EXAMINING ARTIFICIAL NIGHT LIGHTING OF URBAN COMMERCIAL CORRIDORS: THE CASE OF HAYAHUALET MAZORIA, ADDIS ABABA

Milkyas Abdulkerim Abda

A Thesis Submitted to
The department of Architecture
School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in urban planning and design

Office of Graduate Studies
Adama Science and Technology University

June, 2022

Adama, Ethiopia

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Approve of Board of Examiners

I, the advisors of the thesis entitled “**Examining Artificial Night Lighting of Urban Commercial Corridors: The Case of Hayahualet Mazoria, Addis Ababa**” and developed by **Milkyas Abdulkerim Abda** hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis. Dr. Belay Zeleke (Ph.D.)

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Major Advisor/Supervisor Signature Date

We, the undersigned, members of the Board of Examiners of the thesis **Milkyas Abdulkerim Abda** have read and evaluated the thesis entitled **Examining Artificial Night Lighting of Urban Commercial Corridors: The Case of Hayahualet Mazoria, Addis Ababa**” and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in **Urban Planning and Design.**

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Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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Declaration

I hereby declare that this Master Thesis entitled "**Examining Artificial Night Lighting of Urban Commercial Corridors: The Case of Hayahualet Mazoria, Addis Ababa**" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

____________________	____________________	_______________
Name of student	Signature	Date

Recommendation

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled **Examining Artificial Night Lighting of Urban Commercial Corridors: The Case of Hayahualet Mazoria, Addis Ababa**”” prepared under my/our guidance **Milkyas Abdulkerim Abda** submitted in partial fulfillment of the requirements for the degree of Masters of Science in **Urban Planning and Design**. Therefore, I/we recommend the submission of revised version of the thesis to the department following the applicable procedures.

______________________________ ______________________ ____________________

Major Advisor/Supervisor Signature Date

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LIST OF ACRONYMS AND ABBREVIATIONS

3D- Three Dimension

AL- Artificial Light

ALAN- Artificial Light at Night

ANL- Artificial Night Light

CCT- Correlated Color Temperature

CIE-Commission International de L'Eclairage

CT- Color Temperature

EU-European Union

IDA- International Dark Sky Association

LED- Light Emitting Diode

LT-Local Time

MLO-Model Lighting Ordinance

NLIPIP- National Lighting Product Information Program

PAD-Pleasure, Arousal, Dominance

SPSS-Statistical Package for the Social Science

US- United States

USA-United States of America

V22-version 22

ABSTRACT

Light is the most important environmental element that helps our eyes provide information about what's going around us. Over lighting is one of the most rapidly increasing issues that *is affecting the environment and people's visual comfort. This research aims to identify the intensity of artificial lighting from the retail's frontage* along the corridor from Hayahulet *Mazoria square up to Awraris hotel and assess the perception of passers-by along the sidewalk. The study used both probability and non-probability sampling methods. The purposive sampling technique was used when selecting the four shops that have 20-watt white color LED lamps, but differ in the number of lamps they hold. The simple random sampling was taken from a manually counted population of passersby. The data collection was done by adopting a mixed-method consisting of the questionnaire, in situ observation, and measurements of lighting level. Vogels' (2008) instrument was adopted to determine the user's perception and visual comfort. The result of this research shows that the average intensity of lighting from shops 2,3, and 4 is above the allowed lighting level of 1500lux for outdoor frontage at commercial areas set by MLO,2011. The overall perception of user experience shows that coziness is negatively related to brightness, glare, and color temperature. Furthermore, the regression model showed brighter shop creates an atmosphere that is perceived as less cozy and more stimulating. Based on the findings, shop 1 which has 6 LED lamps is the coziest, the less stimulating and less terrifying shop. In contrast, shop 4 with the highest number of LED lamps is the less cozy, the most stimulating and the most terrifying shop. Based on the obtained results, it can be concluded that the overused of artificial lights at night is unnoticed but causes a physical, emotional, and physiological impact on people. It is highly recommended to further study the issue and enact an ordinance to manage the over lighting of artificial night lighting*

Keywords: Artificial night lights, Commercial corridor, Light intensity, Over lighting Perception, Visual comfort

CHAPTER ONE

1. INTRODUCTION

Light is the most important environmental element which helps our eyes to provide information about what's going around us (Gregory, 1998). Recent studies showed us the urban environment is becoming brighter and more illuminated at night (Zielinska & Xavia, 2019). Misdirected, annoying, and unwanted outdoor illumination has lately increased by more than 2% per year (Kyba et al., 2017).

The International Dark-Sky Association (IDA, 2010) defines light pollution as, "any unfavorable effect of artificial light including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste (Chun & Chu , 2014). This issue is requiring a change in the attitude of society. Light pollution has two categories: Annoying and Excessive light. Light pollution can also divide into indoor and outdoor (Longcore & Rich, 2004).

Artificial lighting has become an important need for the developing world in the futuristic approach. Therefore, the application of artificial lighting becomes essential in the field of architecture (Bandara et al., 2018). Humans create and construct things in favor of their comfort and satisfaction (Zhi & Qing, 2011). The main goal of the human being is the pursuit of comfort and satisfaction (Fincher & Boduch, 2009).

