

Impact of Climate Change on the Life Cycle of Construction Projects in India

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Abstract:

Background: Climate change is a scientifically proven phenomenon and affects many major industries all over the world. Due to climate change, the weather in India becomes difficult to predict. Now climate change is considered to possess a major challenge to the construction industry. Climate change has a strong impact on different phases of project life cycle like design, construction, and performance of buildings, equipment, machinery and workers. Hence, there is a need to investigate methods that will allow the construction to progress with minimum damage during bad weather conditions. This research is aimed at providing knowledge about the relationship between climate change and the construction industry, the potential climatic factors that cause damage to construction project's life cycle, to identify the most affected phase and make suitable suggestions to reduce its impact on construction projects life.

Materials and Methods: Questionnaire Survey as the main method of research. The questionnaire includes 125 factors, found by analyzing the literature data. Temperature, Rainfall and Extreme weather conditions are the main factors taken into account to formulate the questionnaires. 71 responses were obtained from construction practitioners to access the impacts of climate change effects on the project lifecycle.

Results: The most affected phase was the Execution phase of Temperature, Rainfall and Extreme weather conditions followed by Initiation, Planning and Designing and Closing phase.

Conclusion: Execution phase is the most sensitive phase since the work is directly exposed to the climatic conditions. The research emphasizes the development of new strategies and plans to overcome climate change which will help to avoid losses, work efficiently and safely.

Key Word: Climate change, Construction, Weather, Project Lifecycle, India.

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I. Introduction

Climate is the basis for human survival provides the necessary condition for living. Climate plays an important role in people's lives and is the base for plans and designs. Climate is changing over time and is a scientifically proven and an interesting phenomenon that has become a major problem worldwide. It is one of the major threats faced by the construction industry.

Buildings are vulnerable to climate change. The construction industry is affected by climate change such as the physical impact of weather like rain, heat and cold, the need for new materials and building techniques that protect structures and roads from severe weather and the cost of insuring climate change. Scientists say that construction deadline goals will be prolonged by a more unpredictable and intense climate. Though the buildings are designed considering the standards, the weather changes at a faster rate leading to quick deterioration of buildings and a decrease in project life.

More precautions and necessary steps have to be taken in order to predict the change in climate change, identify and face the major factors causing the damage and increase the project life. The introduction of new building practices and new materials is necessary to minimize the effects of climate change on the construction project's life cycle. So, there is a greater need to understand the effects of climate change on the construction project's life cycle to suggest better solutions for minimizing the effects of climate change on the life cycle of the construction project's in India. Hence, this project is carried out.

II. Material And Methods

The following data were the findings from the literature review and is used to form the questionnaires.

Climate Change and Project Life

Climate change is inevitable and has strong impact on various phases of a construction project and its lifecycle. The construction practitioners should be aware of the climate factors like temperature, rainfall, wind, extreme

weather, and their predictions and should adopt their works according to the local climate change. Risk management plays a vital role in getting successful project completion.

Impact of Climate Change on Planning and Designing

Climate change affects planning and designing like choice of site selection, delays in construction, damage to structures and materials. The structural damages will lead to extra expenses and delay. So every factor should be taken into account before designing and planning. It also makes the designing complex and affects the pricing of the design strategies. The buildings are being built with minimum required standards and as the climate changes rapidly over the years, the minimum requirement of the building code will change leading to quick deterioration of buildings.

Impact of Climate Change on Work Force

The increased climate change takes its toll on the construction workers. It leads to dangerous working conditions, heat stress and dehydration. If the temperature is high, it may also induce skin cancer and death due to heat stress. Heavy rainfall leads to slippery surfaces. Proper precautions must be taken to ensure the health and safety of the workers. It also affects the productivity and efficiency of the workers. Lower temperature leads to wear extra clothing which is bulky, restricts movement and may increase accidents.

