Operational and Financial Risks from Climate Change in UAE Construction Industry

المخاطر التشغيلية والمالية من تغير المناخ في صناعة البناء في الإمارات العربية المتحدة

by

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Abstract

The current dissertation explores the influence of climate change on operational and financial risks in the construction sector of the United Arab Emirates. It uses the existing literature to identify the five modules of risk factors which include site operations, employees' health, efficiency of equipment, labour productivity, and the overall financial productivity. These five modules encompass the 21 risk factors which are analyzed in the empirical part of this research.

The study operates with the research methodology of realism and uses the method of online survey to collect quantitative data. The analytical methods of descriptive analysis, Cronbach's alpha test and one-way ANOVA are employed in order to examine the data's reliability and measure a correlation between the climate change and the significance of various risk factors inherent to the construction industry. It is found that risks in the module of overall financial productivity are the most significant, but they are not directly connected with the climate change. The effect of climate change manifests itself in making materials less efficient, increasing the chances of catching flu among employees, and generating other effects connected with cold temperatures.

The study argues that the only way to mitigate the negative influence of climate change on the construction sector is to engage various stakeholders in this process. While the government should design legislative measures aimed at preventing environment's pollution, managers must make sure that workers adhere to the existing codes and all the necessary health and safety procedures are effective. From most perspectives, the conclusions of this study harmonize with the conclusions made by other scholars in the same research field.

ملخص

إن البحث الحالي يستكشف تأثير التغير المناخي في التشغيل والمخاطر المالية في قطاع أعمال البناء في دولة الإمارات العربية المتحدة.تم إستخدام البحوثات الموجودة لإيجاد خمس وحدات من عوامل المخاطر التي تتظمن موقع التشغيل, صحة الموظفين,كفاءة المعدات, إنتاجية العمال, والإنتاجية المالية الإجمالية. هذه الوحدات الخمس تشمل علي 21 من عوامل الخطر التي تم تحليلها في الجزء التجريبي من هذا البحث.

وتعمل الدراسة مع منهجية البحث الواقعية وإستخدامات طرق الإستبيان عبر الإنترنت لجمع البيانات الكمية, الطرق التحليلية للتحليل الوصفي " Cronbach's alpha test" و "one-way ANOVA" أستخدامهما بغرض إختبار مصداقية البيانات وقياس الترابط بين التغير المناخي وأهمية عوامل الخطر المختلفة المتأصلة في قطاع البناء والتشييد. ووجد أن المخاطر في وحدة الإنتاجية المالية الإجمالية هي الأهم، ولكنها ليست مرتبطة مباشرة بتغير المناخ. ويتجلى تأثير تغير المناخ في جعل المواد أقل كفاءة، زيادة فرص نقل الانفلونزا بين الموظفين، وتوليد تأثيرات أخرى مرتبطة بدرجات الحرارة الباردة.

وتقول الدراسة إن السبيل الوحيد للتخفيف من التأثير السلبي لتغير المناخ على قطاع البناء هو إشراك مختلف أصحاب المصلحة في هذه العملية. وفي حين يجب على الحكومة أن تصمم تدابير تشريعية تهدف إلى منع تلوث البيئة، يجب على المديرين التأكد من أن العمال يلتزمون بالقوانين القائمة وأن جميع إجراءات الصحة والسلامة الضرورية فعالة. من معظم المنظورات، تتفق استنتاجات هذه الدراسة مع الاستنتاجات التي توصل إليها علماء آخرون في نفس المجال البحثي.

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CHAPTER 1. INTRODUCTION

1.1.Introduction

Climate change is becoming a challenging factor for many economic and political agendas across the world. Climate change presents threats to the survival of humanity through the deterioration of the earth's ecosystem. These impacts are also increasing in frequency and intensity on a global scale due to the increasing greenhouse gas emissions and anthropogenic disturbances resulting from human lifestyles and activities. These impacts have wide-reaching effects as they influence decision making and national policies. Consequently, this research investigates the impact of climate change on the operational and financial aspects of the construction industry in the United Arab Emirates (UAE). Mainly, this chapter presents an introduction to the research. It evaluates the background of the study, the study context, problem statement, research purpose, research objectives, research questions, assumptions of the study, scope of the study, limitation, and lastly the rationale of the study.

1.2.Background to the Study

Many industries tend to have no problems with extreme weather conditions such as high temperatures, humidity, and warm climates. However, the construction industry happens to be the most vulnerable to extreme weather conditions due to the nature of its operations. A majority of activities in the construction industry are conducted at the outdoors by manual workers. Although various researchers have conducted studies on the impact of climate change on UAE, there are limited studies specifically focusing on the impact of climate change on the operation and financial aspects of the construction industry (Alshebani and Wedawatta 2014). For instance, hot and dry weather can increase evaporation of surface moisture in concrete curing in construction services. Excess wind also increases the evaporation rate resulting in the shrinking, cracking, and difficulties in finishing, that are likely to reduce the strength of concrete in the structure of a building. These impacts can have severe consequences to the operation and financial aspects of the construction activities.

Construction work involves three activities: civil engineering, electrical, mechanical, and process engineering, and building. Most construction projects will include all these activities at varying degrees. Some of the climatic risks that the construction industry is exposed to may

include meteorology or atmospheric conditions, which include storm and the wind, rain, snow, hail, and ice as influenced by various temperatures. The second risk involves hydrology or geology, which includes earthquakes, lahars, volcanism, and tsunamis. Changes in climatic conditions may have an impact on ground water events. Several factors make the construction industry vulnerable to risks from climate change, especially in the UAE. These factors include the exposure of projects to the tidal, estuary or coastal storms, open seal, or surge. These risks present numerous operational and financial effects on construction activities.

The construction sector contributes to the economic growth of a nation as a result of its developmental efforts. This industry comprises various businesses in the design, engineering standards, and the establishment of various building structures and materials. Long-term weather changes leading to effects such as coastal erosion, flooding, sea level rise, high winds, and drought influence the choice of construction materials, building techniques, and the construction site. The risks from severe climate and weather conditions also affect the project planning and completion timelines. Therefore, this industry is affected by climate change in many ways necessitating an investigation into the most appropriate ways to mitigate these impacts.

1.3. Context of the Study

UAE is made up of seven Emirates states, and it is situated in the Gulf region. The country is about 83,600 km^2, and it is made up of three main ecological areas that include the desert areas, mountainous, and coastal regions (Radhi 2010). More than four-fifths of the area is dry particularly in the western region of UAE. The United Arab Emirates' climate is arid and semi-arid. The winter season occurs from November to March with temperatures drop to less than 6^o (Radhi 2010). Summer lasts from April to October with temperatures as high as 48^oC, especially at the coastal regions. The humidity levels also reach 90% during the summer. In other areas such as the Al Ain city at the south, temperatures can reach 50^oC (Radhi 2010). High solar radiations at 613 W/m^2 of direct radiation in May are also inherent to the United Arab Emirates. In October, the radiations fall to about 546 W/m^2. The UAE region experiences wind throughout the year from the north-western region. The wind speed slows down during the winter season at about a monthly average of 3.5 m/s. However, throughout the summer season, the wind speed is highest at 4.2m/s to about 4.6 m/s on monthly average.

It is evident that UAE is a hot region during throughout the year. Therefore, the region is vulnerable to weather changes and their impacts. For instance, reports from the Ministry of Energy and the Environmental Agency of UAE indicate that the region is likely to experience temperature increases and precipitation declines by the end of this century. Hence, it is evident that the UAE climate is getting hotter and hotter impacting various industries including the construction sector in the region. Changes in the external air temperature have profound consequences on building operations and overall performance of building.

For many decades, UAE's oil exports have contributed in the growth of the country's economy. The focus on economic diversification has been developing over the years giving a significant boost to various sectors. The construction industry constitutes one of the most vital areas that are emerging. The industry significantly contributes to the country's Gross Domestic Product (GDP) due to the increasing construction activity in UAE. As a key to the achievement of sustained economic growth, UAE's local government started encouraging a reduction in the overreliance on the energy sector. Therefore, the non-oil sectors established various projects that have significant contributions to the country's overall GDP (Kumar, Agarwal, and Khullar 2010). The real estate and construction sector constitute one of the beneficiaries of the new economic ventures in the country.

UAE's infrastructure sector has experienced a record boom in the last ten years. Construction projects in UAE contribute to over $ 1 trillion, with over two-thirds of all construction projects in the Gulf region taking place in the UAE. The construction sector posts double-digit economic contributions to UAE each year resulting in 15 percent contributions to the Gross Domestic Product (Kumar, Agarwal, and Khullar 2010). The city of Dubai and Abu Dhabi lead in construction activities making them hubs to the world's major construction companies such as Emaar Properties, Aldar Properties PJSC, and Nakheel PJSC.

As shown above, it is evident that besides the energy sector, the construction industry is also a major contributor to the country's GDP. The sector is also projected to continue growing due to population growth and technological advancements. The industry is also exposed to the effects of climate change based on the nature of activities that are involved. The projected climate changes characterized by increased temperatures, little precipitation, and a rise in sea levels pose threats to the industry. These threats result from the impacts felt in the operational and financial factors of construction projects in UAE. Consequently, this paper aims to

investigate the effects with a goal of uncovering the most suitable approaches to mitigate these impacts resulting from climatic changes in the UAE.

1.4.Problem Statement

Climate change is evident across the world with varying explanations of its cause. While some scientists believe that the changes are a result of natural variability, others blame human activity as the primary cause of the increased atmospheric concentrations of GHGs as the fundamental cause of climatic changes. Research reveals that UAE is vulnerable to extreme weather conditions due to its arid and semi-arid climatic characteristics (Radhi 2010). Human activities also contribute to the destruction of the environment. The nature of activities in the construction sector makes it vulnerable to effects from climate change. These impacts affect the various construction activities including the choice of the site, concreting activities, labor productivity, and the safety of the workers. These effects can be felt in the economic sector of the entire country given the contribution of the construction industry to the country's economy.

In his study, AlRustamani (2014) attests UAE experiences tremendous impacts on its infrastructure including the construction sector. These impacts have an extending impact on various development policies and sectors including health, socio-economic, and the environment. Conversely, population and economic growth increase the demand for the generation of water, energy, and natural resources that indirectly affect the levels of emissions in the atmosphere and climate change. Therefore, there is a need for interventions to mitigate the negative impacts climate change has on the country's critical sectors such as the construction sector. Over the years, the United Arab Emirate's response to the effects of climate change has been ad-hoc constrained by an overdependence on technological substitution as a tool for adaptation to the harsh climatic conditions (AlRustamani 2014). However, the increased greenhouse emissions and unsustainable consumption patterns necessitate immediate intervention to mitigate their adverse impacts on several sectors across the country. Therefore, despite the existing knowledge on the impact of climate change and its impacts on several sectors in UAE, nothing has been done to prevent the adverse effects. The existing literature also shows an emphasis on the impact of the construction industry on climate change. Hence, there are limited efforts in uncovering how climate change affects the construction industry. Consequently, this paper seeks to specifically identify the operational and financial risks from climatic changes in the construction field in UAE.

1.5. Research Purpose

The main aim of this study is to explore the existing relevant secondary sources and empirical data to identify operational and financial risks from climate change in UAE's construction industry. Further, the study aims to find out factors that are most appropriate for mitigating severe effects of climate change on the construction sector in UAE. This aim is obtained through an investigation of the following objectives.

1.6. Research Objectives

i) To find out the impact of climate change on site operations in the construction industry in UAE
ii) To identify the impact of climate change on the efficiency of equipment in the construction industry in UAE
iii) To evaluate the impact of climate change on labor productivity in the construction industry in UAE
iv) To find out the impact of climate change on employees' health in the construction industry in UAE
v) To identify the impact of climate change on the overall financial productivity of the construction industry in UAE
vi) To find out approaches to mitigate the negative impact of climate change on operational and financial risks in the construction industry in UAE

The study questions include;

1.7. Research Questions

i) What is the impact of climate change on site operations in the construction industry in UAE?
ii) What is the impact of climate change on the efficiency of equipment in the construction industry in UAE?
iii) What is the impact of climate change on labor productivity in the construction industry in UAE?
iv) What is the impact of climate change on employees' health in the construction industry in UAE?

v) What is the impact of climate change on the overall financial productivity of the construction industry in UAE?

vi) What are the approaches to mitigate the negative impact of climate change on operational and financial risks in the construction industry in UAE?

1.8. Assumptions of the Study

This study is based on the assumption that the secondary sources used are credible and relevant to the study. The study also assumes that the literature findings will be relevant to the study location, which is the United Arab Emirates. The study also assumes that the findings meet the study objectives.

1.9. Research Scope

This paper is limited to an evaluation of the operational and financial risks resulting from climate change in UAE construction industry. Due to the limited timeframe and ethical issues that may be involved in conducting primary data at various construction companies, the paper used a content analysis methodology based on relevant secondary sources and an analysis from survey to meet the research objectives. The content was acquired from 25 relevant and reliable secondary sources. Even though this method was limited as it did not provide the opportunity for first-hand data, it is preferable as its validity is ensured through the use of relevant and academic sources to arrive at the findings. The quantitative survey which was conducted among labors in construction fields, will add a value to this paper to understand the impact of the climate change in construction. The ANOVA method was used to find a correlation between climate change and various parameters inherent to the construction industry.

CHAPTER 2. LITERATURE REVIEW

2.1. Introduction

Climate change involves atmospheric warming and increased natural variability of the earth's climate. Climatic changes present various risks to human settlements and communities such as a change in water quality and availability, extreme weather changes, the rise in sea level, and the efficiency of infrastructure. Climate change may result from natural causes or human activities through their irresponsible overconsumption of human resources such as energy leading to increased energy and water demands. In turn, these activities affect climate whose impact can be felt in various sectors including the construction industry. Consequently, this section delves deeper into existing literature reviews concerning the operational and financial risks from climate change in the UAE region. Kitchenham (2004) argues that a literature review identifies, synthesizes, and analyzes the relevant available literature on a particular topic or research question. This study used the secondary study to identify, analyze, and synthesize primary data. The aim of the literature review was to uncover the existing knowledge gaps in the current research. The literature review also helped in understanding the current topic and how primary data support method or theory. To ensure the validity of the reviews, academic sources were used from academic sites such as Google Scholar, Google Books, Proquest, and EBSCOhost to find the most relevant sources. Some of the search terms used to find the sources include; "climate change in UAE", the "construction industry in UAE", "operational risks from climate change", and "financial risk from climate change".

2.2. Conceptualization of Climate Change

Climate refers to the general weather conditions of a particular place over an extended period (Dlugolecki, 2009). In other words, climate change is the prevailing trend. Weather variables present high risks when it comes to the management of projects, not only during the construction period, but also throughout the intended lifespan of a proposed work. Therefore, it is important to critically assess potential changes in climate to establish the anticipated change characteristics and establish the most appropriate mechanisms. People contribute directly to climatic changes through their inappropriate lifestyle behaviors including overconsumption of resources. These activities directly impact natural resources such as water, air, and the soil. As a

result, there is need for people to exercise accountability and responsibility to preserve the natural resources and maintain its sustainability through changing their lifestyles.

2.3. Current Debate

The current century has witnessed a burgeoning amount of call for movements geared towards climate change and the prevention of global warming. As a result, climate change has become a global issue that occupies a significant sector in people's daily thoughts at various levels beginning from policy makers to students. Interest in climate change can also be seen in mass media, politics, movies, as well as all over internet. This expansion of interest interprets to the need to implement factors that target positive change. Climate is controlled by the way through which humans receive energy form the sun and lose it back again into space. The earth's atmosphere receives solar radiations and absorbs them partly or reflects it back into the atmosphere. The climatic system has the ability to regulate itself. However, climatic imbalances observed through conditions such as extreme high temperatures result to global warming, which links to anthropogenic causes.

Concerns regarding to whether increased emissions of carbon dioxide are the primary causes of greenhouse gases is ongoing. The debate specifically concerns whether global warming is a result of human interference or a result of natural ecological system changes. The debate also extends to concerns whether the increased levels of carbon dioxide leads to climate change or not. Research reveals that atmospheric concentrations of CO_2 have increased to 375 ppm from 275 ppm. This trend is projected to continue into the future due to the rapid development, economic growth, and urbanizations across the globe. The consequences of global warming include: increased seal level, spring runoffs, and increased severity to storms, and increased diseases, landslides, heat waves, famine, and wildfires.

2.4. UAE and Global Warming

The 1958 and 1966 oil discoveries in the Abu Dhabi region and Dubai consecutively, dramatically transformed the economy making the state to shift from subsistence to modern economy. UAEs expansion followed the example of developed nations that relied on technology, electricity, and fossil fuel for economic growth. The rapid economic expenditure and significant population growth and architectural projects and low costs of energy have boosted the country's energy consumption. As a result, UAE is currently among the top global energy consumers per

capita. UAE's energy is generally consumed in five sectors that include commercial, residential, agricultural, and industrial sectors. All these sectors account for electric energy consumption in UAE's economy.

In the recent years, the coastal regions are home to a growing population leading to environmental declines in the region especially in developing countries such as UAE (Liz, 2003). Today, many people live within 200 kilometers of the coastal regions. Even though the high populations in the coastal regions leads to many economic benefits like urban development, improved transportation, and even revenue from tourism, the combined effects resulting from this economic and technological development and the booming population growth are threatening to the ecosystems of the coastal regions. Often, these factors lead to devastating impacts on these regions' climatic conditions. Changes in the composition, size, and distribution of human populations at the coastal regions change the region's land use and cover (Liz, 2003). Harvesting or fishing, destroying mangroves, sedimentation, and pollution as a result of human activities can significantly affect the coastal environment. High population density places additional demands on the coasts leading to high risks of the marine ecosystems. Thus, these population pressures contribute to air pollution leading to climate change. This project seeks to delve deeper into the negative impacts of climate change on the construction industry in UAE. The project also focuses on identifying the most appropriate factors that can improve environmental performance in UAE leading to reduced negative climatic impacts in the country.

