9	5	2.31
High machinery maintenance cost	5	6	5	9	5	2.30
Less qualified technical staff of contractor	7	8	8	9	5	2.19
Scope change	7	8	10	9	6	2.54
Act of GOD	7	7	10	9	8	2.79
Non-availability of funds during fiscal year	8	9	10	9	5	2.16
Delay in progress payment	8	8	10	8	4	1.92
Lack of coordination among parties of project	8	8	7	9	4	1.95
Change orders by employer during construction	7	8	8	9	7	2.61
Suspension of work by employer or due to strikes	6	7	8	9	7	2.64
Frequent change of subcontractor	6	7	8	9	7	2.66
Lack of coordination among subcontractors	6	6	8	9	6	2.43

P-7: Construction

	Poor site management and supervision by the contractor	8	9	9	7	3	1.86
P-8: Project Handover	Delay in performing final inspection by third party	6	7	8	9	7	2.59
	Unresolved claims	7	7	8	9	6	2.35
	Delay in conflict resolution (Litigation, etc.)	7	8	8	8	4	2.11
	Unrealistic penalties in case of delay	7	7	7	8	6	2.39
	Unavailability of incentive for finishing ahead	7	7	6	9	7	2.65
General	Political instability	7	7	10	9	7	2.57
	National slump in economy	7	8	10	9	7	2.60
	Delayed decision making process by top management	8	8	10	8	3	1.84
	Unsupportive government policies	7	8	10	9	6	2.35
	Involvement of bureaucracy	8	8	7	9	6	2.40

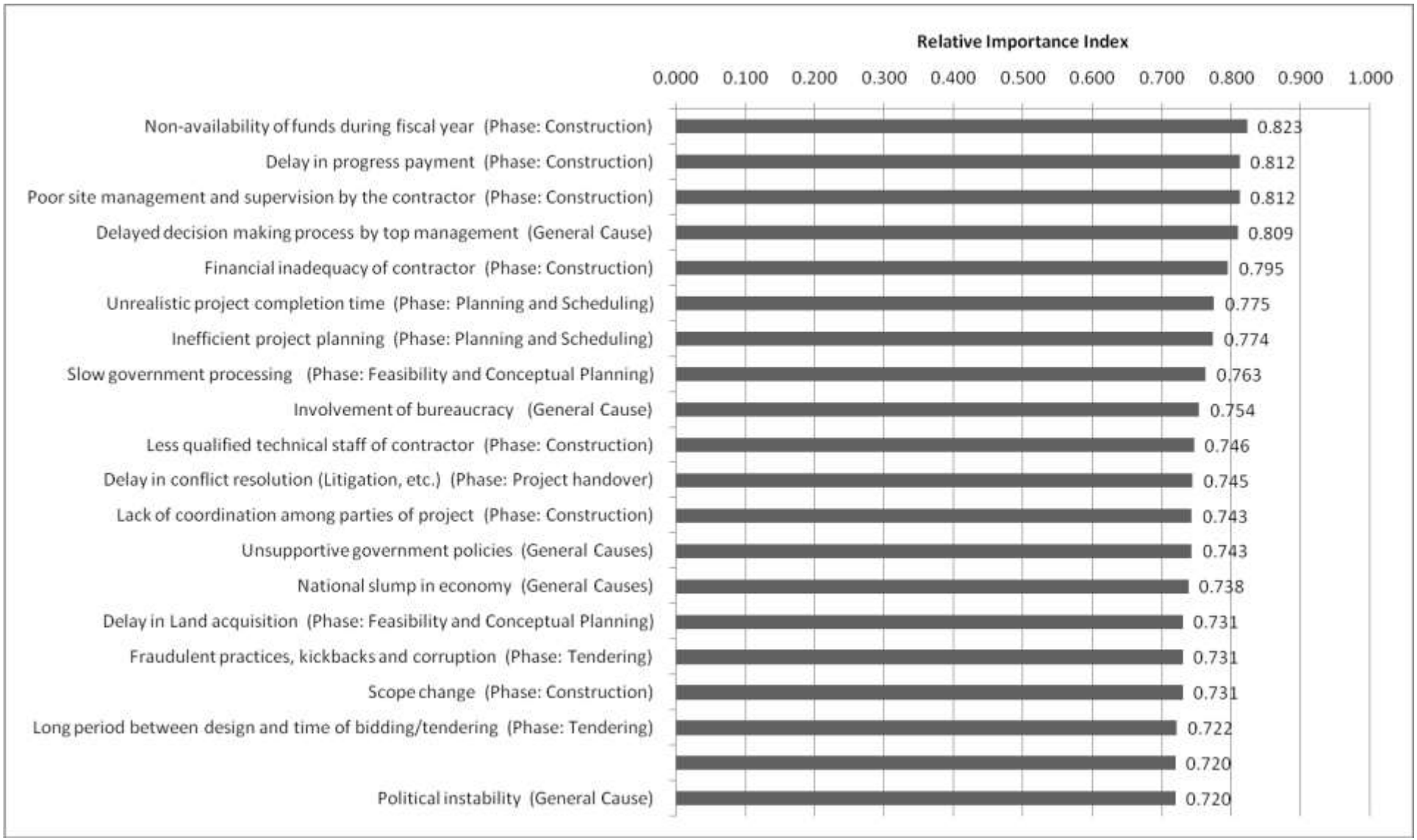


Figure 5.2 Ranking of top 20 causes

5.2. Distribution of causes

Phase wise distribution: To identify the critical phase of construction project, the phase wise distribution is shown in the Fig. 5.3. All the General causes that are indirectly related to the project are found to be the most critical ones. This needs urgent attention in Construction Projects. Then comes the Planning and Scheduling phase (P-4) 2 out of 3 causes of this phase are ranked in top 20. The third critical phase is Feasibility and Conceptual Planning phase (P-2). Similarly 2 out of 6, 7 out of 25 and 1 out of 8 cause(s) of Tendering phase (P-5), Construction phase (P-7) and Mobilization and Procurement phase (P-6) are ranked in top 20 respectively. No cause is ranked in top 20 from Objective or Employer's Perspective phase (P-1) and Design and Engineering phase (P-3).