At night our eyes depend on artificial light sources to navigate any environment including urban spaces. These artificial light sources can be mobile or fixed, personal or public. In some cases, lights are specifically intended to illuminate the public way. In other cases, lighting is simply a byproduct of other uses such as accent lighting and advertisements (Baker & Lyons, 1978). Organizations such as the International Dark-Sky Association (International Dark-Sky Association) are fighting to reign in these wasteful applications (IDA, 2009).

The impact of artificial light is unnoticed in many urban areas. People place lighting as they want. Lack of knowledge and carelessness creates this urban chaos. Very few countries are practicing light law and regulation, but this guideline should be the basic principle of planning (Gaston et al, 2014).

Recently artificial light at night is taken as urban aesthetics and attention-seeking in the market places. Even though it is the basic element in our life, understanding the proper intensity of light for a healthy, comfortable, and safe environment should be taken as a priority (Gaston et al, 2014).

The study focuses on the lighting situation of commercial corridors in particular, by attempting to measure the light intensity emitting from the store frontages and to assess the perception of passers-by along the commercial corridor. Therefore, this study aims to summarize and become a reference for urban night lighting, especially in the commercial corridor.

1.1 Background of the Study

Because of rapid urbanization, in the last decade, artificial night light (ANL) is increased too much extent in both intensity and density (Kyba et al., 2017). Street lighting, lighting from buildings, and advertising are mainly the sources of ANL (Gaston et al., 2015). Planning is needed for the ANL for the better management of energy and also to reduce the impact on the environment but without that, it can cause serious damage to the ecosystem (Katz & Levin, 2016; Levin et al., 2020). As the country develops, urban spaces begin to expand and man-made structures begin to swallow the city. The urban commercial corridor is one of the outcomes of development. With the spread of this urban trade corridor, night lighting has become a major feature of the population decoration and vividness. Therefore, one of the basic functions of outdoor lighting in urban commercial corridors is to provide safety and visual support when perceiving the surroundings. Visual comfort and visual satisfaction are phenomena that play a key role in the successful interaction of humans with urban space (Hafiz, 2013).

Comparatively, if there is a low provision of light than the demand, it will decrease the human's sense of safety and security (Perkins, 2015). So, there is an urgent need to assess effective lighting planning and regulation to reduce the effect of ANL (Gaston et al., 2013).

But it was after the 1980s that urban lighting started to be designed with a systematic approach called urban lighting masterplans. In the last three decades, Urban lighting has become the most popular component in urban design practices, especially in many cities in Western Europe, mostly in France and North America (Narboni, 2004).

They began to realize the urban lighting design scheme and this lighting scheme was planned for the pedestrian zone, landmarks, roadways, and green areas concerning both its function and aesthetics (Narboni, 2004). Addis Ababa is the political capital and the most important commercial and cultural center of Ethiopia (Nicole & Shyngle, 2013). Recently urban lighting has become a concern for city governors to make the urban lit. The Addis Ababa city road authority (AACRA), has planned to brighten up Addis Ababa's streets by introducing what is said to be a new energy-efficient lamp, LED technology (light-emitting diode). This new technology is said to have a brighter light and longer durability time (Yonas, 2018).

1.2 Statement of the Problem

Light is important for the comfortable, productive, and safe lifestyle of human beings. Excessive exposure to artificial light at night harms the ecosystem and human health (Cho, 2015). Over-lighting is one of the most rapidly increasing issues that is affecting the environment. Evidence is increasing that shows the potential relation between ALAN and human health conditions. Light pollution can be described as "the use of light at the wrong place, wrong direction, wrong time, and wrong amount" (Onuk, 2008). Excess LED lights popping out of store windows, building lights, traffic lights, and advertising boards at night are creating intense visual discomfort and dissatisfaction on the pedistrian in Addis Ababa.

This rapid increase in the effect of ALAN on humans and in the interaction of ecosystems has brought a common sense of understanding to develop a legal action against improper usage of light, especially at night (Guanglei et al., 2019). Government involvement in managing the laws against the ALAN has increased (Ko et al., 2016). Due to uncontrolled urbanization and unmanaged illumination facilities, China which is the largest developing country is suffering from an imbalance in the supply and demand of artificial night light (Han et al., 2014; Yao et al., 2020). Even if this issue is clearly seen in the city of Addis Ababa, stakeholders failed to draft laws, ordinances, and perspective measures to manage over-lighting at the commercial corridors.

Now a day's Assessing light pollution on ecology is a hot research topic (Davies & Smyth, 2018). But it is so challenging to find a resource that has made on over-lighting and related issues in a country level. It's a precaution and criteria to have good night lighting for a successful city environment.

To achieve this, an appropriate lighting understanding is a tool. But in the area of this study where a night time commercial activity is highly practiced, the issue of over lighting is neglected.

This is also related to the absence of regulation at the city government level. Since this issue is rapidly increasing such studies that give information about its impact and management are important. Even though the activities regarding reduction of artificial light emission at night are becoming practical in some developing countries, Addis Ababa couldn't have a lighting data of different zones of her city. So, this Artificial night lighting understanding and regulation should to be part of the urban planning practice.

1.3 Objective of the Study

1.3.1 General Objective.

The general objective of this study is to examine the artificial night lighting of the urban commercial corridor around Hayahulet mazoriza, Addis Ababa.

