NEGATIVE ENVIRONMENTAL IMPACTS OF CONSTRUCTION ACTIVITIES IN SNNPRS:

(THE CASE OF BUILDING CONSTRUCTION PROJECTS IN SELECTED TOWNS)

MSc. THESIS

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A THESIS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING
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ADVISOR'S APPROVAL SHEET

This is to certify that the thesis entitled "**Negative Environmental Impacts of Construction Activities in SNNPRS: (The Case of Building Construction Projects in Selected Towns)**" submitted in partial fulfillment of the requirements for the degree of Masters of Science with specialization in construction technology and management, the Graduate Program of the School of Civil Engineering, and has been carried out by **Yidnekachew Esayas**; **ID. No. PG CoTM/049/09**, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence, hereby can submit the thesis to the school.

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We, the undersigned, members of the Board of Examiners of the final Open Defense by Yidnekachew Esayas, have read and evaluated his thesis entitled "**Negative Environmental Impacts of Construction Activities in SNNPRS: (The Case of Building Construction Projects in Selected Towns)**", and examined the candidate. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirement for the Degree of Masters of Science in Civil Engineering (Construction Technology and Management).

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DECLARATION

Here with I declare that, this thesis prepared for the partial fulfillment of the requirements for M.Sc. Degree in Construction Technology and Management entitled **"Negative Environmental Impacts of Construction Activities in SNNPRS: (The Case of Building Construction Projects in Selected Towns)"** is prepared with my own effort except for secondary sources which have been acknowledged, as listed in the bibliography. I have made it independently with the close advice and guidance of my advisor.

Yidnekachew Esayas

Signature: _______________

Date: _______________

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ABBREVIATIONS

BC	Building Contractor
CIP	Construction Industry Policy
CIRIA	Construction Industry Research and Information Association
ECA	Economic Commission for Africa
ECDSWC	Ethiopian Construction Design and Supervision Works Corporation
EEA	Ethiopian Economic Association
EIA	Environmental Impact Assessment
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management Systems
EPA	Environmental Protection Authority
FDRE	Federal Democratic Republic of Ethiopia
GC	General Contractor
GDP	Gross Domestic Product
H_0	Null Hypothesis
H_A	Alternative Hypothesis
ISO	International Organization for Standardization
NEPA	National Environmental Policy Act
PLC	Private Limited Company
RII	Relative Importance Index
SNNPRS	Southern Nation Nationalities People Regional States
UNDP	United Nations Development Program
UNEP	United Nation Environment Program
WHO	World Health Organization

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ABSTRACT

Construction activities affect the environment throughout the life cycle of development. Even though the construction period is comparatively shorter in relation to the other stages of a building's life, it has diverse significant effects on the environment. This study was carried out to identify the major environmental impacts of construction activities on building construction projects of selected towns in SNNPRS and to propose measures for their mitigation. Eleven site activities adversely affecting the environment; thirty-three possible environmental impacts of construction activities; and four groups of people likely to be affected by construction site activities were identified from literature. The 33 impacts were further categorized into nine major groups. The main approaches used in collecting data for the study were through questionnaire survey, and personal observations of some major construction sites in selected towns. Questionnaires were distributed to a total of 174 purposively selected respondents consisting of 58 contractors, 58 consultants and 58 nearby residents on 58 active building construction projects in selected towns. The respondents were asked to identify the most important item from the listed. The relative importance of the items identified were calculated and ranked by the relative importance index. According to the results of the study, the respondents agreed that concrete vibration; concrete batching, mixing and placement; and excavation are the main site activities having adverse environmental impacts in selected towns. Also resource consumption group impacts ranked highest among the major environmental impacts of construction activities in selected towns. The resource consumption group impacts were raw materials consumption, electricity consumption, water consumption and fuel consumption. Local issues impacts was second followed by transport issues impacts. Noise and vibration generation from local issues impacts group was ranked highest of all environmental impacts of construction activities. The respondents also agreed that site workers, nearby residents, and people in schools and hospitals are most likely to be adversely affected by construction site activities. The results of this study will be useful to support the implementation of environmental management systems in construction companies by providing guidance for construction practitioners. The paper recommends that stakeholders in the construction industry should start working with new methods and technologies following sustainable construction techniques to reduce environmental impacts.

Keywords: Construction activities, construction industry, environmental impacts, SNNPRS

1. INTRODUCTION

1.1 Background

The construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. For instance, the share of the sector in the total GDP averaged at about 5.2 percent in the period 2002/03- 2006/07.The sector has registered relatively higher growth as compared to the growth of GDP during this period. Over this period, there has been increased investment on the development and expansion of various infrastructure projects like roads, airports and residential and non-residential housing units (EEA, 2008).

Nowadays construction projects in SNNPRS are increasing from time to time. The Second Growth and Transformation Plan of the Ethiopian Government, rapid growth of cities, and the increasing demand of housing have tremendously increased the number of construction projects in the region. Construction of industrial parks, international hotels, different multi-purpose buildings, highways, and irrigations being undertaken can be mentioned as examples. This shows the emphasis that is given for the construction sector in the region (Sisay, 2018).

However, it has been a major source of environmental damage and occupational health problems. A number of the industry's activities are environmentally not sustainable partly due to lack of awareness of environmentally sound practices and technologies. Construction activities affect the environment in many ways: through resource deterioration, physical disruption and chemical pollution. Large civil engineering projects can easily destabilize fragile hill slopes. Deforestation associated with construction can cause loss of land by soil erosion, silting of reservoirs and disruption of aquatic ecosystems. Cement, lime and bitumen production pollutes the atmosphere. Furthermore, it has long been recognized that many types of construction activities present serious health hazards (FDRE, 2012).

Construction project performance has traditionally been measured in terms of time, cost and quality. Lately, environment has been considered the fourth dimension (Shen and Zhang, 1999) and construction organizations have been urged to adopt environmental management systems (EMS) in order to improve their environmental performance (Tam et al., 2006).

According to Plessis (2002), although the relationship between construction activities and the environment has been extensively studied and has become of strategic importance in the developed countries, the situation is different in many developing countries including Ethiopia.

Construction activities affect the environment throughout the life cycle of development. These impacts occur from initial work on-site through the construction period, operational period and to the final demolition when a building comes to an end of its life. Even though the construction period is comparatively shorter in relation to the other stages of a building's life, it has diverse significant effects on the environment. For that matter, there is progressively growing concern about the impact of construction activities on human and environmental health. Even though, construction project development potentially contributes to the economic and social development, and enhancing both the standard of living and the quality of life, it is also associated with deterioration of the environment (Azqueta, 1992).

Plessis (2002) observed that sustainable construction in developing countries tends to focus on the relationship between construction and human development, often marginalizing the environmental aspect. In his opinion biophysical considerations in the built environment has not been clearly articulated beyond the impact on environmental health, but hoped that with the severe environmental degradation experienced by most of the developing world, the construction industry cannot continue to ignore the environment.

Environmental impact assessment (EIA) is an important management tool to identify the major environmental impacts of construction projects to improve the effectiveness of environmental management systems. Prediction of the environmental impacts of construction project before the construction work, leads to improvements in the environmental performance of construction projects and sites. A construction project causes great impact on the environment. It is necessary to provide mitigation measures to minimize the fast growing threat of environmental impacts of construction projects (Vivek et al., 2016).

The state of affairs of the construction industry in Ethiopia is not quite different from other developing countries. The focus of the Ethiopian construction industry is largely on economic growth and improving the quality of life of the people whilst environmental protection is utterly downgraded. It is against this backdrop that investigating the major impacts of construction activities on the environment in Ethiopia, particularly in SNNPRS and recommending measures to minimize the impacts assume great importance.

Due to the nature of activities of construction, it is commonly related to changes of environmental aspect. It always generates both the positive and negative impacts to the environment. In this regards, this research concerns on the negative (harmful) impacts towards the environment.

1.2 Statement of the Problem

The growing attention on the interactions between development actions and their environmental consequences, and the issue of sustainability has become an overarching goal and frame of reference of conservation and development strategies. The achievement of sustainable development requires a framework of strategies and approaches. One of these approaches is protection of environment during various development actions including execution of construction projects. To achieve this, identification of various environmental impacts and proposing the mitigation measures during construction activities is highly needed.

Construction industry is a big industry in world approximately half of the population depend upon the construction industries directly or indirectly. It is a backbone of all sectors or maximum contribution in country economy. But negative impact of construction site activities is big challenging face for all countries (Jain et al., 2016).

Because of their size and profound societal importance, construction activities and processes are among the largest consumers of materials and energy and significant polluters on the global scale. For these reasons, more attention should be devoted to understanding, researching, and ultimately reducing their environmental impacts (Jain et al., 2016).

Therefore, development of construction industry in Ethiopia as a whole and southern region particularly can cause significant environmental damages and threaten the natural resources base, and the socio-economic and public health of the community unless they are properly and adequately identified, planned and managed properly. This study is therefore an attempt to address such issues.

1.3 Research Questions

Four questions were considered in my study to develop the conceptual framework of the problem. Those were:

1. What are the site activities adversely affecting the environment?
2. What are the negative environmental impacts resulting from construction activities of selected construction sites in the region and their level of severity?
3. Who are likely to be affected by negative effects of construction site activities?
4. What are the mitigation measures taken by construction practitioners toward environmental impacts from construction activities?

1.4 Objective of the Study

1.4.1 General Objective

The general objective of this study was to identify the major environmental impacts of construction activities with their level of severity and to propose measures to be taken to minimize them on building construction projects of selected towns in SNNPRS.

1.4.2 Specific Objectives

1. To identify site activities adversely affecting the environment
2. To identify negative environmental impacts resulting from construction activities of selected construction sites in the region and rank their level of severity
3. To differentiate people likely to be affected by negative effects of construction site activities
4. To assess the mitigation measures taken by construction practitioners toward environmental impacts from construction activities

1.5 Significance of the Study

The outcome of this study will be significant to the key stakeholders in the Ethiopian construction industry such as contractors, consultants, project owners (clients), educational institutions and professional associations. This study will provide sufficient information on environmental impacts of construction activities of selected projects in the region and propose measures for their mitigation. This research will be also important to raise awareness of contractors, consultants, site workers, permitting agents and nearby residents regarding environmental impacts and their level of severity and understand the methods of reduction.

The results of this study will be applicable to the Ethiopian construction industry towards effective environmental management plan of construction practitioners (contractors and consultants) and permitting agents during execution of construction projects to protect health and safety of the workers on site and nearby residents from environmental impacts resulting from construction activities.

1.6 Limitation of the Study

The main scope of this study was on on–going building construction projects within selected towns of SNNPRS. The study generally focused on environmental impacts of construction activities in SNNPRS.

During the course of the study, finding literatures written specifically on environmental impacts of construction activities in the case building construction projects posed difficulties when the researcher was reviewing related literature. Time and financial constraints cannot be understated since a thesis of this nature and magnitude requires ample time and funds. Part of the data for this study was retrieved from secondary sources and questionnaire responses (primary) and therefore, the authenticity of the data was dependent on the accuracy of the data accessed. Due to shortage of time and other constraints the study included only building construction projects.

1.7 Possible Beneficiaries of the Results

- Parties working on Environment

- Contractors
- Consultants
- Project owners
- The general public
- Educational Institutions
- Professional Associations (Ethiopian Civil Engineers Association, Construction Contractors Association of Ethiopia).
- Future studies in construction management and related topics

1.8 Organization of the Research

This thesis is divided into five chapters that organize, illustrate, and describe the steps taken to meet the defined research objectives. This thesis is organized as follows:

Chapter one is an introductory part containing discussions on background, statement of problems, objective of the research, significance of the research, scope and limitation of the research, application of the results, possible beneficiaries of the results and organization or layout of the research.

Chapter two presents literature review with general descriptions by different writers and researchers on environmental impacts of construction activities.

Chapter three discusses about research methodology and design.

Chapter four presents results and discussion of the research findings.

Chapter five contains conclusions and recommendations based on what is discussed in the previous chapters.

2. LITERATURE REVIEW

2.1 Introduction

An extensive literature review was conducted to demonstrate relevant knowledge and existing research to establish a solid starting point to pursue the proposed study. The purpose of this chapter is carrying out a detail literature review about environmental impacts of construction activities. A review of books, journal articles, thesis and relevant website are carried out to develop this chapter.

2.2 Construction and the Environment

The environment is defined by Tulloch (1994) as physical surroundings and conditions, especially as affecting people’s lives; conditions or circumstances of living; external conditions affecting the growth of plants and animals. Other terms to describe environment are: surroundings, atmosphere, climate, habitat, territory, biosphere, ecosystem, and nature. The term also may include aspects such as cities, towns and villages (the urban or built environment), culture in all its manifestations, history, lifestyle and quality of life (Muhwezi et al., 2012).

According to FDRE (2002), "Environment" means the totality of all materials whether in their natural state or modified or changed by humans, their external spaces and the interactions which affect their quality or quantity and the welfare of human or other living beings, including but not restricted to, land, atmosphere, weather and climate, water, living things, sound, odour, taste, social factors, and aesthetics.

Atmosphere: the layer of gases that surrounds the earth.
Hydrosphere: all the water on earth.
Geosphere: all the rock and soil on the continents and on the ocean floor.
Biosphere: made up of all earth’s living things

Construction is defined as a process that consists of building or assembling of a structure. On the other hand, a construction project includes all material and work necessary for the construction of a finished structure for occupancy by end user. This includes site preparation, foundations, mechanical, electrical work, and any other work necessary to complete the project (Muhwezi et al., 2012).

Environment is something that surrounds us, air, water and land. Environment consists of all resources that are available on this planet which are being used and harnessed or are pristine. Construction consumes our finite and non-replaceable resources; renewables and non-renewables. The irony of the fact is that around 50% of all non-renewable resources mankind consumes are used in construction, making it one of the least sustainable industries in the world (Roodman and Lenssen, 1995).

Construction sector is a big sector for every country growth. All the citizens directly or indirectly connect in this sector. It is the main source of income of about 30% percent population in the world. About half of renewable and half of nonrenewable resource used in this sector make construction industry less sustainable in world (Dixon, 2010). Estimating the resources used in buildings are : i) Energy 45-50% ii) water in 50% iii) materials used in building and road (by bulk) 60% iv) agricultural land uses 80%, v) timber product uses 60% out of which 90% use as a hardwood (Hawken et al., 1999). It clearly shows that construction industry is a big industry sector in the world but due to certain negative impact of construction site activities have abhor the worker in this sector. It is a big challenge for construction world and all workers face this problem. The negative impact of construction site activities on environment has recently recognized in this world (Jain et al., 2016).

