

Assessment On The Effects Of Weather Change On Road Construction Planning At Some Selected Projects In Addis Ababa And Oromia

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Abstract— Road construction in Ethiopia is in high demand to meet its short and long term goals in infrastructure development programs. The road network is constructed radiating outwards North-South and East-West direction of the Capital City. Some projects are experiencing weather malady due to changing weather conditions in project locations. The study area of this research was focused on some selected projects in Addis Ababa and Oromia. The research had been addressed the effects of changes in weather in the three project planning phases, namely conception planning, design planning and construction planning. Quantitative research design was used in this study. A literature review was undertaken and the result of which showed that the effects of weather changes are not extensively researched in the construction industry and there are limited references on the effects of weather change within the road construction industry. Sample data were obtained from sixty-three (63) construction practitioners through questionnaires, which were mailed to prospective respondents to assess their opinions. Questions were subdivided into three relevant areas covering demographics, experience with weather change factors, and the effects of weather change on road construction project planning.

The study found that the effects of weather change on road construction project planning are similar to those found in other construction industries. The effects of weather change factors on road project planning vary with planning phases. These weather change factors as well as their effects were listed and ranked based on their frequency of occurrence and mean score. An independent sample t-test was used to compare respondents' opinions on weather change effects between the two sample groups taken in Addis Ababa and part of Oromia. Partial correlation was also employed to identify the relationship between weather change factors and its effect on road construction project planning using SPSS-20. Delay of site preparation activities as a result of weather change on road project conception planning phase has a mean score of the 4.30 Addis Ababa and 4.00 in for Oromia, while the influence of weather change on the selection and specification of construction materials for road project design planning phase has the highest mean score of 4.23 for Addis Ababa and 4.03 for Oromia. The effect of weather change on road worker physiological comfort and quality of work for road project construction planning phase has the highest mean score of 4.80 and 4.58 in Addis Ababa and Oromia, respectively. The study concludes with recommendations for potential research and with useful information and considerations on the effects of weather change on road construction project planning for construction professionals and project managers.

Index Terms— Addis Ababa, Conceptual planning, Design and construction planning, Quality, Road construction, Specification, Weather change.

1 INTRODUCTION

Weather change is one of the common environmental phenomenon's generating great concern around the world nowadays. The research seeks to examine weather change factors and their effects on road construction project planning of Addis Ababa and Oromia. Weather describes the conditions of a specific day and variation across a specific area. The civil built infrastructure is one of the systems most exposed to the ever changing weather and environmental conditions, with huge economic impacts [1].

Ethiopia is vulnerable because its economy is highly dependent on climate-sensitive resources, mechanisms for coping with climate variability are not well established [8]. Many weather events such as rain and winds are caused by fronts. After days at which the effects of weather change are manifested around the world, it is now known that no nation including Ethiopia is immune from its effects. The effects of weather change are evidenced in different parts of Ethiopia. A change in weather will influence the most cost-effective

method of carrying out highway construction. Weather change can both increase detour road deterioration rates, necessitating more routine and structural maintenance. The weather often interacts with other factors which further influence deterioration of detour roads during construction, for example, heavy traffic and extreme temperatures combining to cause more severe rutting.

Weather can be defined as the air temperature, cloud cover, precipitation, and wind at any particular time in any particular location. The weather reflects the prevailing conditions of air masses overlying the land and seas across the globe. Weather patterns over a period of time present a picture of climate. Three main mechanisms cause the weather to change; heat, wind, and moisture. Heat is caused by the absorption and transference of incoming solar radiation within the Earth's atmosphere and at the Earth's surface. Places near the equator get more heat from the sun than the places near the North and South Poles. The Earth's surface heats up and

cools more quickly than bodies of water; conversely, water holds heat longer, and cools less quickly than the Earth's surface. Differential heating and cooling of Earth's surface lead to pressure variations that produce winds. Local and regional winds move moisture locally, regionally and globally. The Earth rotating on its axis over the course of a year can bring a marked change in weather to specific locations, what we more commonly refer to as the seasons. Seasonal variation is highly dependent on latitude, topography and regional weather patterns.

The transportation network system is globally recognized as the cornerstone of civilization as the growth of every Nation economy is measured by the growth of the transport infrastructure. Construction professionals are keenly aware of the effects of weather change on road construction planning performance. Road construction projects are designed for typical weather patterns, reflecting the local climate and incorporating assumptions about a reasonable range of variability in temperature and precipitation. The road construction projects will be affected most by those weather changes that fall outside of the range for which the system was designed [7]. In Ethiopia, research has examined the effects of weather change on agriculture, but currently there is a need to improve research covering road construction project planning.

The research study has considered three projects in Addis Ababa and Oromia. It sought to determine the effects of weather change related to road construction project planning. Weather change is known to affect road construction primarily through increases in high temperature; intense precipitation events; intense winds; and humidity.

A well-developed construction plan is considered the basis for developing at budget and schedule for work. Developing the construction plan is a critical task in the management of construction activities, even if the plan is not written or otherwise formally recorded. In addition to the technical aspects of construction planning, it is often necessary to make organizational decisions about project participants and which organizations are to be included in a project. For example, the extent to which sub-contractors will be used on a project is often determined during construction planning. Project planning is an important phase for every construction work undertaken by the contractor. Without proper planning, it would be only by chance that a project runs smoothly, even if all project deliverables are provided on time, the contractor may pay a high price.