Impact of Climate Change on Machinery and Materials

Machines are more susceptible to climate change. Dust associated with hot weather conditions will cause problems for machineries. The filter has to be changed often and machines have to be checked properly to ensure sudden breakdown. Cold temperature makes the water cooled engines become less efficient. Cold lubricant will not be effective and operating equipment will be less lubricated causing accelerated wearing of equipment's. Both application and performance of paint will be affected by the climate change. Sealants are affected by weather more especially freeze and thaw cycle and UV exposure reduces the resiliency of seals and sealants resulting in loss of elasticity and bonding. Fibrous and porous materials like wood absorb and retain moisture.

Impact of Climate Change on Construction Process

Climate change is highly weather dependent process. Unstable weather may cause delay and damage to structure and raw materials. Dry weather causes water in the concrete to evaporate too fast which results in low strength and bad finishing. Mortars begin to set prematurely due to dry weather and results in reduced bond strength. Poor bonds are formed when the bricks are not properly wetted during construction. The optimum temperature of concrete is 23 degree Celsius, which is 80-100% greater than the improperly cured concrete. Cold weather induces ice crystals and retains moisture. It slows down curing which affects the strength, promote spalling and ruin the finishes. When the site freezes, it retains water and the drying is slowed leading prolonged muddy conditions.

Climate in India

No country is immune to climate change, in particular India is more vulnerable. Temperature, Wind, Rainfall, Cyclone, Snowfall, Precipitation and Droughts are the various types the of climate change that affects India. According to a study conducted by Tata Centre for Development, Chicago, around 1.5 million people may die in India by the end of 2100 due o extreme climate change. The India Meteorological Department (IMD) states that, the climate change keeps increasing in both frequency and intensity. India has a very diverse climateto which ranges from alpine in the Himalayas to temperate in the south. It has four climatological seasons namely Winter, Summer, Rain and Autumn Season. The factors considered in the study are temperature, rainfall and extreme weather.

Temperature

According to IMD data, average temperature in India has increased by 0.6° C between the year of 1901-10 and 2009-18. World bank estimates that by the end of the century, the temperature in India could reach as high as 29.1° C if the climate change goes unhindered (currently 25.1° C). The highest temperature ever recorded in India occurred on 19 May 2016 in Phalodi, Jodhpur District, Rajasthan at 51.0 °C.

Rainfall

India has an average rainfall of 300–650 millimetres and is also very unreliable. South-West monsoon accounts most of the precipitation. India records a maximum average rainfall of 11,872 millimetres in Mawsynram, Meghalaya which is the highest in Asia. The minimum average of rainfall India receive is 102 millimetresLeh, Ladakh. The highest recorded rainfall in one day is 1032 mm in Cheerapunji.

Extreme Weather

Extreme weather often caused massive losses to Indian life and property. India experiences droughts, floods, cyclones, heatwaves, avalanches, landslides, tsunamis and snowfalls. Floods, landslides, cyclone and droughts are the frequent and major disastrous problems. The whole India is almost flood prone and disastrous events such as flash floods and torrential rain have become increasingly common in Central India over the past decades, which coincides with increase in temperature. Cyclones bring heavy rain, storm surges along with heavy winds which cuts the affected areas from relief and supply. The failure of monsoons result in water shortages which in turn leads to droughts in some parts of the country. Intense rainfall triggers massive landslides.

Objectives

The aim of this project was to, identify the potential impact on construction industry due to climate change. Formulate a suitable questionnaire by incorporating all the parameters related to climatic change and its impact on construction industry. Analyze the questionnaires to identify the adverse impacts on construction industry. Suggesting suitable methods to reduce the impact on construction industry due to climate change.

Methodology

The research focusses on identifying the factors affecting the life cycle of construction projects in India, including different project activities for providing a useful tool in accessing the relationship between the construction industry and climate change to help face the unexpected results. To identify the factors affecting the life cycle of construction projects in India, Quantitative approach is adopted as the methodology. Questionnaire survey is made to fulfill the research objectives. The survey targets construction practitioners over India including construction managers, designers, project engineers and site engineers. By analyzing the literature data, 125 factors were identified and the questionnaire is formed. Questions are divided into two types: agreement scale questions and multiple choice questions.