1.3.2 Specific Objective.

1. To measure the intensity of artificial night lights at shop frontage
2. To assess the perception of passers-by

1.4 Research Question

1. What is the intensity of artificial night lights in the commercial corridor?
2. How are passers-by perceive the night-time artificial lighting?

1.5 Significance of the Study

The research mainly focuses on understanding how pedestrian perceives the night-time lighting condition in the commercial corridors, and also it records and develops data on lighting level from the retail frontage. This study could be an input for the local research related to the context of the title.

It helps other researchers to explore more in-depth the current gap in overcoming the impact of artificial night light emission. Generally, it contributes in building a solid understanding of artificial night lighting and how the users respond to it.

1.6 Scope of the Study

The Special scope of research is to examine artificial night lighting in the commercial corridor (Djibouti Street) from Hayahulet Mazoria square up to Awraris hotel. The population which the research study takes are the retail shops along the corridor and pedestrian using the sidewalks at night. This is because the area has high night time commercial activity and passers-by are highly affected by over lighting of the corridor.

As (Boyce et al, 2003) stated, the shop owners might have adapted to the lighting condition and might give a biased data so they are excluded. Thematically, the study focuses on identifying the light intensity and studying the perception of pedestrians of different demographic groups. Literature about the energy side of lighting, electricity, the defect of ANL on astrological practice, and the impact on other ecology is reviewed in detail because its broads and moves out from the thematic area of the study.

1.7 Description of the Study Area

The site is located in the Bole sub-city, Addis Ababa at 9°1′48″N 38°44′24″E with elevation of 2,355 meters.

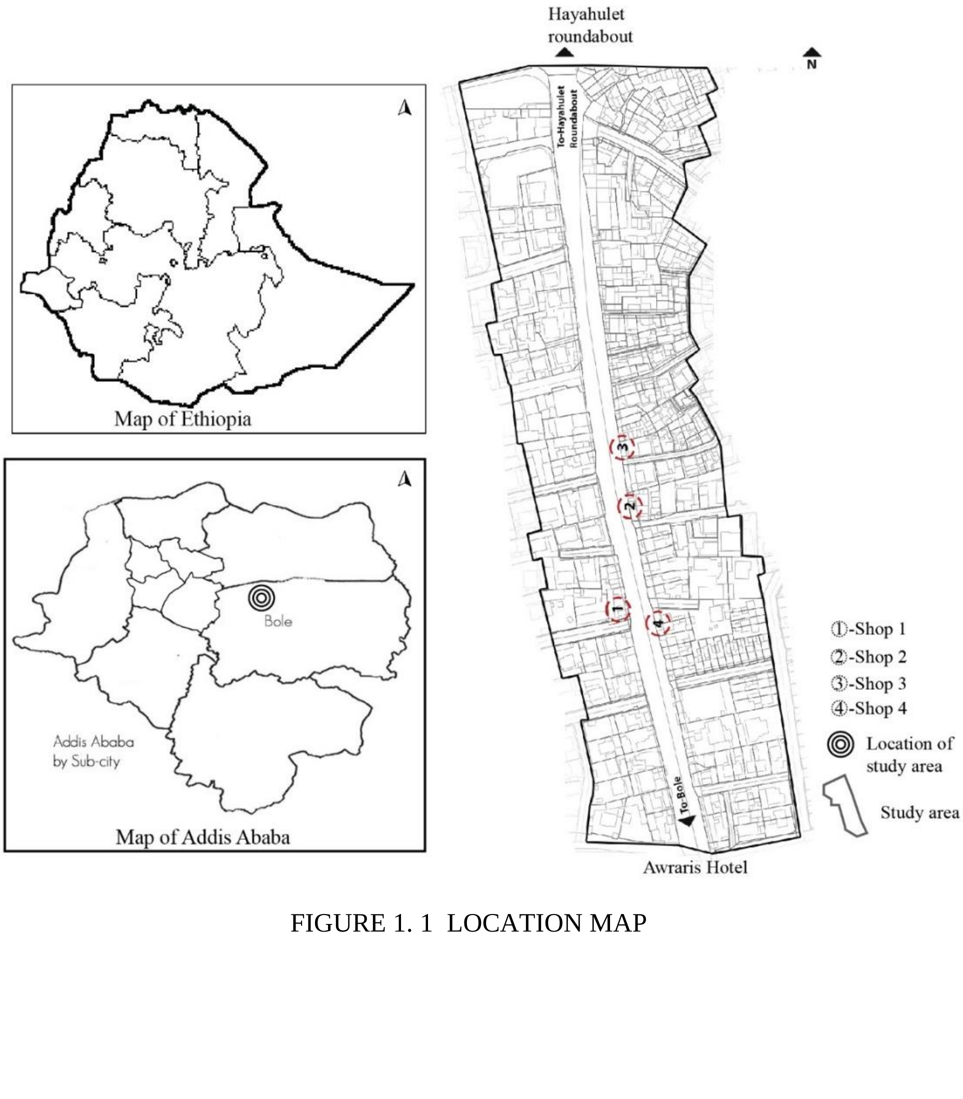

FIGURE 1. 1 LOCATION MAP

1.8 Limitation of the Study

The main limitation of the study was lack of reference document for outdoor artificial lighting in the commercial corridors in Ethiopian context. The night time site survey and engaging with respondents was challenging. The research didn't cover energy side of lighting and electricity because it's outside of thematic area.