Partywise distribution: To identify the inter party and intra party distribution of causes, partywise relative importance index for top 10 causes was calculated in a similar way as for top 20 causes. These top 10 causes are then sorted in table 5.3 based on the RII values.

The table shows that in employer's perspective two causes from construction phasei.e.1-Poor site management and supervision by contractor and 2-less qualified technical staff of contractor are the critical ones for the delay and cost overrun of a project with RII values 0.853 and 0.841.

In consultant's perspective four causesi.e. 1-Fraudulent practices, 2-kickbacks and corruption from tendering phase and3-Non availability of funds during fiscal year, 4-Delay in progress paymentand financial inadequacy of contractor from construction phase are Critical causes with RII values ranging from 0.829 to 0.867, greater than 0.8.

In contractor's perspective the available RII values for top 9 causes out of top 10 are the critical ones having RII values greater than 0.8.

From this partywise discussion it is clear that the Employer blames Contractor while Contractor blames Employeron the other hand Consultant is a neutral party. In other words Consultant is just a medium between Employer and Contractor.

Also the variation of RII values of these top 10 causes elaborates the constraints faced by the contractor during construction phase.

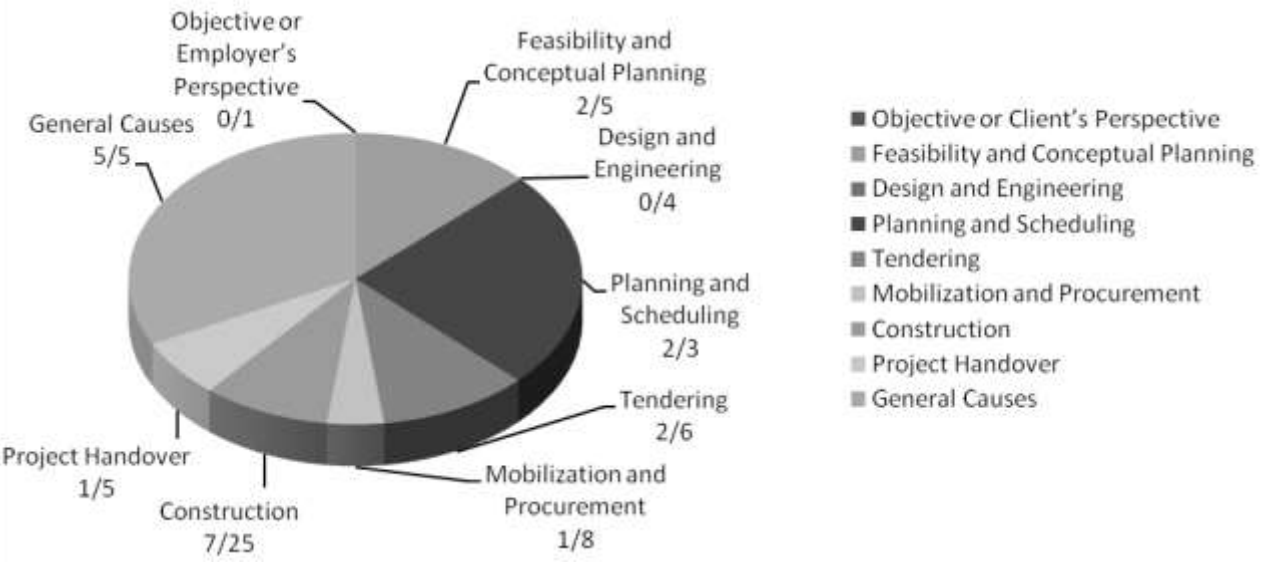


Figure 5.3 Phase wise distribution of causes

Table 5.3 Partywise ranking of causes

Rank	Employer	Phase	RII	Consultant	Phase	RII	Contractor	Phase	RII
1	Poor site management and supervision by the contractor	Construction	**0.853**	Fraudulent practices, kickbacks and corruption	Tendering	**0.867**	Delay in progress payment	Construction	**0.881**
2	Less qualified technical staff of contractor	Construction	**0.841**	Non-availability of funds during fiscal year	Construction	**0.852**	Non-availability of funds during fiscal year	Construction	**0.859**
3	Financial inadequacy of contractor	Construction	0.775	Delay in progress payment	Construction	**0.848**	Delayed decision making process by top management	General	**0.844**
4	Non-availability of funds during fiscal year	Construction	0.775	Financial inadequacy of contractor	Construction	**0.829**	Unrealistic project completion time	Planning and Scheduling	**0.815**
5	Slow government processing	Feasibility & Conceptual Planning	0.771	Delayed decision making process by top management	General	0.795	Unsupportive government policies	General	**0.815**
6	Inefficient project planning	Planning and Scheduling	0.771	Unrealistic project completion time	Planning and Scheduling	0.781	Long period between design and time of bidding/tendering	Tendering	**0.812**
7	Delayed decision making process by top management	General	0.771	Poor site management and supervision by the contractor	Construction	0.781	Inefficient project planning	Planning and Scheduling	**0.811**
8	National slump in economy	General	0.765	National slump in economy	General	0.771	Financial inadequacy of contractor	Construction	**0.811**
9	Delay in conflict resolution (Litigation, etc.)	Project Handover	0.759	Lack of coordination among parties of project	Construction	0.762	Poor site management and supervision by the contractor	Construction	**0.811**
10	Scope change	Construction	0.756	Involvement of bureaucracy	General	0.762	Lack of coordination among parties of project	Construction	0.796

5.3. Management of causes

The third part of the questionnaire provides information from the respondents that can be used for better management of the causes.