The factors are distributed among four groups: group one “Influence of temperature on the project lifecycle”, Group two “Influence of rainfall over the project lifecycle”, and group three “Influence of extreme weather over the project lifecycle and group four “The required procedures to overcome the climate change”. Five-point Likert scale is used to from questionnaires.

Five point Likert scale is classified as follows: strongly agree, Agree, Neutral, Disagree ad Strongly Disagree. The questionnaires are distributed through Electronic mail, Facebook and other electronic means of communication and hand delivery ways. 71 responses are obtained. The data collected from the responses are sorted out and entered into the software program called Statistical Package for Social studies (SPSS). Through this program many tests will be applied to achieve the purpose of analysis.

III. Results and Discussion

Table no 1:Profile of Respondents

Information	Frequency	Percentage
Work Position		
Engineering Consultant	26	36.1
Builder / Contractor	37	51.7
Architect	8	11.11
Years of Experience		
0 -5 Years	55	76.38
6 -10 Years	12	16.66
11 -15 Years	1	1.38
15 -20 Years	3	4.16

Table I represents the profile of the respondents. The respondents who work as Builder or Contractor are 51.7 %, Engineering Consultants are 36.1 % and Architect are 11.1 %. Years of experience of respondents at 0 – 5 years are 76.38 %, 6 – 10 years are 16.66 %, 11 – 15 years are 1.38 % and more than 15 are 4.16 %.

Temperature

Table no 2: Temperature's Influence on the Construction Project's Lifecycle

Section A: Influence of Temperature on the Initiation Phase		Mean	Rank
1.	Problem with determining the project objectives	3.23	1
2.	Plays a major role in deciding the project groups	3.09	3
3.	Influences the employment of suitable project team	3	6
4.	Influences the determination of project demands	3.11	2
5.	Influences the organizational framework	3.07	4
6.	Affects the elevation and topography of the site	2.75	7
7.	Affects the selection of site location	3.02	5
Overall Mean of Section A		3.03	2
Section B: Influence of Temperature over the Planning and Designing Phase		Mean	Rank
1.	Affects planning and designing methods	2.29	9
2.	Influences the choice of construction materials	3.31	1
3.	Excess cost due to structural damage	3.06	4
4.	Planning of structures becomes problematic	2.96	6
5.	Influences the pricing of design strategies	2.96	6
6.	Lead to take into account differences such as building age, construction and mitigation efforts	3.17	2
7.	Influences the implementation of new materials and building methods in the construction industry	3.02	5
8.	Influences the regulation of new building standards	3.1	3
9.	Leads to higher insurance claims	2.91	8
Overall Mean of Section B		2.97	4
Section C: Influence of Temperature on the Execution Phase		Mean	Rank
1.	Workers are subjected to higher risks and dangerous working conditions	3.34	5
2.	Affects the efficiency of heavy machinery and causes problems for equipment	3.26	7
3.	Affects the strength and workability of building materials	3.36	3
4.	Affects the application and durability of paint finishes	3.47	1
5.	Affects the rate of concrete hardening	3.34	5
6.	Affects the process of concrete casting and workability	3.47	1
7.	Affects the process of concrete curing	3.35	4
8.	Reduces the bond strength between motors and bricks	3.24	8
9.	Influences the project completion time	3.23	9
10.	Leads to late delivery incurring more cost	3	10
Overall Mean of Section C		3.3	1
Section D: Influence of Temperature on the Closing Phase		Mean	Rank
1.	Leads to strange conditions after work completion	2.95	5
2.	Leads to delay in handing over to clients	2.92	6
3.	Affects the documentation and reporting at the final stage	2.71	8
4.	Leads to unexpected problems and defects in the structure after the completion	3.02	4
5.	Additional maintenance work required after project completion	3.07	3
6.	Unexpected expenses due to additional resources at the final stages	3.36	1
7.	Play a vital role at the last stage, which may generate a high rate of claim between	2.86	7

	groupies		
8.	Leads to disputes between contractors, subcontractors and suppliers.	3.08	2
Overall Mean of Section D		2.99	3