1.9 Organization of the Research

The research is organized into five chapters. Each chapter examines the content and data of the study. The main chapter in the research is further described as follows.

Chapter One: The introduction to the study illustrates the thesis by stating the general idea of the study, research problems, objectives, questions, significance, scope, description of the study area, and limitations during the research.

Chapter Two: Literature Review is a chapter that discusses key terms related to lighting, and human perception, types and impacts of light pollution, management techniques of light pollution in urban areas, and measured lighting levels. It also includes urban commercial corridors.

Chapter Three: Material and methods is a chapter that discusses approach of the research. This chapter explains the materials and methods used for the study and the data collection process and analysis in detail.

Chapter Four: Result and Discussion is a chapter that reports the qualitative and quantitative data findings. The subjective quantitative data is collected from field observation, and lux meter instruments. The qualitative data are analyzed based on a questionnaire survey, field observation notes, and printed documents. The organized data is presented and interpreted in this chapter.

Chapter Five: Conclusion and Recommendation is the section where the results are discussed in a more meaning full way by comparing each result with the international guideline. The chapter concludes with the results and discussion as well as recommendations for further studies are also given.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

This chapter is to give a general theoretical framework about night-time artificial lighting and its impact; related to this, it also presents facts of previous findings, ambiguity, and arguments about the concept that has been researched. In addition, it explains the variables for illumination study and night-time artificial lighting management method.

2.2 Theoretical Literature Review

This part contains; published journals, magazines, documents research, and different references for understanding the basic concept of lighting, type of light pollution, the light psychology to human beings, variables of the illumination, light intensity standard for different zones, the impact of night lighting on the urban environment, and the character of urban commercial corridors is assessed.

2.2.1 Lighting Attributes.

Light makes it easier for our vision to perceive the physical universe. Therefore, light is the gateway for eyes, and thus the human mind, to connect with the world. Based on this mechanism of light, the composition of light in a room can evoke both psychological and physiological reactions in humans. Human well-being comes from the physiological component of human beings, and human satisfaction comes from the psychological component. When considering artificial lighting, emphasizing visual comfort and visual satisfaction as measured by specific parameters is an important consideration in the design of outdoor spaces in the city (Bandara et al., 2018).

A person's visual comfort and visual satisfaction are determined by the conditions of light sensory perception. The International Commission on Illumination (2005) documents that lighting standards define the following parameters related to visual comfort: Glare, luminance level, luminance factor and uniformity, color rendering, and color temperature (Iacamussi et al., 2015).

The focus of visual comfort includes the following parameters:

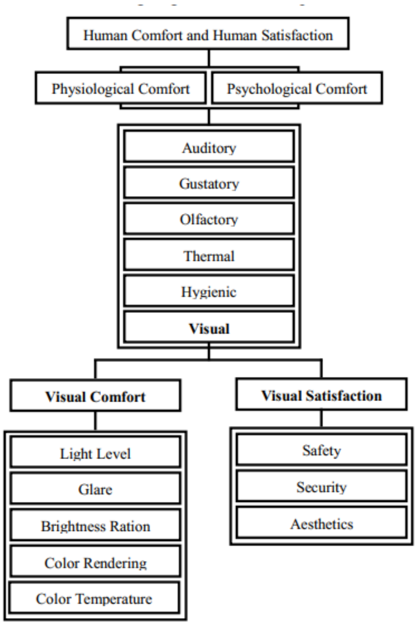

FIGURE 2.1 HUMAN COMFORT AND SATISFACTION

Note: From "The Impact of Artificial Lighting on Visual Comfort and Visual Satisfaction " Bandara et al., 2018).

2.2.1.1 Lighting.

Lighting is one of the many environmental cues which can have an impact on feelings and perceived atmosphere (knez, 1995; Van Erp, 2008).

2.2.1.2 Light level.

This is the amount of visible light emitted by the light source and received by the surface. Luminous intensity is evaluated based on the visual sensations experienced (Cuttle, 2008).

2.2.1.3 Brightness.

Brightness is the subjective quantity of light a source appears to emit. The objective amount of emitted light may be expressed in terms of illuminance and luminance. Illuminance is described as the quantity of light that falls on a given floor, expressed in lux. Luminance is described as the quantity of light emitted by a floor in a given direction, expressed in candelas per square meter (Custers et al., 2010). Research has proven that better brightness ranges appeal to the attention of people, that is called 'phototropism' (Hopkinson & Longmore, 1959). Retail settings are often utilized by making use of excessive brightness ranges in a specific vicinity of a store to ensure that section gets greater attention.

2.2.1.4 Contrast.

Contrast quantifies the visibility of a goal relative to its instantaneous background. A better comparison makes it less difficult to discover the target. In other words, contrast is the difference in brightness of an object that makes that item distinguishable from different objects (Custers, P. J. et.al, 2010).

2.2.1.5 Color temperature.

The color of the light emitted through a light supply may be characterized by the color temperature (CT) or the correlated color temperature (CCT). This degree is based on the reality that a black body's spectral emission is described through Planck's radiation law. Consequently, the chromaticity coordinates of a black body are a feature of its temperature (Custers, P. J. et.al, 2010).