The construction industry has a significant irreversible impact on the environment across a broad spectrum of its activities during the off-site, on site and operational activities, which alter ecological integrity (Uher, 1999). According to Levin (1997), buildings are very large contributors to environmental deterioration. Therefore the analysis of the impact of the construction activities on the environment may need to look at a “cradle to grave” view point (Ofori et al., 2000).

According to Asmawi (2010), construction activities gain a lot of momentum since the era of industrial revolution. It is among the measures of nation’s level of development through provision of basic infrastructures such as housing, roads, schools and many others. It is also a key factor in economic growth. The activities of this construction take place within the environment and with the support of the environmental resources.

The construction activity has numerous effects on the environment, because it ends up making the soil to be compact and impermeable to rainwater (Lowton, 1997). This specifically gives rise to erosion because as rain falls, the vegetal resources that absorb the water and reduce direct fall on the ground surface is destroyed, and the ground itself that absorbs most of the water is occupied by structures covered with cement, glasses and tiles. This subsequently leads to flash floods, erosion and expansion of flood plains. The presence of vegetal resources moderates the concentration of carbon dioxide in the atmosphere and used by the plants during the process of photosynthesis. Construction activities from inception to completion stages are always associated with the destruction of environmental resources (Asmawi, 2010).

Due to the nature of activities of construction, it is commonly related to changes of environmental aspect. It always generates both the positive and negative impacts to the environment. Negative impacts towards the environment include:

2.2.1 Environmental Degradation

Despite the fact that construction plays a vital role in physical, economic and social development of the nation, it is also linked to other environmental problems such as over extraction of raw materials from the environmental resources, reduction in water quality and degradation of valuable resource which is land. One sixth of the world fresh water, one quarter of the wood harvest, two fifth of its material and energy flow is affected because of the activities of construction industries (Darci L., 2008).

According to Asmawi (2010), since industrial revolution, the environment has been suffering severe environmental degradation such as vegetal destruction and land degradation as a result of disturbances on the natural resources of the environment, and gave raise to various ecological problems and land use changes.

2.2.2 Environmental Stress

Construction activities exert more stress on the environment especially through emission of dust particles, toxic and other construction waste into the atmosphere. These wastes in the atmosphere are considered potential threats to public health. Vibration on construction sites during construction activities is a major stress on the environment and may result to seismic activities (Asmawi, 2010). According to BaoShan et al. (2007), large-scale engineering construction has caused the enormous pressure to the regional ecological environment and changed the regional ecological balance. Others include increase solar radiation received and increased intensity of rainfall which results to flooding.

2.2.3 Loss of Habitats

According to Asmawi (2010), the three greatest and most imminent threats to the survival of our civilization are global warming, peak oil (the growing energy gap between supply and demand) and resource depletion. Habitat destruction can have a more immediate and disastrous effect on certain localized areas and species.

The construction needs area, and the first step is land clearing and that normally involves destruction of vegetal resources and may result to the expansion of flood plains (Jesse et al., 2006).

It is hard to keep track of the number of species made extinct every year, and of the further destruction of biodiversity and rare habitats. However the fact that the construction industry is such a huge consumer of materials, particularly of imported chemicals, minerals, metals and organic materials such as timber, inevitably means it has a huge impact and obviously has the greatest impact of any sector in one nation, on habitat erosion and destruction globally (Asmawi, 2010).

Lumber which is a forest product is a major component of building materials and is utilized extensively in both building and infrastructure construction. Plants are fragile living organisms and if too many are removed, it can lead in some areas to environmental catastrophes (Beer and Higgins, 2000).

At present the whole world is heading in the opposite direction, and we will lose huge areas of unique habitat forever in the coming years unless we change the way we consume such materials. This is particularly as regards how we build. It means using less of these materials by building more simply, with more local and plentiful (i.e. sustainable and renewable) materials and with less waste (Asmawi, 2010).

2.2.4 Environmental Pollution

Finally the environmental impact of construction is also experienced in terms of pollution. This is not in the extraction but in the processing of materials for construction. Not surprisingly, the construction industry has the biggest effect of all sector because of the quantity of materials used in construction (Asmawi, 2010).

According to Wilmont Dixon (2010), construction causes pollution. The construction business in many countries is responsible for nearly a third of all industry-related pollution incidents. There is no construction which does not have an environmental impact. The main aspect of construction is making buildings of varied uses be it for residential, commercial, industrial, recreation, healthcare or any other purposes. The estimate of global pollution that can be attributed to buildings is air pollution 23%, climate change gases 50%, drinking water pollution 40%, landfill waste 50% and ozone depletion 50%.

2.2.5 Impacts of Climate Change

Construction of new buildings will add up the existing carbon (CO_2) emission. For example, building use in the UK alone contributes about 50% of the UK's CO_2 emissions and construction contributes about another 7%. It is evident that the Government figures on energy performance of houses grossly underestimate the CO_2 gains that could be made by building energy efficient buildings. The main base performance criteria for energy efficient buildings all concern the thermal performance of the building shell where most of the CO_2 gains can be most easily made (Asmawi, 2010).

2.2.6 Waste Problem

Like any other economic activity, construction uses natural resources and generates waste. The amount of waste generated by construction and demolition activity is substantial. Surveys conducted in several countries found that it is as high as 20% to 30% of the total waste entering landfills throughout the world (Couto and Couto, 2003).

According to Asmawi (2010), it is a fact that construction industry is the major sector that generates waste. The waste can be categorized into two namely: waste generated during the construction activities and waste generated as a result of demolition. Construction waste is a global environmental problem which becomes burden of the environment; this is due to its difficulty to be recycled due to its features like bulk in size and its material and also difficulty to decompose easily.

2.3 Sustainable Construction

2.3.1 The Concept of Sustainability

'Sustainable development', according to the popular definition proposed by Bruntland (1987), is development which meets the needs of the present without compromising the ability of future generations to meet their needs.

The term sustainability refers to the utilization of the available physical and natural resources by the present generation without disclaiming the future generation to also meet their own. It means achieving four objectives at the same time: effective protection of the environment; prudent use of natural resources; social progress which recognizes the needs of everyone; and maintenance of high and stable levels of economic growth and employment (Boswell and Walker, 2009). It is an effort towards efficient utilization of resources. In order to achieve sustainability, there must be a balance between demand of natural resources by the construction industries and supply by nature.

It also goes along with the three Rs (which are: reduce, reuse and recycle). These three terms have been the major emphasis of most sustainable development programmes. Reusing and recycling of wastes is among the best methods to improve the environment, and these helps in minimizing the extraction and consumption of resources. According to Marinković et al. (2010), recycling of construction and development wastes represents on way to convert a waste product into a resource, where the environment benefits through energy consumption, emissions and fallouts reductions.

The sustainability of construction depends on the level of its environmental consideration, economic benefits, social and cultural compliance. Sustainability in construction entails utilization of suitable materials that are recyclable, choose the right construction materials that will ensure energy and resource efficiency in order to improve performance and be ecologically friendly. Sustainable construction could therefore be described as a way of designing and constructing buildings that support human health (physical, psychological, and social) and - which is in harmony with nature, both animate and inanimate (Hendriks and Janssen, 2003).

Sustainable construction aims at reducing the environmental impact of a building over its entire lifetime, while optimizing its economic viability and the comfort and safety of its occupants. Creating sustainable buildings starts with proper site selection, including consideration of the reuse or rehabilitation of existing buildings (Muhwezi et al., 2012).

Schaefer (1994) argued that architects, developers, builders and owners often overlook the site as one of the significant elements of sustainable development and construction. So far, development proceeds in a heroic mode - that nature is to be conquered, mastered and subdued for economic gain. According to Ayarkwa et al. (2014), the construction industry is therefore challenged to adopt sustainable approaches to its operations.

Housing and infrastructural development which are very resource intensive, will so much negatively impact the physical environment. The call for sustainable construction is in the realization of the construction industry's capacity to make a significant contribution to environmental sustainability because of the enormous demands it exerts on global resources (Plessis, 2002).

A construction activity is a diverse in nature and it involves professionals from various backgrounds. Table 2 shows the efforts and actions of various professionals towards development and environmental protection in order to achieve sustainability.

Table 2.1: Interrelationship between construction and other professions (Asmawi, 2010).

Professions	Actions towards sustainability
Town Planning	➢ Developing green neigbourhood planning index. ➢ Incorporating environmental elements into planning system in a sustainable manner.
Architecture	➢ Designing of green buildings index. ➢ Recommending environmentally friendly building materials

Engineering	➢ Adoption of environmentally friendly approach in its engineering works. ➢ Recycling leftover materials use of sustainable materials such as nanomaterial, etc. ➢ Applying green construction method.
End users	➢ Use of sustainable energies.

2.3.2 Environmental Protection in Construction

The above definitions and features of sustainable construction suggest that it forms part of an effort to create a healthy built environment through resource efficient and ecologically sound processes, preservation of ecosystems and maintenance of a balance between development and the carrying capacity of the planet.

Ofori (1992) suggested that to develop a culture of environmental protection in construction, clients should adopt 'the environment' as a 'fourth' project objective in addition to the usual ones of time, quality and cost. Ofori and Chan (1999) argued that contractual agreements between clients and contractors on environmental issues could help to achieve sustainable construction. Stenberg and Kadefors (1999) observed that since construction projects are unique, producers are not driven to invest in innovations that do not pay back in an individual project. Thus, the role of the client in 'greening' construction is vital. CIRIA (1995) advises clients to set up an environmental policy for each project and to consider environmental track records in the selection of consultants and contractors.

Barrett et al. (1998) show that sustainability issues cannot be fully internalized and acted upon in construction firms if sustainability is treated as a discrete problem with an isolated solution. Environmental performance improvement requires strategic focus, and an objective-nested, integrated approach involving quality, health, safety and environmental management systems.

Emitt (1998) suggests that to attain environmentally responsible construction, all practitioners must make a commitment, change their behavior and adopt new products, ideas and practices.

2.3.3 Environmental Management Systems (EMS)

Hawken (1993) notes that, because of regulatory and competitive pressures, businesses are faced with the challenge of integrating environmental considerations into their production and marketing plans.

The construction industry must understand the nature and impact of the environmental damage it causes and take practical measures to address the problems. By corporate environmental management, companies can attain a trade-off between economic growth and the sustainability of the environment. They can meet the customers' pressure for environmentally sound practices, reduce costs and avoid infringing environmental legislation (Ofori et al., 2000).

Although quality management systems have been successfully implemented by contractors over the last 25 years, environmental management systems are less common in construction companies. The two main environmental management certification schemes are the European-wide Eco-Management and Audit Scheme (EMAS) and the worldwide ISO 14001 (Gangolells et al., 2013).

Once an organization has decided to improve its environmental performance it will need to formulate an EMS. As both Cascio (1996) and Drobny (1997) noted, an EMS is a set of management tools, principles and procedures which an organization can use to help protect the environment from the potential impacts of its activities, products, and services. The EMS outlined in ISO 14000 enables companies to adopt proactive measures to manage their processes and procedures to avoid adverse effects on the environment and to comply with the provisions of environmental regulations.

According to Tam et al. (2006), construction organizations have been urged to adopt environmental management systems (EMS) in order to improve their environmental performance.

2.4 Identification of Environmental Impacts of Construction Activities

The construction industry plays an indispensable role in providing physical infrastructure to meet the growing societal needs. On the other hand, it brings about detrimental effects, such as various forms of environmental pollution and resources depletion (Ofori et al., 2000).

Enhancing the identification of the major environmental impacts of construction processes will help to improve the effectiveness of environmental management systems. Furthermore, prediction of the correlated environmental impacts of construction before the construction stage, will lead to improvements in the environmental performance of construction projects and sites. The determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate them (Gangolells.et al., 2011).

The environmental consequences generated from the construction industry relate to many aspects including: (I) consumption of large amounts of energy during the processing of materials, construction processes and in the use of constructed structures; (ii) dust and gas emission released during the production and transportation of materials and in some construction operations; (iii) disruption of people living in the vicinity of construction projects through traffic diversion, noise pollution and others; (iv) production of substantial volumes of waste; (v) waste water discharge; (vi) use of water resources; (vii) pollution from building materials; (viii) land use and (ix) substantial consumption of both renewable and non-renewable resources (Clements, 1996).

The environmental impacts across construction processes consists of ecosystems impact, natural resources impact, and public impact (Li et al., 2010).

Ecosystems Impact: The accumulated amount of adverse environmental impacts like waste, noise, dust, and hazardous emissions still occur during the construction process which cause serious damages to humans and ecosystems (Chen et al., 2004). With the rise in the number of construction of new buildings, the ecosystems impact of construction has become an important issue.

Natural Resources: Various natural resources namely ‘‘energy’’, ‘‘land”, ‘‘materials’’ and ‘‘water’’ are used during the typical construction process (Shen et al., 2005). Moreover, several construction equipment operations involve consumption of natural resources, such as electricity and/or diesel fuel. The building industry is responsible for using a high volume of natural resources and generation a great amount of pollution as a result of energy consumption during extraction and transportation of raw materials (Li et al., 2010; Morel et al., 2001).

Public Impact: Most construction projects are located in a densely populated area. Thus, people who live at or close to construction sites are prone to harmful effects on their health because of dust, vibration and noise due to certain construction activities such as excavation (Li et al., 2010). A thorough literature review, including (Gangolells et al., 2009; Gangolells et al., 2011; Li et al., 2010; Shen et al., 2005; Tam et al., 2006) was performed in order to develop greater understanding of environmental impacts. The environmental impacts can be developed to the further subcategory. A list of 26 subcategories of environmental impacts was identified through the previous research (Gangolells et al., 2011; Li et al., 2010; Shen et al., 2005). Figure 2.1 provides the hierarchy of environmental performance subcategories as environmental impacts across construction process.