To the first question, “Can the identification of causes help in saving time and money?” 61.5% of the respondents ‘strongly agree’ & 33.8% ‘agree’ that identification of these causes can lead to minimization of delay and cost overrun in construction projects. This response tells us that the respondents are interested in the control of these causes showing the necessity for their recognition. Time and money are two of the most important resources for a construction company so it should be a top priority of the management division to find these causes so that remedial measures can be taken in time.

To the second question “Can research and development department improve the performance of organization?” 47.7% ‘strongly agree’ and 41.5% ‘agree’. It depicts that the respondents in the Pakistan construction industry have much confidence in research and development. Pakistani people do have a tendency for innovation and change. This mindset can be beneficial in the long run as most of the foreign companies spend a lot of money on Research and Development and increase their productivity and efficiency to a huge extent. The techniques and equipment used in the construction industry of Pakistan are out-dated. So in Pakistan a lot of preference should be given to the Research and Development like in other developed countries.

These two questions also present the necessity and significance of the kind of research that is carried out in this paper.

The pie charts in Figure 5.4 and 5.5demonstrate it more clearly.

5.4. Hypothesis testing

Normality check: Kolmogorov-Smirnov test was applied to check the normality of data. Only the four primary variables are checked for normality. These variables are later related with the causes while checking the hypothesis. Non parametric tests are applied when even one of the two relating variables has non-normal distribution. The table 5.4 shows the p-values of all the four variables which are less than the significance level of 0.05.

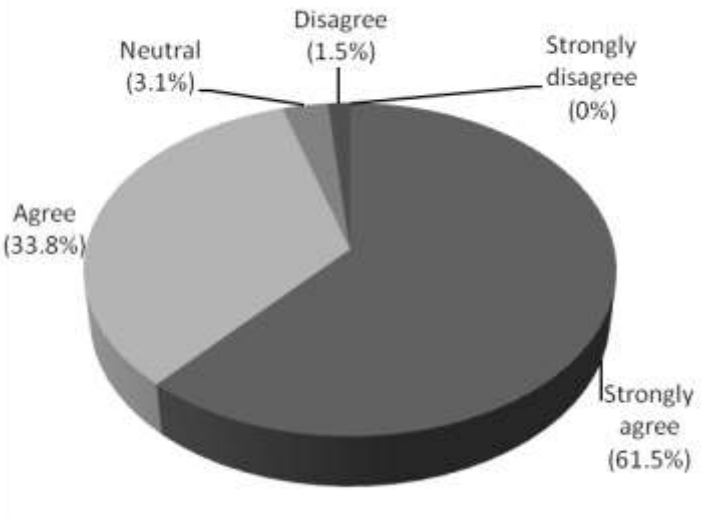


Figure 5.4 Causes of delay and cost overrun, if identified, can help save time and money?

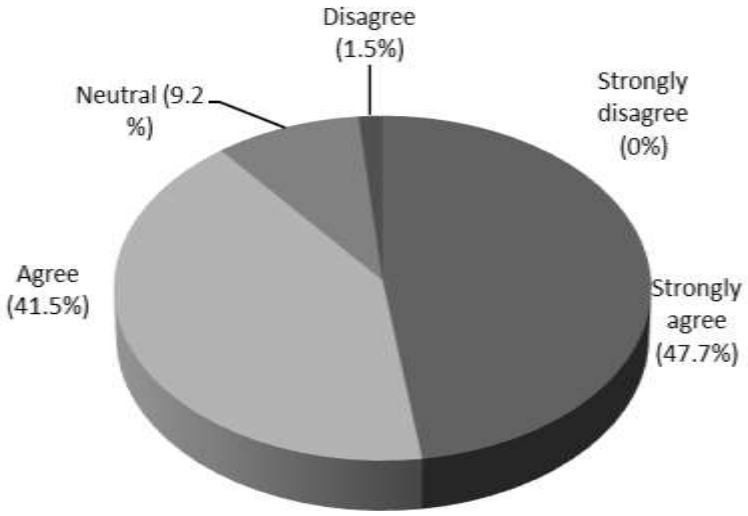


Figure 5.5 Can research and development department improve the performance of organization?

Table 5.4 Normality check

Variable to be related with	P-value (two tailed)
Party of the Project	0.000
Previous Completed Projects	0.000
Education Level of Respondent	0.000
Experience of Respondent	0.002

It means all of these are non-normal so non-parametric test i.e. Kruskal-Wallis is applied for checking the difference. The results prove that the data is non-normal for this research.

Table 5.5 shows the p-values of Chi-square test. The highlighted items are significant with p-values less than the significant level of 0.05 hence there is some association between the above tabulated variables and that particular cause.These filtered causes having association are then checked for the strength of association using Kruskul-Wallis H test. The p-values for these highlighted causes are tabulated in table 5.6.