From Table II, the results obtained states the most affected phase by temperature is the execution phase with mean of 3.3. These Indicate that the temperature change affects most in the execution phase that indicates the activities are more directly exposed to temperate than other phases. The most significant factor related to the Influence of temperature on the initiation phase is problem with determining the project objectives with mean of 3.23. The most significant factor related to the influence of temperature on planning and designing phase is the influences the choice of materials with mean of 3.31. The material choice depends the temperature range of the region, like people in South India prefer Brick lad buildings, whereas deserts like Rajasthan prefers use of mud walls, limestone to keep the houses cool. The most significant factor related to the influence of temperature on execution phase is it affects concrete casting and workability, affects the application and durability of paint finishes with the mean of 3.47. If temperature increases the evaporation rate increases, which causes the concrete to set early lessening the workability of concrete. Depending on the intensity of temperature, it can increase or decrease the paint drying time. Lower temperature causes some paints to thicken increasing the drying time which will result in running or sagging. If paints dry quickly it will result in bumps and wrinkles. The most significant factor related to the influence of temperature on the closing phase is it leads to unexpected expenses due to additional resources at final stage with mean of 3.36.

Rainfall

Table no 3: Rainfall's Influence on the Construction Project's life cycle

Section A: Influence of Rainfall on the Initiation Phase		Rank	Mean
1.	Problem with determining the project objectives	3.45	2
2.	Plays a major role in deciding the project groups	3.33	4
3.	Influences the employment of suitable project team	3.2	7
4.	Influences the determination of project demands	3.25	5
5.	Influences the organizational framework	3.23	6
6.	Affects the elevation and topography of the site	3.36	3
7.	Affects the selection of site location	3.47	1
Overall Mean of Section A		3.32	3
Section B: Influence of Rainfall over the Planning and Designing Phase		Mean	Rank
1.	Affects planning and designing methods	3.36	7
2.	Influences the choice of construction materials	3.51	2
3.	Excess cost due to structural damage	3.58	1
4.	Planning of structures becomes problematic	3.37	4
5.	Influences the pricing of design strategies	3.36	7
6.	Leads to take into account differences such as the building age, construction and mitigation efforts	3.37	4
7.	Influences the implementation of new materials and building methods in the construction industry	3.47	3
8.	Influences the regulation of new building standards	3.37	4
9.	Leads to higher insurance claims	3.28	9
Overall Mean of Section B		3.4	2
Section C: Influence of Rainfall on the Execution Phase		Mean	Rank
1.	Workers are subjected to higher risks and dangerous working conditions	3.45	5
2.	Affects the efficiency of heavy machinery and causes problems for equipment	3.3	10
3.	Affects the strength and workability of building materials	3.56	1
4.	Affects the application and durability of paint finishes	3.5	3
5.	Affects the rate of concrete hardening	3.44	7
6.	Affects the process of concrete casting and workability	3.45	5
7.	Affects the process of concrete curing	3.34	9

8.	Reduces the bond strength between motors and bricks	3.42	8
9.	Influences the project completion time	3.56	1
10.	Leads to late delivery incurring more cost	3.49	4
Overall Mean of Section C		3.45	1
Section D: Influence of Rainfall on the Closing Phase		Mean	Rank
1.	Leads to strange conditions after work completion	3.13	6
2.	Leads to delay in handing over to clients	3.43	2
3.	Affects the documentation and reporting at the final stage	2.95	8
4.	Leads to unexpected problems and defects in the structure after the completion	3.3	3
5.	Additional maintenance work required after project completion	3.26	4
6.	Unexpected expenses due to additional resources at the final stages	3.19	5
7.	Play a vital role at the last stage, which may generate a high rate of claim between groupies	3.1	7
8.	Leads to disputes between contractors, subcontractors and suppliers.	3.56	1
Overall Mean of Section D		3.24	4