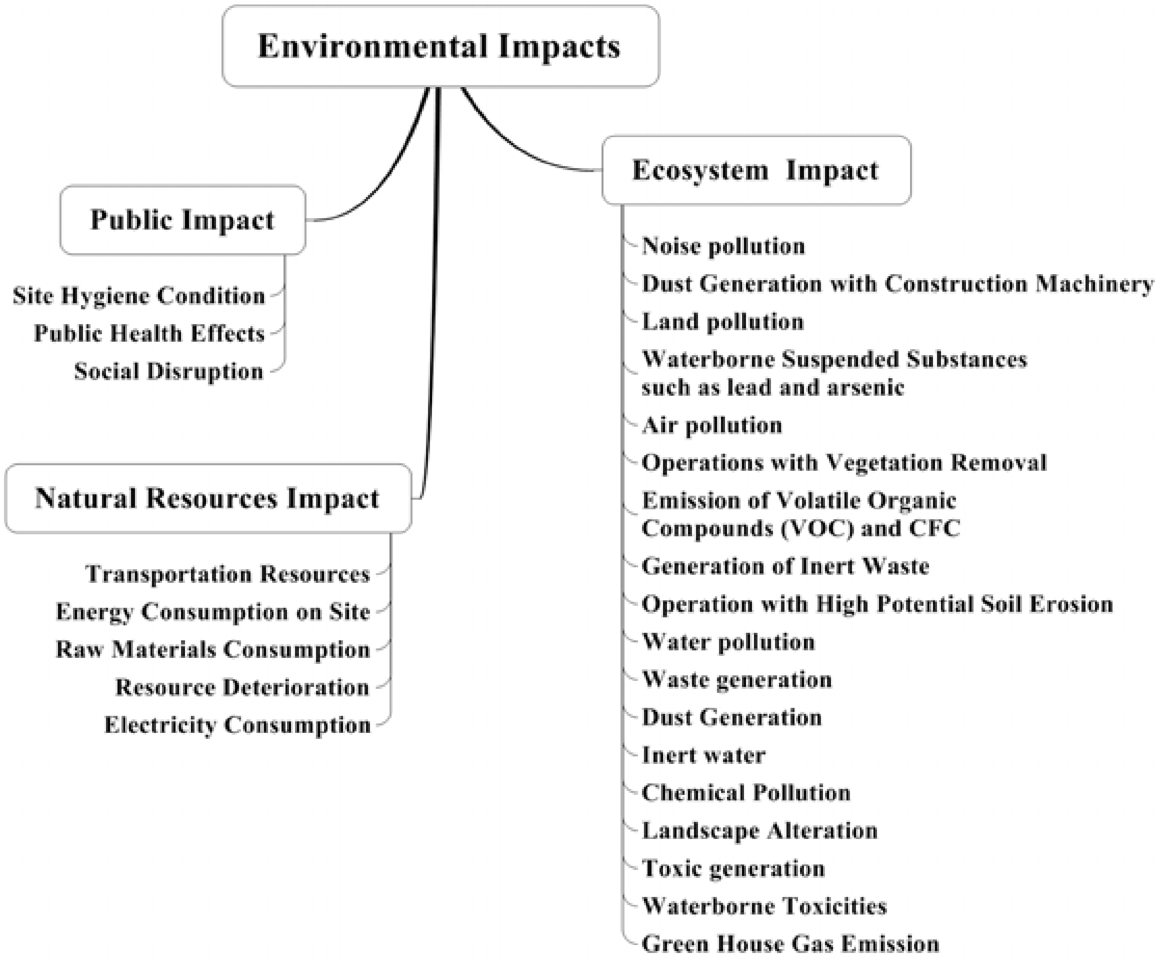


Figure 2.1: Environmental Impacts of Construction Processes (Zolfagharian et al., 2012)

According to Chen et al. (2000), sources of pollution and hazards from construction activities can be divided into seven major types: dust, harmful gases, noises, solid and liquid wastes, fallen objects, ground movements and others. Chen et al. (2005) considered construction impacts under eight categories: soil and ground contamination, underground water contamination, construction and demolition waste, noise and vibration, dust, hazardous emissions and odours, wildlife and natural features impacts and archaeology impacts. On the other hand, Cole (2000) stated that the environmental impacts of the construction process embrace resource uses, ecological loadings and human health issues. March (1992) observed the construction industry’s environmental impacts under the categories of ecology, landscape, traffic, water, energy, timber consumption, noise, dust, sewage, and health and safety hazards. Shen and Tam (2002) classified construction environmental impacts as the extraction of environmental resources such as fossil fuels and minerals; extending consumption of generic resources namely: land, water, air, and energy; the production of waste that require the consumption of land for disposal; and pollution of the living environment with noise, odours, dust, vibrations, chemical and particulate emissions, and solid and sanitary waste. According to Cardoso (2005), typical negative impacts of the construction activities include waste production, mud, dust, soil and water contamination and damage to public drainage systems, destruction of plants, visual impact, noise, traffic increase and parking space shortage and damage to public space.

From the review above, it is apparent that there is no single approach regarding the environmental impacts associated with the construction process in the literature. Eco-Management and Audit Scheme (EMAS) regulation (Gangolells et al., 2009) provides a standardized and comprehensive list of environmental aspects covering almost all the previous mentioned environmental aspects. So finally, guidance provided in EMAS regulation was used to initially identify generic environmental impacts: (1) emissions to air, (2) releases to water, (3) avoidance, recycling, reuse, transportation and disposal of solid and other wastes, particularly hazardous wastes, (4) use and contamination of land, (5) use of natural resources and raw materials (including energy), (6) local issues (noise, vibration, odour, dust, visual appearance, etc.), (7) transport issues, (8) risks of environmental accidents and impacts arising, or likely to arise, as consequences of incidents, accidents and potential emergency situations and (9) effects on biodiversity. However, environmental impacts coming from EMAS regulation had to be customized to the construction processes and for this reason an exhaustive preliminary analysis with a process oriented approach (Zobel and Burman, 2004) was carried out. Environmental impacts provided in EMAS regulation were analyzed for the entire construction process.

Construction practice can have direct and indirect human health effects on construction workers, building occupants and residents near construction sites. Even with careful management, some toxic substances in paints, solvents wood preservatives, pesticides, adhesives and sealants, which are hazardous to workers, are released into the air, soil or water (Ayarkwa et al., 2014). Cole (2000) states that occupants of buildings undergoing remodeling or renovations should also be given adequate degree of protection, since dust and vapours from construction areas are easily transported into occupied zones by air currents, people moving between zones and by heating, ventilation and air conditioning systems.

2.5 Environmental Impacts Assessment (EIA) of Construction Projects

EIA is an important management tool to identify the major environmental impacts of construction projects to improve the effectiveness of environmental management systems. Prediction of the environmental impacts of construction project before the construction work, leads to improvements in the environmental performance of construction projects and sites (Vivek et al., 2016).

2.5.1 Definition and Nature of EIA

Under Ethiopian law, an impact is defined as any change to the environment or to its component that may affect human health or safety, flora, fauna, soil, air, water, climate, natural or cultural heritage, other physical structure, or in general, subsequently alter environmental, social, economic or cultural conditions (FDRE, 2002).

Environmental Impact Assessment (EIA) is a process to assess the environmental consequences of any project and design proper mitigation plans to minimize the possible adverse impacts (Sadler and Verheem, 1996). It is a process of identification, prediction, evaluation, and mitigation of biophysical, social and other relevant effects of developmental activity on environment prior to make commitment (Barlett and Prior, 1991).

According to UNEP (2002), EIA is a systematic process to identify, predict and evaluate the environmental effects of proposed actions and projects. The primary purpose of EIA is to ensure that impacts of projects, policy and programs are adequately and appropriately considered and mitigation measures are incorporated when decisions are taken.

Environmental Impact Assessment (EIA) can broadly be defined as a Process, providing an anticipatory and preventive mechanism for environmental management and protection to achieve sustainable development. It is an administrative process that identifies the potential environmental effects of any proposal along with its advantages and disadvantages on environment. Positive effects are maximized whereas; adverse effects are minimized to greatest possible extent (Vivek et al., 2016).

According to Silesh (2011), Environmental Impact Assessment (EIA) is a systematic process that proactively examines the potential consequences of development actions. As a planning process, the longer-term objective of EIA is to contribute to sustainable development.

EIA was formally introduced in the United States through the National Environmental Policy Act (NEPA) of 1969. According to Goodland (1996), forms of what later became known as environmental assessment had started under town planning, land use and other policies prior to this period. EIA regulations rapidly spread to others, mainly industrialized countries of the world. Today, it is applied in more than 100 countries, and by all development banks and most international aid agencies (ECA, 2005).

In international and national laws, EIA is used as a tool to prevent environmental damage. At the international level, lending banks and bilateral aid agencies have made environmental impact assessment a requirement for lending money (B. Sadler, 1996).

The 1992 Rio declaration also identified Principle 17 that endorses the institutionalization of Environmental Impact Assessment (EIA) at the national level as a decision-making instrument for proposed activities that are likely to have significant adverse impact on the environment (ECA, 2005).

The EIA process involves varies stages and starts with identification of development proposals. Then, screening of the proposal determines whether an EIA is necessary and at what level the assessment should occur. The scoping stage is the process of interaction which aims at identification of: boundaries of the EIA studies, important issues of concern, significant effects and factors to be considered. The next step of the EIA process is undertaking Environmental impact study that involves impact prediction, impact analysis, consideration of alternatives, preparation of management plan (mitigation, monitoring activities), and preparation of contingency plan. Finally, reviewing, decision making and implementation and follow-up will be followed (Silesh, 2011).

2.5.2 EIA Practice in Ethiopia

The government of Ethiopia has established the EIA system for development projects with promulgation of Environmental Impact Assessment Proclamation (Proc. no. 299/2002) (FDRE, 2002). Even though EIA has become a legal requirement after the enactment of the enabling legislation, it has a number of constraints which makes it fall short of realizing its full potential as a frontline instrument to promote sustainable development (Melles and Mesfin, 2008).

Prior to becoming a legal requirement in 2002, the application of EIA in Ethiopia was introduced by a few sectors. The practice of contemplating environmental and health impacts was introduced as early as 1980 into water resources development projects assisted by UNDP/WHO, though the main focus was limited to water-related and water-based health problems (Solomon, 2003). This practice then evolved into a formal requirement in international donor assisted and financed projects in various sectors.

A turning point in the history of EIA in Ethiopia is observed at the recent promulgations of important proclamations including, Establishment of Environmental protection Organs (Proc. No. 295/2002), Environmental Impact Assessment (Proc. No. 299/2002) and Environmental Pollution Prevention and Control (Proc. No. 300/2002). These proclamations have stipulated the need for EIA and institutional issues compounding EIA administration in Ethiopia (EPA, 2006).

According to Silesh (2011), in Ethiopia, EIA is now become a legal requirement and the system has been established. Even though the legal framework and institutional setup are in place to run the system, it is not yet well implemented to help achieving environmentally friendly developments.

The EIA system involves various stages of EIA process. According to the Ethiopian EIA procedural guideline (2000), the major steps in the EIA process that any proposed project subjected to EIA expected to pass through are: prescreening consultation, screening, scoping, environmental impact study, reviewing, decision making and environmental monitoring and auditing (Silesh, 2011).

The EIA proclamation stipulated that every project which falls under the category of lists that require EIA shall be subject to the environmental impact assessment. Based on this provision, projects that require EIA are listed in Directive No.2/2008 issued by EPA. Even in the existence of this directive most of the development proposals owned by private sectors don’t properly pass through the EIA process (Silesh, 2011).

Based on the nature, size and location, the Ethiopian Procedural Guideline categorized projects in to three groups namely projects that requires full scale EIA, preliminary EIA and those that don't require EIA. On other hand, a directive issued to determine the categories of projects subject to EIA, Directive No.2/2008, lists projects requiring only full scale EIA. This is an indication for the existence of an inconsistency in the legal aspects of EIA implementation, where the conflicting legal documents are issued by same institution (Federal EPA).

The Ethiopian EIA proclamation demands the involvement of public particularly communities likely affected by the project during the EIA study and reviewing process (Silesh, 2011).

Ethiopia enacted the Environmental Impact Assessment Proclamation in 2002, providing for EIA and monitoring. This Article mainly focuses on the issue of EIA and monitoring under Ethiopian law. Part II of the Article considers the definition and nature of EIA. Part III deals with the role of EIA in sustainable development. Part IV describes the purpose and scope of EIA. Part V discusses the body that prepares EIA reports. Part VI deals with the criteria that are used to determine whether a project requires an environmental impact assessment. Part VII considers the important elements of an EIA. Part VIII and Part IX address monitoring and enforcement mechanisms, respectively. Conclusions and recommendations (Tesfaye, 2012).

Under Ethiopian law, the project proponent is responsible for undertaking an EIA (FDRE, 2002). The proponent is defined as the initiator of a project - an organ of government in the public sector or a person in the private sector. According to the federal environmental policy, an EIA should be made by the relevant sectorial ministries or departments, if in the public sector, and by the developer, if in the private sector. The underlying presumption is that the developer is the appropriate person to conduct an EIA and submit the information to the decision making agency (Stall Worthy, 2002).

In general, an EIA requires applying relevant scientific multidisciplinary principles and use of experts from different fields such as civil engineering and biology (Tesfaye, 2012).

According to FDRE (2002), in Ethiopia, at minimum, an environmental impact study report should describe:

a) the nature of the project, including the technology and processes to be used;
b) the content and amount of pollutant that will be released during [implementation] as well as during operation;
c) source and amount of energy required for operation;
d) information on likely trans-regional impacts;
e) characteristics and duration of all the estimated direct or indirect, positive or negative impacts;
f) measures proposed to eliminate, minimize, or mitigate negative impacts;
g) contingency plan in case of accident; and
h) procedures of self-auditing and monitoring during implementation and operation.

2.5.3 Objectives of EIA for Construction Projects

According to Vivek et al. (2016), EIA has been used as an effective tool in decision making process for housing projects affecting environmental factors. Objectives of EIA which are considered for housing projects can be summarized as follows:

1. To predict environmental impacts of construction projects due to land use change or modifications.
2. Decision makers considering the environmental costs and benefits before construction projects are started.
3. Reduce adverse impacts during the construction phase.
4. To ensure that the environmental considerations are explicitly addressed and incorporated into the development and decision-making process.
5. To avoid, minimize or offset the adverse significant biophysical, social and other relevant effects on environment.
6. To protect the productivity and capacity of natural systems.
7. To promote sustainable colonies and can optimize resource use as well as management opportunities in future.

2.6 Mitigation Measures to Environmental Impacts from Construction Activities

Following the scoping exercise and the identification of potential environmental effects, mitigation measures should be proposed to avoid or reduce potential negative impacts to air, water, land, ecology and humans, or to introduce and maximize positive aspects to the development (Geho, 2001).

A primary consideration in impact mitigation must be the siting of construction works. The development should avoid damage to important ecological sites and high quality landscapes (Geho, 2001). It is strongly recommended therefore that developers undertake an assessment of alternative sites.