In Ethiopia, the construction industries, such as road infrastructure, residential and commercial buildings, and waterworks, are booming. It is believed that road projects, which involve huge capital investment with long duration, are more vulnerable to weather change factors and effects. It is for this reason that this research study has focused on road projects funded under the Ethiopian Road Authority and

Addis Ababa Road Authority.

This research has sought to identify the consequence of each weather change factor precipitation, temperature, wind, and humidity on construction project planning for road projects in Addis Ababa and Oromia. Moreover, some road construction projects in Addis Ababa and Oromia are facing different problems in terms of cost and time in relation to weather change and there are no identified contributing factors for the effects of weather change on road construction project planning in Addis Ababa and Oromia.

Road Constructions in Ethiopia are boosted in all regions, which include Addis Ababa and Oromia regions. Establishing a Road or extending the operational capabilities requires that a strict project management planning process be followed. The issues that arise from this process are related to the inability of the project managers to execute the project management plan. The process of constructing road is directed by some form of project management.

As in any project, a road construction project needs to follow a structured project planning approach to ensure that the project ends in a success. The project planning has three basic phases which are; Conception Planning Phase, Design Planning Phase and Construction Planning Phase. The effort required in each phase increases to a peak and then tapers off as the project is completed (Gido and Clement, 1999). The literature does not give an indication of whether there are weather change effects in projects in the road construction industry in Ethiopia or for that matter in which phase of the project planning the majority of these weather change effects take place.

The construction industry has been in a little studied in the area of weather change and climate change effect on projects internationally. A list of possible climate change effects has evolved over the past 10 years that covers all major weather change effects in this industry. The most extensive list is that of Bello, W.A., Adekunle, R.A. and Ogunsanmi, O.E. (2012) which listed twenty-eight possible climate change effects on construction project planning [2]. It will be important to test this list of climate change effects with role players in the Ethiopian road construction industry. The trend in investigating the climate change and weather change effects in the construction industry has been to obtain the view of the project owner or sponsor, the consultants and the contractors. It would be relevant to determine which contractors and consultants are used in the Ethiopian road construction projects and what their experiences are in weather change effects at various points in the project planning phases. The weather change effects analyzed in construction projects internationally are limited. From the literature available the authors have referenced articles from construction climate change effects and weather change effects research. The weather change effects analysis in Ethiopia seems to be

written as part of literature related to other sectors e.g. agricultural production. The fact that weather change effects take place is mentioned, but no full analysis has been done on weather change effects specifically in road construction projects.

There are methods of analyzing the effects of climate change on construction projects were used such as the Analysis of Variance as researched by Bello, W.A., Adekunle, R.A. and Ogunsanmi, O.E. (2012) which assists to determine the effect of climate change on the project plan [2]. A model has been constructed by W. J. Maunder, Stanley R. Johnson, and J. D. Mcquigg (1971) to determine the effect of Weather on a road construction project. This model was then applied to a long-term series of daily precipitation records for Jefferson City (1918-65) to calculate road construction conditions over this period. Effects that are related to road construction may include the work can or cannot be done, which varies from month to month of different years.

1.1 Objectives of the Study

The purpose of this study is therefore to assess the effects of weather change on road construction, project planning in Addis Ababa and Oromia, which focused on the following specific objectives:

- To determine the weather change factors that most commonly experience in road construction, project planning within the study area.
- To identify the effects of weather change to be encountered on all road construction project planning phases.
- To examine and compare the relationship between the weather change factors and their effects on project planning phases within the study area.

1.2 Research Questions

The following research questions were addressed:

1. What are the factors due to weather change that mostly occurred on a road construction planning activities within the study area?
2. What are the effects of weather change in road construction planning within the study area?
3. Are there any relationships between weather change factors and their effects on road project planning phase?

This study was designed based on historical weather patterns; however, given weather change, roads may be subjected to extreme weather events during their construction. The costs of not taking this into consideration could be large in terms of delays, project cost and public safety. This study seeks to identify the major effects of weather change in road construction project planning, and to provide recommendations for stakeholders and construction firms.

1.3 Scope and Delimitation of the Study

The study area covered Road Projects in Addis Ababa and Oromia Region constructed by Road Contractors and Consultants under the administration of AACRA and ERA respectively. It assessed respondent's opinion and experience on experienced weather change factors and the effects of weather change in road projects planning in the above road project area and only primary data are employed. This study did not assess the performance of the company referred to and the maturity of the project management system. The other important limitation is that due to their tight schedules, it has not been easy to have questionnaires filled by most of the project managers of consultant and that of construction contractors.

2 RESEARCH METHODOLOGY

2.1 Study Area

The research study was focused on road projects funded and implemented by the Ethiopian Road Authority (ERA), and Addis Ababa City Road Authority (AACRA). The Addis Ababa city rises from 1,800 to 3,200 meters above sea level and is a grassland biome, located at 9°1'48"N 38°44'24"E. The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash.