Table 5.5 Chi-square test p-values

Rank	Cause	H1	H2	H3	H4
1	Non availability of funds during fiscal year	0.825	0.789	0.466	0.657
2	Delay in progress payment	0.176	0.160	0.151	0.871
3	Poor site management and supervision by contractor	0.452	0.648	0.312	0.934
4	Delayed decision making by top management	0.442	0.830	**0.005**	0.911
5	Financial inadequacy of contractor	0.779	0.574	**0.002**	0.675
6	Unrealistic project completion time	0.121	0.374	0.654	0.768
7	Inefficient project planning	0.562	0.856	0.074	0.826
8	Slow government processing	0.556	0.691	0.209	0.547
9	Involvement of bureaucracy	0.351	0.221	0.091	0.214
10	Less qualified technical staff of contractor	0.598	0.741	0.125	0.276
11	Delay in conflict resolution (Litigation, etc.)	0.597	0.745	0.088	0.972
12	Lack of coordination among parties of project	0.582	0.682	0.353	0.743
13	Unsupportive government policies	0.131	0.428	0.874	0.746
14	National slump in economy	0.779	0.465	0.241	**0.041**
15	Delay in land acquisition	0.377	0.771	**0.029**	0.738
16	Fraudulent practices. kickbacks and corruption	**0.034**	0.648	0.327	0.321
17	Scope change	0.389	0.854	**0.001**	0.180
18	Long period between design and time of bidding	0.162	0.513	0.385	0.741
19	Improper planning for procurement of material	0.743	0.249	0.100	0.882
20	Political instability	0.780	0.533	0.632	0.357

Table 5.6 Kruskal-Wallis H test p-values

Rank	Cause	H1	H2	H3	H4
4	Delayed decision making by top management	-	-	0.100	-
5	Financial inadequacy of contractor	-	-	**0.032**	-
14	National slump in economy	-	-	-	0.500
15	Delay in land acquisition	-	-	0.057	-
16	Fraudulent practices, kickbacks and corruption	**0.032**	-	-	-
17	Scope change	-	-	0.426	-

The value of 0.032 of Kruskul-Wallis H test for First hypothesis (H1) i.e. “There is no association and difference between party of the project and the cause” is less than the significant value of 0.05. It shows that there is a difference of ranking between parties of the project for the same cause and it can be seen from the table 5.3that Consultant has ranked this cause to be 1st in top ten causes.

The value of 0.032 of Kruskul-Wallis H test for Third hypothesis (H3) i.e. “There is no association and difference between education level of respondent and the cause” is less than the significant value of 0.05. It shows that there is a difference of ranking between education levels of respondent for the same cause. It can be clearly justified from the Fig. 5.6 that the respondents with education level of Bachelors and Masters have ranked this cause as highest.

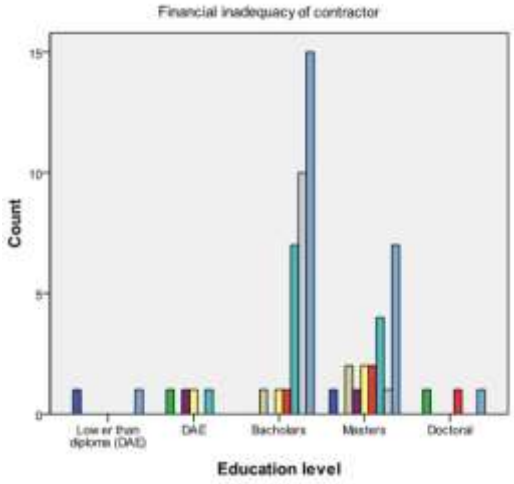


Figure 5.6 Education level ~ Financial inadequacy of contractor

6. Recommendations

All parties are recommended

6.1 Monitor cash flow

Monitoring the cash flow is beneficial for both employer and contractor. Poor cash flow results into delays when procurement cannot be done in time. For employer, delay in progress payment means contractor has no option but to decrease the pace or in worst condition halt the works. To avoid delay both parties should monitor cash flows carefully.

6.2 Project management units

For better site control and supervision the contractor may introduce a project management unit to monitor the site constantly. The same unit may be used to incorporate changes into schedule and work out the required efficiency.

6.3 Proper bidding and award of contract

The employer, at the time of bidding may ensure that the bidders are financially competent enough to handle the project. Further, their technical ability must be evaluated to match the complexity of the project.

6.4 Right decision at the right time

The top management or the hierarchy is recommended to ensure that no delay is caused due to pending decision or the conventional processing time of the bureaucracy. The technical decisions are advised to be taken by technical person not by political heads.

6.5 Implementation of IT

New tools and software like Primavera, SAP may be used for the estimation and planning to reach a realistic project completion date. It will also facilitate real time monitoring of the project by the hierarchy. In addition to these, Building Information Modeling (BIM) software can be used for simulation of construction. Latest means of communication may be adopted to enhance the intra-party communications.

6.6 Right man for the right job

All the parties of project are recommended to employ people with capabilities matching to the job. In case of mismatch, the result is delay, when people are unable to fulfill their responsibilities. Adopting the merit system (for recruitment) will solve the above problem.

6.7 The final report

It is recommended that an evaluation of every project at the time of completion, be done to identify the shortcomings in the planning. On the basis of these evaluations the processes may be redesigned or modified to rectify the mistakes. The effectiveness of this whole exercise is believed to be very high by 47.7% of the respondents.

6.8 Conflict resolution

Delays due to conflicts can be avoided by involving a third party negotiator or appointing the supervision consultant as mediator. The contract may include a mechanism of conflict resolution. Law and litigation may be avoided at any stage by adopting policy of transparency.

6.9. Political influences

Some of the causes like slump in economy, slow bureaucratic processes, political instability and unsupportive policies by government can only be catered by good governance and fair intensions.

6.10. General considerations

The planning may be done on the probabilistic approach of occurrence of cause so that float may be provided at the right place. The critical phase that is construction phase may be given more consideration in the planning. The non-availability of funds may be avoided by completely issuing the budget to the employer by the government. Being in the top twenty this particular cause must be curtailed. The employer may avoid the scope change that drastically affects the schedule.

References

[1] Sambasivan M, Soon YW, 2007. Causes and effects of delays in Malaysian construction industry. International journal of project management, 25, 517-526.

[2] Assaf SA, Al-Hejji S, 2006. Causes of delay in large construction projects. International journal of project management, 24, 349-357.