The United Arab Emirates covers about 1,300 kilometers, over 90 percent of infrastructure and 85 percent of population in the region is situated within a few meters from the coast in low-lying areas (Dougherty, 2009). Currently, the United Arab Emirates is essentially different than it was three to four decades ago. The country's rapid economic diversification, Gross Domestic Product growth, and coastal tourism are accompanied by new challenges for the current century. Coastal regions are densely populated of commerce, manufacturing, and industry (Dougherty, 2009). Further, the UAE coast is also home to various ecological subsystems, artifacts, and various important cultural heritage activities.

The United Arab Emirates straddles the Abu Dhabi emirate and the Tropic of Cancer. Thus, the region is influenced by the direct sun that as topographical location allows. The country's climate is arid and dry, and at the Arabian coast, the levels of humidity can go up to over 90 percent in autumn and summer seasons. Even though the inland experiences less

humidity, temperatures are equally high beyond 50^{o}C in July midday (Dougherty, 2009). The Gulf region is also very shallow and sloppy. The littoral zone of the region is typified by active coastal salt flats or sabkhas, which are recognized internationally as the most extensive and geomorphologically amazing in the globe.

The Arabian coast experiences various threats from the above-identified processes. The coastal regions are also affected by dredging, reclamation, and other activities such as oil drilling. Population growth, the expansion of tourism and coastal development, and well as urban sprawl have resulted to extensive dredged, reclaimed, reduced wildlife, land-filled areas, and habitat loss or coral reefs, mangroves, and sea grass among others. In addition, the coastal regions have also experienced remediation techniques and oil spills (Dougherty, 2009). Approximately 31 percent of global oil navigates through the Strait of Hormuz each day affecting marine life due to thermal discharges leading to oil pollution (Dougherty, 2009). As a result of these impacts, the United Arab Emirates has put mechanisms for Marine Environmental conservation that entail approaches for conserving biodiversity, protection of the quality of marine water, protection of endangered habitats and species, improving waste management, preventing oil spills, and ensuring sustainable fisheries. Efforts have also been put towards creating environmental awareness in schools and communities at large.

2.5. Construction Industry and Climate Change

Construction involves three main categories including mechanical process, and electrical engineering, building, and civil engineering. Mechanical, process, and electrical engineering aims at providing more efficiency and the mitigation of greenhouse gas emissions (Dlugolecki et al., 2009). Building reflects the need for efficient resources such as zero waste, zero energy, and resiliency to climate change. Civil engineering involves sub-surface works and infrastructure surface aimed at offsetting climatic change effects such as drainage and sea defenses. A majority of construction projects will incorporate varying degrees of these construction categories (Dlugolecki et al., 2009). This study focuses on the operational and financial impacts of climate change on the construction industry. Therefore, it will focus on two critical aspects: emissions control and impact management. Climate change impacts the severity or frequency of natural events, which may include hydrology, geology or meteorology, atmospheric (Dlugolecki et al., 2009).

Geological impacts may include tsunamis, volcanism, earthquakes, and lahars. Water or ground-influenced events can be modified by climatic changes. Atmospheric climatic impacts include factors such as rain, wind, ice, storm, snow, or hail among other factors. Exposure to wind and precipitation can also result to impacts on climatic impacts. Construction projects are exposed to various risks such as exposure too estuary or coastal storms, open sea storms, and surge. Other vulnerabilities include cofferdams that consist of dry working conditions and flash floods. Other areas are vulnerable to seismic earthquake disturbances. Unfortunately, regions of vulnerability are not static but keep on changing from time to time. Therefore, the most important aspect to consider is area geology and tectonic chock effect movements. Thus, structures based on estuarial silt or made up of ground infill are vulnerable to liquefaction. Climate changes can also alter the conditions of groundmass resulting to impacts on tectonic shock.

The construction sector provides significant contributions to development making it a significant factor in the economic status of a country. As stated above, the construction sector comprises of various business activities ranging from civil engineering to construction, and building design. Climate change impacts the physical location and planning process of infrastructure, and even more the construction activities in progress. Short term climatic impacts may include factors such as flooding and high winds, while long term impacts may include aspects such as coastal erosion, rise of sea level, and drought. Climate change affects the choice of site where construction activities can take place; they can lead to the destruction or damage of infrastructure and buildings, precipitation changes, temperature increases, and relative humidity. These climatic factors can affect the health and safety and the financial aspects of construction projects. This paper aims at identifying these impacts reflected on construction site operations, the health and safety, labor productivity, equipment, and financial productivity.

2.6. Impact on Site Operations

Brodoli (2010) investigates weather claims in the construction industry in the United Kingdom with the aim of detailing the elements that may be required in making successful claims. He identifies some of the major climatic effects that affect construction activities as inclusive of rainfall, low temperatures, wind speed, precipitation, high temperatures, and snow cover. He goes ahead to explain how each of these factors affects the site operations in a construction project. He argues that in the case of low temperatures, the workforce lacks morale

due to the encumbrance of many clothes to keep them warm. Low temperatures affect the curing process of materials that depend on evaporation or hydration due to water content resulting in lower strengths. Such materials come with specifications for operations at minimum temperatures, which may lead to delays due to the time that may be required for the weather to warm up. Low temperatures result in the freezing up of the ground making it hard to excavate them; hence, reducing productivity. It is also not possible to combat frozen materials. Further, lower temperatures may lead to the formation of ice, which may make surfaces such as roofs slippery. Thus, such surfaces become dangerous to walk on resulting in delayed activities.

The second climatic factor affecting construction operations is rainfall. Brodoli (2010) argues that the impact of rainfall can be measured based on the number of days that it falls and the amount. Rainfall delays construction operations due to disruptions. Also, rain also reduces the morale of workers due to the need to wear excess clothing to protect them from rain and cold. Most building materials are also vulnerable to water such as mortar paint, concrete, glue, and even resins (Brodoli 2010). In the case of concrete, its strength and usefulness can be affected by water. For the case of glues, rain can affect their ability to adhere to surfaces. Rain affects earthworks. For instance, rain makes excavations more difficult by reducing the subsoil's strength. Moving construction vehicles on unprotected substrates damage the surface making locations inaccessible and may require extra work to retain the required levels. As a result, road earthworks may require rescheduling till the end of the wet season. When the rain is cumulative for a short period, it may have detrimental effects as compared to the same amount of rain for a prolonged period. This is the case because roofs are susceptible to leaking and deep excavations are also vulnerable to floods.

The third climatic factor that can affect construction activities at the outdoors is wind speed. Wind effects can be measured in gust wind speed or mean velocity. Wind effects are most felt when a construction project used tower cranes. The Wind can have a devastating impact on crane structure during out of service or in service conditions (Brodoli 2010). A tower crane's manual specifies the maximum amount and speed of the wind at which it can operate efficiently at the outdoor. The fourth factor is snow cover. Snow leads to low temperatures making it difficult to operate efficiently. Snow also increases the likelihood of tips and makes it difficult to haul materials for construction operations. Hence, for efficient operations, the construction team should clear the ice leading to activity delays. The last climatic factor affecting construction

operations is high temperatures (Brodoli 2010). When temperatures are very high, subsoil may become too hard to work with. Too hot temperatures can also restrict the efficiency of workers at construction sites due to sweating, which may make them tired more easily hence lowering their morale to work.

In another study, Crissinger (2005) evaluates the impact of weather on the design and construction of buildings. He begins by attesting that climatic conditions affect the construction, design, and performance of buildings. He states that weather involves a reaction to atmospheric pressure changes, which have an impact on temperature, movement, and humidity. He also agrees that climatic changes can have impacts on construction projects ranging from worker comfort to the choice of a construction site. He states that hot weather conditions can have impacts of a project's site selection, concrete, brick, masonry mortar, equipment, seals and sealants, thermal movement, and on workers. This objective particularly focuses on the impact of climate change of site operations. Thus, according to Crissinger (2005) dry weather leads to dust. Dust can stick to the interior surfaces of buildings necessitating removal leading to delays. The Health and Safety Executive (n.d.) also states that dust exposure among construction workers can also cause respiratory illnesses such as occupational asthma, pulmonary diseases, and silicosis among other health problems.

In another article, Munawar (2017) agrees, based on recent findings from the Emirates Wildlife Society and World Wildlife Funds (EWS-WWF), that climate change will have direct consequences in real estate and construction markets in the United Arab Emirates. He continues to note that UAE has the most advanced infrastructures in the Gulf Corporation Council region with iconic structures and a well-integrated transport system. These findings are according to reports by Industry Outlook of UAE'S construction sector to 2020 (Munawar 2017). Further, the country also improved from position 17 to 16 globally as a top notch infrastructure country that offers attractive destinations for investments in 2017. However, EWS-WWF reports indicate increasing physical risks resulting from extreme weather conditions and rising sea level that put the construction and real estate sector at risk.

Climate change experts predict increases in global temperatures by 2C, which will increase the sea levels up to 50 cm as compared to the current 1.5C at 40 cm. Currently, UAE's coastal region hosts about 85 percent of UAE's total population in its resorts, hotels, and other construction development areas (Munawar 2017). These places are prone to floods, increases in

the sea levels and sea storms. Hence, climate change is affecting the growth of the construction market especially at vulnerable sites such as the coastal regions. As a result, construction values have already shown declines in certain areas such as the Bahamas, which is the world's most attractive holiday location.

Climate change does not only affect direct investments and construction market growth; however, it also has negative impacts on construction site operations leading to longer time used in completing the building, which potentially leads to cost overruns. Munawar (2017) further notes that more humid and hotter weather conditions are likely to reduce the work productivity of construction workers. Heavy precipitations are also likely to necessitate slope stabilization, flood protection, and other protective measures, which have an impact on project completion time. He points out that tall buildings in the region are already a concern as they generate huge electricity and water bills due to overheating in summer weather conditions. Hence, they become significant contributors to greenhouse gas emissions exacerbating climatic conditions. Consequently, it is important to note that climate change does not only impacts site operations through disrupting the normal construction activities but also has led to decreased construction markets especially in the highly vulnerable areas such as coastal regions. These impacts have an ultimate impact on the industry and country's financial status. These literature findings are a clear attestation of the various ways through which climate change affects site operations in the construction industry.

2.7. Impact on the Efficiency of Equipment

As shown above, Crissinger (2005) tackles the impact of construction equipment to dusty conditions. Specifically, he states that machinery and filters on construction vehicles are vulnerable to damage when exposed to dusty conditions leading to premature breakdowns. He continues to state that machinery parts can store dust causing accelerated wear and tear. As a result, it is important to clean the equipment on a regular basis to increase their efficiency. In another study, Chamberland (2014) investigates the impacts of climatic conditions on construction equipment. He discusses the causes and effects of cold weather, hot and dry weather, and wind and storm on construction equipment. For cold weather, Chamberland (2014) argues that grout and mortar can be affected because they require heat for cement hydration. Hence, a decrease in temperature causes the cement hydration process to stop or slow down. In the end, low temperatures reduce the bond strength of masonry. For that reason, frozen masonry

will need to be melted and dried for their efficiency operation. Cold weather freezes mortar mills resulting in reduced compressive strength. Additionally, frozen mortar mills have the potential to reduce masonry resistance and bond strength. A mortar with 6% eater content can cause an increase in volume due to melted ice, thus, reducing bond strength.

The second climatic factor that affects the efficiency of equipment in the construction industry according to Chamberland (2014) is the dry and hot weather. The major issue in this weather is fast absorption and evaporation of water content from motor. Dry motor can have devastating impacts on building materials. High temperatures may lead to the premature settling of mortar without enough water content; hence, brick cannot hold onto it. As a result, the overall bond strength between the mortar and brick will be decreased leading to possible water leakages in the building structure. Dry weather can also cause dry dust, which can lead to machinery complications, as well as risk to the safety and health of construction workers. Construction machinery and equipment usually have filters. Therefore, these filters need proper fixing on a regular basis for efficiency. Dust and dirt particles can clog machinery and equipment parts leading to breakdowns (Chamberland 2014). Consequently, dust may cause time delays due to the need to clean and lubricate all the machinery and equipment on a regular basis. Additional, the elasticity of seals and sealants can reduce due to high temperature, hot and dry weather conditions hence damaging the hardware. The replacement of this equipment is also costly.

The last climatic effect on equipment functionality is wind and storm. It is vital to ensure good judgment when working in windy construction atmospheres because there are some construction equipment that cannot work at maximum wind speeds. Notably, the speed of speech is affected by height. As stated above, some of the equipment vulnerable to wind effects includes crane booms, which are likely to fall at high wind speeds. Lifting and hoisting operations during windy conditions can also result to the rotating and swinging of equipment, which can pose a danger to workers and also increases the likelihood of the crane crashing. Therefore, Chamberland (2014) suggests that it is important to assess the shape and size of a load to determine if it can be dangerous to lift it in windy conditions.

In their book, Tolba and Saab's (2009) analyze the impact of climate change on infrastructure. In this topic, they claim that increased temperatures can soften asphalt leading to the degradation of construction industry infrastructures such as roads. In turn, the degradation of roads increases the likelihood of traffic accidents. The authors continue to argue that hot weather

decreases the efficiency of construction equipment and activities; hence increasing heat-related illnesses among construction workers and even commuters. The table below summarizes some of the climatic impacts on the construction industry equipment, specifically the transport infrastructure.

Climatic changes	Impact on structural elements of infrastructure	Impact on operation of the infrastructure
Increases in frequency and intensity of very hot days and heat waves.	• Excessive expansion in bridge joints and pavement surfaces • Decreased viscosity of asphalt which may lead to traffic-related rutting and displacement of pavement. • Deformities in metal components including rail-tracks, bridge steel elements, etc	• Limitation on the maximum load capacity of trucks and airplanes due to weakening of pavement. • Harsh climatic conditions will reduce the effectiveness and increase the cost of construction and maintenance.
Increase in sea water level / sea surges.	• Inundation of coastal transportation elements including roads, bridges, airports, etc. • Erosion and deterioration of pavement, bridge support and its base. • Costly adjustment in harbour and port facilities to accommodate tidal increases and more intense sea surges.	• Frequent closure of coastal roads due to sea surges. • Storm surges may disrupt operations and pose hazards to passengers of coastal airports (e.g., Beirut and Manama Airports).
Increase in the frequency and intensity of sandstorms, thunderstorms, and windy conditions.	• Increased damages to road, rails and bridges. • Increased risk of mudslide and rockslide in mountainous regions, such as in Lebanon.	• Intense sandstorms in desert areas across the Arab world would cause disruption of road traffic and increase frequency of closures and accidents. • Disruption of the operation of airports.

Table 1: Impact of extreme weather conditions on transportation infrastructure (Tolba and Saab 2009)

2.8. Impact on Labor Productivity

Palmer and Creagh (2013) examine the influence of climate change on labor efficiency. They identify humidity as one of the factors likely to reduce the capacity of workers, especially during peak months. They project that humidity levels are expected to grow to 20 percent by 2050. They continue to note that nothing has been done to establish the impact of humidity changes on labor productivity. Dunne, Stouffer, & John (2013) investigate reduced labor capacities due to heat resulting from climate warming. They argue that increased temperatures pose severe limitations to workers' activity especially in mid-latitude and tropical regions. UAE experienced increased temperatures during summer, April to October each year. They identify

wet-bulb as one heat-stress metric that has health implications. In their study, Dunne, Stouffer, & John (2013) combine wet-bulb temperatures and the earth system model predictions with military and industrial guidelines. They estimate that increased temperature stress reduces labor capacities among construction site workers to about 90 percent.

Ailabouni (2010) conducts an investigation on the factors affecting the employees' productivity levels in UAE's construction sector. In his journal Ailabouni (2010) identifies harsh weather conditions as one of the effects impacting worker productivity in the construction sector. He writes that UAE has extreme and harsh summer climatic conditions that can go up to 49 degrees Celsius while extremely cold weather characterizes winters. During such peak hours, workers are not allowed to work outdoors. High humidity levels also lead to effects such as fatigue, sweating, and loss of working morale among construction workers. In a more recent study, Gidado and Ailabouni (2012) evaluate the factors affecting the productivity of workers in UAE's construction industry. They also mention harsh weather conditions as one of the impacts of worker productivity and go ahead to explain that extreme harsh weather conditions reduce the workers' morale leading to delayed completion of activities.

Crissinger (2005) investigates the impact of climate change on workers. He explains during hot weather, the physical activity involved in the construction process can cause a significant loss of body fluid. Loss of body fluid leads to the worn out of body energy causing disorientation, drowsiness, fatigue, dizziness, and dehydration. These outcomes can result in sickness, loss-time accident resulting in decreased productivity. He continues to argue that even in cold weather; workers will require extra bulky and heavy clothing to keep them warm (Crissinger 2005). Such heavy clothing can increase accident due to restrictions on movement on construction sites. Further, when workers have cold weather protective clothing, their joints and muscles are not as flexible as of when they have normal clothing resulting in low work activities.

Further, Yildirim, Koyuncu, and Koyuncu (2009) conduct a study to find out whether temperature changes have an impact on labor productivity. They use cross-section data from 111 countries between 1997 and 2006. Their study findings indicate a negative relationship between labor productivity and temperature changes. Yildirim, Koyuncu, and Koyuncu's (2009) results differ from those of Dunne, Stouffer, & John (2013) and Palmer and Creagh (2013) due to the fact that they do not target a particular industry yet Dunne, Stouffer, & John (2013) and Palmer and Creagh (2013) concentrated on the field construction sector. This study also emphasizes on

the impact of climate changes on the construction sector. Furthermore, the strenuous activities involved in construction work drain employees' body fluids when working in the hot conditions. The extreme weather affects the productivity of workers and may lead to death when the temperature reaches extreme levels (Alshebani and Wedawatta 2014).