As the national economic center, Addis Ababa receives approximately 54% of Ethiopian investment and is currently Ethiopia's largest metropolis, an official diplomatic capital of Africa, and the fourth largest diplomatic center in the world. The major rainy seasons in the study area include Mid-November to January is a season for occasional rain. The highland climate regions are characterized by dry winters, and this is the dry season in Addis Ababa. During this season the daily maximum temperatures are usually not more than 23 °C, and the night-time minimum temperatures can drop to freezing. The short rainy season is from February to May. During this period, the difference between the daytime maximum temperatures and the night-time minimum temperatures is not as great as during other times of the year, with minimum temperatures in the range of 10–15 °C. At this time of the year, the city experiences warm temperatures and a pleasant rainfall. The long wet season is from June to mid-September; it is the major winter season of the country.

The study sites were, "6-kilo to Ferensay Legasion road projects, Ministry of Water and Energy to Coca Cola Square and Ministry of Mines of Ministry of Water and Energy road projects" this both asphalt road projects link the eastern and western part of Addis Ababa which covers a total of 8.3km long. This area is characterized by somewhat up and down topographic features.

Likewise, the study has also selected road projects found in Oromia, which extends from 3°24'20"-10°23'26"N latitudes and 34°07'37"-42°58'51"E longitudes. "Nekemte-Bedele project,

Chora-Metu and Chora-Bedele road projects situated in the western parts of Ethiopia in Oromia region covering a total of 285km, Gedo-Fincha-Lemelem Berha Road upgrading Project will connect the West Shoa and Horo Gudru zones of the Oromia Region it has a total of 80.5km length and Adaba-Angetu 100km road project, this road will connect the Eastern Arsi Zone with Bale. The study was conducted from August 2014 to February 2015 in the study area.

2.2 Research Design

2.2.1 Research Type

2.2.1.1 Quantitative Research Method

According to Aliaga and Gunderson (2000), quantitative research is explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics). In quantitative research, numerical data would be collected. This is closely connected to the final part of the definition: an analysis using mathematically based methods. In order to be able to use mathematically based methods, data have to be in numerical form. While a quantitative research is a method used to answer questions about the relationships among measured variables with the purpose of explaining, predicting, and controlling phenomena [6]. This method of research does not include generalizations as with a qualitative study.

2.2.1.2 Qualitative Research Method

Qualitative research is aimed at gaining a deeper understanding of a specific organization or event, rather than a surface description of a large sample of a population. It aims to provide an explicit rendering of the structure, order, and broad patterns found among a group of participants. Tracy (2010) researched the use of criteria for research methodology and found in a review of the literature that there are opposing views on this matter.

2.2.1.3 Research Method Used

Based on the strengths and weaknesses of quantitative and qualitative research methods (Johnson and Onwuegbuzie, 2004, p. 20) and the helpfulness to this research the method chosen is quantitative. Few studies have been conducted in the research on the effects of weather changes in various fields. This study has only expanded the study area into the road construction sector of the economy.

2.3 Sampling Process

The study population refers to road construction projects funded and administered by the Ethiopian Road Authority and Addis Ababa City Road Authority. The project includes Road and Bridge construction. The purpose of the study is to examine the effect weather change on road construction project planning. Therefore, the study has employed a multi stage sampling techniques in which road projects in different areas of Addis Ababa and Oromia are selected. Addis Ababa

and Oromia have been selected because of the time and cost constraint, and it is also easy to get access to most of Road construction projects to obtain relevant information for project managers of various stakeholders.

□ Accordingly, on the first stage, road projects have been selected from each region using judgmental sampling (due to the limited size & number of the projects).

□ On the second stage, the research has identified all project management experts and engineers working in client, contractor, and consulting firms so that it is possible to obtain data pertinent to the study.

Using the above procedures, the sample size of the study was 6 projects in Addis Ababa and Oromia with corresponding 63 respondents have been selected and contacted as a population size. There were four groups of respondents considered. These are from the Ethiopian Road Authority (ERA), Addis Ababa City Road Authority, Private General Road Contractors and Consultants working in Ethiopia.

2.4 Study Variables

2.4.1 Dependent Variable

The "dependent variable" which is associated with the research title "Effects of weather change on Road Project planning" is as follows:

□ Conception Planning Phase

- Delays site preparation activities
- Increases insurance cost
- Influence the choice of site Location
- Force majeure (natural disaster)
- Influence the structure of site organization plan
- Affect the bearing capacity of soil which will determine the type of foundation to be used
- Affect the elevation and topography of the site

□ Design Planning Phase

- Influence the selection and specification of construction materials
- Influence the method of construction design
- Affects the design of the built facility
- Damage the structural design and stability of the built facility causing high cost implication of remedial works
- Affect the site layout plan

□ Construction Planning Phase

- Adversely affects construction schedule, production of granular materials and mixing of concrete.
- During construction of the built facility scour and damage to structures causing delay and extra expense.
- Affect the physiological comfort of workers who will not be able to give off their best

- Delays transport and delivery of materials affecting site programming and costs
- Delays site construction activities/programming and increase site construction costs
- Affects the health and safety of all site workers and laborers, particularly those working outdoors on construction sites and this in turn will delay site construction activities and cost.