The construction industry has been encouraged to re-use built assets, minimize waste, re-cycle materials, and minimize energy in the construction and use of buildings (Ofori et al., 1999). The industry should also use environmental management systems to reduce pollution, enhance biodiversity, conserve water, respect people and their local environment, measure performance and set targets for the environment and sustainability (Ofori et al., 1999).

According to Silesh (2011), as in most cases, a large proportion of environmental and social impacts are associated with project construction activities, it is possible to reduce adverse environmental effects by including environmental protection measures in the legal documents.

Good construction practice offers both environmental and economic benefits such as reduced health and safety impacts on staff and local community, reduced liability costs in connection with disposal, less remedial work and reduced construction delays (Cole, 2000).

According to Muhwezi et al. (2012), there is need to reduce the consumption of construction materials which can be done through recycling and reuse of wastes and this will reduce on the use of virgin materials and the subsequent waste of energy used in production of new ones.

According to Geho (2001), the following measures have been arranged towards the impacts of construction works according to their primary receptor, however, it should be noted that many of the following mitigation measures are inter-related.

Protecting the water environment

In order to minimize potential impacts on the water environment, the design and execution of construction works must ensure that:

- an appropriate water management system is used, including, for example, sustainable drainage systems to minimize the impacts of the developers' site on receiving watercourses;
- the use of permeable surfaces is used wherever possible to reduce runoff and facilitate groundwater recharge (runoff reduction will assist in soil protection);
- hazardous or potentially polluting materials such as fuel, oil or wastes, must be sited on an impervious base away from water, properly bunded and kept locked when unattended;
- car parks are carefully sited and, perhaps, built at an early stage to provide areas for temporary storage compounds and parking areas for workers;
- culverting is avoided but where there is no alternative, it is adequate to accommodate maximum predicted flood flows and designed to reduce impact on the movement of fish and mammals;
- a risk assessment is carried out for each substance to be used or stored on site, and the appropriate containment measures installed;

Protecting the land environment

- use of techniques to minimize compaction of soil, such as restricting access during wet conditions, and using protective boarding and low ground pressure machinery. If necessary, soil should be carefully removed and stored for subsequent reinstatement;
- storage and handling of soils should be undertaken so as to maintain soil structure as far as possible;

- imported soils should be carefully selected and properly cared for during and after emplacement;
- appropriate designs for buildings and structures on site;
- appropriate screening for visual impacts;
- effective stabilization (e.g. by use of vegetation) of altered landforms to minimize soil erosion and the potential for water pollution from suspended solids;
- adoption of waste minimization strategies.

Protecting the air environment

- minimize exposed areas to reduce dust generation;
- areas generating dust during dry weather should be sprayed with water to reduce dust nuisance, but this may not be acceptable during periods of drought;
- the use of vegetation screens to act as a barrier to dust;

Protecting ecology

Measures designed to prevent or reduce impacts on water or land will also benefit ecological populations. The following list identifies further strategies for reducing or avoiding impacts to terrestrial and aquatic species and their habitats:

- phasing of construction work to minimize disturbance to wildlife at sensitive times of the year, such as during flowering, fish spawning and bird breeding seasons, or when young are being raised;
- sensitive terrestrial habitats and trees should be avoided during construction work;
- existing habitat features should be incorporated into site design and protected from change;
- further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential of the site;
- restoration plans should incorporate measures to improve the ecological status of the site;

Protecting the human environment

- risk assessment and emergency planning measures

- management operations should aim to minimize disturbance to adjacent residential and recreational uses, for example by setting the route and timing of construction traffic so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes);
- where access restrictions result from the development, arrangements for alternative access should be made with the provision of gates, bridges or stiles;
- safety concerns should be addressed by such measures as implementing strict health and safety procedures and the installation of adequate fencing and other site security to prevent trespass and vandalism;
- sites of archaeological or cultural interest should be preserved in situ where possible. As relocation is rarely feasible, thorough archaeological investigation should be undertaken where damage is unavoidable**.**

2.7 Summary and Research Gap

From literature review, total of 33 environmental impacts resulting from construction activities were identified and grouped into nine (9) parts as follows: (1) atmospheric emissions, (2) water emissions, (3) waste generation, (4) soil alteration, (5) resource consumption, (6) local issues, (7) transport issues, (8) effect on biodiversity, (9) accidents and incidents

The identification of the major environmental impacts of construction processes will help to improve the effectiveness of environmental management systems. Also the determination of major environmental impacts will assist to consider a range of on-site measures in order to mitigate them. However, various aspects of environmental impacts of construction activities are not identified by researchers in Ethiopian construction industry. Most of the researchers in Ethiopian construction industry are concerned about problems regarding to cost, quality and time of the project while environmental impacts resulting from construction activity of that project and their mitigation measures have not been identified. Therefore, to improve the effectiveness of environmental management systems, this basic knowledge needs to be identified and documented so that practitioners can use it.

3. MATERIALS AND METHODS

3.1 Description of the Study Area

The study area of this research was in south nations, nationalities and people's regional state (SNNPR) in case of selected towns (i.e. Hawassa, Dilla and Wollayta Sodo). A survey was administered to major building projects which are active (on-going) in the selected towns. The goal of the research was to identify the major environmental impacts of construction activities with their level of severity and to propose measures to be taken to minimize them on building construction projects of selected towns in SNNPRS.

3.2 Study Subject

The study is intended to get in depth information about environmental impacts of construction activities in SNNPRS in the case of building construction projects; so it is good to have adequate sample size. In this research determined number of volunteer participants were included.

3.3 Study Design

The types of study design adopted in this research were mainly descriptive survey and exploratory (qualitative). The study also adopted the concurrent mixed study approach (Quantitative and Qualitative). According to Simon and Samuel (2015), Quantitative research investigates facts and tries to establish relationships between these facts. While qualitative research is a subjective assessment of a situation or problem, and takes the form of an opinion, view, perception or attitude towards objects. A combination of quantitative and qualitative approach is advocated because it takes advantage of the strengths in the two approaches while limiting the weaknesses. Quantitative study of human phenomena can only give frequencies of occurrences of certain observable manifestations of the phenomena without explaining why they occur. Therefore it is important to also adopt a qualitative research paradigm to compensate for the limitations of using quantitative approach for a study.

The use of mixed methods approach for this research was intended to drive the benefits of both quantitative and qualitative approaches. The quantitative features in this case enabled the researcher to generate data from the sample size about different variables then to generalize the results to the population, whereas, the qualitative features will allow the researcher to explore the current status of environmental impacts of construction activities on building construction projects.

3.3.1 Sampling Technique and Sample Size Determination

The population for a research has been defined by Parahoo (1997) as the total number of units from which data can be collected, and this includes individuals, artifacts, events or organizations. Also, Burns and Grove (2003) defined population as all the elements that meet the criteria for inclusion in a study. Sampling is the process of selecting a group of people, events or behavior with which to conduct a study.

The general population of this research paper is building projects that are under construction in SNNPRS in case of three selected towns. The main principle behind selecting sample population was to come up with projects whose construction activities result in environmental impacts and companies that were willing to cooperate for the research. Also in selecting sample population on going (live) building construction projects were considered, this made it possible for the researcher to observe live environmental impacts of construction activities. In order to know the specific number of general population, the researcher tried to visit construction offices of three selected towns in the region. Data obtained from respective construction offices showed that the number of active (ongoing) building construction projects are: in Hawassa city, 45; in Dilla, 25 and in Wolaita Sodo, 32. Therefore, the general population of the study was 102 active building construction projects in three selected towns.

Simple random sampling procedure was applied to generate the sample for the study. A sample size of 58 active building projects in three selected towns (i.e. in Hawassa city, 26; in Dilla, 14 and in Wolaita Sodo, 18) was determined from the total population of 102 active building construction projects in those selected towns using the formula proposed by Yamane (1967) as follows: $n = N/1+N(e)^2$, Where N = the total population size; e = the standard error of sampling distribution assumed to be 8.5% and n is the sample size. The sample population includes office buildings, hospital buildings, educational buildings, hotels (resorts) and multi-purpose building projects in the selected towns.

The researcher used purposive/judgmental type of sampling to select the respondents basing on their level of education and experience in their interaction with people involved in construction activities. For each project of the sample, three (3) respondents were selected (one (1) from contractor side, one (1) from consultant side and one (1) from nearby residents). In total, the study covered 174 respondents which the researcher considered adequate to provide reliable data pertaining to the research objectives and questions.

The target respondents to the questionnaires on the various sites in this research included contractor side (i.e. project manager, project engineer, site engineer, office engineer and forman); consultant side (i.e. resident engineer/supervisor) and nearby residents (public/civil servants, business/self-employed people, and the unemployed).

The respondents drawn from the selected sites were in two categories – construction practitioners (either contractor side or consultant side) and nearby residents. The construction practitioner-respondents targeted in the study were mainly senior management personnel who are relevant to decision making in their firms or those considered technically competent to address issues raised, whilst nearby residents who lived within 100 meters radius or distance from the selected sites were targeted.

Table 3.1: Summary on research questionnaire respondents

Towns	Number of projects from each towns	Respondents from each construction projects	**Total**
Hawassa	26	3	78
Dilla	14	3	42
Wolaita Sodo	18	3	54
Total Respondents			**174**

3.4 Study Methodology

The research methodology is a description of how the objectives can be realized. This research work was accomplished with a combination of the following research methods.

- Thorough and detailed literature review was conducted on books, journal articles and relevant websites to learn about the environmental impacts resulted from construction activities.
- A sample of 58 building construction projects that are under construction in three selected towns in SNNPRS were selected for the study. A simple random sampling technique was implemented to select these building construction projects. A total of 174 respondents consisting of construction practitioners (either contractor side or consultant side) and nearby residents were selected using purposive sampling method.
- Primary data was collected through questionnaire survey, and personal observations of some major building construction projects in SNNPRS in case of selected towns.
- Secondary data was obtained from published sources including books, journal articles and relevant websites.
- The data was analyzed both qualitatively and quantitatively. Quantitative data was analyzed based on descriptive statistics analysis method; descriptive statistics gives numerical and graphic procedures to summarize a collected data in a clear and understandable way. Also inferential statistics such as relative importance index method (RII) was used. The data collected through questionnaire were analyzed using Microsoft excel. Qualitative data was analyzed and presented using figures and tables with narrative statements.
- Based on the result, conclusions and recommendations were made.

3.4.1 Data Collection Procedures

Among the different tools used to collect data, questionnaire in the form of both close and open-ended questions, and observation were used to collect all the relevant data used to answer the research question. Checklists and camera are used during physical observation on site to record relevant data.

The data collection process involved two stages. The first stage consisted of literature search for information on the impacts of construction activities on the environment in other countries and unstructured interview of some experts involved in the implementation process. The purpose of interviewing the experts was essentially to validate a preliminary set of impacts of construction activities on the environment gleaned from the literature and to determine from their experience other impacts of construction activities on the environment in selected towns. In addition, during the interview, site activities adversely affecting the environment and people likely to be affected were checked.

The first phase resulted in the identification of thirty-three (33) impacts of construction activities on the environment (variables); eleven (11) site activities adversely affecting the environment and four (4) types of people likely to be affected. The second stage involved the development of questionnaire incorporating those data identified in the literature reviewed. The survey data consisting of the 33 causes of environmental deterioration were analyzed and grouped into nine major areas: Atmospheric emissions, water emissions, waste generation, soil alteration, resource consumption, local issues, and transport issues, effects on biodiversity, and accidents and incidents. A structured questionnaire was developed based on the specified objectives of the study. Respondents were asked to express their views on the impacts of construction site activities on the environment on a five-point Likert scale (from 1(not important) to 5(extremely important)). Respondents were then asked to indicate by ticking a column, the relative importance of each of the impacts of construction activities on the environment.

The questionnaire designed for this research included both closed and open-ended questions. In the close- ended part of the questionnaire the respondents were asked simply to indicate the relative importance of each of the impacts. In the open-ended part of the questionnaire respondents were asked to express their opinion or to reply in whatever content they like for the questions asked, concerning the mitigation measures taken by them towards negative environmental impacts resulting from construction activities.

The questionnaire consisted of two parts. The first part inquired about the context of the respondents business and professional background. The second part comprised issues about the impacts of construction activities on the environment. The second part of the questionnaire also included four sections. The first section identified site activities adversely affecting the environment. The second section identified Potential negative environmental impacts resulting from construction activities. The third section identified People likely to be affected by negative effects of construction site activities. The last section identified the mitigation measures taken by construction practitioners towards environmental impacts from construction activities.

A total of 174 questionnaires were distributed by the researcher to respondents in the selected construction projects and nearby residents: 58 (33.33%) to the contractors, 58(33.33%) to the consultants and 58(33.33%) to randomly selected nearby residents in a face-to-face approach. The total number of questionnaires returned was 140 (general response rate of 80.46%). The number of questionnaires returned from contractor side was 50 (86.2%), consultant side 50 (86.2%) and nearby residents 40 (67%). Table 3.2 below shows the summary of questionnaires distributed and percentage of responses received.

Table 3.2: Summary of questionnaires distributed and percentage of responses received.

Respondents	**Questionnaires Distributed**	**Questionnaires Returned**	**Response Rate**
Contractor side	58	50	86.2%
Consultant side	58	50	86.2%
Nearby residents	58	40	67%
Total	174	140	80.46%

The response rates obtained were considered enough to ensure validation of the data obtained.

In addition to the questionnaires, field observations of the sites were made. For the field observation check list was prepared that shows environmental impacts resulting from each project's construction activities. Where it was allowed photographs were taken during the observation. The site observation provided useful insights into how the construction activities cause environmental impacts; which site activity adversely affect the environment and what mitigation measures have been taken to minimize it.

3.4.2 Reliability and Validity of Data Collection Instrument

Sound measurement must meet the tests of reliability and validity. In fact, these are the two major considerations one should use in evaluating a measurement tool.