[3] Frimpong Y, Oluwoye J, Crawford L, 2003. Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. International journal of project management, 21, 321-326.

[4] Iyer KC, Jha KN, 2005. Factors affecting cost performance: evidence from Indian construction projects. International journal of project management, 23, 283-295.

[5] Sweis G, Sweis R, Hammad AA, Shboul A, 2008. Delays in construction projects: The case of Jordan. International journal of project management, 26, 665-674.

[6] Kaliba C, Muya M, Mumba K, 2009. Cost escalation and schedule delays in road construction projects in Zambia. International journal of project management, 27, 522-531.

[7] Al-Momani AH, 2000. Construction delay: a quantitative analysis. International journal of project management, 18, 51-59.

[8] Odeh AM, Battaineh HT, 2002. Causes of construction delay: traditional contracts. International journal of project management, 20, 67-73.

[9] Flyvbjerg B, Holm MKS, Buhl SL, 2004. What causes cost overrun in transport infrastructure projects? Transport Reviews, Vol 24, 3-18.

[10] Chan DWM and Kumaraswamy MM, 1997. A comparative study of causes of time overruns in Hong Kong construction projects. International journal of project management, 1, 55-63.

[11] Le-Hoai L, Lee YD, Lee JY, 2008. Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. KSCE Journal of civil engineering, 12(6), 367-377.

[12] Manavazhi MR, Adhikari DK, 2002. Material and equipement procurement delays in highway projects of Nepal. International journal of project management, 20, 627-632.

[13] http://www.dailytimes.com.pk/default.asp?page=2009%5C10%5C30%5Cstory_30-10-2009_pg5_5

INCREASING AWARENESS OF THE NEED TO REDUCE CARBON DIOXIDE EMISSIONS

Dr Gary William Theseira[6]

In December 2009, Malaysia's Prime Minister Datuk Seri Najib Razak announced at the United Nations Summit on Climate Change in Cophenhagen that Malaysia agreed to reduce its carbon dioxide emission to 40% by the year 2020 compared to the 2005 levels, subject to assistance from developed countries.

United Nations data shows Malaysia's carbon emissions in 2006 stood at 187 million tonnes, or 7.2 tonnes from each Malaysian.

That was five years ago. How much has been achieved in mitigating climate change?

According to Dr Gary, the National Policy On Climate Change was developed to ensure climate resilient development to fulfil national aspirations for sustainability. This means the national climate response must ensure that economic and development activities are not impacted. He says: "To do so requires a balance of Adaptation measures (to manage extreme weather events) and Mitigation (to reduce the severity of future climate change impacts)." At the United Nations Climate Change Conference in Copenhagen in December 2009, the Prime Minister had pledged to reduce Malaysia's CO_2 emissions intensity by 40% by the year 2020, compared with 2005. What progress has been made in fulfilling this pledge?

"In Copenhagen, the Prime Minister announced that Malaysia was adopting a Conditional Voluntary Indicator to reduce the country's emissions intensity of GDP by up to 40% relative to 2005 emissions, by 2020 subject to adequate levels of financial support and transfer of technology from developed countries," says Dr Gary.

"The announcement was made to reaffirm the centrality of the UN Framework Convention on Climate Change (UNFCCC) under which developed countries, in view of their responsibility for historic emissions since the beginning of the industrial revolution, have a commitment to reduce their emissions and to provide finance and technology to developing countries to enable them to adapt to the impacts of climate change."

He adds that developed countries also have a commitment to provide financial and technological support to developing countries to enable them to mitigate emissions to reduce future climate impacts.

Unfortunately, in the 22 years that the Convention has been in force, these developed countries have not provided adequate finance or transferred relevant technologies to enable Malaysia to transition to a low-carbon society.

---

[6] The Deputy Undersecretary of Environment Management and Climate Change Division in Ministry of Natural Resources and Environment about reducing Malaysia's carbon footprint

"Nevertheless, using domestic finance and either endogenously developed or purchased technology, the Malaysian Government and the private sector are making attempts to reduce emissions relative to the Business As Usual (BAU) scenario to the extent possible." says Dr Gary.

THE SHORTFALLS

There were several factors that have contributed to the discouraging results. According to Dr Gary, the first and primary shortfall was, of course, the failure on the part of developed countries, in the last 22 years the Convention had been in effect, to provide adequate financing and to transfer relevant technologies to developing countries like Malaysia.

But there are other shortcomings too, including the lack of efficient biomass and biogas utilisation systems and technologies. Cost is another primary factor. Technologies such as Solar Photovoltaic (PV) or Hybrid Automobile technology are extremely expensive and therefore, are slow to implement. Finally, there is the inability of the Malaysian public and private sectors to move from an awareness phase to an understanding and implementation phase.

Dr Gary says that while the public and private sectors do not lack awareness of climate change and what can be done about it, adequate systems are not in place to stimulate appropriate actions. For example, where waste-specific bins are available, Malaysians have proved that they are able and willing to sort waste. However, the places which provide these amenities are restricted to public areas such as airports and shopping malls.

Public transportation is another area that needs to be improved. The key aspects of an efficient transportation system are connectivity and predictability, but the current systems suffer from poor connectivity due to a lack of coordination between systems, and low predictability due to traffic congestion. Dr Gary feels that quick and substantial improvement can be achieved through the implementation and enforcement of dedicated public transportation lanes.

Indeed, transportation is recognised as another sector that contributes CO_2 emission to the environment. Green vehicles seem to be the direction that developed countries are heading for. In Malaysia, the most recent national automotive policy recognises and promotes energy efficient vehicles (EEVs) which include efficient fossil fuel powered vehicles, hybrid vehicles and electric vehicles. However, the cost of such vehicles and the lack of infrastructure continues to pose as obstacles to their widespread use.