2.4.2 Independent Variables

The "independent variables" represent the inputs or causes, or are tested to see if they are the cause. The Independent variables associated with this study are weather change factors like:

- Cold temperature
- Heavy Precipitation
- Temperature
- High Wind
- Moisture

2.5 Data Collection

For the survey, a questionnaire was prepared in three parts. The first part contained six important questions that are relevant in forming biographical question. The second part of the questionnaire was based on the possible weather change factors that are mostly experienced while the third part contained the questionnaire based on possible effects of weather change, considering scale of 1 to 5 depending upon its event, 5 being always and 1 never. The respondents were asked their opinion about the effects of weather change on road construction projects, planning, on a scale of 1 to 5 depending upon its effect, 5 being the strongly agree and 1 the strongly disagree. These answered questions were served as the data to answer the research question.

Table 2.1: Classification of questions

Part 1	Biographical details The questions establish the background of the respondent in terms of the company they work, gender, age, experience and level in the project management structure.
Part 2	Experiencing weather change factors To determine the frequency of weather change factors in road construction project planning.
Part 3	Effects of weather change on road construction projects planning To determine what the specific effects of weather change are that have been experienced in road construction project planning.

2.6 Data Processing and Analysis

Measurement scales ultimately dictate the statistical procedures that will be used in the analysis of the collected data [6]. The measurement scales for this research study was firstly being nominal, which restricts the data into discrete

categories. Nominal measurement enables the analysis of variables such as gender, race and position in an organization. Respondents are working in construction, consulting and government organizations. All construction experts participated in road construction planning, in the organizations was approached for answering the questionnaire. This was done to preserve the quality of the opinions gathered in the survey. The experts were made to understand that their responses should not be biased towards any particular project, whether it was highly successful or highly disastrous. The data received in the first part of the questionnaire was analyzed by descriptive statistics to determine the frequency of their responses. The data received in the second and third part of the questionnaire was analyzed by mean to establish an average score;

- i. Experienced weather change factors in Road Projects Planning
- ii. Effects of weather change on Road Projects Planning

These were also analyzed by using independent sample t-test to compare respondent's opinion and experience on weather change effects between the two independent groups (Addis Ababa & Oromia). Further analysis like partial correlation was also carried to examine the relationship between the weather change factors and its effects on road projects planning phases of the study areas by using SPSS-20.

3 RESULTS AND DISCUSSION

The collected data were presented and it was used to answer the research questions posed in part one. To answer these research questions which weather change factors are experienced on road project planning phases and the results from the questionnaire were combined. The consultant, contractor and client respondents were requested to indicate whether they had been experiencing weather change factors during their stay in the projects.

3.1 Experienced Weather Change Factor at Conception Planning Phase

Table 3.1 shows the descriptive statistical results of the experienced weather change factors listed in the questionnaire. The respondents indicated that they sometimes experienced heavy precipitation in Oromia and hot temperature in Addis Ababa with a mean score of 3.06 and 3.20 respectively. They also replied that they often experienced heavy precipitation in Addis Ababa and hot temperature in Oromia with a mean score of 3.57 and 4.03 respectively.

Table: 3.1 Experienced Weather changes Factors at conception planning

No.	Weather	Respondents Project Location
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	change factors	Addis Ababa			Oromia Region		
		Mean	Std. Dev	Median	Mean	Std. Dev	Median
1	Cold temperature	2.33	0.711	2.00	2.09	0.843	2.00
2	Heavy Precipitation	3.57	0.774	4.00	3.06	0.827	3.00
3	Hot temperature	3.20	0.997	3.00	4.03	0.883	4.00
4	High Wind	2.80	0.761	3.00	3.03	0.770	3.00
5	Moisture	2.37	0.999	2.00	2.18	0.950	2.00

Moreover, a high wind sometimes experienced in Addis Ababa and Oromia with a mean score of 2.80 and 3.03 respectively on conception planning. Most of the respondents indicated that they have rarely experienced cold temperature in Addis Ababa and Oromia with a mean score of 2.33 and 2.09, respectively. While it was rarely experienced moisture in Addis Ababa and Oromia with a mean score of 2.37 and 2.18 respectively.

3.2 Experienced Weather Change Factor at Design Planning Phase

The table 3.2 below shows the ranked experienced weather change factors as indicated by the respondent's opinion using the mean as the ranking variable. Accordingly, weather change factors that sometimes experienced in Addis Ababa are hot temperature and heavy precipitation with equal mean score of 3.30. Moreover, they experienced sometimes heavy precipitation & high wind in Oromia with a mean score of 2.85 and 3.03 respectively.

Table: 3.2 Experienced Weather changes Factors at design planning

No.	Weather change factors	Respondents Project Location					
		Addis Ababa			Oromia Region		
		Mean	Std. Dev	Median	Mean	Std. Dev	Median
1	Cold temperature	2.27	.691	2.00	1.73	.674	2.00
2	Heavy Precipitation	3.30	.794	3.00	2.85	.712	3.00

3	Hot temperature	3.30	.794	3.50	4.00	.791	4.00
4	High Wind	2.33	.547	2.00	3.03	.684	3.00
5	Moisture	2.27	.868	2.00	2.09	.914	2.00

As indicated by the respondent, hot temperature is often experienced in Oromia, but rare to see cold temperature and moisture in both study areas.