In the widest definition, reliability can be described as clearness degree of measurement results from random errors (Cohen et al., 2007). Up to today, lots of reliability coefficients have been recommended for estimating reliability of measurement tools. Alpha coefficient developed by Cronbach (1951), is generally used in acquiring reliability in terms of internal consistency regarding a single test especially in combined measurements. This coefficient is also known as Cronbach’s alpha coefficient. Cronbach's Alpha is a coefficient of internal consistency. It is commonly used as an estimate of the reliability of a psychometric test for a sample of examinees. It was first named alpha by Lee Cronbach in 1951, as he had intended to continue with further coefficients. Standard Cronbach Alpha formula is

$$\alpha = \frac{k\,r'}{1+(k-1)\,r'} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3.1)}$$

Where k is the number of items (variables) and r’ is average correlation

Manerikar and Manerikar (2015) described internal consistency of Cronbach Alpha as follows:

Cronbach Alpha, α	**Internal Consistency**
$0.9 \leq \alpha$	Excellent (High Stakes Testing)
$0.7 \leq \alpha < 0.9$	Good (Low Stakes Testing)
$0.6 \leq \alpha < 0.7$	Acceptable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

In this study Cronbach’s alpha coefficients was used to check the reliability of the data collection tool and the internal consistency was indicated according to Manerikar and Manerikar (2015) classification.

Validity refers to how fairly you can generalize your findings to other groups or other situations. Also it can refer to the most critical criterion and indicates the degree to which an instrument measures what it is supposed to measure. But the question arises: how can one determine validity without direct confirming knowledge? The answer may be that we seek other relevant evidence that confirms the answers we have found with our measuring tool (Kothari, 2004).

In this study the researcher applied the following validity strategies to make the research trustworthy and accurate. Frist, triangulation of data was made; by doing this, data was collected through different sources (i.e. questionnaire survey, observation/site visit and interview). Second, prolonged time was spent on visiting construction sites. In this way, the researcher developed an in-depth understanding of the environmental impacts.

3.5 Data Management and Analysis

The quantitative data were analyzed using the Microsoft excel software. Two forms of statistical analysis were undertaken: Descriptive statistics such as percentages were used to summarize information from respondents. Descriptive statistics gives numerical and graphic procedures to summarize a collection of data in a clear and understandable way. Also inferential statistics such as relative importance index method (RII) was used herein to determine construction practitioners (either contractor side or consultant side) and nearby residents' perceptions of the relative importance of the identified environmental impacts of construction activities; site activities adversely affecting the environment and people likely to be affected by negative effects of construction site activities. Qualitative data was analyzed and presented using figures and tables with narrative statements. Moreover, reviewed literature was also used as one of the tools for the analysis of the findings.

As mentioned above, the relative importance index (RII) method was adopted in this study for analysis of objective 1,objective 2 and objective 3 within two groups (construction practitioners and nearby residents). The five point scale ranged from 1 (not important) to 5 (extremely important) was transformed to relative importance index (RII) for each factor by using the following formula (Fagbenle et al., 2004):

$$\mathrm{RII} = \frac{\sum \mathrm{PiUi}}{(\mathrm{N})(\mathrm{n})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Where, RII= relative importance index

Pi = respondent's rating given to each factor (ranging from 1 to 5)

Ui = number of respondents placing identical weighting (rating)

N = sample size (the total number of respondents)

n = the highest attainable score (in this case is 5)

The RII value is range from 0 to 1 which the higher the value of RII, the more important was the activity and impacts. The RII was used to rank the different site activities and environmental impacts. RII was used for the analysis because it best fits the purpose of this study. The RII is then being classified based on the RII classification table (Syahira and Khairulzan, 2016), as shows in Table 3.1.

Table 3.3: Classification of RII

Scale	Level of Preference	RII
1	Not preferred at all	$0.0 \leq RII \leq 0.2$
2	Slightly preferred	$0.2 < RII \leq 0.4$
3	Moderately preferred	$0.4 < RII \leq 0.6$
4	Preferred	$0.6 < RII \leq 0.8$
5	Most Preferred	$0.8 < RII \leq 1.0$

Agreement analysis

The Spearman's rank correlation coefficient (ρ) was used to check the degree of agreement between the rankings of any two parties. The Spearman's rank correlation is a non-parametric test. Non-parametric tests are also referred to as distribution-free tests. These tests do not require the assumption of normality or the assumption of homogeneity of variance. They compare medians rather than means and, as a result, if the data include one or two outliers, their influence is negated (excluded) (Bright et al.,2016).

In this research, the correlation coefficient is used to show the degree of agreement between the different groups. The correlation coefficient varies between -1 and +1, where +1 implies a perfect positive relationship (agreement), while -1 results from a perfect negative relationship (disagreement).The result is interpreted as: If the rank is close to -1 implies negative correlation, close to 0 implies no linear correlation and close to +1 implies positive of good correlation.

The Spearman's (Rho) rank correlation coefficient for any two groups of ranking is given by the following formula (Naoum 1998):

$$\text{Rho } (\rho) = 1 - 6 \text{ x} \frac{(\Sigma \text{ di2})}{\text{N x (N2} - 1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3.3)$$

Where:

Rho (ρ) – Spearman's rank correlation coefficient

di – The difference between the ranks given by any two respondents for an individual factor.

N – Number of factors (variables)

Accordingly, in this study after determining the relative importance index (RII) values for all variables described in the questionnaire, ranks were given based on their respective RII value of ratings calculated. Then, since the respondents for the questionnaire were from two groups in the building construction projects, rank correlation coefficients were determined between construction practitioners and nearby residents; then based on rank order correlation coefficients, the significance of agreement between the two groups in their rankings were checked by hypothesis testing.

Procedures for hypothesis testing:

1. Define the null hypothesis (H_0) and the alternative hypothesis (H_A).
2. Choose a value for ρ. (i.e. choose the significance level)
3. Calculate the value of the test statistic, Rho (ρ).
4. Compare the calculated value with a table of the critical values of the test statistic.
5. If the calculated value of the test statistic is less than the critical value from the table, accept the null hypothesis (H_0). If the absolute (calculated) value of the test statistic is greater than or equal to the critical value from the table, reject the null hypothesis (H_0) and accept the alternative hypothesis (H_A).

The Null Hypothesis (H_0): There is no agreement in the ranking order between the two groups of respondent.

The Alternative Hypothesis (H_A): There is agreement in the ranking order between the two groups of respondent.

4. RESULTS AND DISCUSSION

4.1 Introduction

This section discusses the findings from the analysis of the data collected. It used the methods of data analysis discussed under the previous chapter. The results of the analysis of primary data based on survey conducted on one hundred seventy four (174) participants from fifty eight (58) selected construction projects in SNNPRS in case of selected towns are documented in this chapter.

The responses to the questionnaires were subjected to Relative Importance Index (RII), spearman's rank correlation and Cronbach's Alpha reliability tests and the results are presented in respective tables. The RII value has a range from 0 to 1 (0 not inclusive), the higher the value of RII, the more important is the activity or impact. The RII for all the variables and groups was calculated using equation (3.2). The indexes were ranked for all the respondents and the group index which is the average of the RII of the activity or impact in each group was also determined.

Initial analysis indicated that there were no significant differences in the responses from contractors' side and consultants' side. Their responses were therefore grouped together under ''construction practitioners'' in the analysis. The views of residents near construction sites were considered separately from that of the construction practitioners.

The results of the analysis were presented in accordance with the specific objectives of this study namely: to identify site activities adversely affecting the environment; to identify negative environmental impacts resulting from construction activities of selected construction sites in the region and rank their level of severity; to differentiate people likely to be affected by negative effects of construction site activities; and to assess the mitigation measures taken by construction practitioners toward environmental impacts from construction activities on building construction projects in selected towns of SNNPRS.

4.2 Profile of Survey Respondents

The respondents in this study were categorized into two groups; namely construction practitioners (both contractor side and consultant side) and nearby residents. The profile features of the construction practitioners for this study had three components; namely, level of education, position in the company and experience in the construction industry as shown in Table 4.1 below. From the majority of the construction practitioner respondents B.Sc. holders dominated the study with 62%; M.Sc. holders accounted for 24% and Diploma holders accounted 14%.

The area of expertise was also examined. 28% of the survey respondents (construction practitioners) were Project managers; office engineers, site engineers and resident engineers were 17% each; and formen were 21%. The respondents' experience of this group in the construction industry was also examined. 41% of respondents were with experience of less than five years; 21% of respondents were with experience of 5 to 10 years and 38% of respondents were with experience of greater than 10 years.

Table 4.1: Profile of survey respondents (construction practitioners)

Profile		**Frequency**	**Percentage**
Education	Below diploma	0	0%
	Diploma	14	14%
	B.Sc. degree	62	62%
	M.Sc. degree	24	24%
	PhD	0	0%
Position	Project Manager	28	28%
	Office Engineer	17	17%
	Site Engineer	17	17%
	Resident engineer	17	17%
	Forman	21	21%
Experience	Less than 5 years	41	41%
	5 to 10 years	21	21%
	Above 10 years	38	38%

The second group of respondents were nearby residents. The profile features of the nearby residents for this study had three components; namely gender, job and educational background. 58% of this group of respondents were males and 42% were females. Based on job, 42% of the respondents were public/civil servants; 38% of respondents were business/self-employed people and 20% of respondents in this group were unemployed. Regarding educational background of the respondents in this group, the majority (47.5%) were BSc holders; 25% were MSc holders and 27.5% were diploma holders.

Table 4.2: Profile of survey respondents (nearby residents)

Profile		Frequency	Percentage
Education	Below diploma	0	0%
	Diploma	11	27.5%
	B.Sc. degree	19	47.5%%
	M.Sc. degree	10	25%
	PhD	0	0%
Job	public/civil servants	17	42%
	business/self-employed people	15	38%
	unemployed	8	20%
Gender	Male	23	58%
	Female	17	42%

4.3 Site Activities Adversely Affecting the Environment

In this section, respondents in the two categories were asked to indicate the relative importance of site activities which had adverse environmental effect; and the result was presented in the Table 4.3 below.

Table 4.3: The relative importance index (RII) and rank of site activities adversely affecting the environment according to the two groups

Site Activities	Construction Practitioners		Nearby Residents		Average	Overall
	RII	Rank	RII	Rank	RII	Rank
Site clearance	0.53	6	0.50	7	0.52	7
Earthmoving	0.58	4	0.55	6	0.56	6
Demolishing	0.46	8	0.30	9	0.38	9

Excavation	0.59	3	0.65	3	0.62	3
Driving piles	0.39	10	0.20	10	0.30	10
Test drilling	0.42	9	0.35	8	0.39	8
Transportation	0.50	7	0.65	3	0.57	5
Landfill, compaction and leveling	0.54	5	0.65	3	0.60	4
Concrete batching, mixing and placement	0.60	2	0.90	1	0.75	2
Concrete vibration	0.61	1	0.90	1	0.76	1
Renovation/renewing	0.39	11	0.20	10	0.29	11

The perspectives of construction practitioners and nearby residents of the 11 site activities adversely affecting the environment were analyzed based on the relative importance index. The results are shown in Table 4.3 above. The relative importance index and ranks of site activities by all the respondents are presented in Table 4.3. Table 4.3 also illustrates the average relative importance index and ranks of site activities by all respondents.

Based on the overall's view (both construction practitioners and nearby residents), among site activities adversely affecting the environment: concrete vibration was indicated as the first site activity with the average RII of 0.76; concrete batching, mixing and placement was ranked as the second with the average RII of 0.75; excavation; Landfill, compaction and leveling and transportation were ranked third, fourth and fifth with the average RII of 0.62, 0.60 and0.57, respectively. Renovation/renewing was ranked as the last site activity adversely affecting the environment with the average RII of 0.29. The results show that renovation works have no serious environmental effect.

Based on the level of preference in classification of RII (Table 3.2), concrete vibration, concrete batching, mixing and placement and excavation were the preferred site activities by both groups of respondents which had the most adverse environmental effects. Landfill, compaction and leveling and transportation were moderately preferred site activities. Whereas renovation/renewing, driving piles, demolishing and test drilling were slightly preferred site activities by both groups of respondents.

The activities identified in this study are among those reported by the (Ayarkwa et al., 2014) as resulting in environmental impacts. The results therefore indicate that if these activities can be controlled or carried out within acceptable levels, the adverse environmental impacts of construction activities can greatly be reduced.

4.3.1 Correlation Tests for Agreements on the Site Activities Adversely Affecting the Environment on Building Construction Projects

The purpose of this analysis was to check the degree of agreement between the rankings of two groups (construction practitioners and nearby residents) regarding site activities adversely affecting the environment on building construction projects. In this section, the degree of agreement between the rankings of two groups of respondents was checked using Spearman's rank correlation coefficient. The spearman's rank correlation coefficient (ρ) was calculated using equation 3.3 and the result obtained was (ρ=0.868).As indicated in the analysis part, this result is close to +1 and it implies that there is positive of good correlation between two groups.

The purpose of a hypothesis test is to avoid being deceived by chance occurrences; the tests also helped to evaluate whether consensus of opinions exist among respondents. In order to decide whether to accept or reject the null hypothesis, the level of significance 95% (P = 0.05) was used. This allows to state whether there is "agreement" between respondents' response or not.

The spearman's rank correlation coefficient (ρ) value indicated that there is strong correlation between the two groups on the ranking order of the site activities adversely affecting the environment. Therefore the null hypothesis that there is no significant agreement between the respondents is rejected i.e. the null hypothesis is rejected.

From Table 4.4 below, it can be concluded that there is strong correlation between the attitudes of the respondents and hence the null hypothesis should be rejected and the alternative hypothesis should be accepted. This means that construction practitioners and nearby residents have the same perception about the site activities adversely affecting the environment on building construction projects.

Table 4.4: Summary of correlation test on the ranking of the site activities adversely affecting the environment on building construction projects.

Respondent	Rho $= 1 - 6 \text{ x} \frac{(\Sigma \text{ di2})}{\text{N x (N2} - 1)}$	Critical Value of ρ (Annex E, a)	Significance for P < 0.05	Reject / don't reject the Null Hypothesis
Construction Practitioners versus Nearby Residents	0.868	0.7545	Significant	Reject

4.3.2 Cronbach's Alpha Coefficient Test Result on the Site Activities Adversely Affecting the Environment

Cronbach's alpha coefficient is generally used in acquiring reliability in terms of internal consistency. Reliability pertains to the consistency of scores. The less consistency within a given measurement, the less useful the data may be in the analysis. In this study, the researcher needed to understand score reliability because of the possible impact the reliability has on the interpretation of research results. Cronbach's alpha reliability coefficient normally ranges between 0 and 1. The closer Cronbach's alpha coefficient to 1.0, the greater the internal consistency of the items in the scale. In this study, Cronbach's alpha coefficient was calculated by using Standard Cronbach Alpha formula, indicated on (Equation 3.1) and the result obtained was ($\alpha = 0.98$ or 98%). Therefore, the reliability test on site activities adversely affecting the environment resulted in ($\alpha = 0.98$ or 98%). According to the classification performed by Manerikar and Manerikar (2015), this result indicates that 98% of the site activities answered by the respondents have excellent reliability (internal consistency).