HOPE FOR THE FUTURE

But the scenario is not all bleak. Dr Gary says that, as he mentioned earlier, the public is increasingly aware and willing to respond to climate change if the systems and infrastructure are available.

"This includes the private sector which has been encouraged to participate in the MYCarbon Voluntary Corporate Greenhouse Gas Reporting Programme. Response to date has been very encouraging," he says. "The burning of fossil fuel accounted for 75% of the increase in C02 from human activity in the past 20 years. This included gas flaring, coal, oil and gas burning as well as cement production."

The government is working to reduce the C02 emissions from these activities.

For instance, says Dr Gary, in the production of electricity, Malaysia has promoted the use of biomass, biogas and other renewables as alternatives to fossil fuel. In the cement industry for instance, biomass such as palm kernel shells are being used instead of fossil fuel.

"Apart from the traditional renewable energy resources such as hydro-electric and biomass, the government is also exploring alternative energy resources such as thermal solar and solar PV, as well as ocean thermal energy," he adds.

EYE ON OUR FORESTS

Another major factor that leads to global warming is deforestation. This had been inevitable because of the need to open and convert land for agriculture use and development. But the country needs to make an effort to find a balance between deforestation and change in land use. To this end, Dr Gary says, Malaysia has managed to retain large areas of land as forest. "While the gazetting of new forest reserves is in progress, efforts need to be intensified to ensure more land area is protected under this system of land management. One way to reduce the need to convert forest to agricultural land use is to increase crop yields on existing agriculture land," he says.

WORKING TOGETHER

While Malaysia is one of the many countries committed to contributing and playing an active role in combating global warming and the problem of climatic change, there is no special task force as yet, set up to study, evaluate and implement policies to achieve the desired goal or dedicated to specifically address climate change.

However, the NRE (Natural resources and Environment Ministry) is working together with other ministries such as Kementerian Tenaga, Teknologi Hijau dan Air (KeTTHA), Ministry of Science, Technology and Innovation (MOSTI) and various agencies as well as research institutions to adapt and mitigate measures into development plans.

"The ministry has developed a roadmap to reduce emissions intensity and is expected to present it to the Cabinet soon. The ministry is also working at the city and State levels to ensure a coherence of policies across ministries, sectors and all levels of government," says Dr Gary.

In conclusion, he assures that there is much hope for the future. As awareness and understanding of the global scenario grows, developing countries are putting increased political pressure on developed countries to live up to their commitments. There is also hope that as awareness continues to grow in developed countries, NGOs and other civil society organisations will also put similar pressure on the countries concerned.

Add to this the fact that Malaysians already have a moderate-to-strong awareness of climate change although they need to move beyond the phase of climate awareness to-the phase of climate understanding.

"Sadly, many people continue to perceive the problem as one which only affects other countries and which may only affect them at some point in the future. Or they may feel that the problem is, in some way, disconnected from their way of life because resources

like electricity are invisible," says Dr Gary.

"But there is a growing number of Malaysians who are becoming increasingly conscious about how their daily activities consume resources and energy and they feel compelled to change and do what is needed to live more sustainable lifestyles.

"The financial, health and lifestyle benefits of a sustainable lifestyle are evident and Malaysians too want to enjoy the fruits of technology in a clean, safe and sustainable environment."

WATER USE EFFICIENCY, WATER RESOURCE MANAGEMENT AND THE IMPLICATIONS OF CLIMATE CHANGE IN PAKISTAN

Engr. Ishteqaq Ahmad Kokab[7]

Engr. Husnain Afzal[8]

Engr. Adnan Yousaf[9]

Key Words: Water Use Efficiency, Water Resource Management, Water Stress and Ground Water Degradation

ABSTRACT

It is not difficult to deduce that our very lives revolve around water. The human civilization has always leaned to settle close to water. People move when there is too little of it. People displace when there is too much of it. As a matter of fact it's not only mankind which depends on it, the whole life need it for their survival. But we stand today at the verge of global water crisis. The 20th Century has inherited us with the population and technological explosions which has laid down a massive impact on our water supply. More and more freshwater sources are being consumed and contaminated. The technological advancement has allowed us to exploit much of the world's water for industry, energy, and irrigation but unfortunately the same has been attained at a terrible social and environmental price.

Similarly the water crisis in Pakistan has aggravated with the gradual depletion of water resources and sedimentation in existing reservoirs. The country is facing the worst water shortage of history due to overuse of ground water resulting from the drought conditions from the year 2000 till June 2010. The simultaneous effects of agricultural growth, industrialization and urbanization coupled with declining surface and groundwater quantity, intra and interstate water disputes, and inefficiencies in water use practices are some of the crucial problems faced by water sector. The effects of climate variability and change, including reduced water flows from melting glaciers and increasing frequency of extreme phenomena such as floods, tropical storms or droughts, are also creating pressures on scarce water supplies of the country. Immediate and multiple steps backed with proper planning are required to overcome the ever degrading water scenario of Pakistan.

---

[7] M.Sc in Environment & Public Health Engineering working in Water Sector of Water and Power Development Authority Pakistan as Chief Engineer (WRPO) at WAPDA House Lahore, Pakistan E-mail (1): cewrpo@gmail.com

[8] M.Sc in Water Resource Engineering working in Water Sector of Water and Power Development Authority Pakistan as Assistant Director (Civil) at WAPDA House Lahore, Pakistan E-mail (2): husnainafzal@ymail.com

[9] A Civil Engineer working in Water Sector of Water and Power Development Authority Pakistan as Assistant Director (Civil) at WAPDA House Lahore, Pakistan E-mail (3): engradi86@yahoo.com

INTRODUCTION

Among the water resources in Pakistan, The Indus River is strategically most vital water resource for Pakistan's economy and society. The Indus River system is especially critical since rainfall in the lower Indus valley is scarce. It comprises the main Indus and its major tributaries, the Kabul on the right bank and the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej on the left Bank. The Indus Basin Irrigation system commands an area of 36.2 Million acres and its tributaries on average bring about 152 MAF of water annually. This includes 143 MAF from the three western rivers and 8.4 MAF from the eastern rivers. According to the the average annual flow data, provided by government of Sindh, the average escapage below Kotri is about 32 MAF (1976-2011), while the release requirement downstream of Kotri is only 8.6 MAF. Therefore it is utmost important to initiate schemes on war footing bases to utilize the precious water resources before spilling into the sea.