3.3 Experienced Weather Change Factor at Construction Planning Phase

Table 3.3 illustrates that the majority of the respondents often experienced heavy precipitation in Addis Ababa and hot temperature in Oromia with a mean score of 3.63 and 3.91 respectively. They sometimes experienced hot temperature in Addis Ababa and heavy precipitation in Oromia with a mean of 3.50 and 3.06 respectively. In addition to this, the respondents indicated that high wind sometimes experienced in Oromia with a mean score of 2.76. It is rarely experienced moisture and cold temperature in both of the study areas.

Table: 3.3 Experienced Weather changes Factors at Construction Planning

No.	Weather change factors	Respondents Project Location					
		Addis Ababa			Oromia Region		
		Mean	Std. Dev	Median	Mean	Std. Dev	Median
1	Cold temperature	2.23	.679	2.00	1.94	.496	2.00
2	Heavy Precipitation	3.63	.850	4.00	3.06	.933	3.00
3	Hot temperature	3.50	.731	3.00	3.91	.678	4.00
4	High Wind	2.43	.728	2.00	2.76	.751	3.00
5	Moisture	2.27	.907	2.00	2.33	.890	2.00

3.4 Effects of Weather Change on Conception Planning Phase

Table 3.4 illustrates the mean and standard deviation of different effects of weather change on road project conception planning as indicated by the respondent's opinion.

Table 3.4: mean to rank and identify effects of weather change on conception planning phase

No.	Effects of Weather change	Respondents Project Location			
		Addis Ababa		Oromia Region	
		Mean	Std. Dev	Mean	Std. Dev
1	Delays site preparation activities	4.30	.466	4.00	.433
2	Increases insurance cost	3.03	.615	2.94	.348
3	Influence the choice of site Location	3.70	.535	3.42	.708
4	Affect the bearing capacity of soil which will determine the type of foundation to be used	3.13	.973	3.06	.933
5	Influence the structure of site organization plan	3.70	.596	3.52	.508
6	Force majeure (natural disaster)	3.83	.648	3.45	.711
7	Affect the elevation and topography of the site	4.00	.525	3.27	.801

Table 3.4 shows the descriptive statistics for the two groups (Addis Ababa and Oromia) separately, and reveals that the delay of site preparation activities as a result of weather change with a mean score of 4.30 and 4.00 in Addis Ababa and Oromia respectively has the highest mean score on road project conception planning phase.

This is followed by weather change affecting the elevation and topography of the site, influences the structure of the site organization plan with a mean rating of 4.00 and 3.52 respectively. The least ranked effects of weather change on road project conception planning as shown in the table above, is increased of insurance cost with a mean score of 3.03 and 2.94 in Addis Ababa and Oromia respectively.

It could be noted that the means within each of the seven pairs look somewhat different, so further comparing of mean were carried out using independent sample t-test to compare the variables between the groups. Based on the mean and t-test as indicated by the respondent's opinion, Addis Ababa has the higher delays on site preparation activities than Oromia.

Table 3.5: Independent Sample t-test for Addis Ababa and Oromia on conception planning phase

Effects of Weather change	t-test for Equality of Means			
	t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference
				Lower

Delay site preparation activities	Equal variances assumed	2.648	61	.010	.073	.527
	Equal variances not assumed	2.639	59.285	.011	.073	.527
High insurance cost	Equal variances assumed	.755	61	.453	-.155	.343
	Equal variances not assumed	.736	44.907	.465	-.163	.351
Influence the choice of site location	Equal variances assumed	1.730	61	.089	-.043	.595
	Equal variances not assumed	1.753	59.084	.085	-.039	.591
Affect the bearing capacity of soil which will determine the type of foundation to be used	Equal variances assumed	.303	61	.763	-.408	.553
	Equal variances not assumed	.302	59.851	.764	-.409	.554
Influence the structure of site organization plan	Equal variances assumed	1.329	61	.189	-.093	.463
	Equal variances not assumed	1.319	57.280	.192	-.096	.465
Force majeure (natural disaster)	Equal variances assumed	2.203	61	.031	.035	.723
	Equal variances not assumed	2.213	60.999	.031	.036	.721
Affect the elevation and topography of the site	Equal variances assumed	4.214	61	.000	.382	1.072
	Equal variances not assumed	4.297	55.674	.000	.388	1.066

Considering the mean and independent sample t-test of the respondent's opinion in Table 3.5 Addis Ababa has the highest effects as a result of weather change on the elevation and topography of the site than Oromia. Moreover, note that for high insurance cost due to the effects of weather change the t-value is not statistically significant (p=0.453) so, there is no significant difference in respondent's opinion between Addis Ababa and Oromia on the effects of increasing insurance cost.

3.5 Effects of Weather Change on Design Planning Phase

Table 3.6 illustrates the mean and standard deviation of the effects of weather change on road project design planning phase as indicated by the respondent's opinion. The influence

of weather change on the selection and specification of construction materials has the highest mean score of 4.23 and 4.03 in Addis Ababa and Oromia, respectively.