4.4 Negative Environmental Impacts Resulting from Construction Activities

In this section, respondents in two categories were asked to indicate the relative importance of negative environmental impacts resulting from construction activities of building projects by ranking their level/degree of importance from 1 to 5, where 1= Not important, 2= less important, 3= important, 4= highly important and 5= Extremely important; and the result was presented in the Table 4.5 below.

Table 4.5: The relative importance index (RII) and rank of impacts of construction activities on the environment according to the two groups.

Environmental Impacts	**Construction Practitioners**		**Nearby Residents**		**Average**	**Overall**
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**
1. Atmospheric emissions					**0.56**	**4**
greenhouse gas emissions (such as CO_2, ozone)	0.61	11	0.55	14	0.58	15
emission of VOCs and CFCs	0.57	18	0.50	22	0.54	21
2.Water emissions					**0.44**	**9**
water from excavation	0.47	31	0.25	32	0.36	33
water from cleaning tools	0.49	29	0.45	23	0.47	24
sanitary water	0.48	30	0.50	20	0.49	23
3.Waste generation					**0.54**	**5**
excavated waste material	0.55	24	0.65	10	0.60	13
municipal waste (garbage, e.g. product packaging)	0.63	9	0.55	14	0.59	14
inert waste (not reactive waste, e.g. sand, concrete)	0.59	14	0.55	14	0.57	17
ordinary waste (solid waste, sewage ,waste water)	0.57	18	0.45	23	0.51	22
toxic waste (chemical wastes like old batteries, paint)	0.51	25	0.30	30	0.40	30
4. Soil alteration					**0.53**	**6**
land occupancy	0.60	12	0.65	10	0.63	10
concrete release agent	0.51	25	0.35	26	0.43	27
cleaning agents	0.50	27	0.35	26	0.43	27
construction machinery waste	0.59	14	0.70	6	0.64	9

5. Resource consumption					**0.73**	**1**
water consumption	0.67	5	0.80	3	0.74	3
electricity consumption	0.67	5	0.80	3	0.74	3
fuel consumption	0.71	3	0.60	13	0.65	8
raw materials consumption	0.75	1	0.85	2	0.80	2
6. Local issues					**0.68**	**2**
dust generation from machinery	0.70	4	0.70	6	0.70	6
dust generation in earthworks	0.65	8	0.70	6	0.68	7
dust generation in cutting operations	0.62	10	0.50	20	0.56	19
noise and vibration generation	0.72	2	0.95	1	0.84	1
landscape alteration	0.59	14	0.65	10	0.62	12
7.Transport issues					**0.60**	**3**
road traffic load	0.57	18	0.70	6	0.63	10
interference in road traffic	0.57	18	0.55	14	0.56	19
8. Effects on biodiversity					**0.51**	**7**
vegetation removal	0.57	18	0.25	32	0.41	29
loss of edaphic soil (topsoil)	0.59	14	0.55	14	0.57	17
potential soil erosion	0.57	18	0.35	26	0.46	25
interception of water bodies	0.43	33	0.35	26	0.39	31
Interference with the ecosystems	0.67	5	0.75	5	0.71	5
9. Accidents and incidents					**0.47**	**8**
fire outbreaks	0.45	32	0.30	30	0.37	32
breakage of service pipes	0.60	12	0.55	14	0.58	15
breakage of receptacles(containers)	0.50	27	0.40	25	0.45	26

4.4.1 Discussion

The perspectives of construction practitioners and nearby residents of the 33 negative environmental impacts resulting from construction activities were analyzed based on the relative importance index. The results are shown in Table 4.5 above. The relative importance index and ranks of environmental impacts by all the respondents are presented in Table 4.5. This table also illustrates the average relative importance index and ranks of environmental impacts by all respondents and also by all groups of environmental impacts.

Based on the level of preference in classification of RII (Table 3.2), noise and vibration generation was the most preferred environmental impact by both groups of respondents which had the most adverse environmental effects. Raw materials consumption, water consumption, electricity consumption, interference with the ecosystems, dust generation from machinery, dust generation in earthworks, fuel consumption, construction machinery waste, road traffic load, land occupancy and landscape alteration were preferred environmental impacts resulting from construction activities by both groups of respondents. Toxic waste, interception of water bodies, fire outbreaks and water from excavation were slightly preferred environmental impacts by both groups of respondents.

Generally, both groups of respondents (construction practitioners and nearby residents) agreed that the top eleven most important environmental impacts of construction activities in case of building projects in selected towns in their descending order are:

- Noise and vibration generation
- Raw materials consumption
- Water consumption
- Electricity consumption
- Interference with the ecosystems
- Dust generation from machinery
- Dust generation in earthworks
- Fuel consumption
- Construction machinery waste
- Road traffic load
- Land occupancy

Based on the different groups of environmental impacts, the respondents generally agreed that the top three groups of impacts in their descending order are:

- Resource consumption (group's average relative importance index, RII = 0.73)
- Local issues (group's average relative importance index, RII = 0.68)
- Transport issues (group's average relative importance index, RII = 0.60)

The following discussion is focused on the nine groups of environmental impacts in descending order of their ranking.

1. **Resource Consumption**

The resource consumption group of environmental impacts was ranked highest by all the respondents put together. Raw materials consumption (average RII=0.80) was determined by all respondents under the resource consumption group of environmental impacts as the second major environmental impact of construction activities in selected towns of SNNPRS. The Worldwatch Institute (2003) opined that building construction consumes 40 percent of the world's raw stones, gravel and sand and 25 percent of the virgin wood per year. It also consumes 40 percent of the energy and 16 percent of water annually. Water, electricity and fuel consumption which are all under the resource consumption group of environmental impacts were ranked within the top eleven most important environmental impacts of construction activities in selected towns of SNNPRS.

2. **Local Issues**

Local issues group were ranked the second most important environmental impact of construction activities by two groups of respondents. Noise and vibration generation (average RII=0.84) was determined by all respondents under the local issues group of environmental impacts as the first major environmental impact of construction activities in selected towns of SNNPRS. It is encouraging to note that physical observation on construction sites also assured that noise and vibration generation is the most important environmental impact. Dust generation from machinery and dust generation in earthworks which are both under the local issues group of environmental impacts were also ranked within the top eleven most important environmental impacts of construction activities in selected towns of SNNPRS. According to Chen et al. (2000), Pollution sources from the construction process include harmful gases, noise, dust, and solid and liquid waste.

3. **Transport Issues**

Transport issues as an environmental impact group was ranked the third most important environmental impact of construction activities by the two groups of respondents. Within this group, both the respondents together agreed that road traffic load was the most important environmental impact of construction activities that was also ranked within the top eleven most important environmental impacts of construction activities in selected towns of SNNPRS. According to Couto and Couto (2003), Traffic of vehicles and machinery from the site or related to the site may introduce a significant increase in local traffic.

4. **Atmospheric Emissions**

The atmospheric emissions group of environmental impacts was ranked fourth by all the respondents. Construction practitioners and nearby residents agreed that within the atmospheric emissions group of environmental impact of construction activities, greenhouse gas emissions (such as CO_2, ozone) was a major environmental impact. According to Levin (1997), in the USA, construction is responsible for 40 percent of atmospheric emissions. The emissions include some toxic substances such as nitrogen and sulphur oxides. They are released during the production and transportation of materials as well as from site activities and have caused serious threat to the natural environment (Spence & Mulligan, 1995; Ofori & Chan, 1998). Other harmful materials, such as chlorofluorocarbons (CFCs), are used in insulation, air conditioning, refrigeration plants and firefighting systems and have seriously depleted the ozone layer (Clough, 1994).

5. **Waste Generation**

Construction practitioners and nearby residents together ranked waste generation group as the fifth most essential environmental impact of construction activities with group's average relative importance index of 0.54 .within this group, construction practitioners ranked municipal waste (garbage, e.g. product packaging) as the most important environmental impact of construction activities. Nearby residents on the other hand ranked excavated waste material as the most important. According to Ofori and Chan (1998), majority of the wastes generated from construction activities resulted from the production, transportation and the use of materials. A study conducted by Teo and Loosemore (2001) also posited that construction activities contributes approximately 29 percent of waste in the USA, more than 50 percent in the UK and 20-30 percent in Australia to the overall landfill volume. However, Sterner (2002) stated that implementing a waste management plan during the planning and design stages can reduce waste on-site by 15 percent, with 43 percent less waste going to the landfill through recycling, and it delivers cost savings of up to 50 percent on waste handling.

6. Soil Alteration

Soil alteration group of environmental impacts was ranked sixth by all the respondents. Construction machinery waste (with average RII = 0.64) and land occupancy (with average RII = 0.63) which are both under the soil alteration group of environmental impacts were also ranked within the top eleven most important environmental impacts of construction activities in selected towns of SNNPRS.

7. Effects on Biodiversity

Effects on biodiversity as an environmental impact group was ranked the seventh most important environmental impact of construction activities by the two groups of respondents put together. Within this group, both construction practitioners and nearby residents agreed that interference with the ecosystems was the most important environmental impact of construction activities. Interference with the ecosystems (with average RII = 0.71) was also ranked within the top eleven most important environmental impacts of construction activities in selected towns of SNNPRS.

8. Accidents and Incidents

The two groups of respondents together ranked accidents and incidents as the eighth most important environmental impact of construction activities. Accidents and incidents as an environmental impact group was ranked relatively low. Both groups of respondents agreed that breakage of service pipes was the most important factor in this category.

9. Water Emissions

The water emissions group was ranked the lowest by the two groups of respondents. Regarding all the factors in the group, both the respondent groups put together ranked sanitary water high. As indicated by the respondents, water emissions from construction activities do not impact the environment so much in selected towns of SNNPRS.

4.4.2 Correlation Tests for Agreements on the Negative Environmental Impacts Resulting from Construction Activities

In this case also, the degree of agreement between the rankings of two groups of respondents was checked using Spearman's rank correlation coefficient. The spearman's rank correlation coefficient (ρ) was calculated using equation 3.3 and the result obtained was (ρ=0.796).As indicated in the analysis part, this result is close to +1 and it implies that there is positive of good correlation between two groups of respondents.

With a significance level of 95% (P = 0.05), the calculated value of ρ for the respondents (construction practitioners and nearby residents) was greater than the critical values of ρ, so the hypothesis that there is no significant agreement between the respondents is rejected i.e. the null hypothesis is rejected and the alternative hypothesis shall be accepted. This means that most of the respondents have the same perception on ranking the environmental impacts of construction activities. Therefore the result indicated that there is a strong rank order correlation between the construction practitioners and nearby residents' side on ranking the negative environmental impacts resulting from construction activities.

Table 4.6: Summary of correlation test on the ranking of the negative environmental impacts resulting from construction activities

Respondent	Rho (ρ) $= 1 - 6\,x \frac{(\Sigma\ di2)}{N\,x\,(N2\ -\ 1)}$	Critical Value of ρ (Annex E, b)	Significance for $P < 0.05$	Reject / don't reject the Null Hypothesis
Construction Practitioners Versus Nearby Residents	0.796	0.347	Significant	Reject

4.4.3 Cronbach's Alpha Coefficient Test Result on the Negative Environmental Impacts Resulting from Construction Activities

In this case also, Cronbach's alpha coefficient was calculated by using Standard Cronbach Alpha formula, indicated on (Equation 3.1) and the result obtained was (α = 0.99 or 99%). Therefore, the reliability test on the negative environmental impacts resulting from construction activities resulted in (α = 0.99 or 99%). According to the classification performed by Manerikar and Manerikar (2015), this result indicates that 99% of the environmental impacts answered by the respondents have excellent reliability (internal consistency).

4.5 People Likely to be Affected by Negative Effects of Construction Site Activities

In this section also, respondents in the two categories were asked to indicate the relative importance of people likely to be affected by negative effects of construction site activities; and the result was presented in the Table 4.7 below.

Table 4.7: The relative importance index (RII) and rank of the people likely to be affected by negative effects of construction site activities according to the two groups.

People likely to be affected	Construction Practitioners		Nearby Residents		Average	Overall
	RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Site workers	0.81	1	0.75	2	0.78	1
Nearby residents	0.69	2	0.80	1	0.74	2
People in schools and hospitals in the neighborhood	0.48	3	0.50	3	0.49	3
Others	0.46	4	0.35	4	0.41	4

The perspectives of two groups of respondents regarding the people likely to be affected by negative effects of construction site activities were analyzed based on the relative importance index. The results are shown in Table 4.7 above. The relative importance index and ranks of the people likely to be affected and also the average relative importance index and ranks by all the respondents are presented in Table 4.7.

Based on the level of preference in classification of RII (Table 3.2), site workers and nearby residents were preferred groups of people likely to be affected by negative effects of construction site activities by both groups of respondents put together. Site workers were the most preferred group of people by construction practitioners whereas nearby residents were the most preferred group of people by nearby residents. People in schools and hospitals in the neighborhood and others are moderately preferred groups of people likely to be affected by negative effects of construction site activities by both groups of respondents put together.

On people likely to be adversely affected by the impacts of construction site activities, respondents indicated three groups most severely affected in the following order: site workers (average RII = 0.78), nearby residents (average RII =0.74), and people in schools and hospitals in the neighborhood (average RII =0.49). The results explain why residents are worried and concerned about effects of construction activities in their neighborhood, given the close proximity of some residents to construction sites. Public concerns over the environmental impact of construction activities must therefore be given serious attention. The results show that construction practitioners are not only concerned about the health of residents in the neighborhood but also that of their site workers. Building construction operations can be disturbing to people living near the site. Noise and odour can be annoying and disruptive to nearby residents, site workers, and people in schools and hospitals in the neighborhood (Blodgett, 2004; Cole, 2000). Excessive noise generated on construction sites affect the right to silence, comfort and health of workers, nearby residents and the visiting population, and influence normal activities of nearby schools, hospitals and other services (Teixeira, 2005; Blodgett, 2004).

4.5.1 Correlation Tests for Agreements on the People Likely to be Affected by Negative Effects of Construction Site Activities

In this case also, Spearman's rank correlation coefficient was used to check the degree of agreement between the rankings of two groups of respondents. The spearman's rank correlation coefficient (ρ) was calculated using equation 3.3 and the result obtained was (ρ=0.80). As indicated in the analysis part, this result is close to +1 and it implies that there is positive of good correlation between two groups of respondents.