THE ISSUES AND CHALLENGES

Pakistan water sector is facing multiple challenges which are briefly described as under;

i) Water Stress

The per capita water availability in Pakistan at the time of independence was 5,600 cubic meters, which has drastically reduced to only 951 m3 per annum by the end of 2014, with the surface water of 145 MAF as detailed in Table 1. By the end of 2015, it will be 935 m3 per annum, placing Pakistan towards one of the water-scarce countries. Further analysis of the agricultural expert's suggest that Pakistan is wasting two-third of its water by following traditional conservation methods and agricultural practices which adds to the water stress fiasco.

Average Annual Flows (MAF)	Annual Flows (Cubic Meters)	Population (Million)	Year	Per Capita Water Availability (Cubic Meters)
145	178854866444.39	188	2014	951
145	178854866444.39	192	2015	935

Table-1 Per Capita Water Availability

ii) Storage of additional water

The spillage of water into sea and non storage of additional water during rains and floods has been a problem of the country for many years. The irony of the matter is that there is still no mega reservoir taken in hand since 1976 which will resolve this issue in near future.

iii) Ground water Degradation

Groundwater is overexploited in many regions, and its quality is deteriorating. The threat to groundwater sustainability is rising with the increase in population as the per capita demands are ever increasing. Also the agricultural requirements demand additional wells each year. The excessive exploitation is resulting in saline intrusion, permanent

depletion of the aquifer systems, land subsidence and water quality deterioration.

iv) Water Infrastructure

Most of the hydraulic structures are in dire need of proper maintenance. Sukkur Barrage for example. The design capacity of 1.5 million cfs and flaws in design forced ten bays to close which curtailed the barrage capacity to 0.9 million cfs. Since 1973, a series of high floods exceeding 0.9 million cfs upto maximum of 1.2 million cfs caused heavy damages to the Barrage with serious threats to its stability and safety. The Gross Commanded Area (GCA) of the Barrage is 8.24 million acres, thus any severe damage to the barrage can prove catastrophic to the inhabitants as well as to the agriculture. Similarly most of the canals are unlined and due to the increase in sediment concentration in the Indus basin, the events of canal breaches have become more frequent resulting not only in the loss of water but also to the properties and human lives as well.

v) Climate Change Impacts on Indus River Basin

The annual mean surface temperatures in Pakistan are on a continuous rise during the past century. A rise in mean temperature of 0.6-1°C in the coastal areas along with a 0.5 to 0.7% increase in solar radiation over southern half of country has been observed The variation in climate change is a potential threat to the agriculture and energy sector of the country as well. Global warming and the associated changes in precipitation, extreme weather events, glacier melt, floods and droughts, are causing considerable impacts on water resources management in Pakistan.

The Indus River Basin is the back bone of economy of the country. Originating from glaciers of Tibetan Plateau it consists of six main rivers (the Indus, Jhelum, Chenab, Ravi, Sutlej, and Kabul) provides irrigation to more than 16 million hectares of agricultural land and has a hydropower potential of 38608 MW. Glacial retreat and changes in precipitation patterns are expected to alter considerably river basin behavior and jeopardize hydropower generation and irrigated agriculture production. Initial short-term increases in water flow may endanger the sustainability of downstream infrastructure but in the long run the reduction in inflows will result in loss of hydropower generation which may directly induce the **carbonization** of the power sector (countries shifting to thermal power plants to compensate the shortfall created by reduction in hydropower generation). A resulting increase in greenhouse gas emissions would contribute further to atmospheric global warming and subsequent glacial melt.

POLICIES AND PLANS

The River Indus, like other complex river basins, faces a common set of institutional and policy challenges such as:

- Indus water treaty tensions over upstream development.
- Sectoral integration across water, agriculture, environment, climate, and energy agencies at the national level.
- National-provincial coordination in a federal system of government.
- Interprovincial water conflict resolution.

For the systematic and efficient management of these Transborder and provincial issues the Government of Pakistan has responded in several creative ways, beginning with the establishment of the Water and Power Development Authority (WAPDA) as a semi-autonomous federal water agency, followed by the Indus River System Authority (IRSA) responsible for distribution of water among provinces and the Planning Commission's Vision 2030 on agricultural production, water management, food security, and climate change. WAPDA has launched a comprehensive integrated water resource and hydropower development plan, for development of water resources and hydropower generation summarized in the following table.