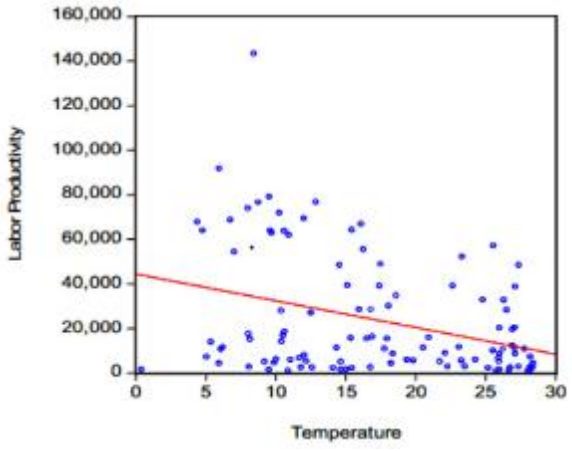


Figure 1. The Impact of Temperature on Labour Productivity

Source: (Alshebani and Wedawatta 2014).

On the other hand, Yildirim, Koyuncu, and Koyuncu's (2009) study findings also indicate a significant relationship between climate change and a country's per capita income. These findings are also relevant to this study as they support this study's fifth objective that evaluates the impact of climate change of financial risk of the UAE construction industry.

2.9. Impact on Employees' Health

Climatic changes have affected the health and safety of workers due to the loss of body fluids as noted by Crissinger (2005). Hazardous hot and cold temperatures also have negative impacts on the health of workers. For instance, Chan et al. (2011) affirm deaths resulting from heat stress. Extreme weather conditions constitute one of the major factors that can be stressful to the workers' conditions. Consequently, it is vital to assess the welfare of construction workers during extreme weather conditions to prevent adverse impacts on their well-being.

In their article, Xiang et al. (2014) agree that exposure to extreme hot or cold weather environments due to climate change poses health and safety challenges among construction workers. Some of the health issues identified include heat stress and heat illnesses. Other impacts include respiratory diseases, physiological and psychological effects. Kerr, Ryburn, Mclaren, and

Dentons's (2013) article is also relevant in this section as it focuses on the health and safety of construction workers on UAE. They present the health and safety policies that are relevant to construction projects and argue that the labour law contains the major legislative provisions of the health and safety of workers in the construction industry in the country. Therefore, their findings are significant as they highlight that the health and safety of workers is a nation-wide aspect that should be taken into consideration.

Kerr, Ryburn, Mclaren, and Dentons (2013) investigate the state of construction projects in the UAE. In their article, they evaluate the health and safety policies that are relevant to construction projects. They state that the health and safety law in the UAE does not exist at the federal level. They further state that the major legislative provisions of the safety and health of workers in the construction firms can be found in the labour law and it extends to criminal offenses. Therefore, it is a mandate by the law that all companies including the construction sector ensure the health and safety of their workers through the following; providing adequate protective gear to prevent injuries during accidents and to provide detailed instructions that clearly indicate the necessary measures to prevent fires and hazards. Companies should provide first aid kits, drinking water, adequate lighting, and toilet facilities. It is also the role of an organization to provide adequate information that highlights the dangers eminent in various work activities. This analysis is important as it highlights that workers health and safety at all conditions is in compliance with the Labour Laws. Therefore, even in climatic change impacts, it is the role of the construction industry to ensure that each worker works in safe and healthy conditions to avoid dangers or negative impacts to their well-being.

2.10. Impact on the Overall Financial Productivity

The above analyses have clearly identified various operations impacts of climate change on the operational factors of the construction industry. Financial productivity stems from these identified risks that occur in the form of delayed time due to weather changes. For instance, on the impact of climate change on the efficiency of equipment, Crissinger (2005) argues that there is need to clean the equipment on a regular basis to increase their effectiveness. He continues to explain that dust can lead to the wear and damage to equipment. Regular cleaning of the material leads to the wastage of precious time that would be used in the completion of construction projects to avoid cost overruns. The wear and damage of equipment also result in losses as it will necessitate the purchase of other equipment.

In an article on Shareej Times, Shabeeh (2017) writes that climate change is likely to slow down the UAE's efforts towards the achievement of economic growth and overall wellbeing. Specifically, he argues that climate change will increase sea levels leading to the disruption of infrastructure in the transport and real estate businesses. As a result, it will also have impacts on the tourism sector. Impacts on construction operations have an ultimate impact on the industry's financial status as time delays can lead to cost overruns and equipment destruction also necessitates replacements.

Chamberland (2014) also supports Crissinger;s (2005) argument that dust and dirt particles from dry weather conditions can clog equipment and machinery leading to breakdowns. Such breakdowns trip down to the economic sector of the country as more funds will be required from the industry to replace the broken machines and equipment. The above analysis also identifies health and safety issues of the workers including vulnerabilities to illnesses such as occupational asthma, pulmonary diseases, and silicosis. Deaths resulting from such diseases also contribute to the loss of critical human resources, who have a significant impact on the entire economic sector. These outcomes have implications for the health sector as more money will be used in managing or treating these illnesses. Floods, wind, and storms can also destroy construction projects leading to massive financial losses on construction investment.

In a study, Mendelsohn et al. (2007) investigated the impact of climate change on per capita through its effects on productivity in Brazil and USA. Their findings showed that climate change is responsible for significant variations in per capita in the income of both Brazil and USA. Their study further showed a significant relationship between temperature increases and declines in the Gross Domestic Product of these countries (Mendelsohn et al. 2007). Therefore, their findings show that increased temperatures have adverse implications on a country's economic status. Hence, even the construction industry is vulnerable to climatic change impacts. Regarding

productivity, the authors attest that increased temperatures can have significant impacts on labor productivity. They explain this factor by arguing that when temperatures are high, working environments may not be conditioned (Mendelsohn et al. 2007). As a result, the efficiency of employees may be reduced due to a lack of motivation. Hot temperatures may also affect the mood of workers leading to exhaustion and difficulties in breathing. These issues affect workers in a negative way. Hot weather conditions are also hubs for the development of epidemic

illnesses (Mendelsohn et al. 2007). Hence, workers may get epidemic diseases leading to reduced productivity.

On the other hand, high temperatures lead to increasing heat and dusty storms which slow down the rate of working and eventually increased project costs. Further, visibility is lowered when there are dust storms although their frequency varies. Extreme weather conditions decrease the productivity of workers as shown in the table below.

Weather variable	Frequency (Week)	Average Production Reduction (week)
Heat	25.7%	0.86%
Dust Storm	5.1%	0.23%

Table 2. The Impact of Weather Extreme Weather Conditions on Workers' Productivity

Source: (Rashid 2015).

2.11. Mitigation of Climate Change

In his evaluation of the impact of weather conditions on the construction sector, Chamberland (2014) provides approaches that can help in mitigating the impacts. He provides necessary precautions for cold weather, hot and dry weather, and wind and storm weather. In cold weather, he suggests that all construction project managers and workers should follow the recommended building codes for masonry and concrete work. For instance, he suggests that it is important to ensure that grout and mortar get sufficient heat so that they can achieve the average typical cement hydration levels. Further, construction workers should melt and dry frozen masonry units before use. He advocates for the heating up of bricks even at temperatures of -6.7OC. Preheating bricks will make them have similar absorption characteristics as those at standard temperatures. It is the role of worker to ensure that mortar does not freeze and alliterate the proportions of the machine within particular ranges to avert the effect of cold weather. He also advocates for the use of lime content in cold weather to enable the mortar to lose water faster.

In the hot and dry weather, Chamberland (2014) proposes that construction project personnel should not keep Masonry units exposed to direct sunlight because high temperatures

may make the mortar to settle early. In this weather condition, he recommends the sprinkling of water on construction bricks before they are laid down because, in hot weather, bricks absorb water rapidly. Bricks also lose moisture more rapidly in hot weather making them easy to take in water from mortar mixtures leading to significant decrease in bond strength. Additionally, in the wind and storm weather, construction workers should take a keen consideration into the appropriate judgment required in performing construction operations in storms and windy conditions. In this factor, he advises that it is vital to prepare adequately for any risks that may occur. Munawar (2017) also argues that some UAE has established initiatives such as Estidama and Green Building Codes to help in the implementation of appropriate building regulations and codes for water and energy efficiencies to combat climate change. Other initiatives include developments in weather predictions to establish early measures to prevent impacts.

Byravan and Rajan, (2015) explore the possible solutions to the rising sea levels and climate change. In their evaluation they attribute the rising sea levels to the melting of glacier and the expansion of water. They also note that human activity significantly contributes to the subsidence of land resulting in coastal flooding. As a solution, they emphasize that the only remedy for the problematic climate change is the developing new global resettlement regions on higher ground that are far from disaster. Byravan and Rajan, (2015) also argue that it is important to re-evaluate the human activities contributing to climate change and put mechanisms geared towards preventing such mechanisms. Activities such as industrial emissions, population growth, and lifestyle change. An adoption and implementation of these aspects can help in eliminating these impacts, which have far reaching effects on the economic aspects of the construction industry.

Luomi (2014) offers a range of measures and mechanisms to mitigate emissions. He classifies them into both international and domestic mechanisms. The international climate change approaches are relevant to the UAE region and they include relevant mitigation-related incentives and instruments, global emission trajectories, and legal principles. Other international approaches include low-emission development measures and economic diversification. The domestic-level approaches emphasize on the adaptation to measures and other relevant approaches (Luomi 2014). The following section provides a comprehensive evaluation of these approaches.

2.12. International Mechanisms and Frameworks

The United Nations Framework Convention on Climate Change (UNFCCC), which was established in 1992, has played a significant international role in the creation and implementation of actions aimed at mitigating climate change (Luomi 2014). The primary goals of UNFCCC were to stabilize greenhouse gas levels in the atmosphere at safe levels that can mitigate anthropogenic dangers. The Intergovernmental Panel on Climate Change (IPCC) has been the primary scientific contributors UNFCCC's work (Luomi 2014). The IPCC has established a Fifth Assessment Report (AR5), which provides clear definitions of standard greenhouse gas emissions.

IPCC's AR5 from 2007 indicates that countries ought to reduce their greenhouse gas emissions by 25 to 40 percent to stay below 2^{o} C warming as of 2020 (Luomi 2014). In the same way, developing countries including the UAE should deviate from greenhouse emissions trajectories (Luomi 2014). Therefore, developing countries should put mechanisms alongside implementable actions to mitigate climate change through technology transfer, finance, and capacity building. UAE is a member of the UNFCCC and its Kyoto Protocol, which is a legally binding instrument for compliance to climate change strategies. The binding instrument, established in 1997 provides emission reduction commitments to the GCC countries including UAE. Which have an obligation to reduce a total of 18 percent emissions by 2020 accounting for about 15 percent of worldwide emissions (Luomi 2014).

UNFCC established that the attainment of the above set goals depends on the availability of technology transfer and financial resources from developed countries. Therefore, it is crucial that developed countries provide support for the implementation of the required measures for the attainment of these objectives. Thus, as a relevant strategy, developed countries have pledged to raise about US $100bilion each year targeted at mitigating climate change (Luomi 2014). The pledge is set to begin from 2020. The convention further mentions that countries dependent on fossil fuels such as the United Arab Emirates should be considered as a group of countries with specific concerns and needs that negative impact climate (Change, Intergovernmental Panel on Climate 2014). Thus, these countries require insurance, funding, economic diversification, and technology among other approaches.

UNFCC convention institutes that all members states should report to the Conference of the Parties information regarding the steps it has taken or plans to take to mitigate greenhouse

gas emissions. Another international approach is the establishment of the Clean Development Mechanism (CDM) (Change, Intergovernmental Panel on Climate 2014). CDM is a development of the Kyoto Protocol whose aims include the provision of important incentives for reducing greenhouse gas emission in developing countries (Luomi 2014). The other approach is adaptation and implementation of response measures. Adaptation and mitigation are important aspects in UNFCC leading to the establishment of various multilateral institutions and processes such as the Adaptation Fund and the Adaptation Committee. These approaches are aimed at supporting developing countries through approaches such as networking and information support and capacity building (Luomi 2014). A significant UNFCC tool used in planning adaptation and action especially in the UAE include the National Adaptation Plans that are financial and technically supported by developed countries.

Low emission development strategies have also been suggested at the international platform. These approaches emerged from the need for mitigation actions and information guide given the paucity of mitigation strategies in developed nations. Thus, it is an obligation of developed countries to come up with cow-carbon plans or strategies for sustainable development. As a result, the UNFCCC Committee of Parties encouraged developing states to seek technical and financial support from developed countries.

2.13. Domestic Mitigation Strategies

Domestic greenhouse emissions incorporate policy measures and technology solutions aimed at achieving a low carbon economy for the stabilization of climate. These measures include the economic, information, and regulatory instruments, as well as, other actions such as technological and development and voluntary agreement. Economic mitigation tools and instruments include policies aimed at curbing the escalation of emissions (Intergovernmental Panel on Climate Change 2014). Energy supply industries involves in the transformation, extraction, and transportation of energy such as oil production and refining and electric generation. The IPCC report indicates policy related objectives in fuel switching, carbon capture, renewable energy, and carbon storage (Luomi 2014). Economic regulatory instruments in energy supply include fiscal incentives, lower subsidies, capital grants, tradable emission permits, feed-in-tariffs, and capital grants. Regulatory instruments include renewable energy targets, minimum efficiency standards, emission restrictions, and power plant fuel portfolio strategies.

Buildings are also significant contributors to greenhouse gas emissions due to their energy use in household appliances, water heating, heating and cooling, refrigeration and lighting among others. Construction projects contribute to even more significant greenhouse gas emissions. Barriers such consumerism, lack of information, perceived financial disincentives, and fragmentations of the construction sector are blockades to change (Intergovernmental Panel on Climate Change 2014). Consequently, residents should implement measures such as technological mitigation strategies including energy-efficiency in heating and cooling systems, air-conditioners, lighting, motors, and appliances. Other approaches involve insulating buildings, use of natural day lighting, and use of solar energy for heating and cooling (Luomi 2014). Other effective approaches to mitigating emissions include establishment and implementation of building codes, eco-labeling, investment subsidies, and demand-side management programs.

In the construction and manufacturing sector, industries such as chemicals, iron and steel, pulp and paper, petroleum refining, and cement contribute to about 45 percent of energy consumption in the industry. Energy-intensive industries are generally recognized as the most potential sectors for energy efficiency leading to reduced emissions, recycling of materials, space cooling, process controls, efficiency in lighting, and product design (Intergovernmental Panel on Climate Change 2014). Hence, regulation is the most appropriate approach for behavior change regarding greenhouse gas emissions in the industry. Putting in place standards for equipment efficiency can also enhance reductions. The 2007 IPCC report emphasizes on mitigation technologies such as material and energy efficiency, power recovery, fuel switching, feedstock change, deployment of renewables, and CO_2 sequestration.

Another domestic sector contributing to greenhouse gas emissions is the transportation sector. IPCC improvements in this sector include approaches for curbing global sectorial emissions from transportation industries. There is also hope in advanced technologies such as the use of alternative fuels and electric vehicles, biofuels, compressed natural gas, and electricity. Further developments include the expansion of public transport infrastructure and plans for land-use especially in dense settlements (Luomi 2014). In this approach literature also identified the reduction of overall travelling by supporting cycling and walking.

The last domestic climate change mitigation is prevention of fugitive emissions. Fugitive emissions are evidently dominant in the UAE and they range from methane, nitrous oxide, and carbon dioxide, which result from equipment leaks, evaporation losses, process flaring and

venting, as well as, accidental discharges. In the UAE, fugitive emissions are emitted from the oil and gas sector through various processes such as exploration, processing, production, storage, transmission, distribution, and refining. Reduction in flaring can lead to significant economic benefits. For example, in since 2007, the Kuwait Oil Company has reported gains of about US$2.75bn as a result of flaring cuts. Particularly, literature in fugitive emissions emphasizes in methane, which in abundance is a significant contributor to global warming and anthropogenic climate forging (Luomi 2014). The global private and public methane initiative has put strategies geared towards reducing methane emissions in the oil and gas sectors. Benefits from such efforts reflect on improved air quality, economic growth, and worker safety. Measures to mitigate methane emissions include technical fixes operational improvements and the use of retrofitted equipment.

Besides the above identified sectors, other sectors such as forestry and agriculture are also major contributors to global greenhouse gas emissions, which in turn cause climate change. Saudi Arabia contributes the greatest amount of absolute emissions. Mitigation measures in agriculture may include improving crop and managing grazing land, and also soil restoration. Waste emissions can be mitigated by factors such as the establishment of policies that encourage reuse and recycling, water minimization, and energy recovery (Luomi 2014). Thus, these policies can include prevention of water, composting, recycling, and capturing methane from wastewater and landfills, and waste-to-energy incineration (Intergovernmental Panel on Climate Change 2014). Finally, behavior change is also vital as its impact runs across several sectors including buildings, waste management, and transportation. Cultural and social norms, as well as, knowledge are the primary barriers to behavior change. These barriers can be overcome through regulatory instruments, voluntary agreements, and communication. In conclusion, the above factors significantly identify various approaches that can be used in preventing climate pollution, hence mitigate climate change. Thus the activities are important in mitigating the negative impacts of climate change in construction activities.

2.14. Study Gap

The above literature analyses have shown varying findings regarding the impact of climate change on the operational and financial risks in the UAE. However, no study had a particular emphasis on UAE. As shown above, a majority of the studies such as those of Mendelsohn et al. (2007) and Brodoli (2010) focus on other countries such as Brazil, USA, and the UK. Only one review focused on UAE's general view of law on the health and safety (Kerr, Ryburn, Mclaren, and Dentons 2013). Hence, this study is significance as it will help in filling the knowledge gap on the impact of climate change on the operational and financial risks in the United Arab Emirates region.