The spearman's rank correlation coefficient (ρ) value indicated that there is strong correlation between the two groups on the ranking order of the people likely to be adversely affected by construction site activities. Therefore the null hypothesis that there is no significant agreement between the respondents is rejected i.e. the null hypothesis is rejected and the alternative hypothesis shall be accepted. This means that most of the respondents have the same perception on ranking the people likely to be adversely affected by construction site activities. Therefore the result indicated that there is a strong rank order correlation between the construction practitioners and nearby residents' side on ranking the people likely to be affected by negative effects of construction site activities.

4.5.2 Cronbach's Alpha Coefficient Test Result on the People Likely to be Affected by Negative Effects of Construction Site Activities

In this case also, Cronbach's alpha coefficient was calculated by using Standard Cronbach Alpha formula, indicated on (Equation 3.1) and the result obtained was (α = 0.94 or 94%). Therefore, the reliability test on the people likely to be affected by negative effects of construction site activities resulted in (α = 0.94 or 94%). According to the classification performed by Manerikar and Manerikar (2015), this result indicates that 94% of the people likely to be affected answered by the respondents have excellent reliability (internal consistency).

4.6 The Mitigation Measures Taken by Construction Practitioners toward Environmental Impacts from Construction Activities

Following the scoping exercise and the identification of potential environmental effects, mitigation measures should be proposed to avoid or reduce potential negative impacts to air, water, land, ecology and humans, or to introduce and maximize positive aspects to the development (Geho, 2001).

According to Sadler and Verheem (1996), environmental impact assessment (EIA) as a process to assess the environmental consequences of any project, is needed to design proper mitigation plans to minimize the possible adverse impacts.

The targeted survey respondents for this issue were only construction practitioners. Out of those respondents, only 14% were stated that there was environmental impact assessment (EIA) conducted for their project. Also regarding the implementation of the mitigation measures/alternatives stated in EIA report, from those respondents whose projects had EIA, 28.6% stated that the implementation was poor; 42.8% stated that the implementation was satisfactory; and 28.6% stated that the implementation was good. The implementation level of mitigation measures is summarized in figure 4.1 below.

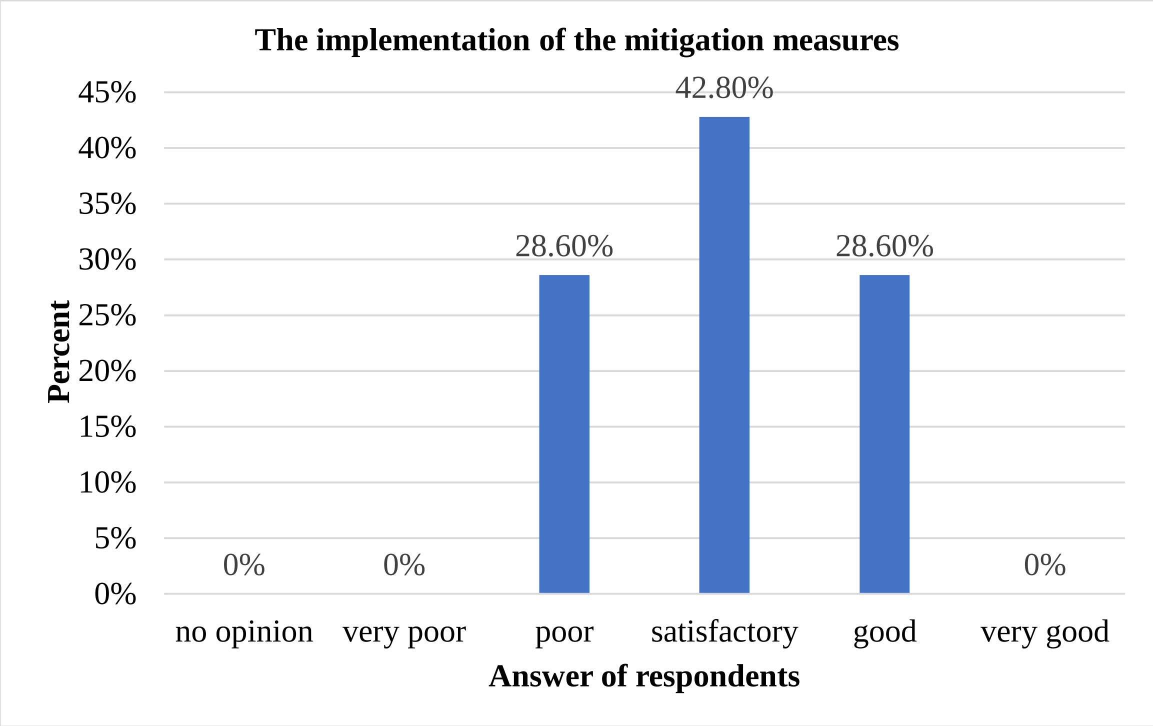


Figure 4.1: The implementation of the mitigation measures/alternatives stated in EIA report

Finally, the construction practitioners were asked to indicate if there was any mitigation measures taken by them towards negative environmental impacts in general, and accordingly, only 21% of the respondents stated that they had taken the mitigation measures towards negative environmental impacts from their respective project activities. The result shows that most of the construction practitioners (79%) had not taken any mitigation measures towards negative environmental impacts. Those respondents who had taken the mitigation measures were also asked to list the types of the mitigation measures they adopted. Accordingly the answers of the respondents are summarized below.

- Reuse of materials like timber ,panels ,eucalyptus posts and others to minimize resource consumption
- Effective and efficient use of machineries to reduce fuel consumption
- Avoiding dust pollution by sprinkling water onto aggregates and other dusty materials
- Using environmentally friendly materials which do not cause negative impact on the environment

- Enclosing the surrounding of the project to reduce dust effect on nearby residents and road traffic interference
- Disposing excavated waste material to selected area where its impact on the environment is less
- Selected material quarry site is selected from where its impact on the environment is less
- During cart away of waste materials, firstly materials that affect the environment were identified and then dumped at the location identified by local governor or burnt at site
- Removing all wastes from construction area keeping the environment clean and safe from negative impact of the project

4.6 Site Observation

This process of information gathering afforded the researcher the opportunity to have first-hand information and actually observe existing environmental impacts resulting from construction activities on some of selected project sites. The information gathered during site observation was very important to strengthen and assure the data collected through questionnaire survey.

During the site visit of different projects the researcher tried to observe various environmental impacts resulting from construction activities by using checklist. A check of these environmental impacts resulting from construction activities in comparison with what was adopted from the review of literature showed that there is existence of similarity. Annex B is a checklist that is used to check the existence of various environmental impacts resulting from construction activities on visited projects.

Most of the construction projects visited had dust generation, and also noise and vibration generation. According to Couto and Couto (2003), construction sites activities in urban areas may cause damage to the environment, interfering in the day to day of local residents, that frequently claim against dust, mud, noise, traffic delay, space reduction, materials or waste deposition in public space, etc.

The pictures below show some of the project sites generating dust, noise and vibration.

a) Dust generated by project site in Dilla   b) Dust generated by project site in W/Sodo

c) Noise and vibration generation from construction site in Wolaita Sodo

Figure 4.2: Dust, noise and vibration generation from construction sites

During site visit of projects, the researcher observed that most of the projects had generated various types of waste. However, many of the projects did not have areas designated to collect and handle waste. This improper waste handling on site has great impact on the environment including site workers and nearby residents; so it is good to have appropriate waste handling and disposal methods and area. Also according to reviewed literature; waste management for construction activities has been promoted with the aim of protecting the environment and the recognition that wastes from construction and demolition works contribute significantly to the polluted environment. The construction industry plays a vital role in meeting the needs of society and enhancing the quality of life. However, the responsibility for ensuring the construction activities and products in consistent with environmental policies needs to be defined and good environmental practices through reduction of wastes need to be improved. Normally, the best way to deal with material wastes is not to create it in the first place (V. T. Shen, 2002). The following picture shows waste generated from different sites.

a) Waste generated from Wolaita Sodo projects

b) Waste generated from Dilla project c) Waste generated from Hawassa project

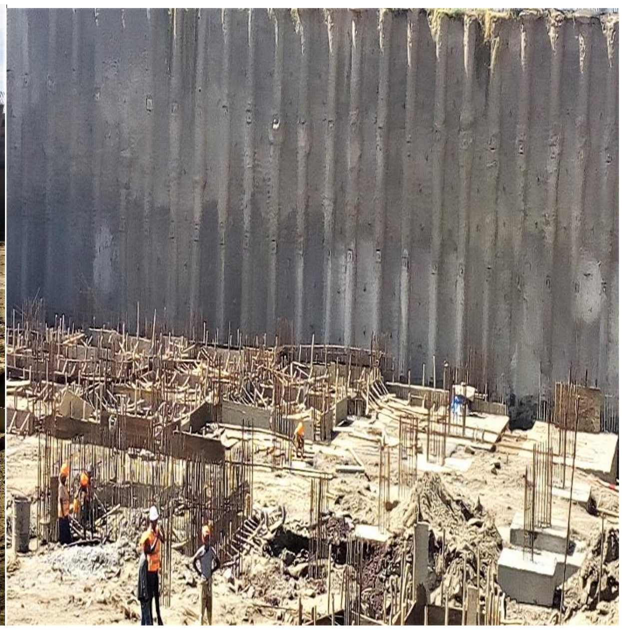
Figure 4.3: Waste generation from construction sites

Some of the project sites visited had landscape alteration, loss of top soil and landslide. The picture below shows those environmental impacts resulting from project sites.

a) Landscape alteration in Dilla project

b) Landslide in Wolaita Sodo project

c) Landscape alteration in Wolaita Sodo projects



d) Loss of topsoil in Hawassa projects

Figure 4.4: Landscape alteration, loss of topsoil and landslide seen on various projects

Also some of projects visited have caused increase in traffic load and interference on road traffic. According to Cardoso (2005), typical negative impacts of the construction activities include waste production, mud, dust, soil and water contamination and damage to public drainage systems, destruction of plants, visual impact, noise, traffic increase and parking space shortage and damage to public space.

Figure 4.5: Increase in road traffic load and interference on road traffic

Finally, the researcher understood that the environmental impacts resulting from construction activities were very vast while the attempt taken by construction practitioners to control those impacts was very less. Therefore, attention is needed to be given by all stakeholders including construction practitioners and local authorities to protect the environment and the residents from such impacts and sustain healthy life.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As it is recalled, the general objective of this study was to identify the major environmental impacts of construction activities with their level of severity and to propose measures to be taken to minimize them on building construction projects of selected towns in SNNPRS. The results obtained from the analysis of the questionnaire survey have been discussed and presented in the previous chapter in detail. Therefore, based on the results, the following major conclusions have been derived and summarized:

- ✓ Concrete vibration; concrete batching, mixing and placement; and excavation are the construction site activities that were found to have the most severe environmental effects in selected towns of SNNPRS preferred and agreed by all the respondents.
- ✓ The study showed that, out of a total of 33 environmental impacts identified, the top eleven most important environmental impacts factors agreed by all the respondents are as follows: noise and vibration generation, raw materials consumption, water consumption, electricity consumption, interference with the ecosystems, dust generation from machinery, dust generation in earthworks, fuel consumption, construction machinery waste, road traffic load and land occupancy. The 33 environmental impacts identified in the study were grouped into nine categories and ranked accordingly. The results also indicated that, all the respondents agreed that the resource consumption group of environmental impacts was the most influential impact. Local issues impacts were considered the second most important causing environmental deterioration followed by transport issues impacts.
- ✓ Site workers, people living near construction sites, and people in schools and hospitals are most likely to be adversely affected by construction site activities.
- ✓ The results showed that only a few (14%) of the target group of respondents had Environmental Impact Assessment (EIA) conducted for their project; and also the implementation of the mitigation measures/alternatives stated in EIA report for those projects which had EIA was very less. In general, again only a few of the construction practitioners had taken the mitigation measures towards negative environmental impacts from their respective project activities and some of those mitigation measures were: recycling (reuse) of materials to minimize resource

consumption; avoiding dust pollution by sprinkling water onto aggregates and other dusty materials; effective and efficient use of machineries to reduce fuel consumption; using environmentally friendly materials which do not cause negative impact on the environment; enclosing the surrounding of the project to reduce dust effect on nearby residents and road traffic interference; disposing excavated waste material to selected area where its impact on the environment is less; and selected material quarry site is selected from where its impact on the environment is less.

- ✓ Because the success of an environmental management system largely depends on the correct identification and assessment of environmental impacts, the main contribution of this study is to support the implementation of environmental management systems in construction companies by providing guidance for construction practitioners.

5.2 Recommendation

The following recommendations are made based on the findings in this research and are forwarded to stakeholders in the construction industry to contribute to the mitigation of negative environmental impacts of construction activities.

- ✓ Noise and vibration should be managed on site to reduce the impact on site workers, nearby residents and its neighborhood. Some of the methods to mitigate this issue are: Preparing personnel so as to avoid inadequate use of plant and equipment, namely, running full power when the work does not necessitate it ; Ready mix concrete should be preferred, otherwise concrete mixers should be electrical; Perform maintenance on machines so they do not output as much noise; Operation time for a noisy equipment should be minimized, especially if it can be replaced by an alternative less noisy construction process; Obtain probable values for noise emission from the equipment to be used before commencement of works, this is a valuable aid to the choice of equipment.
- ✓ There is need to reduce the consumption of construction materials which can be done through recycling and reuse of wastes and this will reduce on the use of virgin materials and the subsequent waste of energy used in production of new ones.
- ✓ Exposed areas should be minimized to reduce dust generation and areas generating dust during dry weather should be sprayed with water to reduce dust nuisance. Limits to hours of working must be specified to reduce the impact of dust on local residents and businesses. There should also be specific requirements on construction vehicles transporting materials to and from sites. For example, dusty materials must be sprayed with water during dry weather, and the loads of any vehicles carrying potentially dusty materials must be covered during transportation.
- ✓ Management operations should aim to minimize disturbance to adjacent residential and recreational uses, for example by setting the route and timing of construction traffic so as to avoid residential areas or other sensitive human receptors (e.g. schools, hospitals, nursing homes).
- ✓ There should be adoption of waste minimization strategies.
- ✓ Construction practitioners should start working with new methods and technologies following sustainable construction techniques to reduce environmental impacts.

- ✓ Finally, there is a pressing need for government to intervene in order that the use of sustainable construction designs and construction strategies that is environmentally friendly becomes the custom in Ethiopia. The paper therefore recommends that government with the support of stakeholders in the construction industry should come up with special legislations, codes or standards relating to sustainable construction practices specific to Ethiopia’s construction environment to ensure its proper and effective implementation. Besides, all forms of construction activities should be subjected to an environmental impact assessment to determine the potential impacts and also come up with some mitigation measures before they are executed.