2.2.1.6 Glare and sparkle.

Glare occurs when there is excessive and uncontrolled brightness of the light. It can cause discomfort and unsatisfying effects (Boyce et al., 2003).

2.2.2 Lighting and Human Perception.

Until now few researches are made about the results of retail lighting on the perceived environment. However, the results of lighting on ecosystem notions in laboratory settings (Custers et al., 2008).

(knez, 1995) investigated the outcomes of indoor lighting and used (Watson, D et al.) PANAS scales to measure emotions, while the room light reviews of the members have been assessed by seven unipolar adjectives: glaring, dim, soft, bright, warm, intense, and cool. No massive outcomes have been determined concerning fine mood. Nonetheless, for terrible moods, a massive interplay among color temperature and gender turned into obtained. Males' negative mood increased dramatically in the 'warm' as compared to the 'cool' condition. Females' negative mood, on the contrary, is reduced in the 'warm' and increased in the 'cool' white light condition. Knez (1995) determined no huge results of illuminance.

(Falchi, F et al., 2011) investigated the impact of intensity, color temperature, and direct/indirect lighting ratio on emotions. (Mehrebian & Russel, 1974) used the PAD device was for compare participants' emotions.

An excessive intensity, in comparison to low intensity, was discovered more pleasant. High color temperature lights (‘cool’ white light) became discovered more arousing in comparison to low color temperature lights (‘warm’ white light) on effect, which was strengthened through the findings of (Hygge & Knez, 2001).

2.2.3 Light Pollution.

Because of rapid urbanization, in the last decade, artificial night light (ANL) is increased too much extent in both intensity and density (Kyba et al., 2017). Street lighting, lighting from buildings, and advertising are mainly the sources of ANL (Gaston et al., 2015; Katz, Y., & Levin, N., 2016). Planning is needed for the ANL for the better management of energy and to reduce the impact on the environment but, rather than this it can cause serious damage to the ecosystem (Katz & Levin, 2016). For Example, studies have stated that ANL changes the natural cycle of wildlife (Gaston et al., 2014a) and affects the circadian pattern of living things (Davies & Smyth, 2018) Comparatively, if there is a low provision of light the demand, it will decrease the human’s sense of safety and security (Perkins et al., 2015). So, there is an urgent need to assess effective lighting planning and regulation to reduce the effect of ANL (Gaston et al., 2013). In the last three decades, urban lighting has become the most popular component in urban design practices, especially in many cities in Western Europe, mostly in France and North America. They began to realize the urban lighting design scheme and this lighting scheme was planned for the pedestrian zone, landmarks, roadways, and green areas concerning both its function and aesthetics (Narboni, 2004).

2.2.4 Types of Light Pollution.

2.2.4.1 Skyglow.

Skyglow or Night Sky Luminance is a brightening of the sky by artificial light that is either emitted directly upward or reflected from the ground (Guide, NLPIP, 2008). It reduces the ability to see the dark sky and stars (Neugent & Massey, 2010).

The key elements to reduce the sky glow are to control the direction of the lighting and to reduce the light intensity but adjusting the direction of light is taken as the best way to prevent the sky glow. For example, using the full cut-off lighting fixture will make the light only focus on the area if needed, this reduces the unnecessary light escaping (Guide, NLPIP, 2008).

2.2.4.2 Glare.

It's the most serious form of light pollution caused by excessive brightness which can make a person blind. Lack of planning in intensity and poor designed light installation can be the reason to create glare. The extent of brightness or glariness is depended on different situations like the direction of the glare, the physiological status, and the age of a person. There are two categories of glare: Disability glare and Discomfort glare. Disability glare is the type of glare that can reduce and affect the visibility of a person (Tashiro et al., 2014), whereas Discomfort glare is the annoying moment that is caused by an over-bright source (Ganesh et al., 2015). According to Narboni (2004) to minimize the effect of glare changing the direction of light downwards is the effect on its own but additional measures like reducing light intensity and decreasing the number of light fixtures should be taken to reduce the discomfort.

2.2.4.3 Light trespass.

(Guide, NLPIP, 2008) states that light trespass is a light directed to an unwanted area. For example, light from the street illuminates a residence unit and create uncomfortable condition during their sleeping time or privacy. This trespass condition is the most common example.

2.2.4.4 Clutter.

It's an excessive grouping of lights. Clutter contributes highly to sky glow trespass and glare. The redundant use of lighting that we see in many urban areas causes clutter of light (Yang, et al., 2017). Our eyes have a natural capacity in a lowlight environment, but when the environment is over-lighted our eyes will get the chance to adapt to the night. Reducing unnecessary light also saves money and energy. Over lighting neither increases visibility nor improves night time safety and security (Guide, NLPIP, 2008).

2.2.5 Impact of Light Pollution.

2.2.5.1 Human health.

New health problem sources are occurring other than those we mostly know like Air pollution and stress related to lifestyle. Even though health care in several sections of the world is improved significantly, still there are places the urban and industrial ecosystem is not for living.