Table: 3.6 mean to rank and identify effects of Weather change on design planning phase

No.	Effects of Weather change	Respondents Project Location			
		Addis Ababa		Oromia	
		Mean	Std. Dev	Mean	Std. Dev
1	Influence the selection and specification of construction materials	4.23	.626	4.03	.467
2	Influence the method of construction design	3.80	.407	3.85	.364
3	Affects the design of the built facility	3.87	.346	3.42	.502
4	Damage the structural design and stability of the built facility causing high cost implication of remedial works	3.67	.479	3.42	.792
5	Affect the site layout plan	3.93	.521	3.36	.783

It is followed by weather change that affects the site layout plan with a mean score of 3.93 in Addis Ababa and influence the method of construction design with a mean score of 3.85 in Oromia based on the respondent's opinion on road project design planning phase. The factor which ranked last on the effect of weather change on road project design, planning as indicated in Table 3.6 is a damage on the structural design and stability of the built facility causing high cost implication of remedial works with a mean score of 3.67 in Addis Ababa and affects the site layout plan with a mean score of 3.36 in Oromia.

Table: 3.7 Independent Sample t- test for Addis Ababa and Oromia on design planning phase

Effects of Weather change		t-test for Equality of Means					
		t	df	Sig. (2-tailed)	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Influence the selection and specification of construction materials	Equal variances assumed	1.468	61	.147	.138	-.074	.480
	Equal variances not assumed	1.448	53.360	.154	.140	-.078	.484

Influence the method of construction design	Equal variances assumed	-.499	61	.619	.097	-.243	.146
	Equal variances not assumed	-.497	58.500	.621	.098	-.244	.147
Affects the design of the built facility	Equal variances assumed	4.034	61	.000	.110	.223	.662
	Equal variances not assumed	4.105	56.992	.000	.108	.227	.658
Damage the structural design and stability of the built facility causing high cost implication of remedial works	Equal variances assumed	1.452	61	.152	.167	-.091	.576
	Equal variances not assumed	1.485	53.430	.143	.163	-.085	.570
Affect the site layout plan	Equal variances assumed	3.363	61	.001	.169	.231	.908
	Equal variances not assumed	3.427	56.061	.001	.166	.237	.903

Based on the mean and t-test as indicated by the respondent's opinion as shown in table 3.7 for the effects on the selection and specification of construction materials, the t-value is not statistically significant ($p = 0.147$) so, there is no significant effects difference between Addis Ababa and Oromia on the selection and specification of construction materials. For a weather change for affecting the site layout plan as indicated by the respondent's opinion, t-value is statistically significant and Addis Ababa has higher weather change effects of the site layout plan than Oromia. Differently, weather change in influencing the method of construction design as indicated by the respondent's opinion is not statistically significant ($p = 0.619$). This means, there is no significant opinion difference between Addis Ababa and Oromia of weather change effects of construction design method.

3.6 Effects of Weather Change on Construction Planning Phase

Table 3.8 illustrates the mean and standard deviation of the effects of weather change on construction planning phase as indicated by the respondent's. Assessment of respondents' opinion on the effects of weather change on road construction planning as revealed in Table 3.8 indicates that the effect of Weather change on physiological comfort of workers who will not be able to give off their best has the highest mean score of 4.80 and 4.58 in Addis Ababa and Oromia, respectively.

Delays transport and delivery of materials affecting site programming and costs has the second highest mean score of 4.70 in Addis Ababa, while the delays in site construction activities/programming and increase site construction costs

has the second highest mean score of 4.55 for Oromia. During construction of the built facility, scour and damage to structures causing delay and extra expense has the highest mean score of 3.60 and 3.21 in Addis Ababa and Oromia respectively. It was found to be the least ranked effects of weather change on road construction planning. This report verified that weather related impacts require new building techniques and materials to withstand adverse weather conditions; influence the choice of site and increase premiums of insurance [6].

Table: 3.8 Mean to rank and identify effects of weather change on construction planning phase

No.	Effects of Weather change	Respondents Project Location			
		Addis Ababa		Oromia Region	
		Mean	Std. Dev	Mean	Std. Dev
1	Interfere with the construction schedule, production of granular materials and mixing of concrete will be adversely affected	4.63	.556	4.52	.508
3	During construction of the built facility scour and damage to structures causing delay and extra expense	3.60	.770	3.21	.960
4	Affect the physiological comfort of workers who will not be able to give off their best	4.80	.484	4.58	.561
5	Delays transport and delivery of materials affecting site programming and costs	4.70	.535	4.24	.614
6	Delays site construction activities/programming and increase site construction costs	4.57	.504	4.55	.506
7	Affects the health and safety of all site workers and laborers, particularly those working outdoors on construction sites and this in turn will delay site construction activities and cost	4.57	.568	4.21	.485

3.7 The Relation of Weather Change Factors and its Effects at Conception Planning

As illustrated in table 3.9 of respondent’s opinion, delay in site preparation activities was significant and has a fair correlation with cold temperature, with the exception of other variables

Table 3.9: Partial Correlation of Weather Change Factors and Its Effects at Conception Planning