2.15. Chapter Summary

The aim of this section was to identify various literatures on the impact of climate change on the operational and financial risks of the construction industry. The analysis identifies various factors according to the study objectives. For instance, the evaluation of the impact of climate change on site operations in the construction industry reveals that high temperatures can reduce the worker's morale, which affects the project's completion. Rainfall can cause construction delays; it may damage some building materials such as mortar paint, concrete, glue, and resins.

The second objective entails an evaluation of the impact of climate change on the efficiency of equipment in the construction industry. In this objective Crissinger (2005) states that machinery and filters on construction vehicles are likely to be damaged by dusty conditions leading to premature breakdowns. The third objective entails the impact of climate change on labour productivity. In this objective, the reviews reveal that climate change including humidity, high and low temperatures, and even rain can reduce the capacity of workers. The fourth objective entailed an evaluation of climate change on the health and safety of procedures in the construction industry. The literature review for this objective shows that hazardous hot and cold temperatures can have negative impacts on the health of workers.

The fifth goal involved an evaluation of the impact of climate change on economic productivity. The review reveals that economic productivity stems from the above-identified risks that occur in the form of delayed time due to weather changes. These factors have negative implications on the industry's financial state. The last objective entailed an evaluation of the most appropriate approaches to mitigate adverse impacts of climate change on the construction

sector. The section reveals that it is important for all construction project managers and workers to comply with the recommended building codes for masonry and concrete work. Likewise it is important that UAE complies with the international regulations on climate change such as annual reporting to the international climate change corporation on its plans and achievements regarding climate change. Cooperating with developed countries can enable UAE to obtain financial, technical, and technological support, which are important aspects in climate change mitigation. Domestically, UAE can implement strategies and policies aimed at mitigating greenhouse gas emissions such as the use of renewable energy, reducing emissions, recycling of materials, space cooling, process controls, efficiency in lighting, and product design. Behavior change has also been identified as a significant aspect that would mitigate greenhouse emissions. Practices such as communication and provision of education can prevent barriers to behavior change and in turn lead to behavior changes regarding air pollution. Even though these reviews show the various impacts of climate change on the construction industry, there is a knowledge gap on the effects in the United Arab Emirates region and specifically in the construction industry. Hence, this study is important since it fills the knowledge gap in this area.

CHAPTER 3. RESEARCH METHODOLOGY

3.1. Introduction

It is critically important in a thesis to clearly describe and justify a research design. Considering the research purpose of this dissertation, it seems logical to choose the research philosophy of realism and an inductive research method. Other three research philosophies were barely applicable to the study. Positivism implies the use of highly structured data and large samples, pragmatism is usually employed within the framework of mixed research methods to explore various points of view, and interpretivism solely relies on human factors in investigating research phenomena. Specialists agree that realism is the most suitable research philosophy when data provided by respondents is used in order to analyze research phenomena in detail with the help of statistical tools (Lewis, Thornhill and Saunders 2009). The choice of an inductive research approach was predetermined by an intention to use empirical data as the ground for analyzing the influence of climate change on the UAE's construction industry.

This chapter provides an evaluation of the methods used in gathering primary data. Precisely, it establishes the research design, the sampling techniques, and data collection procedures. It also justifies the applicability of ANOVA in data analysis and explains which variables will be used.

3.2. Research Method

The research design of this study does not differ significantly from other similar investigations. On the basis of the model proposed by Wallace et al. (2004), it uses a quantitative methodology in order to create a new model of risks associated with climate change for the UAE's construction industry. A choice between quantitative, qualitative and mixed methodologies is traditionally regarded by specialists as one of the crucial aspects of empirical studies (Williams 2007). The scholar argues that qualitative methods are mostly used in business sciences to follow the explanatory research purpose when a research phenomenon is characterized by a high level of uncertainty. In most cases, qualitative methodology is effective when there is no clear research hypothesis. In contrast, when the study has a descriptive research purpose like this one, the choice of a quantitative methodology seems justified. The effectiveness of quantitative research methods lies in the area of checking hypotheses, especially those

hypotheses which require measuring variables and relationships between them. In this particular dissertation, the research objectives laid out in the introduction clearly require measuring the influence of climate change on several parameters related to the UAE's construction industry. In this situation, quantitative methodology seems to be a rational choice.

The research method of a survey was chosen to provide quantitative data that can be further analyzed in light of the research objectives. With the help of the Likert's (1934) five-point scale, it was planned to measure all the variables including the significance of climate change in the United Arab Emirates, the efficiency of equipment, labour productivity, effectiveness of site operations, effectiveness of health and safety procedures, and the overall financial productivity of the UAE's construction industry. With the help of on-way ANOVA, we will measure a correlation between the climate change in the country and the five dependent variables.

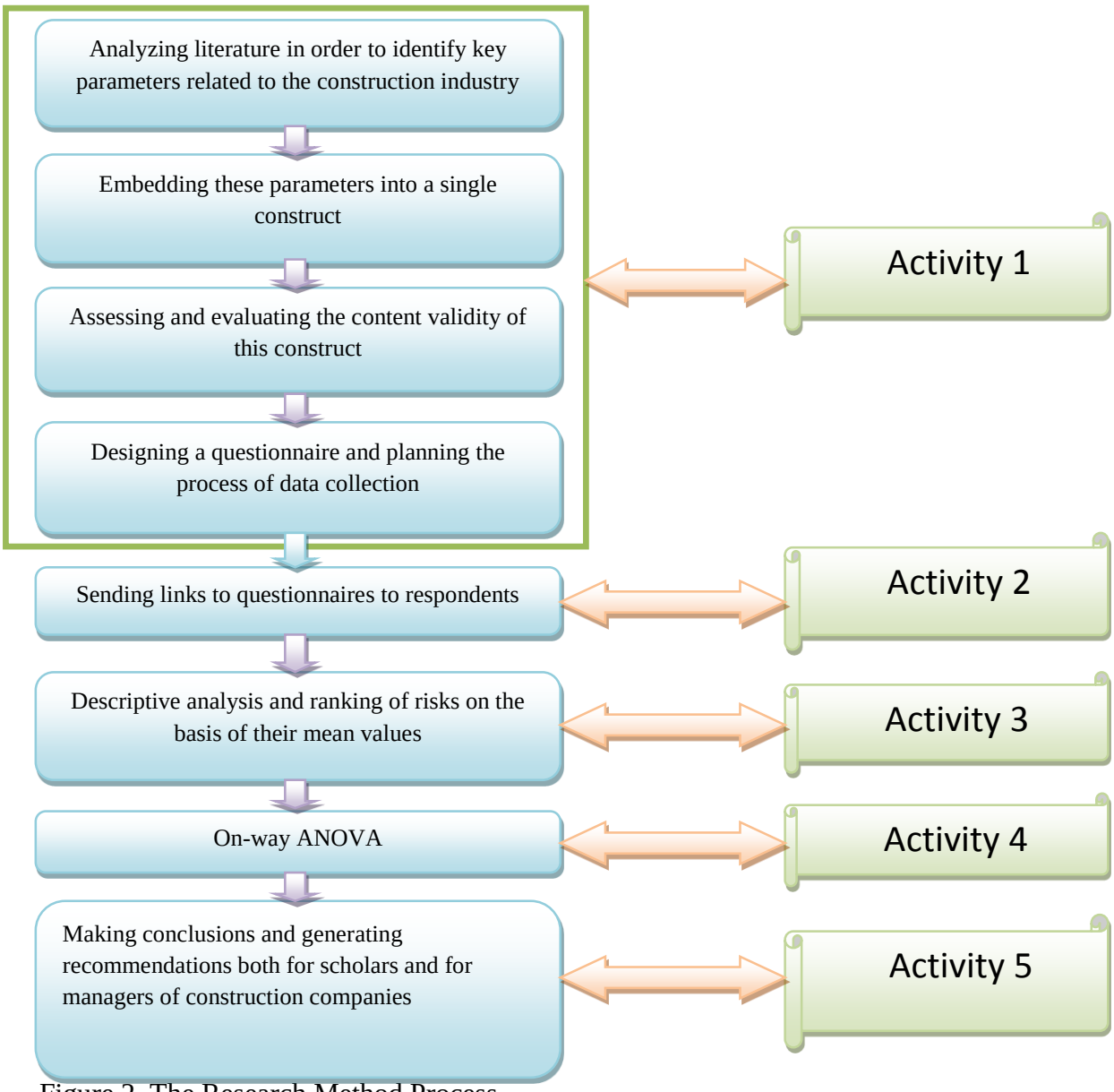


Figure 2. The Research Method Process

On the basis of p-values, the following hypotheses can be formulated:

1. *Effectiveness of site operations:*

H_{A0}: ($p > 0.05$) – survey's results indicate no significant correlation between the climate change in the United Arab Emirates and site operations;

H_{A1}: ($p < 0.05$) – survey's results indicate a significant correlation between the climate change in the United Arab Emirates and site operations.

2. *Efficiency of equipment:*

H_{B0}: ($p > 0.05$) – survey's results indicate no significant correlation between the climate change in the United Arab Emirates and the efficiency of equipment;

H_{B1}: ($p < 0.05$) – survey's results indicate a significant correlation between the climate change in the United Arab Emirates and the efficiency of equipment.

3. Labour productivity:

H_{C0}: ($p > 0.05$) – survey's results indicate no significant correlation between the climate change in the United Arab Emirates and the productivity of labour;

H_{C1}: ($p < 0.05$) – survey's results indicate a significant correlation between the climate change in the United Arab Emirates and the productivity of labour.

4. Effectiveness of health and safety procedures:

H_{D0}: ($p > 0.05$) – survey's results indicate no significant correlation between the climate change in the United Arab Emirates and employees' health in the construction industry;

H_{D1}: ($p < 0.05$) – survey's results indicate a significant correlation between the climate change in the United Arab Emirates and employees' health in the construction industry.

5. Overall financial productivity of the construction industry:

H_{E0}: ($p > 0.05$) – survey's results indicate no significant correlation between the climate change in the United Arab Emirates and the overall financial productivity of its construction industry;

H_{E1}: ($p < 0.05$) – survey's results indicate a significant correlation between the climate change in the United Arab Emirates and the overall financial productivity of its construction industry.

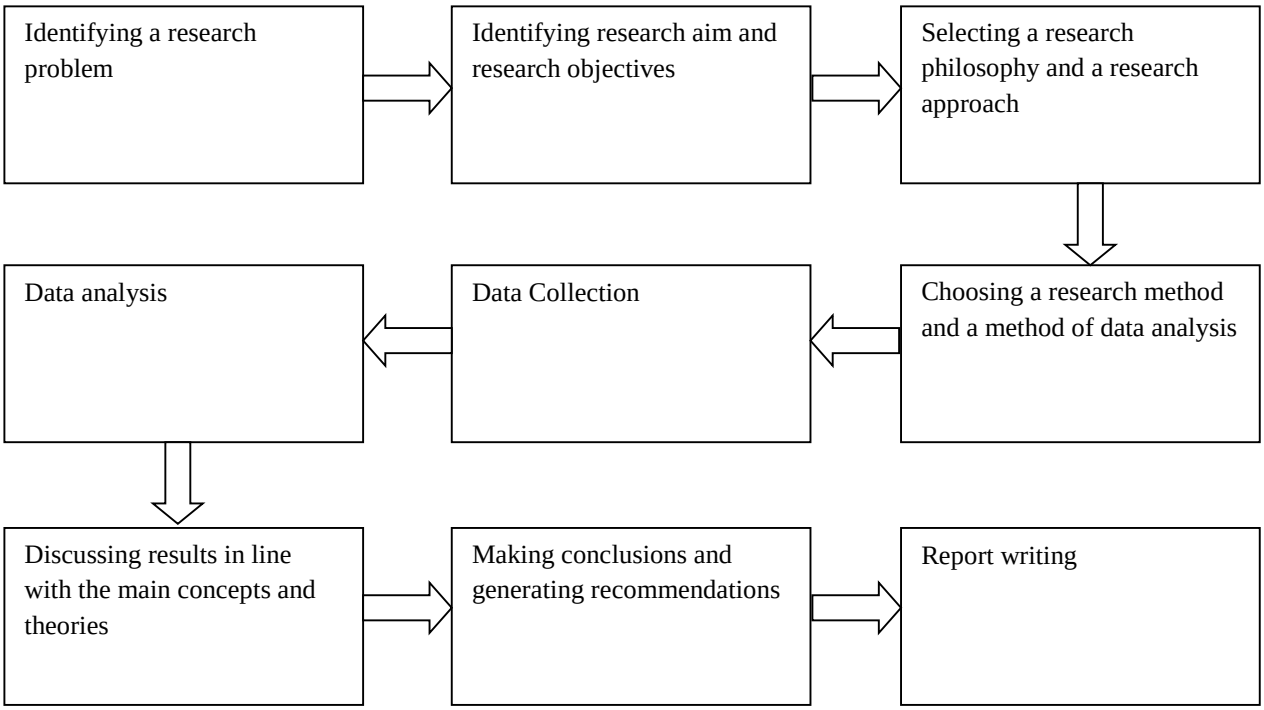


Figure 3. The Research Process

3.3. Questionnaire Design

This subsection aims to describe the questionnaire in detail. It will justify the choice of its type and focus on it structure. In the end, the chapter will explain a pre-test stage of the questionnaire's design which is mandatory before proceeding with the full-scale survey.

3.3.1. The Choice of a Questionnaire's Type

It is of paramount importance to select a suitable type of a questionnaire because this choice is crucial in the field of ensuring a high validity of survey's results. Specialists point out that this process usually implies measuring the advantages and disadvantages of self-completion, interviewer-administered and phone surveys (Meadows 2003). In self-completion surveys, respondents fill questionnaires on their own. In contrast, interviewer-administered questionnaires provide an interviewer with a possibility to fully control the process of collecting data. The scholar explains that this questionnaire's type is widely used in modern studies because an interviewer can ensure that all the respondents are in equal conditions and, therefore, are not influenced by different factors of the external environment. Unfortunately, interviewer-administered questionnaires usually require substantial financial costs. Therefore, it was decided

not to select this option. This factor is also relevant in case of phone questionnaires. Besides, both interviewer-administered and phone questionnaires require a lot of time since respondents should be interviewed successively. Based on the arguments laid out above, it seems logical to select a self-completion type of a questionnaire for this survey.

3.3.2. Questionnaire Structure

A survey with a closed-ended questionnaire was used for data collection. The questionnaire included questions divided into three sections corresponding to each research objective. Section one gathered the respondents' demographic information including sex, period of experience in the construction industry, and their specific area designation. The section provided closed-ended choices where the respondents would select the most appropriate response that described their biographical details.

Section two delved deeper into investigating the impact of climate change on the construction industry. In this section, there are twenty two questions which are designed in line with the Likert's (1934) five-point-scale. Respondents are expected to measure the variables. This section is crucially important as it simultaneously provides us with a possibility to analyze mean values of each variable and generates numbers which can be used in one-way ANOVA. These questions play the key role in answering research questions of this dissertation.

Finally, the third part of this questionnaire aims to explore respondents' experience and their reflections on the impact of climate change on their work. The section delves deeper into investigating the impact of climate change on the construction industry. The first question in this section requires the respondents' responses as to whether weather conditions affect activities at their specific constriction sites. Therefore, the question provides a 'yes' or 'no' option for the respondents to tick their responses. Part two of the first question provides a range of options that describe the impact of climate change on the construction industry where the respondents are to pick on the impacts they experience at their work stations. The second question in the section two gathers the respondents' responses concerning the impact of extreme climatic conditions on construction work. The third question requires respondents to indicate whether extreme climate conditions limit their activities at the construction sites. Finally, the last question gathers responses concerning the factors that can help in mitigating the impact of climate change on the construction industry.

3.3.3. Pre-Test

Before creating online questionnaires in Survey Monkey, it was decided to test them. A focus group was gathered in order to determine whether a questionnaire harmonizes with the research design and has a potential to collect data that is required for answering research questions. I managed to convince seven students who are currently studying to obtain Master's degrees in project management from different universities in UAE. Their informed opinions helped us to improve the questionnaire. While they did not have any concerns regarding the first and second sections, they proposed to change the third part of the questionnaire. In particular, they insisted on making the questions less general. For example, instead of asking respondents whether they think that climate change have significantly influenced site operations, they recommended asking the following question: 'Do you experience a significant influence of climate change on site operations in your work?". In other words, the focus of question was shifted towards an emphasis on personal experience.

3.4. Data Collection and Survey Validity

Thus, this study used a non-probability sampling techniques due to the nature of data collection methodology, which took place on survey monkey. A nonprobability sampling technique uses subjective methods to find the elements that should be included in a sample. In this study, the population is not well defined. A snowball sampling design was used in accessing the sample who took part in the study. In this case, a few known construction workers were requested to recommend their fellow workers to complete the survey. The study was able to gather 204 responses, which were used for data analysis.

For a research to be considered valuable, it must meet specified qualities that can be termed as reliability and validity. In quantitative research, validity can be defined as the degree to which a concept can be evaluated (Heale, 2015). Reliability also refers to the measure of accuracy of instruments used in collecting data. In other words, reliability can be measured through the consistency of similar findings if the instrument is used in repeated occasions or similar situations. This study ensured content and construct validity by ensuring that the survey covered all the content that it was supposed to cover with respect to research questions and variables. The primary aim of this study was to find out the impact of adverse impacts of climate change on the operational and financial aspect of the construction industry. The specific research

objectives focus on finding out the operational, financial, and health impacts resulting from climate change. The survey covers all these factors meaning that it meets content and construct validity.

As stated above, reliability involves consistency of a measure in a data collection instrument. This study ensured reliability through the providing questions aimed at measuring a similar construct. For instance, some sections of section two required a 'yes' or 'no' answer followed by a question that required the respondents to indicate an elaboration of their responses. Therefore, if a respondent answered yes, and indicated his or her response in the following question, it attested reliability.