Nowadays a health issue regarding the excessive use of artificial light is increasing without being noticed. This imbalance is causing headaches, worker fatigue, mood disorder, anxiety, depression, and diabetes (IDA, 2015). Visible light is a fraction of the light spectrum that a human eye can see, recent a study has shown us that human time rhythms are being regulated by the blue part of the visible light spectrum (Abraham Haim, 2013).

2.2.5.2 Disruption of the ecosystem.

Nocturnal biodiversity is affected by Light pollution like insects, bats, and loris (IDA, 2015). A large number of migratory birds are losing their navigation confused by the ALAN (Ramachandra, 2011). The predator-prey relations between insects and animals are also changed by ALAN. Because some predators use light as an advantage and disturb the cycle of the food web. In the water bodies region, the effect of ALAN is also increasing. Sea turtles are one of the animals influenced by night light. They don't come to shore because they are usually disturbed by the light made for decoration at the edge of water bodies. There is a decline in the population of those species that depend on insects. Since the insects are attracted by the light the food chain is disturbed (Franz, 2010). ALAN impairs the night vision of species like bats, coyotes, moose, deer, and raccoons (Gad Perry, 2008).

2.2.6 Managing the Light Pollution in the Urban Area.

2.2.6.1 Hierarchy of brightness.

The selection of correct luminance levels for the right place and at the right time is important in saving energy and reducing the impact of light pollution. Every area must be carefully assessed and provided a design to achieve the intended amount of light for the specific area. With the hierarchy of functions, the intensity of light is ordered. For example, Retail and commercial districts are ranked too high and medium brightness, whereas residential and recreational areas are placed under lower brightness levels (Zielinska-Dabkowska, 2014).

2.2.6.2 Brightness area division in urban.

(Guide, 2003) States that; to know the effect of light pollution well we have to divide the environmental regions into four zones. This is; a naturally dark environmental region, a low-brightness environmental region, a medium-brightness environmental region, and a high-brightness environmental region. Countries like Shanghai, Guangzhou, and Beijing use the division of zones to understand light radiation management (Guanglei et al., 2019).

2.2.7 Measurement and Modeling.

2.2.7.1 Identifying the light level.

Night time brightness might come from direct or reflected lighting like sky glow, security, advertisement, and decor lighting (Cheon & Kim, 2020). There is a huge change seen in the level of ALAN comparing the first and new world map of ALAN brightness using the satellite photo (Falchi et al., 2016). Lux is the unit to measure ALAN which indicates the brightness of light that is perceived by the human eye. The amount of lux varies for different sources. For example, here its stated form lower to higher. The lower lux values are sky glow (0.15 lux), full moon (0.1–0.3 lux), residential street light (5 lux), and roadside street (15 lux). The higher lux values are mostly home (100–300 lux), office (400–600 lux), cloudy day (1000–10,000 lux), partly sunny (50,000 lux), and full sunlight (103,000 lux) (Cheon & Kim, 2020).

In Shanghai, there is a limit to the maximum visible brightness of the outdoor LED display when the outdoor natural environment lighting is 200lx or less (there is no limit to the maximum visible brightness of the LED display when the outdoor natural environment lighting exceeds 200lux). Shanghai proposed the selection of test points using the measurement method when measuring the intensity of outdoor lighting. The test should be run in several places that are convenient for viewing the display screen and influencing the crowd. The measurement results can be listed or displayed as the maximum value. (Guanglei et al, 2019). The horizontal illuminance at 1.5 m from the floor changed into the natural ambient illuminance of the check site. The illumination of ambient environment of the screen was determined by selecting at least four points as close as possible to the periphery of the display screen measuring the incident illuminance withinside the ordinary route of the display at every point, and calculating the arithmetic mean suggest to light up the ambient surroundings across the show display (Guanglei et al, 2019).

In a certain period of time, use the luminance meter to capture the highest brightness at the LED display and record. The city of Guangzhou only controls the timing of lighting, and there are no objective restrictions on lighting. Tianjin and Beijing have not issued any restrictions on LEDs. Tables 2.1 and 2.2 show the maximum visible brightness of indoor and outdoor LED displays in Shanghai (Guanglei et al, 2019).

Table 2. 1 Limit of the maximum visible brightness of outdoor LED displays in Shanghai

NO	**Area S (m^2)**	**Limit of the Maximum Visible Brightness**		
		Commercial Center Area	**Public Area**	**Residential Area**
1	S < 10	800 cd/m2	600 cd/m2	300 cd/m2
2	S < 10	600 cd/m2	400 cd/m2	300 cd/m2

(*Note*: From "A comparative study on current outdoor lighting policies in China and Korea: A step toward a sustainable nighttime environment " Guanglei et ali., 2019).

Table 2. 2 Limit of the maximum visible brightness of indoor light emitting diode (LED) displays

NO	**Area S (m^2)**	**Limit of the Maximum Visible Brightness**		
		Commercial Center Area	**Public Area**	**Residential Area**
1	S < 10	1200 cd/m2	800 cd/m2	400 cd/m2
2	S < 10	960 cd/m2	640 cd/m2	320 cd/m2

(*Note*: From "A comparative study on current outdoor lighting policies in China and Korea: A step toward a sustainable nighttime environment " Guanglei et ali., 2019).