The Table III, the results shows the most important factor rainfall affects in the execution phase with mean of 3.45. Execution phase is the most sensible phase which gets directly affected by the rainfall because the project activities are directly exposed to rain than the others phases. The most important factor related to the influence of rainfall on the initiation phase is it affects the selection of site location with mean of 3.47. The rainfalls intensity, direction and amount affects all the soil and thus decides aspects in a building design like roof deign, drainage, rainwater harvesting which directly affects the selection of site. Planning and designing is also directly influenced by the rainfall. The most important factor related to the influence of rainfall on execution phase is it affects the strength and workability of building materials and it influences the project completion time, both with mean of 3.56. The rainfall may delay the Project completion time by decreasing the productivity or stopping the construction work temporarily. These delay may lead to high penalties to the contractors. Rainwater will increase the water content in the concrete mix during mixing, transporting, compacting or finishing, which reduces the strength of concrete and affects the workability. The most important factor related to the influence of rainfall on the closing phase is it leads to disputes between contractors, workers and suppliers with mean of 3.56. Rainfall may delay the transportation of materials and production of raw materials. Due to less availability of materials or delay may lead to disputes between contactors and suppliers.

Extreme Weather

Table no 4: Extreme Weather's influence on the Construction Project's Lifecycle

Section A: Influence of Extreme Weather on the Initiation Phase		Mean	Rank
1.	Problem with determining the project objectives	3.3	3
2.	Plays a major role in deciding the project groups	3.27	6
3.	Influences the employment of suitable project team	3.22	7
4.	Influences the determination of project demands	3.28	5
5.	Influences the organizational framework	3.29	4
6.	Affects the elevation and topography of the site	3.32	2
7.	Affects the selection of site location	3.52	1
Overall Mean of Section A		3.31	3
Section B: Influence of Extreme Weather over the Planning and Designing Phase		Mean	Rank
1.	Affects planning and designing methods	3.24	9
2.	Influences the choice of construction materials	3.43	3
3.	Excess cost due to structural damage	3.55	1
4.	Planning of structures becomes problematic	3.4	5
5.	Influences the pricing of design strategies	3.43	3
6.	Lead to take into account differences such as building age, construction and mitigation efforts	3.35	6
7.	Influences the implementation of new materials and building methods in the construction industry	3.47	2
8.	Influences the regulation of new building standards	3.3	8

9.	Leads to higher insurance claims	3.34	7
Overall Mean of Section B		3.39	2
Section C: Influence of Extreme Weather on the Execution Phase		Mean	Rank
1.	Workers are subjected to higher risks and dangerous working conditions	3.62	1
2.	Affects the efficiency of heavy machinery and causes problems for equipment	3.43	6
3.	Affects the strength and workability of building materials	3.31	10
4.	Affects the application and durability of paint finishes	3.5	4
5.	Affects the rate of concrete hardening	3.59	2
6.	Affects the process of concrete casting and workability	3.39	8
7.	Affects the process of concrete curing	3.47	3
8.	Reduces the bond strength between motors and bricks	3.37	7
9.	Influences the project completion time	3.47	5
10.	Leads to late delivery incurring more cost	3.37	9
Overall Mean of Section C		3.45	1
Section D: Influence of Extreme Weather on the Closing Phase		Mean	Rank
1.	Leads to strange conditions after work completion	3.26	5
2.	Leads to delay in handing over to clients	3.43	2
3.	Affects the documentation and reporting at the final stage	2.99	8
4.	Leads to unexpected problems and defects in the structure after the completion	3.34	3
5.	Additional maintenance work required after project completion	3.28	4
6.	Unexpected expenses due to additional resources at the final stages	3.25	6
7.	Play a vital role at the last stage, which may generate a high rate of claim between groupies	3.15	7
8.	Leads to disputes between contractors subcontractors and suppliers.	3.57	1
Overall Mean of Section D		3.45	1