Effects at Conception Planning		Cold Temperature	Precipitation	Hot Temperature	Wind	Moisture
Delay site preparation activities	Correlation	.307	-.150	-.309	.086	-.231
	Significance (2-tailed)	.018	.257	.017	.518	.079
	df	57	57	57	57	57
High insurance cost	Correlation	.255	.283	.042	.230	-.307
	Significance (2-tailed)	.051	.030	.749	.080	.018
	df	57	57	57	57	57
Influence the choice of site location	Correlation	.468	-.244	-.141	-.093	-.142
	Significance (2-tailed)	.000	.062	.286	.483	.282
	df	57	57	57	57	57
Affect the bearing capacity of soil which will determine the type of foundation to be used	Correlation	.198	.111	-.125	-.288	-.229
	Significance (2-tailed)	.134	.404	.346	.027	.081
	df	57	57	57	57	57
Influence the structure of site organization plan	Correlation	.012	-.280	-.343	.044	.176
	Significance (2-tailed)	.927	.031	.008	.740	.181
	df	57	57	57	57	57
Force majeure (natural disaster)	Correlation	.160	-.269	-.300	.095	.123
	Significance (2-tailed)	.226	.040	.021	.475	.354
	df	57	57	57	57	57
Affect the elevation and topography of the site	Correlation	-.051	-.144	-.487	-.001	.043
	Significance (2-tailed)	.700	.275	.000	.991	.748
	df	57	57	57	57	57

Like precipitations, wind, moisture, and hot temperature, and significant at $r(57) = 0.307$, $p < 0.05$. Note that precipitation was not significant, negative and poorly related to the delay in site preparation activities when controlling the effects of the other variables like cold temperature, hot temperature, wind and moisture. Hot temperature were significant at $r(57) = -0.309$, $p = 0.017$ and has a negative and moderate relation to delay in

site preparation activities when controlling the effects of the other variables of cold temperature, precipitation, wind and moisture. Moisture was not significantly related to the delay in site preparation activities when controlling the effects of other variables like cold temperature, hot temperature, precipitation and wind. High insurance cost were significant at $p = 0.03$ and poorly related at $r(57) = 0.283$ with precipitation when controlling the effects of other variables like cold temperature, hot temperature, wind and moisture.

Moreover, the high insurance cost was significant at $p = 0.018$ and negative moderate relation at $r(57) = -0.307$ with moisture when controlling the effects of other variables like cold temperatures, precipitation, hot temperature and wind. The influence on the choice of site location was significant at $p = 0.000$ and fairly related at $r(57) = 0.468$ with cold temperature when controlling the effects of other variables like hot temperature, precipitation, wind and moisture.

Other variables like precipitation, hot temperature, wind and moisture was not significant even if they comprised negative score and poorly related with influence on the choice of site location when controlling the effects of other variables. Cold temperature, precipitation, wind and moisture were not significant even if they are negative and poorly related with effect of elevation and topography of the site when controlling the effects of other variables.

In contrary, hot temperature were significant and negative fair relation with effect of elevation and topography of the site when controlling the effects of other variables like cold temperatures, precipitation, wind and moisture.

3.8 The Relation of Weather Change Factors and its Effects at Design Planning

As illustrated in table 3.10 of the respondent's opinion the influence on selection and specification of construction materials was significant and moderately strong relation with precipitation when controlling the effects of other variables like cold temperature, hot temperature, wind and moisture.

In addition to this, moisture was significant, negative and fairly related to the influence on selection and specification of construction materials when controlling the effects of other variables like cold temperatures, precipitation, hot temperature and wind.

Other variables like cold temperature, hot temperature and wind are not significant even if they are negative and poorly related with influence on selection and specification of construction materials when controlling the effects of other variables.

Table 3.10: Partial Correlation of weather change factors and its effects at Design Planning

Effects at Design Planning		Cold Temperature	Precipitation	Hot Temperature	Wind	Moisture
Influence the selection and specification of construction materials	Correlation	-.209	.579	-.019	-.146	-.425
	Significance (2-tailed)	.112	.000	.884	.271	.001
	df	57	57	57	57	57
Influence the method of construction design	Correlation	-.149	-.061	-.247	.120	.206
	Significance (2-tailed)	.260	.647	.060	.364	.118
	df	57	57	57	57	57
Affects the design of the built facility	Correlation	.033	-.080	-.277	-.070	-.100
	Significance (2-tailed)	.806	.548	.034	.601	.453
	df	57	57	57	57	57
Damage the structural design and stability of the built facility causing high cost implication of remedial works	Correlation	.078	.104	-.165	-.265	-.289
	Significance (2-tailed)	.558	.433	.211	.043	.026
	df	57	57	57	57	57
Affect the site layout plan	Correlation	.426	.122	.070	-.403	-.195
	Significance (2-tailed)	.001	.358	.600	.002	.139
	df	57	57	57	57	57

The influence of the method of construction design was not significant even if it is negative and poorly related with cold temperature, precipitation and hot temperature when controlling the effects of other variables. Weather change affecting the site layout plan was significantly and fairly related with cold temperature when controlling the effects of other variables like precipitation, hot temperature, wind and moisture. Moreover, weather change affecting the site layout plan was significant, negative and fairly related to wind when controlling the effects of other variables.