3.5. Analytical Methods

It was decided to employ several statistical tests in order to analyze the data. First of all, we have conducted a descriptive analysis that aimed to recognize the types of data and different categories of survey's responses. The second stage implies launching a reliability test which was supposed to measure the internal consistency of the five risk modules. The Cronbach's alpha test in MS Excel was used for this objective. Finally, the one-way ANOVA test was run to determine the influence of climate change on the 21 risk factors of the UAE's construction industry. The eventual results of this study are supposed to be useful for scholars as this research is the first one that explores the influence of climate change on operational and financial risks of UAE's construction industry.

3.6. Ethical Considerations

Ethical concerns refer to a set of guidelines that direct a researcher's behavior during a study. In the current study, the respondents were notified about the study before the study through an introductory letter at the beginning of their survey. The letter contained information that assured the respondents of their willingness to participate in the study and withdraw at any time they felt that the study was violating their rights. The instructions in the introductory section of the questionnaire also assured the respondents that their responses were confidential and they were not required to indicate their names anywhere in the questionnaire. The informed consent was important in ensuring that participation was voluntary and not coerced.

This study was also conducted in compliance to the ethical issues in research as recommended by Creswell's (2014). For instance, it was important to ensure that the literature

supported the relevance of the current study. The research strictly complied with the principles of beneficence, maleficence, and fairness throughout the research. Finally, this research also complied with research ethics by ensuring that the final report is free of any form of plagiarism, concealed information, or false information (Creswell, 2014). I, as the researcher made all the possible efforts to ensure that the report is thorough, accurate, and precise. The final report will also be shared with the relevant stakeholders including the participants (Creswell, 2014).

3.7. Summary

The current dissertation uses the research methodology of realism and the inductive research approach to explore the influence of climate change on the operational and financial risks on the UAE's construction industry. It focuses on the five modules of operational and financial risks: site operations, equipment's efficiency, labour productivity, employees' health, and the overall financial productivity. The research method of online survey was implemented to collect quantitative data. We have employed the descriptive analysis in order to characterize data and describe it. The Cronbach's alpha test was run in order to ensure that modules of risk factors have an acceptable level of internal consistency. The on-way ANOVA in MS Excel was used to measure a correlation between the perceived significance of climate change and the significance of risk factors.

CHAPTER 4. DESCRIPTIVE ANALYSIS

4.1. Introduction

As it was explained in the methodology part, this survey was carried out on the basis of the Survey Monkey website. This website is well-known as an optimal mechanism of conducting online surveys (Miliaekiala et al. 2014). After creating the online questionnaire, we have sent links to potential respondents through e-mails. Unfortunately, only around a fourth of them actually participated in the survey. This section presents results of this study in the most general way and describes demographic characteristics of respondents.

4.2. Reliability Test

Since the risk factors explored in this study were embedded in the five modules, it was crucially important to measure an internal consistency between respondents' assessments of these factors. In order to achieve this goal, it was decided to employ the instrument of Cronbach's alpha. This instrument has proved its effectiveness in empirical studies (Tavakol & Dennick 2011). Simultaneously, there is no agreement among researchers regarding the acceptable values of this parameter. All the scholars insist on the necessity of reconsidering the questions if the Cronbach's alpha is less than 0.5. At the same time, some of them prefer using the data only if this parameter is higher than 0.7. With the help of MS Excel, we have used this test to measure the internal consistency of components of all the five modules. Eventual results of this test are presented in the table below whilst tables with Cronbach's alpha, mean, SD, and SEM can be found in the Appendices section.

Modules of risk factors	Cronbach's Alpha	Number of Items
Site operations	0.737	4
Efficiency of equipment	0.598	3
Labour	0.773	6
Employees' health	0.692	3
Overall financial productivity	0.675	5
All modules	0.853	21

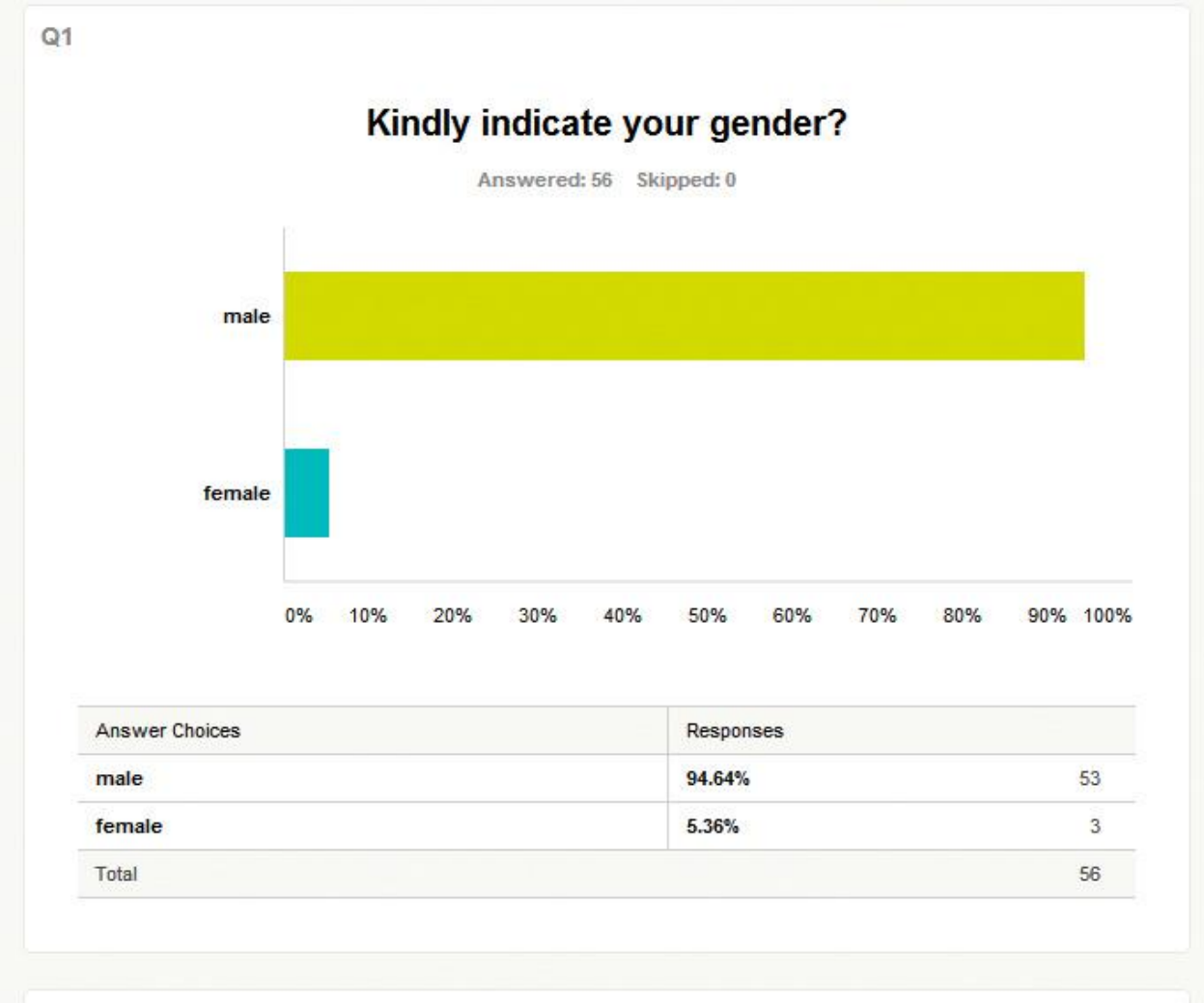
Table 3. The Cronbach's Alpha Test

Among the five modules included in this survey, only one module, "The efficiency of equipment", has a Cronbach's alpha below 0.6. Whilst the number "0.598" seems low, it does not automatically mean that the questions from this module should be necessarily reconsidered. Most scholars point out that this parameter might be acceptable at the rate above 0.5. In the case of this survey, it seems to be acceptable because the problem of equipment's efficiency is extremely complex and it is very hard to list all the aspects of this phenomenon. The other four modules demonstrate acceptable alphas and vary between 0.675 and 0.773.

4.3. Descriptive Statistics

This section presents demographic information about the respondents. While there is no premise to claim that respondents' demographic characteristics might significantly influence results, it is important to review them in order to make sure that there are no obvious inequalities in the distribution of demographic characteristics.

All the 56 respondents responded to questions in this section. The first question required them to indicate their genders. The findings reveal that 94.64 percent of the respondents were male while only 5.36 percent were female as shown in the figure below. These findings are evident of the various existing literature on the paucity of women in technical industries such as engineering and construction among others. Typically, the construction industry is regarded a male dominated field. Therefore, there are very few women working in the construction industry.

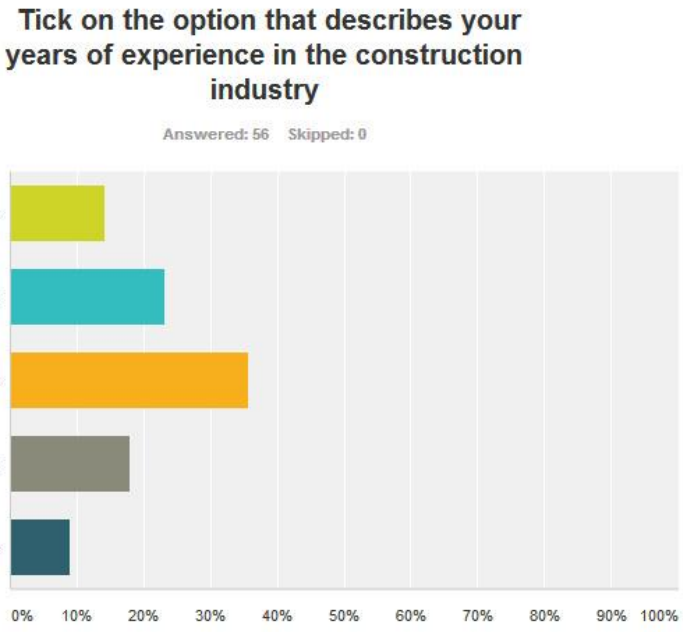


Answer Choices	Responses	
male	**94.64%**	53
female	**5.36%**	3
Total		56

Figure 4. Respondents' gender

The second question gathered information regarding the respondents' years of experience in the construction industry. Out of 56 respondents, 8 had an experience of below 3 years, 13 have worked in the construction industry between 3 to 6 years, 20 have 6 to 9 years of experience, 10 have worked in the industry for 10 to 13 years, while only 5 have an experience of more than 13 years. Interestingly, all these five respondents are construction managers. The Figure 5 below provides an illustration of the respondents' areas of experience in the construction industry as obtained from the study findings on survey monkey.

Q2

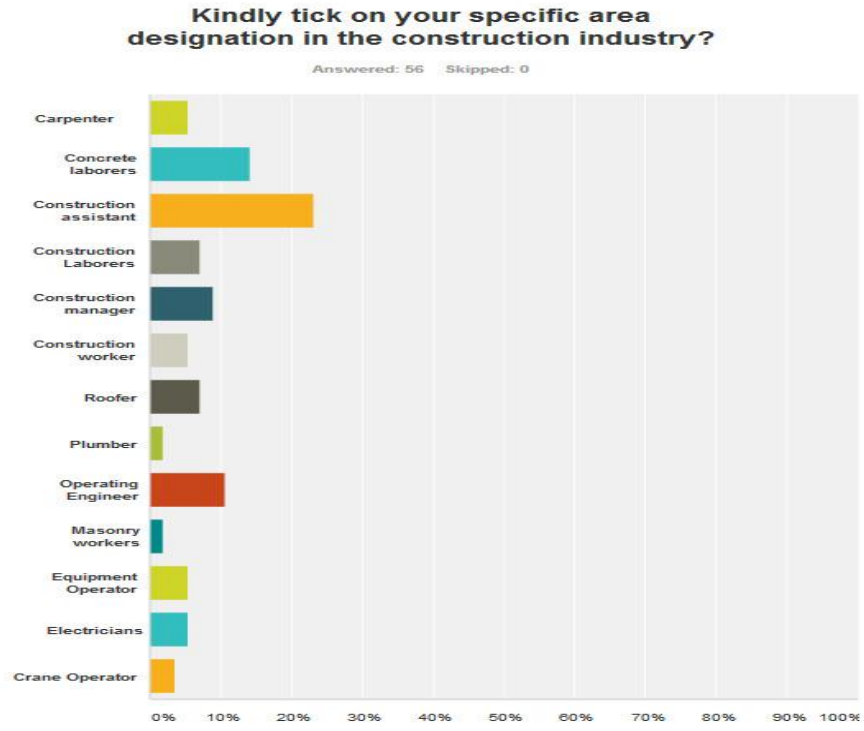


Answer Choices	Responses	
Below 3 years	14.29%	8
3-6 years	23.21%	13
6-9 years	35.71%	20
10-13 years	17.86%	10
13 and above	8.93%	5
Total		56

Figure 5. Respondents' Working Experience in the Construction Industry

Question three in the bibliographic section required the respondents to indicate their specific areas of designation in their industries. The question provides options of various construction industry posts including carpenters, concrete laborers, construction laborers, construction managers, construction workers, rooters, plumbers, operating engineers, masonry workers, equipment operators, electricians, and crane operators. Figures 4 and 5 below summarize the occupation of the respondents as obtained from survey monkey.

Q3



Answer Choices	Responses	
Carpenter	5.36%	3
Concrete laborers	14.29%	8
Construction assistant	23.21%	13
Construction Laborers	7.14%	4
Construction manager	8.93%	5
Construction worker	5.36%	3
Roofer	7.14%	4
Plumber	1.79%	1
Operating Engineer	10.71%	6
Masonry workers	1.79%	1
Equipment Operator	5.36%	3
Electricians	5.36%	3
Crane Operator	3.57%	2
Total		56

Q4

Figure 6. Respondents' Working Position

4.4. Experience and Knowledge in Different Modules

In line with the Likert's five-point scale, respondents were asked to evaluate their experience and knowledge in the following areas: site operations, equipment's efficiency, labour productivity, employees' health, and the overall financial productivity. The table below illustrates the results of these questions.

Module	Site operations	Efficiency of equipment	Labour	Employees' health	Overall financial productivity
Mean Value	4.43	3.95	2.93	4.02	2.89

Table 4. Respondents' Knowledge and Experience in the Modules

The eventual mean values of respondents' responses seem natural. The overwhelming majority of people who participated in the survey are workers. Thus, they do not possess the necessary knowledge and experience in monitoring the overall financial productivity of the industry or measuring the productivity of labour. At the same time, they are certainly capable of analyzing the influence of climate change on site operations and on employees' health. The mean values of 4.43 and 4.02 confirm this statement. In the case of equipment's efficiency, the mean value is 3.95. The available evidence provides a premise to believe that some employees, such as roofers or construction assistants, are not well-aware of the phenomenon of equipment's efficiency while some others, such as equipment operators, are experts in this field.

4.5. Ranking of Risks Connected with the Influence of Climate Change on the Construction Industry

In this survey, 21 questions about the risks inherent to the construction industry are combined into the five modules: site operations, equipment's efficiency, labour productivity, employees' health, and the overall financial productivity. These modules consist of the four, three, six, three and five components respectively. On the basis of mean values given to each of them, we have gained an opportunity to rank risk modules. In accordance with the instrument proposed by Morgan et al. (2004), it was decided to employ the average weighted mean, as the basic method of evaluation. The figure below shows a general scheme of the risk modules and their elements.

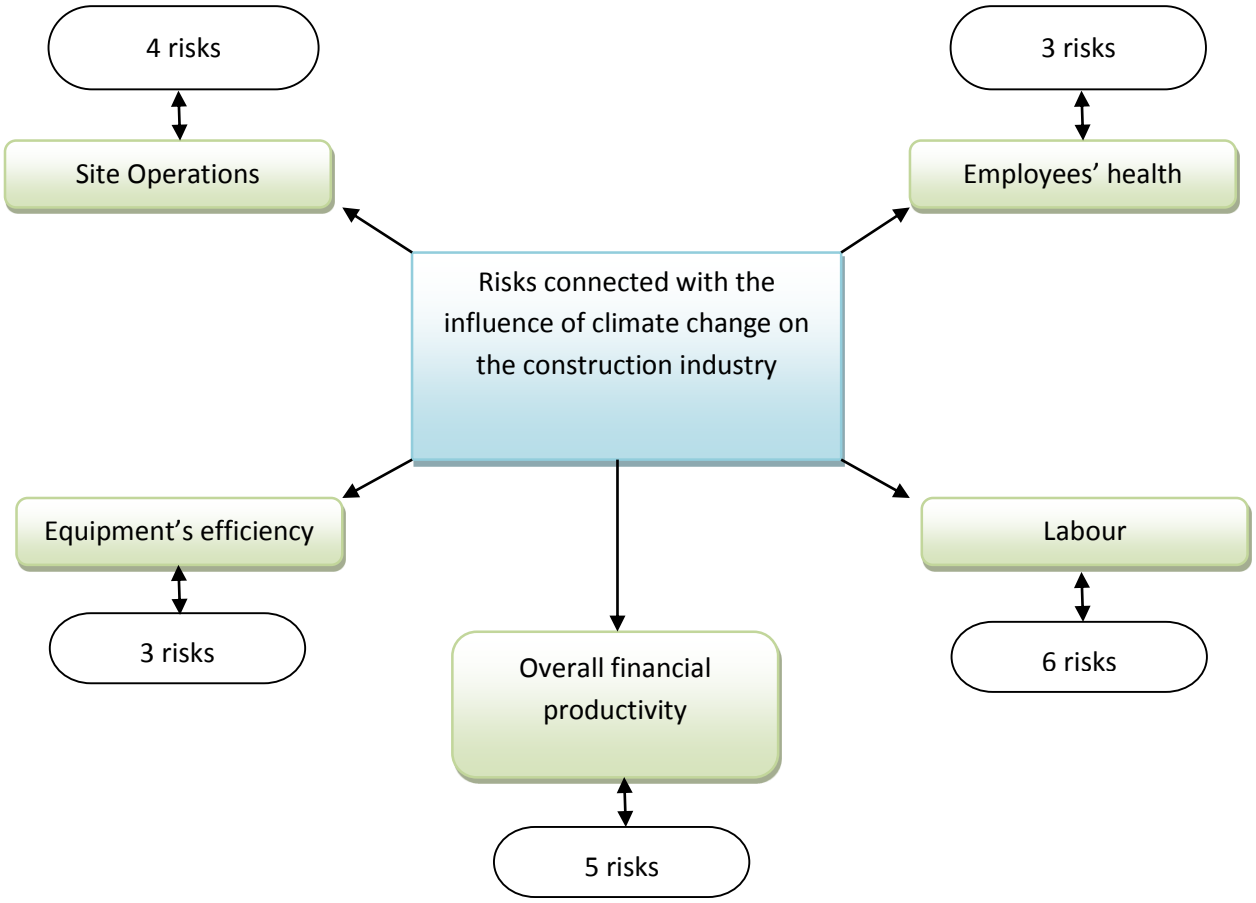


Figure 7. The Construct of Models' Ranking

4.6. Analysis and Ranking

The Likert's five-point scale used in this survey allows us to measure the weighted mean and section average.