2.2.8 Urban Commercial Corridor.

Darmawan in Wardhana says the corridor is a path running along the left and right sides that is bounded by a wall and forms a facade. A street is considered a corridor if it can connect from one place to another and can combine parts of that place. its development is often dependent on circulation (Wardhana, I. W., & Haryanto, R., 2016). According to the Bishop of Asha, there are two types of urban corridors Including a Commercial corridor, and a Scenic corridor. A commercial corridor is a corridor with solid activities and runs from commercial parts to the urban center such as office buildings, trade, and services along the corridor. Commercial corridors have lanes for pedestrians and motorists running through a city. A scenic corridor is a corridor that presents a unique natural landscape to provide an entertainment experience for pedestrians and vehicle users (Asha & Rochani, 2019).

2.3 Empirical Literature Review

2.3.1 World Scenario.

The intensity of ALAN, causes light pollution, is rising with the urbanization and development of countries worldwide. Skyglow or night luminance is a showcase for increase. Most cities now have night radiance that is seen many kilometers. Most cities don't have the experience of darkness. 66% of US and 50% of EU residents don't have the chance to see the milky way at night. In addition to that 20% of the EU and 40% of the US population doesn't have the experience to see dark night time. Since 2012 the resolution of night-time imagery has become better and people are getting great information from an image. This night-time imagery also gives information on how the city light emission compared to the other. For example, the light emission of cities in the USA is more than that of Germany (Christopher & Kyba, 2015).

2.3.2 Seoul Light Pollution Ordinance.

The Seoul Metropolitan Government issued an ordinance on the prevention and management of light pollution on July 15, 2010. The purpose of regulation is to improve the quality of citizens life, protect ecosystems and save energy by avoiding unnecessary lighting practices. This applies to three categories of lighting techniques: ambient lighting, advertising lighting, and decorative lighting. The ordinance also classifies all regions of Seoul into four classes based on the land use mandated by the Korean Ministry of Transport. These classes are known as "light environment management zones" (Guanglei et al, 2019).

Table 2. 3 Classification of areas for lighting management

Light Environment Management Zone	Description
Class 1	Green areas for conservation
Class 2	Natural green areas and productive green areas
Class 3	Residential areas
Class 4	Semi-industrial and commercial areas

(*Note*: From "A comparative study on current outdoor lighting policies in China and Korea: A step toward a sustainable nighttime environment " Guanglei et ali., 2019).

Space lighting includes all types of lighting installed to promote safe and enjoyable night activities, including security and street lighting. Decorative lighting refers to outdoor lighting installed for decorative or recreational purposes. The ordinance defines advertising lighting as outdoor lighting fixtures for advertising purposes (Lim et al, 2018).

The ordinance stipulates the maximum lighting brightness value legally permitted in each lighting management zone. Table 2.4 shows the allowable brightness values for advertising lighting.

Table 2. 4 Permissible luminance values for advertisement lighting

Light Environment Management Zone	Class 1	Class 2	Class 3	Class 4	
				Semi-Industrial Area	**Commercial Area**
Maximum luminance / [cd/m2]	<50	<400	<800	<900	<1000

(*Note*: From "A comparative study on current outdoor lighting policies in China and Korea: A step toward a sustainable nighttime environment " Guanglei et ali., 2019).

In China, attention to light pollution is a recent activity, and the theoretical research results are relatively limited. Laws to protect against light pollution are also sparse. So far, China has not enacted any special legislation to prevent or control light pollution. Current legislation does not effectively solve China's current light pollution problem. Therefore, it is necessary to evaluate the current state of China's light pollution prevention law. China has no national light pollution control laws or regulations, but the government has introduced many measures to prevent and control light pollution. (Guanglei et al, 2019).

2.3.3 People's Republic of China.

As Guanglei et al stated, according to Article 26 "The State must protect and improve the environment in which people live and the ecological environment. It prevents and controls pollution and other public hazards." This regulation can be considered as the basis and premise of all legislation to avoid environmental pollution, but it is only a basic regulation of the rough structure. It is not specified which type of pollution should be controlled. The expression "other public dangers" is also ambiguous. It cannot be used as a direct legal basis for relief.

2.4 Gap of Literature Review

Researchers that tried to assess the human perception of artificial light used experimental, interior and controlled environment rather than outdoor lighting. So, some of the methods and variables were hard to adapt in the assessment of artificial night lighting at shop frontages.

CHAPTER THREE

3. MATERIAL AND METHODS

3.1 Introduction

The research examines the effect of night-time artificial lighting emitted from store frontage on the perception of individuals and also measures lighting level of retail frontage. Typically, the deductive research approach is used with highly-structured data and the support of measurement.

The research type is Quasi experimental and survey research. The nature of the research is Exploratory, by triangulating theoretical findings, filed evaluations, and examining the output of both quantitative and qualitative types of research. The method helped the study's aim to understand the social phenomena in real-life inquiry. It is more focused on direct measurable values and variables. The study explores more in-depth by showing the figure, tables, and graphs, which can project to the larger population. This method helps to understand the relationship between artificial night light and the customers or passersby.

3.1.1 Research Type and Approach.

3.1.1.1 General methodology.

The nature of the research is Exploratory, where it tries to investigate the problem which is not clearly defined and to conduct a clear understanding of the phenomena. Since the research is based on a set of theories and standards and about the influence of over-lighting on the perception of passers-by along the urban commercial corridors, the research approach is deductive. Therefore, this study used a confirmatory approach (under exploratory) where it confirms the relations between theory and collected data.