3.9 The Relation of Weather Change Factors and its Effects at Construction Planning

As illustrated in table 3.11 of respondent's opinion weather change effect that are affected by interfering with the construction schedule, production of granular materials and

mixing of concrete was significantly and poorly related with moisture when controlling the effects of other variables.

Table 3.11: Partial Correlation of weather change factors and its effects at Construction Planning

Effects at Construction Planning		Cold Temperature	Precipitation	Hot Temperature	Wind	Moisture
Interfere with the construction schedule, production of granular materials and mixing of concrete will be adversely affected	Correlation	-.177	.090	-.152	.255	.098
	Significance (2-tailed)	.180	.500	.251	.052	.458
	df	57	57	57	57	57
During construction of the built facility scour and damage to structures causing delay and extra expense	Correlation	-.030	.388	-.018	-.267	.215
	Significance (2-tailed)	.824	.002	.893	.041	.102
	df	57	57	57	57	57
Adversely affect the physiological comfort of workers who will not be able to give off their best	Correlation	-.056	-.015	-.321	.256	-.521
	Significance (2-tailed)	.676	.911	.013	.050	.000
	df	57	57	57	57	57
Delay transport and delivery of materials affecting site programming and costs	Correlation	-.044	.229	-.169	-.214	-.281
	Significance (2-tailed)	.740	.082	.201	.104	.031
	df	57	57	57	57	57
Delay or impact costs associated with transport and delivery of construction products/materials	Correlation	.010	.364	-.141	.114	.021
	Significance (2-tailed)	.941	.005	.287	.389	.874
	df	57	57	57	57	57
Affect the health and safety of all site workers and laborers, particularly those working outdoors on construction sites and this in turn will delay site construction activities and cost	Correlation	.071	.130	-.350	-.020	-.391
	Significance (2-tailed)	.591	.325	.007	.883	.002
	df	57	57	57	57	57

Cold and hot temperature was not significant even if they are negative and poorly related with effects on construction schedules, production of granular materials and mixing of concrete when controlling the effects of other variables. Hot temperature and moisture were significant at ($p = 0.013$ & $p = 0.00$) and have a negative fair relation at $r(57) = -0.321$ & -0.521 respectively with physiological comfort of workers when controlling the effects of other variables.

Delay or impact costs associated with transport and delivery of construction products/materials,

delay on site construction activities/programming and increasing site construction cost was significant at $p = 0.005$ and fairly related at $r(57) = 0.364$ with precipitation when controlling the effects of other variables.

4 CONCLUSION

The majority of the personnel involved in road projects in Addis Ababa and Oromia, Ethiopia is predominantly Contractors. The majority age of the personnel is between 23 to 40 years old, of which the majority is having more than 5years professional experience in project management and design. Substantially the respondents are a senior project manager with degree holders and above.

The results from this research study are mainly based on the perception of persons that have had many years of experience in road projects. The number of projects they have been involved was not clarified, but for those having more than 5 years' experience in road related projects, it can be assumed that it is more than one. This demonstrates that the road construction industry had utilized experienced people in their project management teams.

The different weather change factors that affect road construction projects planning have been experienced at different phases of the planning between the study areas. Accordingly, the analysis showed that at conception planning phase heavy precipitation and hot temperature are predominantly experienced in Addis Ababa and Oromia respectively. At design planning phase, precipitation and hot temperature sometimes experienced in Addis Ababa, but in Oromia hot temperature and wind, often and sometimes experienced respectively. Moreover, at construction planning phase precipitation and hot temperature sometimes experienced in the study areas.

The effects of weather change factors on road project planning vary with planning phases. Even though, at conception planning, weather change delays site preparation activities in the study areas the effect is higher in Addis Ababa than Oromia and it has a negative and poor correlation with precipitation rather than it has a fair correlation with cold temperature. The effect on the elevation and topography of the site by changing its feature is higher in Addis Ababa than Oromia and it has a negative fair correlation with hot temperatures. At design planning phase, weather change factors in both project locations showed equal influence the selection and specification of construction materials while it has a negative poorly related to cold temperature, precipitation and cold temperature. In addition to this, construction planning phase weather change factors affect the physiological comfort of workers who will not be able to give off their best has significant and negative fair relation with hot temperature and moisture.

However, prior to these analyses, the study has provided construction professionals, especially project managers, with useful information about the effects of weather change on a road construction, project planning to help them guided and informed, and to enable them adopt formal and systematic approach to construction planning which would minimize the impacts of weather change.

5 RECOMMENDATION

Based on the results and discussion, hereunder are the following recommendations to help and improve the road construction planning in Ethiopia. This is to avoid negative or adverse effect of weather change in road planning by the project management team:

- Awareness about the weather change factors; which are contributory to the attainment of good quality of the completed road project shall be taken into consideration prior the implementation of the project.
- Proper coordination with the weather bureau about the forecasted weather conditions within the project location and duration in order to know favorable condition to work and to limit working on rainy days should be undertaken.
- Road project planning reports must be updated with respect to the forecasted weather conditions within the project areas.
- Further Research should be undertaken to identify the effects of weather change on road project planning phase using a secondary data like meteorological data to be more reliable on the impacts it has on the planning phase.

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