1. The formula used for the weighted mean is: [Sum (Rate * Fq)] / N

   Where,

   - Rate: The Rate given to each risk element
   - Fq: Frequency of answers
   - N: Total numbers of respondents

2. The formula used for the Section Average (AVG) is: risk module [Average (Severity Index)]

   Where,

   - Average: The function average
   - Severity index: As explained above in (2)

4.7. Overall Ranking and Mean of Significance of Risk Elements

The statistical ranking of the 21 risk elements provides a possibility to analyse respondents' responses on the basis of mean values given to each risk factor. This subsection presents the ranking of risk factors and risk modules. It was found that the risks associated with a decrease in the overall financial productivity are considered by respondents as the most significant whilst risks in the field of employees' health are the least significant. The most essential risks are excessive project costs (3.86), wastage of time due to delays (3.77) and excessive sweating of employees (3.23). Simultaneously, the risk of suffering from pneumonia (2.29) and being vulnerable to falls due to frost (2.70) are the least significant.

Module of risks	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Site operations	3.48	3.31	3.23	2.85	3.28	3.95
Equipment's efficiency	3.46	3.38	3.03	3.33	2.83	3.60
Labour	3.23	2.58	3.01	3.02	3.13	3.20
Health	3.04	3.21	3.15	2.67	2.60	3.67
Financial productivity	3.50	3.00	3.25	3.08	3.14	3.76

Table 5. Mean Values of Modules

At first sight, the factor of working experience does not influence employees' responses to the survey's questions. However, it seems that certain regularities exist. In particular, people who have a solid working experience in the industry that is more than 13 years tend to pay a lot of attention to the risk factors. It may be partially explained by the fact that most of them work as construction managers and, thus, have a wider spectre of responsibilities than other employees. It is also interesting to point out that most employees who have been working in the industry for less than 3 years tend to focus on risks too. In particular, they are very concerned about the risks associated with site operations and equipment's efficiency and, moreover, they overestimate the risks to employees' health.

Site Operations	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Inefficiency of materials	3.39	2.63	3.23	3.20	3.10	3.60
Freezing ground	3.48	3.50	3.23	2.50	2.90	3.40
Low morale of employees	3.50	3.50	2.85	3.00	3.40	4.00
A substantial number of work delays	3.55	3.63	3.62	2.70	3.70	4.80

Table 6. Mean Values of The First Module's Risk Factors

In the module of risks associated with site operations, an increase in the number of work delays has received the highest mean value (3.55). Simultaneously, this value is mostly driven by

responses of the five construction managers with more than 13 years of working experience. A similar situation can be observed in the case of employees' low morale. Whilst experienced managers and newbies are concerned about the low morale of employees, the rest of respondents regard this factor as averagely significant. The factors of freezing ground and materials' inefficiency have received relatively low mean values (3.48 and 3.39 respectively).

Equipment's inefficiency	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Premature breakdowns	3.63	3.38	2.92	3.35	3.30	3.40
Slowing down of the cement hydration process	3.45	3.13	3.38	3.10	2.30	3.60
Increased water leakage in the building structure	3.30	3.63	2.77	3.55	2.90	3.80

Table 7. Mean Values of The Second Module's Risk Factors

Among the chosen problems with equipment, an increased water leakage (3.30) is considered by respondents as the less significant risk whilst premature breakdowns (3.63) constitute a significant problem. Interestingly, experienced employees look at the situation differently. They are concerned about the potential water leakage (3.80) and are pretty sure that a situation with premature breakdowns is under control (3.40).

Labour	Average mean value	Working experience				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Excessive sweating of employees	3.64	2.88	2.69	3.00	3.40	3.20
Increased fatigue	3.38	3.00	2.85	2.80	3.30	3.20
Employees' dizziness	3.32	2.63	2.62	2.75	2.90	3.20
Employees' dehydration	3.46	2.75	3.00	2.75	3.20	3.40
Employees' freezing	2.88	1.88	3.38	3.45	2.70	3.20
Employees' vulnerability to falls due to frost	2.70	2.38	3.54	3.35	3.30	3.00

Table 8. Mean Values of The Third Module's Risk Factors

The table brightly illustrates that labour productivity is likely to be affected by risk factors associated with high temperatures. The increased fatigue, excessive sweating, dizziness and dehydration have received high mean in the range between 3.32 and 3.64. Simultaneously, risk factors associated with cold weather, specifically employees' freezing and vulnerability to falls, have low mean values below 3.00.

Employees' health	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Suffering from a heat stress	3.39	3.25	3.00	2.15	2.50	3.80
Catching a flue	3.43	3.38	3.77	2.95	2.80	3.80
Pneumonia	2.29	3.00	2.69	2.90	2.50	3.40

Table 9. Mean Values of The Fourth Module's Risk Factors

The questions related to possible risks to employees' health have received different responses from respondents. The risk of suffering from pneumonia on the workplace is very slight (2.29) whilst the other two risks are significant (3.39 and 3.43). This regularity is inherent for responses of the four respondent groups.

Overall Financial Productivity	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Wear and tear of equipment	3.61	4.00	3.08	3.25	2.90	3.40
Wastage of time due to delays	3.77	3.00	3.38	3.45	3.70	4.00
Loss of human labour due to the death of workers	2.71	3.00	3.38	2.35	3.40	3.20
Total destruction of construction projects due to floods, winds, or storm	3.55	2.00	3.00	3.15	3.30	3.80
Excessive project costs	3.86	3.00	3.38	3.20	2.40	4.40

Table 10. Mean Values of The Fifth Module's Risk Factors

The risk factors in this module are various. Some of them, like decreased profits due to the loss of human labour because of workers' deaths, are barely significant (2.71) whilst excessive project costs (3.86) are currently the most topical risk in the construction industry. Surprisingly, the risk of projects' total destruction because of floods, winds, or storm has received a relatively high mean value (3.55). Furthermore, an understanding of this risk's significance comes with a working experience. Except for those employees who have been working in the industry for less than 3 years and tend to overestimate all the risks, others

demonstrate a stable trend. The more experienced is the employee, the more concerned he becomes about this risk.

Perceived Significance of Climate Change in the UAE	**Average mean value**	**Working experience**				
		<3 years	***3-6 years***	***7-9 years***	***10-13 years***	***>13 years***
Significance of climate change	3.57	3.38	3.62	3.35	3.60	4.60

Table 11. Mean Values of The Perceived Significance of Climate Change

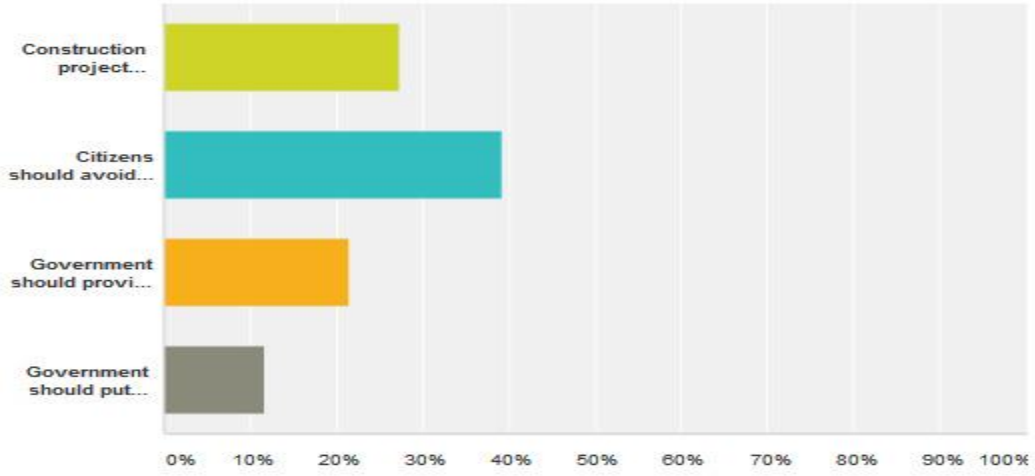
A relatively high mean value (3.57) illustrates that respondents recognize the significance of climate change in the United Arab Emirates. This phenomenon seems especially disturbing to experienced construction managers since they can observe how it influences the working process in general. Whilst other employees are less concerned about this factor, the mean values given by them are still average and fluctuate between 3.35 and 3.60.

The last question in the survey required the respondents to tick from the options given, factors that they feel need to be implemented by the construction industry, government, of UAE residents, that can mitigate the impact of climate change on the construction industry. A majority of the respondents, 39.22 percent indicated that it is the responsibility of each citizen to avoid activities that can exacerbate climate. Another significant number of respondents, 14 (27.45 percent) indicated that it is the responsibility of construction project workers and managers to follow the standard recommendation codes for building in concrete work and masonry to avoid weather impacts. A notable number of respondents, 21.57 percent agreed that government should provide the necessary measures that reduce climatic pollution from industries. The Figure 8 below illustrates the responses in to the last question.

Q14

Based on the impacts you have identified above, kindly tick on the factors that you feel should be implemented by the government, construction industry, or citizens to mitigate the impact of climate change on the construction industry?

Answered: 51 Skipped: 5



Answer Choices	Responses
Construction project managers and workers should follow recommended building codes for masonry and concrete work	27.45% 14
Citizens should avoid activities that increase climate acidification	39.22% 20
Government should provide necessary measures to prevent causes of climate pollution	21.57% 11
Government should put necessary measures to prevent the negative impact of climate change	11.76% 6
Total	51

Figure 8. Approaches to Mitigate the Impact of Climate Change on the Construction Industry

4.8. Summary

This section used mean values of variables and the Cronbach's alpha test to conduct a descriptive analysis of the data. It was found that risks associated with the overall financial performance, such as excessive project costs and wastage of time due to delays resulting in decreased profits, are regarded by respondents as the most disturbing risks. Simultaneously, risks in the sphere of employees' health are not critical. Among the risks which are directly connected with weather, those caused by high temperatures are much more disturbing than those caused by low temperatures. Such risks as a vulnerability to falls due to frost or employees' freezing are regarded by respondents as slightly relevant. In contrast, the risk of suffering from a heat stress is topical.

The Cronbach's alpha test shows that the level of internal consistency is acceptable for all the modules, although the internal consistency is poor in case of the equipment's efficiency model.

CHAPTER 5. ANALYSIS OF VARIANCE – ANOVA

5.1.Introduction

The previous chapter was focused on explaining which risks are the most significant in the UAE's construction industry. However, this discussion occurred without considering the significance of climate change. In contrast, this section will use mean values of the variables to run a regression analysis. The eventual goal of this section is to illustrate how each variable and each module is influenced by the climate change.

The on-way ANOVA test has been employed as the instrument of a regression analysis. The ANOVA test will be run separately for each business module. Therefore, it will be presented in the five different tables in concordance with the five modules of risk factors. In the survey, respondents were asked to evaluate the significance of climate change in the United Arab Emirates. They have evaluated this variable with the use of the Likert's (1934) five-point scale. A relatively high mean value (3.57) shows that respondents recognize the significance of this phenomenon and can observe its influences on the construction industry. The perceived significance of climate change will be used as a dependent variable whilst the risk factors will be use as independent variables.

The ANOVA analysis of variance is widely used by modern scholars because it is a simple technique to measure a correlation between the variables. Unfortunately, the number of observations is small. Most scholars recommend collecting at least 200 observations before launching a one-way ANOVA. However, considering that there are a lot of studies that operate with the number of observations below 100, there is a premise to assume that the sample of 56 respondents will be enough for making general conclusions on the problem under investigation.

As it is known, there are several requirements towards the data which enable the use of ANOVA. First of all, the dependent variable should be continuous. In our case, this requirement is met since the dependent variable is represented by mean values of the climate change's significance provided by respondents. All the questionnaires contain certain mean values. Secondly, sets of data used as an independent variable should be independent from each other. In this study, the mean values of different risk factors constitute the independent variable. These two criteria have been met which provides a premise to believe that the results of ANOVA test will be valid.

5.2. Results of One-Way ANOVA for the Five Modules of Risk Factors

The tables presented in this article provide results of ANOVA for the five modules. The regression was run in MS Excel through the Data Analysis application. This section contains brief versions of results whilst tables with all the parameters including Multiple R and R Square can be found in the Appendices.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	4	39.17508103	9.793770258	22.16059929	1.20309E-10
Residual	51	22.53920468	0.44194519		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	-0.440171449	0.465608502	-0.945368152	0.348928531
Inefficiency of materials	0.262745572	0.114754104	2.289639878	0.026213606
Freezing ground	0.312862106	0.119726592	2.613137992	0.011760694
Low morale of employees	0.294084378	0.111362664	2.640780744	0.010950734
A substantial number of work delays	0.281805495	0.108163428	2.605367653	0.011998026

Table 12. ANOVA results: The First Module

An extremely low rate of the Significance F shows that the results are significant and the correlation exists. All the four factors incorporated in the module of site operations have p-values below 0.05. Respondents clearly indicate that changes in the climate decrease employees' morale, freeze the ground, substantially increase the number of work delays, and decrease the efficiency of many materials.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	19.17303599	6.391011997	7.812008956	0.000212908
Residual	52	42.54124972	0.818100956		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	0.713538269	0.612503486	1.16495381	0.249354137
Premature breakdowns of equipment	0.353405875	0.136091036	2.59683433	0.012205971
Cement hydration process' slowing down	0.162935838	0.120727504	1.349616555	0.182985551
Increased water leakage in the building structure	0.307318095	0.112133372	2.740647929	0.00838443

Table 13. ANOVA results: The Second Module

In the module of equipment's efficiency, the impact of climate change is much less significant. It was found that this factor does not slow down the cement hydration process since its p-value is 0.18 which is way above 0.05. At the same time, the phenomenon of climate change leads to premature breakdowns of equipment (0.012) and increases water leakage in the building structure (0.008). A correlation between the climate change and water leakage is the most significant among all the risk factors presented in this study.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	6	33.69989784	5.616649641	9.824088738	4.24516E-07
Residual	49	28.01438787	0.571722201		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	-0.03460323	0.500511037	-0.069135799	0.945162897
Excessive sweating	0.102038246	0.122051398	0.836026846	0.407198245
Increased fatigue	0.249686617	0.109337539	2.283631204	0.026766318
Dizziness	0.179436595	0.127547585	1.406820791	0.165791736
Dehydration	0.166319507	0.122109923	1.362047438	0.179411919
Freezing	0.185241048	0.090436203	2.048306337	0.045907326
Falls due to frost	0.254743102	0.103943966	2.450773358	0.01787074

Table 14. ANOVA results: The Third Module

The module of labour productivity presents the influence of climate change on various factors that lead to a decrease in labour productivity. Interestingly, a significant positive correlation is observed only in three out of six risk factors. The climate change in the country makes employees vulnerable to falls due to frost (0.017), makes them freeze (0.045) and increases their fatigue (0.026). The other three risk factors have p-values above 0.05. A correlation between climate change and employees' excessive sweating, dizziness and dehydration is not significant.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	19.16474014	6.388246712	7.807106387	0.000213949
Residual	52	42.54954558	0.818260492		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	1.387493952	0.488407719	2.840851807	0.006409777
Suffering from a heat stress	0.240846201	0.136148581	1.768995312	0.08275929
Catching a flue	0.289379194	0.136959737	2.112877845	0.039430348
Pneumonia	0.163896525	0.121530385	1.348605326	0.183308223

Table 15. ANOVA results: The Fourth Module

A similar situation occurs in the module of employees' health. The risk of catching a flue is directly connected with the climate change. Its low p-value (0.039) confirms an assumption that the climate change in the UAE mostly adds the factor of low temperatures. Simultaneously, the issues of heat stress and pneumonia are irrelevant to the problem under investigation as their p-values are below the acceptable level.