5.2.1 Suggestions for Future Work

For future research work, the following suggestions are forwarded:

1. Environmental impacts of construction activities in case of road and dam projects in Ethiopia.
2. Environmental impacts of construction materials production in Ethiopia.
3. Environmental management system on construction sites.

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ANNEXES

ANNEXE A: <u>Questionnaire for Construction Practitioners and Nearby Residents</u>

Environmental Impacts of Construction Activities in SNNPRS:
(The Case of Building Construction Projects in Selected Towns)

Detail of the Researcher:

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This research study titled "**Environmental Impacts of Construction Activities in SNNPRS: (The Case of Building Construction Projects in Selected Towns)**" is undertaken by Yidnekachew Esayas at Hawassa University Institute of Technology, Civil Engineering Department to investigate environmental impacts of construction activities in SNNPRS on building construction projects. Please answer ALL questions.

Thanks in advance for your co-operation and help!

Sincerely,

Yidnekachew Esayas

Note:

1- **Not important** –indicates that the activity has no impact/ insignificant
2- **Less important-** indicates that the activity has negligible impact/minor impact
3- **important -** indicates that the activity has significant/moderate impact
4- **highly important -** indicates that the activity has major impact
5- **Extremely important-** indicates that the activity has extremely sever impact/catastrophic

- ❖ **CFC-**Chlorofluorocarbons-are fully halogenated paraffin hydrocarbons that contain only C, Cl & F; the most common representative is dichlorodifluoromethane. Refrigerants are common sources of CFC.
- ❖ **VOC-**Volatile organic compounds-are organic chemicals that have a high vapor pressure at ordinary room temperature. They are emitted as gases from certain solids or liquids like fuels.

Questionnaire for construction practitioners (either contractor side or consultant side)

PART I: GENERAL INFORMATION

1. Name of the company ____

2. Grade of the company __________________________________

3. Name of the project ____

4. Educational background

❑ Below Diploma ❑ Diploma ❑ B.Sc. degree ❑ M.Sc. degree ❑ PhD

5. Your current position in the company: ___________________________

6. Experience in the construction industry:

❑ Less than 5 years ❑ 5 to 10 years ❑ Above 10 years

PART II: ISSUES ABOUT THE IMPACTS OF CONSTRUCTION ACTIVITIES ON THE ENVIRONMENT

SECTION A: Site activities adversely affecting the environment

The under listed are the site activities adversely affecting the environment in the case of building construction projects. Please use the ranking below to indicate its level/degree of importance:

1- Not important 2- less important 3- important 4- highly important 5- Extremely important

No.	Site activities adversely affecting the environment	Rankings				
		1	2	3	4	5
1	Site clearance					
2	Earthmoving					
3	Demolishing					
4	Excavation					
5	Driving piles					
6	Test drilling					
7	Transportation					
8	Landfill, compaction and leveling					
9	Concrete batching, mixing and placement					
10	Concrete vibration					
11	Renovation/renewing					

SECTION B: Potential negative environmental impacts resulting from construction activities The under listed are the negative environmental impacts resulting from construction activities. Please use the ranking below to indicate its level/degree of importance: **1- Not important 2- less important 3- important 4- highly important 5- Extremely important**

No.	the negative environmental impacts resulting from construction activities	Rankings				
		1	2	3	4	5
1.	**atmospheric emissions**					
	greenhouse gas emissions (Such as CO_2, ozone)					
	emission of VOCs and CFCs					
2.	**water emissions**					
	water from excavation					
	water from cleaning tools					
	sanitary water					
3.	**waste generation**					
	excavated waste material					
	municipal waste (garbage, e.g. product packaging)					
	inert waste (not reactive waste, e.g. sand, concrete)					
	ordinary waste (solid waste ,sewage ,waste water)					
	toxic waste(chemical wastes like old batteries, paint)					
4.	**soil alteration**					
	land occupancy					
	concrete release agent					
	cleaning agents					
	construction machinery waste					
5.	**resource consumption**					
	water consumption					
	electricity consumption					
	fuel consumption					
	raw materials consumption					
6.	**local issues**					
	dust generation from machinery					
	dust generation in earthworks					
	dust generation in cutting operations					
	noise and vibration generation					
	landscape alteration					
7.	**transport issues**					
	road traffic load					
	interference in road traffic					
8.	**effects on biodiversity**					
	vegetation removal					
	loss of edaphic soil (topsoil)					
	potential soil erosion					
	interception of water bodies					
	interference with the ecosystems					
9.	**accidents and incidents**					
	fire outbreaks					
	breakage of service pipes					
	breakage of receptacles (containers)					

SECTION C: People likely to be affected by negative effects of construction site activities

To what extent do you agree that the under listed peoples are likely to be affected by negative effects of construction site activities? Please use the ranking below to indicate its level/degree of importance.

1- Not important 2- less important 3- important 4- highly important 5- Extremely important

No.	People likely to be affected	Rankings				
		1	**2**	**3**	**4**	**5**
1	Site workers					
2	Nearby residents					
3	People in schools and hospitals in the neighborhood					
4	Others					

SECTION D: The mitigation measures taken by construction practitioners toward environmental impacts from construction activities

1. Is there any environmental impact assessment (EIA) conducted for your project?

   ❑ Yes ❑ No

   If yes, how is the implementation of the mitigation measures/alternatives stated in EIA report?

   ❑ Very good ❑ good ❑ satisfactory ❑ poor ❑ very poor ❑ no opinion

2. In general, is there any mitigation measures taken by you toward negative environmental impacts? ❑ Yes ❑ No

   If yes, please list them.

   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____
   ____

Questionnaire for nearby residents

PART I: GENERAL INFORMATION

1. Gender ❑ male ❑ female

2. Job ___________________________________

3. Educational background

❑ Below Diploma ❑ Diploma ❑ B.Sc. degree ❑ M.Sc. degree ❑ PhD

PART II: ISSUES ABOUT THE IMPACTSOF CONSTRUCTION ACTIVITIES ON THE ENVIRONMENT

SECTION A: site activities adversely affecting the environment

The under listed are the site activities adversely affecting the environment in the case of building construction projects. Please use the ranking below to indicate its level/degree of importance:

1- Not important 2- less important 3- important 4- highly important 5- Extremely important

No.	**Site activities adversely affecting the environment**	**Rankings**				
		1	**2**	**3**	**4**	**5**
1	Site clearance					
2	Earthmoving					
3	Demolishing					
4	Excavation					
5	Driving piles					
6	Test drilling					
7	Transportation					
8	Landfill, compaction and leveling					
9	Concrete batching, mixing and placement					
10	Concrete vibration					
11	Renovation					

SECTION B: Potential negative environmental impacts resulting from construction activities

The under listed are the negative environmental impacts resulting from construction activities. Please use the ranking below to indicate its level/degree of importance: **1- Not important 2- less important 3- important 4- highly important 5- Extremely important**

No.	the negative environmental impacts resulting from construction activities	Rankings				
		1	2	3	4	5
1.	**atmospheric emissions**					
	greenhouse gas emissions					
	emission of vocs and cfcs					
2.	**water emissions**					
	water from excavation					
	water from cleaning tools					
	sanitary water					
3.	**waste generation**					
	excavated waste material					
	municipal waste					
	inert waste					
	ordinary waste					
	toxic waste					
4.	**soil alteration**					
	land occupancy					
	concrete release agent					
	cleaning agents					
	construction machinery waste					
5.	**resource consumption**					
	water consumption					
	electricity consumption					
	fuel consumption					
	raw materials consumption					
6.	**local issues**					
	dust generation from machinery					
	dust generation in earthworks					
	dust generation in cutting operations					
	noise and vibration generation					
	landscape alteration					
7.	**transport issues**					
	road traffic load					
	interference in road traffic					
8.	**effects on biodiversity**					
	vegetation removal					
	loss of edaphic soil					
	potential soil erosion					
	interception of water bodies					
	interference with the ecosystems					
9.	**accidents and incidents**					
	fire outbreaks					
	breakage of service pipes					
	breakage of receptacles					

SECTION C: People likely to be affected by negative effects of construction site activities

To what extent do you agree that the under listed peoples are likely to be affected by negative effects of construction site activities? Please use the ranking below to indicate its level/degree of importance.

1- Not important 2- less important 3- important 4- highly important 5- Extremely important

No.	People likely to be affected	Rankings				
		1	2	3	4	5
1	Site workers					
2	Nearby residents					
3	People in schools and hospitals in the neighborhood					
4	Others					

ANNEXE B: Checklist for environmental impacts of construction activities on visited project sites

No.	the negative environmental impacts resulting from construction activities	
1.	**atmospheric emissions**	
	greenhouse gas emissions	
	emission of vocs and cfcs	
2.	**water emissions**	
	water from excavation	
	water from cleaning tools	
	sanitary water	
3.	**waste generation**	
	excavated waste material	
	municipal waste	
	inert waste	
	ordinary waste	
	toxic waste	
4.	**soil alteration**	
	land occupancy	
	concrete release agent	
	cleaning agents	
	construction machinery waste	
5.	**resource consumption**	
	water consumption	
	electricity consumption	
	fuel consumption	
	raw materials consumption	
6.	**local issues**	
	dust generation from machinery	
	dust generation in earthworks	
	dust generation in cutting operations	
	noise and vibration generation	
	landscape alteration	
7.	**transport issues**	
	road traffic load	
	interference in road traffic	
8.	**effects on biodiversity**	
	vegetation removal	
	loss of edaphic soil	
	potential soil erosion	
	interception of water bodies	
	interference with the ecosystems	
9.	**accidents and incidents**	
	fire outbreaks	
	breakage of service pipes	
	breakage of receptacles	

ANNEXE C: The Visited Construction Projects

No.	**Name of Construction Projects**	**Contractor**	**Consultant**
	Hawassa Projects		
1	Commercial Bank of Ethiopia Hawassa District Office Building	Zamra Construction PLC	Addis Mebratu Architects
2	Ethiopian Revenue & Customs Authority Building	Bereket Endashaw GC	ECDSWC
3	Hawassa City Administration police Department Head Office Building	Man GC	ECDSWC
4	Nib International Bank Hawassa	Santa Maria Construction PLC	Bereket Tesfaye Architects & Engineers
5	All in One (HU)	Yirgalem Construction PLC	Zeleke Belay Architects PLC
6	Dormitory-1 (HU Iot)	Homa Construction PLC	Obon Voyage Architects PLC
7	Adare General Hospital	Abera Lisanu BC	South Design & Supervision Enterprise
8	Southern Teachers Association Building	Atem BC	South Design & Supervision Enterprise
9	Hawassa City Administration branch office	Tesfaye Tsegaye BC	ECDSWC
10	Hawassa City High Courts Sub-office Building	Tamirat Tesfaye GC	Hawassa City Contruction Office
	Dilla Projects		
11	Dilla University Teaching & Referral Hospital	Flintstone Engineering	ECDSWC
12	PG & Research School	Unity Engineering	BUDSWS
13	Dilla University Administration Office Building	FE Construction PLC	ECDSWC
14	Dilla Industrial Park	Pyramid Construction PLC	MH Engineering
15	DU Hasedilla Campus Dormitory Building	Tower Construction PLC	ECDSWC
16	DU Staff Resident Building	Bereket Endashaw GC	ECDSWC
	Wollayta Sodo Projects		
17	Library	Abera Lisanu BC	YTH Architects
18	Class Rooms	Yohannes Haile Construction	MH Engineering PLC
19	Dormitory	Etete Construction PLC	YTH Architects
20	Soyas Hotel Building	Zeleke Kolcha Construction PLC	

ANNEX D: Pictures from Some of the Visited Construction Projects

Waste material deposit on site

Deep excavation on construction sites

Construction materials and vehicles on the road

Land occupancy and effect on vegetation

ANNEX E: Spearman's Test Static Table

a)

n	.001	.005	.010	.025	.050	.100
4	—	—	—	—	.8000	.8000
5	—	—	.9000	.9000	.8000	.7000
6	—	.9429	.8857	.8286	.7714	.6000
7	.9643	.8929	.8571	.7450	.6786	.5357
8	.9286	.8571	.8095	.7143	.6190	.5000
9	.9000	.8167	.7667	.6833	.5833	.4667
10	.8667	.7818	.7333	.6364	.5515	.4424
11	.8364	.7545	.7000	.6091	.5273	.4182
12	.8182	.7273	.6713	.5804	.4965	.3986
13	.7912	.6978	.6429	.5549	.4780	.3791
14	.7670	.6747	.6220	.5341	.4593	.3626
15	.7464	.6536	.6000	.5179	.4429	.3500
16	.7265	.6324	.5824	.5000	.4265	.3382
17	.7083	.6152	.5637	.4853	.4118	.3260
18	.6904	.5975	.5480	.4716	.3994	.3148
19	.6737	.5825	.5333	.4579	.3895	.3070
20	.6586	.5684	.5203	.4451	.3789	.2977
21	.6455	.5545	.5078	.4351	.3688	.2909
22	.6318	.5426	.4963	.4241	.3597	.2829
23	.6186	.5306	.4852	.4150	.3518	.2767
24	.6070	.5200	.4748	.4061	.3435	.2704
25	.5962	.5100	.4654	.3977	.3362	.2646
26	.5856	.5002	.4564	.3894	.3299	.2588
27	.5757	.4915	.4481	.3822	.3236	.2540
28	.5660	.4828	.4401	.3749	.3175	.2490
29	.5567	.4744	.4320	.3685	.3113	.2443
30	.5479	.4665	.4251	.3620	.3059	.2400

Source: Daryl S. Paulson 2003

b) Critical values for the Spearman's Rank Correlation Coefficient

	Significance level	
Number of pairs of measurements (n)	**p = 0.05 (95%) (+ or -)**	**p = 0.01 (99%) (+ or -)**
5	1.000	
6	0.886	1.000
7	0.786	0.929
8	0.738	0.881
9	0.683	0.833
10	0.648	0.818
11	0.623	0.794
12	0.591	0.780
13	0.566	0.745
14	0.545	0.716
15	0.525	0.689
16	0.507	0.666
17	0.490	0.645
18	0.476	0.625
19	0.462	0.608
20	0.450	0.591
25	0.400	0.526
30	0.364	0.478
35	0.336	0.442
40	0.314	0.413

Source: https://www.field-studies-council.org/media/2594645/spearmans-wksheet.pdf