Table IV results show that the most important phase that the extreme weather affects is the execution phase with mean of 3.35. This is also in correspondence with temperature and rainfall. The execution phase is more directly exposed to the extreme weather events than the other phases. Extreme weather is very hard to predict and it easily affects the work time and decreases productivity. It also damages the buildings and materials which incurs increased cost. The most important factor related to the influence of Extreme Weather in the initiation phase is it affects the selection of site location with mean of 3.52. Extreme Weather like flash floods are common occurrence in some part of the country, so the site needs to be in a higher elevation, have good drainage system, it also decides a buildings design like flood proofing which directly affects the selection of site location. The most important factor the Extreme Weather affects in the planning and designing phase is it increases the cost of construction due to structural damage with mean of 3.62. Extreme climate like floods, cyclone affects the raw materials and causes significant damage to the structures leading to more repair work, which increases the budget to the whole project. The most important factor the Extreme Weather affects in the execution phase is workers are subjected higher risks and more dangerous working condition with mean of 3.62. Workers subjected to higher temperatures might develop cancer or heatstroke. Working in wet conditions might lead to slipping and snowfalls may cause frost damage. The most important factor the Extreme Weather affects in the closing phase is it leads to disputes between contactors and suppliers. Extreme Weather will cause increased consumption of raw materials which leads to deficiency, the production might get delayed or temporarily stopped due to extreme conditions, which prolongs the project completion time creating problems between contactors and suppliers.

Influential Factors

Table no 5: Most important section of the three groups

Group	Mean	Rank
Influence of Extreme Weather on the Construction Project's Lifecycle	3.36	1
Influence of Rainfall on the Construction Project's Lifecycle	3.35	2
Influence of Temperature on the Construction Project's Lifecycle	3.07	3

Influence of Extreme Weather on the construction project's life cycle is ranked the most influential factor with mean of 3.36 followed by Influence or Rainfall and Temperature on the construction projects lifecycle with mean of 3.35 and 3.07 respectively. Rainfall has a higher range of influence on construction more than the Influence of temperature.

Table no 6: Importance of all groups over the other

Factor	Phase	Mean	Rank
Rainfall	Execution	3.45	1
Extreme Weather	Execution	3.45	1
Rainfall	Planning	3.4	3
Extreme Weather	Planning	3.39	4
Rainfall	Initiation	3.32	5
Extreme Weather	Initiation	3.31	6
Temperature	Execution	3.3	7
Extreme Weather	Closing	3.28	8
Rainfall	Closing	3.24	9
Temperature	Initiation	3.03	10
Temperature	Closing	2.99	11
Temperature	Planning	2.97	12

Table VI, shows the ranks and mean value obtained from the responses due to climate change on the project's lifecycle. This shows that every factor plays a major role in influencing the project lifecycle regardless the phases.

Management Procedures

Table no 7: Procedures Required to Face the Climate Change

Section A: Management Procedures		Mean	Rank
1.	Monitoring and reporting climate change must be required to face climate change	3.36	7
2.	Mandatory documentation of site plan to deal with climate change	3.55	3
3.	Organizing training programs to get familiar with climate change	3.56	2
4.	Experience and knowledge of staff about climate change should be considered before recruiting	3.51	5
5.	The past record of the climate change data should be taken into account	3.41	6
6.	The organization must have communication channels to use when dealing with climate charge aspects	3.59	1
7.	Cooperation between various levels of an organization to handle the climate change issue	3.54	4
8.	Mandatory recruitment of a formal representative related to climate change to discussions and meetings	3.26	8
Overall Mean of Section A		3.47	1
Section B: Procedures for Temperature		Mean	Rank
1.	To reduce the temperature on buildings, use insulation such as roofing paints and glazing	3.30	5
2.	Shadings can prevent the transfer of temperature through buildings	3.59	1
3.	Shading of Construction materials can resist the increasing temperature	3.45	4
4.	Effects of temperature on concrete curing can be reduced using admixtures	3.55	2
5.	Double walling system may be used to handle temperature changes	3.48	3
Overall Mean of Section B		3.47	1
Section C: Procedures for Rainfall		Mean	Rank
1.	To resist rainfall impacts more appropriate window protection is required	3.20	5