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	5	18.88281601	3.776563203	4.408631351	0.002105721
Residual	50	42.8314697	0.856629394		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	0.678940179	0.729047706	0.931269893	0.35618894
Decreased profits due to the wear and tear of equipment	0.171229294	0.109116474	1.569234119	0.122900933
Decreased profits due to delays	0.16898154	0.12474958	1.354566004	0.181645546
Decreased profits due to the deaths of workers	0.035716572	0.134891389	0.264780224	0.792267271
Total destruction of projects because of weather floods, winds, or storm	0.316603323	0.114280177	2.770413306	0.007838472
Excessive project costs	0.107884015	0.134139428	0.804267741	0.425049954

Table 16. ANOVA results: The Fifth Module

Finally, the last module illustrates the influence of climate change on several factors related to the overall financial productivity of the sector. The fact that a total destruction of projects because of weather conditions is associated with climate change seems logical. Its p-value (0.007) is one of the lowest among all the risk factors. Simultaneously, all the other factors

have high p-values. Therefore, it can be concluded that the influence of climate change on the overall financial productivity of the construction industry is not significant. Sometimes construction projects get destroyed because of weather conditions, but it does not happen often. At the same time, other aspects in which the climate change can affect the industry are not significant.

5.3.Summary

The regression analysis run in this study has acceptable rates of the Significance F parameter. A correlation between the variable of climate change and different risk factors vary significantly depending on the nature of risks. In the module of site operations, a positive correlation is indicated in all the four risk factors. In the field of equipment's efficiency, the cement hydration process is found to be irrelevant to the problem under investigation since it is not significantly influenced by the climate change. In the module of labour productivity, only a half of risk factors have received acceptable p-values. It was found that the climate change increases employees' fatigue and makes them more vulnerable to freezing and to falls due to frost. Simultaneously, it does not make workers more dehydrated and does not influence their vulnerability to excessive sweating and dizziness. In the module of employees' health, only the risk of catching a flue is influenced by climate change whilst the risk of pneumonia and a heat stress are associated with this factor. Finally, it can be concluded that the phenomenon of climate change in the United Arab Emirates does not lead to a significant decrease in the overall financial productivity of the construction industry.

CHAPTER 6. DISCUSSION AND CONCLUSION

6.1. Introduction

The reviews present findings from seven relevant reviews on the operational and financial impact of climate change in the United Arab Emirates. The findings clearly comply with those from the literature review section and also augment literature findings on various aspects. This section critically discusses research findings in the light of research objectives and concepts analyzed in the literature review.

6.2. Ranking

The 21 risk factors analyzed in this dissertation possess significant threats to the construction industry. In the empirical part of the study, respondents were asked to evaluate them in line with the five-point scale. First of all, it should be pointed out that there is no significant difference between the modules of risk factors. Respondents consider risks associated with a decrease in the overall financial productivity as the most disturbing (3.50) whilst the chance of worsening employees' health (3.04) is the least essential, but the difference between these two numbers is certainly not critical. It can be explained by the fact that the significance of risk factors can be barely explained by the module in which they are included. For example, the module of financial productivity simultaneously has the two most significant risks (excessive project costs and wastage of time due to delays), and one risk factor which is at the bottom of the ranking list (the loss of human labour due to workers' deaths). A similar situation can be observed in other modules.

In general, risks associated with delays, problems with equipment and high project costs are the most significant. Simultaneously, problems caused by cold weather and various potential problems with employees' health are regarded by respondents as less disturbing. The inferences received on the basis of the descriptive analysis harmonize with the findings of most other scholars. In the fourth part of this section, this issue will be discussed in detail.

6.3. Hypothesis's Testing

As it was explained in the methodology section, this study operated with the five hypotheses related to a correlation between the climate change and the modules of risk factors. Among the twenty one risk factors included in the research, ten rejected the null hypothesis.

Their p-values were above the acceptable rate and, therefore, it was concluded that there is no correlation between the significance of climate change in the United Arab Emirates and the significance of these risk factors.

Four of them are embedded in the module of the overall financial productivity, two are components of the module of employees' health, three are included in the labour productivity module, and one is incorporated into the module of equipment's efficiency. The fact that only one risk factors from the module of the overall financial productivity has received a low p-value can be explained by the fact that the phenomenon of financial performance is influence by numerous factors and stakeholders and, thus, there are a lot of other issues which can influence financial performance of projects in a more radical manner than climate change. The only situation in which the climate change can play an essential role in changing the performance parameters of the industry is the total destruction of projects due to weather floods, winds, or storm. For example, such cyclones as Gono and Ashobaa can lead to catastrophic consequences for the construction sector. Whilst cyclones are more dangerous for Oman than for UAE, they still have a potential to disrupt the entire construction projects (Suliman 2009).

In the sphere of labour productivity, it seems barely possible that the climate change can influence employees' dehydration, dizziness or excessive sweating. Although these risks are significant, they are rather connected with the current climate in the UAE than with its potential change. In contrast, the risks associated with cold weather that is not typical for the country may be caused by the climate change. A similar situation can be observed in the case of employees' health. Employees are vulnerable to a heat stress under the current weather conditions whilst the threat of catching a flue may be increased by climatic transformations.

6.4. A Brief Review of the Research Objectives

On the impact of climate change on site operations, findings from Munawar (2017) reveal that climate changes have direct impacts on real estate and construction markets. He continues to argue that climate change does not only affect direct investments and the construction market growth but it also has negative implications on-site operations leading to time overruns, which potentially leads to cost overruns. These findings are valid as they correspond to those of Brodoli (2010) and Crissinger (2005) who also find out those harsh climatic conditions have adverse implications to construction site operations. For instance, Crissinger (2005) argues that hot

climate conditions can have an impact on site selection, concrete, brick, masonry mortar, equipment, seals and sealants, thermal movement, and on workers.

Objective two entails an evaluation of the impact of climate change on the efficiency of equipment in the construction industry. The findings from Tolba and Saab (2009) reveal that increased temperatures have a bearing on the construction industry infrastructure equipment such as roads. Further, Tolba and Saab (2009) indicate that hot weather decreases the efficiency of construction equipment and activities; hence increasing cost and time overruns. These findings match those of Crissinger (2005) and Chamberland 2014 from the literature review section. Crissinger and Chanberland argue that machinery and filters in the construction sector are vulnerable to damages from dust and even humidity exposures causing accelerated wear and tear. As a result, it is vital to clean the equipment regularly. These factors result in time and cost overruns; hence, impacting the project completion.

The third objective involves assesses the impact of climate change on labor productivity in the construction industry in UAE. Reviews on this objective reveal that indeed climate conditions, especially hot and cold weather, have an impact on the productivity of employees in UAE's construction industry. For instance, Ailabouni (2010) notes that during extreme weather conditions, workers are not allowed to work outdoors. He further notes that high levels of humidity are likely to lead to effects such as fatigue, sweating, and loss of working morale among construction workers. These findings comply with those of Palmer and Creagh (2013), Dunne, Stouffer, and John (2013, and Crissinger (2005) who indicate that hot temperatures lead to the loss of body fluids leading to the loss of energy causing disorientation, drowsiness, fatigue, dizziness, and dehydration.

The fourth objective entails an evaluation of climate change on safety and health procedures in the construction sector. Findings in this section from Xiang et al. (2014) show that indeed, exposure to harsh climatic conditions can lead to health and safety challenges among construction workers. Some of the health issues they identify include heat stress and illnesses, respiratory diseases, physiological and psychological impacts. Kerr, Ryburn, Mclaren, and Dentons (2013) also note that worker's health and safety is an issue of concern by the labor laws of the United Arab Emirates. These findings reflect those of Crissinger (20050, Chan et al. (2011), and Kerr, Ryburn, Mclaren, and Dentons (2013) from the literature review section that

attest that indeed climate change affects the health and safety of workers in the construction industry.

The last objective entails an evaluation of approaches to mitigate adverse impacts of climate change on operational and financial risks in the construction industry. The findings in this object augment those of Chamberland (2014) from the literature review by revealing that various sectors in the UAE regions have established different approaches such as Estidama and Green Building Codes to alleviate the effects of climate change on the construction industry. The results attest that climate change direct and indirect affects operational and financial aspects of a construction project. Extreme weather conditions disrupt development activities through delaying project completion time as workers will need to clean equipment in cases of dust and dirt substances. Some construction equipment such as mortar may also fail to function efficiently in humid conditions resulting from rain or high humidity levels. Therefore, construction workers may require time until these equipment are suitable for working. Water may also affect the adhesive capabilities of bricks, which may compromise the overall quality and safety of a building.

The literature review section reveals knowledge gaps on the impact of climate change specifically on the construction industry of the United Arab Emirates. Therefore, the methodology seeks to fill that gap by identifying literature specifically focusing on the operational and financial impacts of climate change on the construction industry. The findings comply with those of the literature review section that indeed climate change affects the operational and financial risks of construction projects in UAE. Further examination indicates that some regions in the UAE are making an effort to curb these impacts through mitigating factors that contribute to climate change. However, as shown above, natural or human made outcomes may be contributing to climate change. Therefore, the findings are of significance to the construction industry as they highlight the vulnerabilities of the industry to extreme weather conditions. Therefore, this study recommends that construction industries and weather departments should focus their efforts on early weather predictions to mitigate the impacts through early planning. Construction companies should also avoid implementing their projects in highly vulnerable sites such as the coastal regions.

6.5. Impact of Climate Change on Site Operations

Results in this section indicated that indeed weather conditions can have significant impact on site operations. All the respondents indicated that harsh climatic conditions can have various impacts such as lack of working morale, inefficiency of materials, work delays. Munawar (2017) and Crissinger (2005) also note that climate change can lead to time delays and inefficiency of construction materials. Other findings from the literature reviews identify factors such as slowing down of the curing process of materials that depend on evaporation or hydration due to water content leading to lower strengths. Another literature finding on the impact of climate change of site operations reveal that harsh climate conditions such as high temperature can affect negatively the working productivity of the projects, rainfall can reduce the strength and usefulness of concrete, rain can also affect the adhesive ability of glue and affect earthworks (Brodoli, 2010). Rain can accelerate the damages of unprotected surfaces by moving vehicles making locations inaccessible. Thus it may require more effort to retain the required level of activities during wet seasons. Rain can make roofs susceptible to leaking. It can also make deep excavations vulnerable to floods (Brodoli, 2012). High temperatures make subsoil too hard making it hard to work with. Hot temperatures also restrict the efficiency of workers at construction sites due to sweating.

Literature findings from Crissinger (2005) indicate that hot weather can affect site selection, operations with concrete, brick, masonry, mortar, equipment, seals and sealants, thermal movement, and on workers. Crissinger notes that dry weather can lead to dust, which can stick on the interior surfaces of buildings necessitating removal. Such activities lead to delays. Literature findings from Manuwar (2017) identifies factors such as physical risks, floods, increases seal levels, sea storms, delays, cost overruns, and reduced work productivity. Consequently, it is evident from both literature reviews and primary data collection that harsh climatic conditions due to climate change can impact site operations, which in turn affects the financial productivity of the construction industry.

6.6. Impact of Climate Change on the Efficiency of Equipment

Empirical findings from the survey indicate that indeed extreme climatic conditions can have a negative impact on construction equipment. The ANOVA test implicates a positive correlation between the climate change and the premature breakdowns of equipment and an

increased water leakage in the building structures. These findings correspond to those of Crissinger (2005); Chamberland (2014); and Toba and Saab (2009) from the literature review section. Other impacts identified in the literature review regarding the impact of climate change on construction equipment include accelerated wear and tear. Chamberland (2014) augments the findings in this objective by stating that cold weather can affect mortar and grout because they require heat for cement hydration, low temepratures slows or stops the hydration process of cement, low temperatures can also reduce the bond strength of masonry. Dry and hot weather can lead to premature settling of mortar without sufficient water leading to decreased strength of brick contact. As a result, the bond strength of brick and mortar decreases resulting to the possibility of water leakage in a building structure. Dry weather can complicate machinery due to dry dust. Dust can also lead to machinery breakdowns due to clogging on parts. Thus, dust can lead to delays due to the time required to clean the equipment, which has an impact on the operational and financial aspects of the construction projects. Tolba and Saab (2009) states that increased temperatures can soften asphalt leading to the degradation of construction industry infrastructures such as roads. Degraded roads can lead to traffic accidents leading to more impacts on the economic status of a nation. Thus, it is evident from empirical findings and literature reviews that climatic change can affect the efficiency of equipment in the construction industry.

6.7. Impact of Climate Change on Labor Productivity

Findings in this objective assert that severe climatic conditions have an impact on labor productivity. However, this impact is limited. The majority of risks in this sphere are not connected with the change of climate whilst only a vulnerability to falls due to frost and the risk of freezing are associated with this phenomenon. These factors can have an impact on labor productivity due to their impacts on construction activities. However, the fact that dehydration, dizziness and sweating are found to be not attributed to climate change contradicts with literature reviews from authors such as Palmer and Creagh (2013); Dunne, Stouffer, & John (2013); Ailabouni (2010); Crissinger (2005); and Yildirim, Koyuncu, and Koyuncu (2009). Augmenting findings from these reviews identify factors such as humidity, heat, increased temperatures, and wet-bulb. These factors decrease workers' morale, leads to fatigue, sweating (Gidado and Ailabouni, 2012). Other impacts include loss of body fluid leading to disorientation, drowsiness, fatigue, dizziness, and dehydration (Crissinger, 2005). Outcomes such as sickness,

loss of time, and increased accidents can also lead to negative impact on financial outcomes. Therefore, although the influence of climate change on labour productivity has been found both in this study and in researches of other scholars, its specifics differ significantly. In this study, only the phenomenon of cold weather seems to have an essential impact on labour productivity. It is required to conduct more researches with a bigger sample in order to look closer on this issue.

6.8. Impact of Climate Change on Employees' Health

Objective four of this study involved an investigation of the impact of climate change on the health of the construction workers. Without a doubt, climate change can negatively influence employees' health. In this study, it was found that working under extreme weather conditions increases the chance of catching a flu. These findings correspond to those of reviews from Crissinger (2005); Chan et al. (2011); Xiang et al. (2014); and Kerr, Ryburn, Mclaren, and Dentons's (2013).

All these authors agree that undeniably working on harsh climatic conditions can affect an individual's health. Further, their reviews supplement the empirical findings from the current study by identifying other factors such as death that can result from heat stress, respiratory diseases, psychological effects, and physiological impacts. The literature reviews from Kerr, Ryburn, Mclaren, and Dentons (2013) highlight that the health and safety of workers is a mandate by the Labour Law. Therefore, all companies including the construction sector in UAE should adhere to these laws by providing adequate protective gear to prevent injuries during accidents and to provide detailed instructions that clearly indicate the necessary measures to prevent fires and hazards. Consequently, these findings attest that extreme weather conditions are threats to the health and safety of construction workers. In turn, these impacts have a significant impact on the financial aspects of the construction industry. Simultaneously, like in the case with labour productivity, only matters associated with cold weather are associated with the climate change in accordance with the ANOVA test.

6.9. Impact of Climate Change on the Overall Financial Productivity

The respondents regard risks associated with the overall financial productivity as the most disturbing. However, only one of the risk factors from this module is actually connected with the climate change. It is evident from the other findings above that the impact of climate

change on labour productivity, the health and safety of workers, construction equipment, and site operations affects the financial outcomes of construction projects. But the direct impact of climate change on the sector's financial performance is limited. These findings do not support those of the literature review section specifically from the reviews of Crissinger (2005); Shabeeh (2017); Chamberland (2014); Mendelsohn et al. (2007); Mendelsohn et al. 2007; and Rashid (2015). All these authors agree that climate change characterized by harsh climatic conditions have a significant impact on the financial outcomes of construction projects and the construction industry in general. Their findings indicate factors such as death of workers and time wastage as the most significant impacts experienced due to extreme weather conditions. These impacts have negative implications on the financial outcomes of construction projects and eventual impact on the financial outcomes of the entire construction industry. Other financial impacts identified in this study include increased project costs, total project destruction, and wear and tear of equipment. All these factors have an overall impact on the financial aspect of construction projects, but only the total destruction of projects due to winds or other extreme weather conditions are associated with the climate change.

Literature review findings also provide significant contributions to findings in this objective. These findings include increased sea levels leading to floods, which have a devastating impact on infrastructure, delays lead to cost overruns, equipment destruction necessitate replacements or renovations (Shabeeh, 2017). Chamberland (2014) notes of the economic impacts that can result from deteriorated health among construction workers. Deaths can also lead to loss of human resources. Wind and storms can also destroy construction projects leading to massive financial losses. Extreme temperatures can reduce the efficiency of employees, which may reflect on financial outcomes. Therefore, it is distinctive that the climate change affects the financial outcomes of a construction projects and the overall impact on construction industries, but the significance of this impact is limited.

6.10. Approaches to Mitigate the Negative Impact of Climate Change in the Construction Industry in UAE

In this objective, the respondents provided varied options regarding the intervention strategies that should be put in place to mitigate harsh climatic conditions. A majority of the respondents indicated that all citizens have a mandate to avoid activities that can increase

climatic pollution. The findings correspond to those suggested by Chamberland (2014); Manuwar (2017); (Intergovernmental Panel on Climate Change 2014), and Luomi (2014). Thus, the findings suggest various approaches such the provision of necessary measures to prevent the negative impacts of climate change by government. Thus, it is evident that the above findings are valid as they comply with those from the literature reviews. The literature reviews also provide significant findings that support and augment the empirical findings of the current study. Byravan and Rajan, (2015) also adds on to these findings by suggesting the development of new global resettlement regions on higher grounds that are safer from disasters. Construction companies should also avoid implementing their projects in highly vulnerable sites such as the coastal regions. Further, people should put mechanisms to curb activities such as industrial emissions and population growth that can have negative impacts on climate. Lifestyle changes are also recommended for citizen as ways of mitigating air pollution.