MEDIUM TERM PROJECTS (UPTO 5 YEARS)

Project Name	Estimated Cost (Rs Billion)	Gross Storage (MAF)	Live Storage (MAF)	Status
Naulong Dam	18.0	0.24	0.20	Bids opened on 23 July 2013 being evaluated.
Ghabir Dam	11.7	0.07	0.026	Land Acquisition in progress. Bids are being evaluated.
Winder Dam	11.5	0.04	0.0361	Bids on EPC basis invited on 29 October 2013.
Hingol Dam	26.5	1.20		Bids are to be invited.
Kurram Tangi Dam	59.6	1.20	0.90	Land demarcation in progress. USAID funding awaited for award of works.
Daraban Dam	5.8	0.07		EPC bids would be invited on availability of funds.
Tank Zam Dam	59.4	0.35	0.289	Detailed Engineering Design in process.
Bara Dam	14.2	0.09		Detailed Engineering Design in process.
Papin Dam	8.6	0.09	0.048	Release of funds awaited for invitation of Bids on EPC basis.
Garuk Dam	6.9	0.05	0.025	EPC bids would be invited on availability of funds.
Pelar Dam	8.7	0.09		EPC bids would be invited on availability of funds.
Mohmand Dam (Munda)	2.417 (Billion US$)*	1.29	0.490	Feasibility completed. Consultants mobilized for Detailed Engineering Design to be completed by June 2014.
Shyok Dam (Gilgit-Baltistan)	0.159583	10.70	5.40	Feasibility Study is to be taken by WAPDA.

LONG TERM PROJECTS (7-12 YEARS)

Project	Estimated Cost (Rs Billion)	Capacity (MW)	Status
Diamer Basha	1268.6	4500.0	Project infrastructure activities in progress.
Dasu (Phase-II)	124.0	2160.0	Detailed engineering design completed, contracting will be taken up after Phase-I
Bunji	920.0	7100.0	Detailed Engineering Design completed, PC-I submitted. Plan for BOOT construction.
Akhori Dam	610.0	600.0	PC-II approval awaited.
Rehabilitation of Mangla Power House	39.7	310.0	Prequalification of bidders is in Progress.
Rehabilitation of Warsak (New Power House)	49.4	300.0	Feasibility Study under finalization.

* Source Water and Power Development Authority (WAPDA)

ONGOING DEVELOPMENT PROJECTS IN AGRICULTURAL SECTOR

The Pakistan Council of Research in Water Resources (PCRWR) under GoP has undertaken several projects to Design, develop and evaluate water conservation technologies for irrigation, however, the extent of these projects are still confined to a limited extent. Some of the ongoing activities are described as under.

- Different water conservation technologies / practices i.e. bed and furrow irrigation, zero tillage, laser land leveling, growing low delta crops and irrigation scheduling are being evaluated at the farmers' fields, with their participation. The results of these studies showed better crop yield with maximum water use efficiency.

- Watershed management practices to enhance the groundwater recharge in Baluchistan.

- Construction of storage reservoirs and improvement of conveyance channels i.e. lift and trickle irrigation systems have been installed at various sites in Punjab, Khyber Pakhtunkha and Northern Areas for efficient use of water.

CONCLUSION AND RECOMMENDATIONS

Pakistan's water resources are diminishing at an alarming rate, as can be concluded from the stated facts in this report. Effective management of this crisis in Pakistan requires close cooperation with neighboring countries in joint watershed management,

increasing the efficiency of irrigation and water use, joint development of technologies, sustainable agriculture practices and institutional arrangements to manage food shortages as well as natural disasters. The following recommendations are proposed to overcome with this scenario:

- Construction of storage reservoirs for hydropower generation, irrigation releases and flood control It has been observed that some projects get delayed due to non consensus of political parties and social sector. A committee involving technical experts and political representatives of all four provinces may be constituted in order to stream line the development of water sector projects and to avoid causing unnecessary delays thereby saving valuable economy of the country

- Lining of main and branch canals

- Lining of distributaries and minor canals

- Irrigation system rehabilitation program

- Change in cropping patterns i.e. cultivating crops having less water requirement

- Agriculture is the major contributor to economy and is largely dependent on surface water availability for its consistent flourishing. The international Food Policy Research Institute has estimated that the total (direct and indirect) effect of a $1.00 sales increase in agriculture as it multiplies through the economy is $2.81 and for electricity (assumed to come from hydropower) the effect is $2.74. Therefore agriculture sector reforms need to be introduced on fast track basis by employing modernized techniques.

- Steps may be taken to counter water theft and misuse of irrigation water.

- Watercourse Improvement must be undertaken

- Increase groundwater recharge through catchment restoration, recharge dams, recharge wells, flood management, and other means

- Measures should be taken to counter pollution of water bodies as many aquifers and open water bodies like lakes, rivers and streams are being increasingly contaminated by pollution from industrial, agricultural and municipal wastes. According to estimates, pollution in River Ravi due to sewage disposal from the city of Lahore claims the lives of over 5,000 tons of fish every year

- Proper criteria for water charges (abiana) may be formulated to avoid misuse of water. Existing data suggest that water charges in irrigated agriculture are currently only 5% of the production input values.

- Bed and Furrow planting technology permits saving of about 30% irrigation water

- Employment of drip and sprinkler Irrigation techniques

- In coastal areas drinking water can be obtained by installing low cost water treatment plants that use solar energy for the desalination of sea water, the salt obtained from this process can be used in commercial and industrial applications.

- Rainwater harvesting

- Electronic and Print media can play a significant role in educating the society to employ the conservation of water at house hold level. Therefore awareness may be created among people and at school/college level as well on the importance and efficient usage of water.

- Awareness among farmers may be promoted through “Farmers Associations”, educating them on the use of water efficient techniques and growth of low delta crops.

References:

1. Mikhail Gorbachev (2000) “Introductory article written for Civilization, the Magazine of the US Library of Congress”.

2. Winston Yu, Yi-Chen Yang, Andre Savitsky, Donald Alford, Casey Brown, James Wescoat, Dario Debowicz, Sherman Robinson (2013) “The Indus Basin of Pakistan: The Impacts of Climate Risks on Water and Agriculture”.

3. Pakistan’s Water Economy: Running Dry, World Bank 2005, John Briscoe & Usman Qamar.

4. Asrar ul haq “Water resources management in Pakistan: the challenges, climate change implications and way forward”.

5. Water & Power Development Authority Vision 2025.

6. The International Food Policy Research Institute (IFPRI)