2.	To resist the effects of rainfall on building proper insulation materials should be used	3.31	4
3.	Use of proper rainwater harvesting system to collect water to ensure supply on rainy days.	3.44	3
4.	Ensure well-maintained roofs and drainage systems to avoid rain damage	3.58	1
5.	Diverting rainwater from buildings to avoid the damage of drainage of buildings.	3.45	2
Overall Mean of Section C		3.4	3
Section D: Procedures for Extreme Weather Events		Mean	Rank
1.	To reduce the effects of extreme weather events on buildings external claddings and glazing may be used	3.25	5
2.	Improvement of system fixation such as to walls and walls to floors must be bear in mind to resist extreme weather events	3.34	2
3.	Brick clad buildings can perform better in extreme weather events	3.38	1
4.	Construction of a wall or levee around buildings to resist extreme weather	3.33	4
5.	Buildings designed for heavy wind load can adapt to extreme weather events	3.34	2
Overall Mean of Section D		3.3	4

From Table VII, it can be seen that the organization must having more communication channels while dealing with the climate change is the most effective method in the management procedures with mean of 3.59. Organizing training programs to get familiar with the climate change and mandatory documentation of site plans to deal with the climate change are the second and third most effective strategy with mean of 3.56 and 3.55 respectively. Organizing training programs can help workers get familiar with the problems faced during climate change, helps to decrease damage to the raw materials and reduce the injury rates. Documentation indicates the organization's role and flexibility in adapting to the climate changes and measures it has taken to mitigate or adapt it.

The most effective procedure to face the temperature is to provide more shading to prevent the transfer of heat through the buildings with mean of 3.58. By growing well strategically planned trees around buildings, it can provide shade and decrease the heat during warm periods and allows sunshine through the branches to keep warm during winter and prevents entry of cold winds. The other effective measures are to use admixtures to help concrete curing and using double wall systems to prevent heat transfer with mean of 3.55 and 3.48 respectively. High temperature leads to accelerated loss of water and cement hydration increasing the stiffening of concrete and causes cracks. Use of admixture can prolong the hydration giving the time required for the concrete to proper curing. Double glazing system helps to insulate the window pane and helps to regulate the heat entering the living space.

The most effective procedure in facing the rainfall is Ensuring well maintained roofs and drainage system to avoid rain damage with mean of 3.58. A well maintained roofs ensure the smooth passage of rainwater from roof to the drainage system which decreases the probability of clogs or rainwater intrusion into the roofs. A well maintained drainage ensures the rainwater to reach the sewage preventing blockage and flash floods. The other effective procedure to face the rainfall is diverting the rainwater from buildings to avoid damage of drainage system of buildings and using rainwater harvesting system to save water for future use during summer seasons with mean of 3.45 and 3.44 respectively.

The most effective procedure in facing the extreme weather is brick clad buildings can perform better in extreme weather conditions with mean of 3.38. Brick buildings protect against harsh storms, its terminate proof, fire proof and in a long run it is durable. It is good for cold regions because bricks retains heat and stays warm for longer period. The other important factors were designing building to withstand heavy wind loads and improvement of systems fixation to resist extreme weather events, both with mean of 3.34.

IV. Conclusion

After exploring the impacts of climate change on the construction projects life cycle, it can be concluded that the construction practitioners should be aware of the climate factors like temperature, rainfall, wind and extreme weather, should predict and adapt their works according to the local climate change. The most significant phase the temperature affects are execution phase followed by initiation, closing and planning and designing phase. The most significant phase the rainfall affects are execution phase followed by planning and designing, initiation and closing phase. The most significant phase the extreme weather affects are execution phase followed by planning and designing , initiation and closing phase. From this it can be concluded that the execution phase is the most sensitive phase, since the work is directly exposed to the climatic conditions. The

research emphasis the development of new strategies and plans to overcome the climate change which will help to avoid losses, work efficiently and safely.

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