Luomi (2014) identified both domestic and international approaches that can be put in place to mitigate climate pollution. Internationally, UAE should comply with regulations from international organizations such as UNFCCC whose goals entail stabilizing greenhouse gas levels in the atmosphere. UAE should put mechanisms and actionable plans to mitigate climate change through technology transfer, finance, and capacity building. Specifically collaboration with developed countries such as the United Kingdom and the US can help UAE in accessing technological and financial support towards the implementation of these strategies. The state should also comply with UNFCC regulations through reporting to the Conference of the Parties information regarding the achievements and steps taken or planned to be taken towards mitigating greenhouse gas emissions. Domestic mitigation strategies should include the incorporation of policy measures and technology solutions aimed at achieving a low carbon economy for the stabilization of climate. These measures include the economic, information, and regulatory instruments, as well as, other actions such as technological and development and voluntary agreement. UAE residents should also adhere to policies and regulations aimed at preventing household pollutions. An implementation of strategies such as energy conservation can significantly prevent emissions. Construction and manufacturing sectors such as chemicals, iron and steel, pulp and paper, petroleum refining, and cement should implement mechanisms for energy efficiency leading to reduced emissions, recycling of materials, space cooling, process

controls, efficiency in lighting, and product design. An incorporation of the above factors can play a significant role in mitigating climate pollution and in turn prevent climate change.

6.11. Conclusion and Recommendations

The above findings and discussion clearly attest that climate change has an impact on the operational and financial aspects of the construction industry. Specifically, they reveal five specific negative impacts that can be felt in the construction industry as a result of climate change. These factors include labour productivity, site operations, construction equipment, health of the construction workers, and financial productivity. Labour productivity and site operations can be affected during extreme weather conditions, which necessitate delays as workers cannot work in these conditions. Working in such conditions can lead to illnesses such as heat stress, respiratory complications, falls, and even death. Such health outcomes have negative implications on the project's expenses as funds will be required to pay for treatments or replacement of workers in cases of death. Deaths are significant losses to human resources, who are the core of labour activities in the industry and the nation at large. Weather factors such as humidity, rain, wind, heat, high temperatures also make construction operations difficult. As a result, workers are required to wait till the climate gets favorable for them to continue working. These delays have an ultimate impact on construction operations, which in turn impacts impact the financial sector of the construction industry. Dust resulting from dry weather leads to clogs in construction equipment resulting in their breakdown or inefficiency. All these outcomes lead to negative outcomes as project managers need to adjust their budgets to cater for the delayed activities or for the replacement of destroyed equipment.

Simultaneously, it is very important to point out that, despite the undeniable significance of the risk factors reviewed above, only around a half of them are connected with the climate change. For example, the threat of suffering from a heat stress is naturally a disturbing risk for a foreigner who is working as a construction worker in the United Arab Emirates, but this risk is rather determined by the current weather conditions in the country than by the change of its climate.

It is valuable to put mechanisms that can mitigate climate change. This study identifies various approaches such as strict adherence to construction codes, mitigation of activities that can increase climate pollution, the provision of necessary measures by government to prevent

factors causing climate pollution. The study findings emphasize that citizens should avoid activities that increase climate pollution. Governments should provide resettlement areas to prevent construction activities at vulnerable regions. Construction companies should also avoid implementing their projects in highly vulnerable sites such as the coastal regions regardless of the financial income that such projects may promise. The UAE should comply with both international and domestic efforts geared towards preventing emissions. For instance, vulnerable industries should implement energy efficiency mechanisms as identified in the literature review section above. Further, people should put mechanisms to curb activities such as industrial emissions and population growth, which, according to research are significant contributors to air pollution.

6.12. Limitations of the Research

An effective completion of this study was constrained by limitations of time, and access to sufficient and effective secondary resources to augment the accessible information. Time limits resulted due to the tight schedule between university, job, and family. However, this challenge was resolved through creation of time for the project every day after work. Additional time was also acquired during the weekends. The challenge of secondary resource accessibility was resolved through gaining access to some academic sites such as University library, Google Scholar, Google Books, and ProQuest which sufficiently supplemented the Library sources. During survey I faced issue with labors in understanding the questionnaire due to language barriers and level of education. However, I had friend which translated the questionnaires to the labors and elaborated to them all the points in simple way.

The study was also limited to finding out the operational and financial impacts of climate change in the construction industry. Therefore, the findings may not be replicable to other industries.

REFERENCES

Ailabouni, N., 2010. *Factors affecting employee productivity in the UAE construction industry* (Doctoral dissertation, University of Brighton).

AlRustamani, Z., 2014, 'Impacts of Climate Change on Urban Development in the UAE: the Case of Dubai'.

Alshebani, M.N. and Wedawatta, G., 2014, 'Making the construction industry resilient to extreme weather: lessons from construction in hot weather conditions ', *Procedia Economics and Finance, 18*, pp.635-642.

Brodoli, D., 2010, 'Weather Claims in the United Kingdom Construction Industry'. Viewed 24 May 24, 2017; file://C:/Documents%20and%20Settings/Admin/My%20Documents/Downloads/weather-claims-in-uk-construction.pdf

Byravan, S, & Rajan, S 2015, 'Sea level rise and climate change exiles: A possible solution', *Bulletin of the Atomic Scientists*, 71, 2, pp. 21-28, Academic Search Premier.

Chamberland, S., 2014, 'Three Weather Conditions that Severely Affect Construction Equipment'. Viewed 24th May 2017 at: http://www.equipmentfa.com/blogs/2708/3-weather-conditions-that-severely-affectconstruction-equipement

Chan, A.P.C., Wong, F.K.W., Yam, M.C.H., Chan, D.M.W., Mok, E.C.M., Shea, G.Y.K., Guan, Y., Chung, G.W.Y., Biggs, H., & Dingsdag, D. 2011, 'A Research Framework for Assessing the Effects of Heat Stress on Construction Workers. Zurich, ISEC-6 the Sixth International Structural Engineering and Construction Conference'.

Change, Intergovernmental Panel on Climate. "IPCC." *Climate change* (2014). *Civil and Environmental Research, 7*(11), pp. 54-58.

Creswell, J. W. (2014). *Research design: Quantitative, qualitative, and mixed methods approaches (4th ed.).* Thousand Oaks, CA: Sage Publications

Crissinger, J. 2005, 'Design and Construction vs Weather'. Viewed 24th March 2014; file:///C:/Documents%20and%20Settings/Admin/Desktop/CLIMATE%20CHNAGE/2005-02-crissinger.pdf

Dlugolecki, A., 2009. Coping with climate change: risks and opportunities for insurers. *Chartered Insurance Institute, London*.

Dougherty, W. (2009). *Climate Change, Impacts, Vulnerability & Adaptation for Coastal Zones in the United Arab Emirates.*

Dunne, J. P., Stouffer, R. J. &. John, J. G. 2013, 'Reductions in Labour Capacity from Heat Stress under Climate Warming'. Viewed 24th March 2017 at: http://www.nature.com/nclimate/journal/v3/n6/full/nclimate1827.html

Gidado, K. and Ailabouni, N., 2012. 'Evaluation of factors affecting productivity in the UAE construction industry'.

Heale, R. and Twycross, A., 2015. Validity and reliability in quantitative studies. *Evidence-based nursing*, pp.ebnurs-2015.

Health and Safety Executive (n.d.), 'Respiratory Disease'. Viewed at: http://www.hse.gov.uk/construction/healthtopics/respiratory.htm

Intergovernmental Panel on Climate Change, 2014. *Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects*. Cambridge University Press.

Kerr, M., Ryburn, D., Mclaren, B. and Dentons, Z., 2013, 'Construction and projects in United Arab Emirates: overview'. *MULTI-JURISDICTIONAL GUIDE*, *14*, pp.1-12.

Kitchenham, B., 2004, 'Procedures for performing systematic reviews'. *Keele, UK, Keele University*, *33*(2004), pp.1-26.

Kumar, B., Agarwal, A. and Khullar, R., 2010, 'Real Estate and Construction Sector in the UAE: Growth Strategies'. *HEC Montreal. Center for Case Studies.*

Liz, C. (2003). *Ripple effects.* Washington, DC: Population Reference Bureau.

Luomi, M., 2014. Mainstreaming Climate Policy in the Gulf Cooperation Council States.

Meadows, K.A., 2003. 'So you want to do research? 5: Questionnaire design', *British journal of community nursing*, 8(12), pp. 562-570.

Mendelsohn, R., Basist, A., Kurukulasuriya, P. and Dinar, A., 2007. Climate and rural income. *Climatic Change*, *81*(1), pp.101-118.

Munawar. 2017, 'How will climate change impact construction and real estate in the UAE?'. [online] TakticalRealty.com. Available at: https://takticalrealty.com/news/7490/how-will-climate-change-impact-construction-and-real-estate-in-the-uae [Accessed 24 May 2017].

Neuman, W.L. and Robson, K., 2014. *Basics of social research*. Pearson Canada.

Palmer, C. & Creagh, S. 2013, 'Climate Change Linked to Declines in Labour Productivity'. Viewed on 24th March 2017 at; http://theconversation.com/climate-change-linked-to-declines-in-labour-productivity-12407

Radhi, H., 2010, 'On the effect of global warming and the UAE built environment'. INTECH Open Access Publisher.

Rashid, H.A., 2015. Weather Effect on Workflow, and Labor Productivity of Construction Plant.

Saunders, M.N.K., Thornhill, A. & Lewis, P., 2009. *Research methods for business students*. Pearson.

Shabeeh, R. 2017. 'How climate change can impact UAE industries'. *Khaleej Times*. [online] Available at: http://www.khaleejtimes.com/a-warmer-world-by-more-than-15-c-its-impact-on-industries-in-the-uae [Accessed 24 May 2017].

Suliman, A.S., 2009. 'Cyclone disaster management: A case study of MODES experience with Cyclone Gonu', *Indian Ocean tropical cyclones and climate change, 4*, pp. 277-285.

Tavakol, M. & Dennick, R., 2011. 'Making sense of Cronbach's alpha', *International journal of medical education, 2*, pp. 53-55.

Tolba, M.K. and Saab, N.W., 2009, 'Arab Environment–Climate Change: Impact of Climate Change on Arab Countries (Beirut: Arab Forum for Environment and Development; Technical Publications and Environment & Development magazine)'.

Williams, C. 2007. 'Research methods', *Journal of business & economics research, 5(3)*, pp. 65-72.

Xiang, J., Peng, B.I., Pisaniello, D. and Hansen, A., 2014. Health impacts of workplace heat exposure: an epidemiological review. *Industrial health*, *52*(2), pp.91-101.

Yildirim, K., Koyuncu, C. and Koyuncu, J., 2009, 'Does Temperature Affect Labor Productivity: Cross-Country Evidence'. *Applied Econometrics and International Development*, *9*(1), pp.29-39.

APPENDIX A: QUESTIONNAIRE

Section 1

1. Kindly indicate your gender

- Male
- Female

2. Kindly indicate your age

_____

3. Tick on the option that describes your years of experience in the construction industry

- Below 3 years
- 3-6 years
- 6-9 years
- 10-13 years
- 13 and above

4. Kindly tick on your specific area designation in the construction industry

- Carpenter
- Concrete laborers
- Construction assistant
- Construction laborers
- Construction manager
- Construction worker
- Roofer
- Plumber
- Operating engineer
- Masonry workers
- Equipment operator
- Electricians

- Crane operator

Section 2

5. Kindly indicate your knowledge and experience in the following five areas using the five-point scale ("1" means that you do not have any knowledge and experience in this field while "5" means that your knowledge and experience are significant)

Field	1	2	3	4	5
Site Operations					
Equipment's efficiency					
Measuring labour productivity					
Monitoring employees' health					
Monitoring the overall financial productivity					

6. Kindly indicate the significance of climate change in the United Arab Emirates in accordance with your personal opinion

1	2	3	4	5

7. Kindly indicate the significance of risk factors in the UAE's construction industry which are listed above

Risk Factor	1	2	3	4	5
Inefficiency of materials					
Freezing ground					
Low morale of employees					
A substantial number of work delays					
Premature breakdowns of equipment					
Slowing down of the cement hydration process					
Increased water leakage in the building structure					
Decrease in labour productivity due to excessive sweating of employees					
Decrease in labour productivity due to employees' increased fatigue					
Decrease in labour productivity due to employees' dizziness					
Decrease in labour productivity due to employees' dehydration					
Decrease in labour productivity due to employees' freezing					
Decrease in labour productivity because of employees' vulnerability to falls due to frost					
Employees' suffering from a heat stress					

Employees' risk of catching a flu					
Employees' risk of suffering from a pneumonia					
Decreased overall financial productivity due to the wear and tear of equipment					
Decreased overall financial productivity due to delays					
Decreased overall financial productivity due to the loss of human labour because of workers' deaths					
Decreased overall financial productivity due to a total destruction of construction projects because of floods, winds, or storm					
Decreased overall financial productivity due to excessive project costs					

Section 3

8. Can working under extreme weather conditions limit your activities?

- Yes
- No

9. Can working under extreme weather conditions worsen your health?

- Yes
- No

10. Can working under extreme weather conditions decrease your working morale?

- Yes
- No

11. Based on the impacts you have identified above, kindly tick on the factors that you feel should be implemented by the government, construction industry, or citizens to mitigate the impact of climate change on the construction industry

- Construction project managers and workers should follow recommended building codes for masonry and concrete work
- Citizens should avoid activities that increase climate acidification
- Government should provide necessary measures to prevent causes of climate pollution
- Government should put necessary measures to prevent the negative impact of climate change

APPENDIX B: CRONBACH'S ALPHA TEST

Test results for SITE OPERATIONS	
Mean	13.92857143
SD	2.889989761
Cronbach a	0.737018937
SEM	1.48203528
Number of questions	4

Test results for EFFICIENCY OF EQUIPMENT	
Mean	10.375
SD	2.049063375
Cronbach a	0.598313967
SEM	1.298669845
Number of questions	3

Test results for LABOUR	
Mean	19.375
SD	4.10819086
Cronbach a	0.773185709
SEM	1.956526884
Number of questions	6

Test results for EMPLOYEES' HEALTH	
Mean	9.107142857
SD	2.540237415
Cronbach a	0.692627001
SEM	1.408338868
Number of questions	3

Test results for OVERALL FINANCIAL PRODUCTIVITY	
Mean	17.5
SD	3.139608711
Cronbach a	0.675668025
SEM	1.788011915
Number of questions	5

Test results for RISK FACTORS IN THE CONSTRUCTION INDUSTRY	
Mean	70.28571429
SD	10.91642649
Cronbach a	0.852664217
SEM	4.190198643
Number of questions	21

APPENDIX C. ANOVA TABLES

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.796731702
R Square	0.634781406
Adjusted R Square	0.60613681
Standard R	0.664789583
Observations	56

ANOVA

	df	*SS*	*MS*	*F*
Regression	4	39.17508103	9.793770258	22.1
Residual	51	22.53920468	0.44194519	
Total	55	61.71428571		

	Coefficients	*Standard Error*	*t Stat*	*P-Val*
Intercept	-0.440171449	0.465608502	-0.945368152	0.34
Inefficiency of materials	0.262745572	0.114754104	2.289639878	0.02
Freezing ground	0.312862106	0.119726592	2.613137992	0.01
Low morale of employees	0.294084378	0.111362664	2.640780744	0.01
A substantial number of work delays	0.281805495	0.108163428	2.605367653	0.01

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.557381552
R Square	0.310674194
Adjusted R Square	0.270905398
Standard R	0.904489335
Observations	56

ANOVA

	df	*SS*	*MS*	
Regression	3	19.17303599	6.391011997	7.
Residual	52	42.54124972	0.818100956	
Total	55	61.71428571		

	Coefficients	*Standard Error*	*t Stat*	*P-V*

Intercept	0.713538269	0.612503486	1.16495381	0.
Premature breakdowns of equipment	0.353405875	0.136091036	2.59683433	0.
Cement hydration process' slowing down	0.162935838	0.120727504	1.349616555	0.
Increased water leakage in the building structure	0.307318095	0.112133372	2.740647929	0

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.738960865
R Square	0.546063159
Adjusted R Square	0.490479057
Standard R	0.756123139
Observations	56

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	df	*SS*	*MS*	*F*
Regression	6	33.69989784	5.616649641	9.82408873
Residual	49	28.01438787	0.571722201	
Total	55	61.71428571		

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	-0.03460323	0.500511037	-0.069135799	0.94516289
Excessive sweating	0.102038246	0.122051398	0.836026846	0.40719824
Increased fatique	0.249686617	0.109337539	2.283631204	0.02676631
Dizziness	0.179436595	0.127547585	1.406820791	0.16579173
Dehydration	0.166319507	0.122109923	1.362047438	0.17941191
Freezing	0.185241048	0.090436203	2.048306337	0.04590732
Falls due to frost	0.254743102	0.103943966	2.450773358	0.0178707

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.557260954
R Square	0.310539771
Adjusted R Square	0.270763219
Standard R	0.904577521
Observations	56

ANOVA

	df	*SS*	*MS*	*F*	*Sig*
Regression	3	19.16474014	6.388246712	7.807106387	
Residual	52	42.54954558	0.818260492		
Total	55	61.71428571			

	Coefficients	*Standard Error*	*t Stat*	*P-Value*
Intercept	1.387493952	0.488407719	2.840851807	0.006409777
Suffering from a heat stress	0.240846201	0.136148581	1.768995312	0.08275929
Catching a flue	0.289379194	0.136959737	2.112877845	0.039430348
Pneumonia	0.163896525	0.121530385	1.348605326	0.183308223

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.553146957
R Square	0.305971556
Adjusted R Square	0.236568711
Standard R	0.925542756
Observations	56

ANOVA

	df	*SS*	*MS*
Regression	5	18.88281601	3.776563203
Residual	50	42.8314697	0.856629394
Total	55	61.71428571	

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.678940179	0.729047706	0.931269893
Decreased profits due to the wear and tear of equipment	0.171229294	0.109116474	1.569234119
Decreased profits due to delays	0.16898154	0.12474958	1.354566004
Decreased profits due to the deaths of workers	0.035716572	0.134891389	0.264780224
Total destruction of projects because of weather floods, winds, or storm	0.316603323	0.114280177	2.770413306
Excessive project costs	0.107884015	0.134139428	0.804267741