The study employed both quantitative research (Questioners) and qualitative (Interview) methods. Quantitative research used surveys (Questioners) to understand the of influence of over lighting on customers by collecting data and statistical methods to analyze it. Specifically, the study adopted the Quasi experimental method. Qualitative research is used to explore participants' (informal interview) perceptions or feeling about the situation in the study area.

Thus, the study used mixed research methods which used qualitatively to explore a situation and develop a set of hypotheses. Finally, the study triangulates findings of the quantitative with that of the qualitative analysis.

3.2 Measurement of the Lighting Intensity at the Corridor

3.2.1 Method and Material Used for the First Objective.

3.2.1.1 Sampling.

Sub-city of the study area is selected by preliminary research during the proposal stage. (See Appendix C). After that, a different criterion is set to take the right site as a study area. The criteria for selection are; The site should be a commercial corridor, with a mixed character of residential and commercial or must be under lighting Zone 3 according to (MLO, 2011), and finally, the site should have active night time activity (see Appendix G). Based on this criterion the site selected as a study area for this research is Hayahulet Mazoria which is under the Bole sub-city.

FIGURE 3. 1 LOCATION OF SELECTED SHOPS

The specific study area, Wereda 4, with its old district Kebele 15 and 17 or commercial corridor from Hayahut Mazoria up to Awraris hotel is then selected purposively. There are 103 retails with frontage from Hayahut Mazoria up to Awraris hotel on both sides of the road. From all the 103 retails, the study covered those with 20W and round lamp types.

The retails having 20W round lamp is 42. After assessing all the retail's conditions, the retails are then stratified into four sub-populations based on the number of lamps their store frontage holds. These are (below 6), (6-12), (12-18), and (above 18) lamps. From each classified sample, a shop with similar frontage height and color, one retail is selected randomly.

Table 3. 1 Number of retails with 20W LED light fixtures

No	Number of lamps	Number of retails
1	Below 6	7
2	6-12	20
3	12-18	10
4	Above 18	5

Based on the assessment, 4 samples are selected as shown in the figure below. The selected samples are retailed that have 6, 12, 14, and 18 lamps.

FIGURE 3. 3 FIELD PHOTO OF SHOP 1

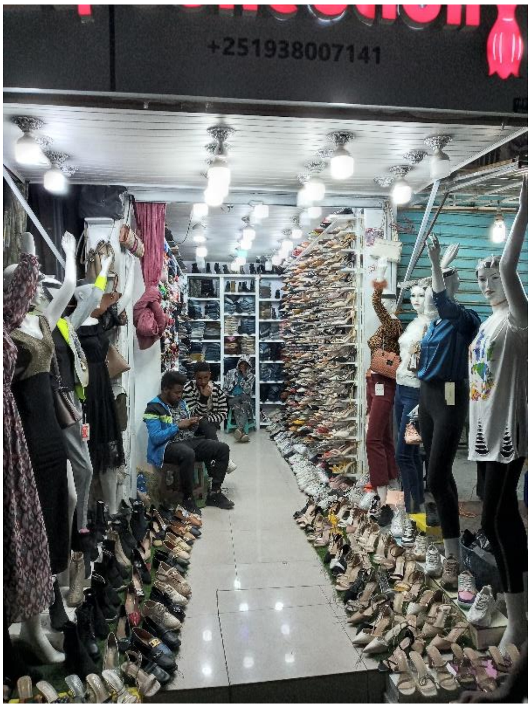

FIGURE 3. 2 FIELD PHOTO OF SHOP 2

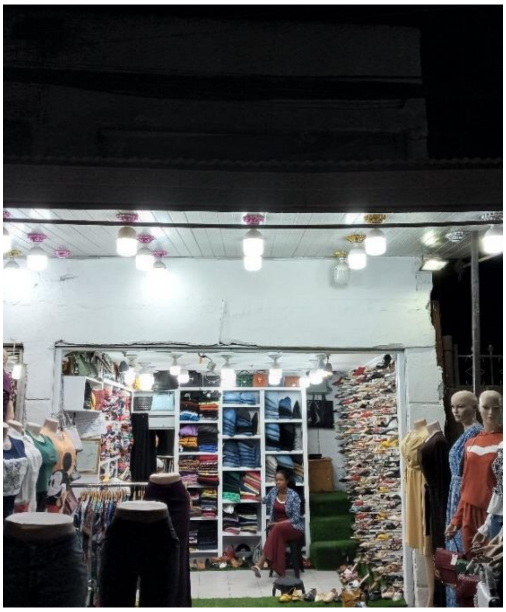

FIGURE 3. 5 FIELD PHOTO OF SHOP 3

FIGURE 3. 4 FIELD PHOTO OF SHOP 4

3.2.1.2 Data.

To achieve the purpose of this study, both primary and secondary sources were gathered. For the secondary data, articles and regulations about commercial retail frontage were used as a source. The primary data of this section is the illuminance level from the retail frontage. Illuminance is the measure of light intensity amount received on a surface. It is expressed in lux (lm/m^2). It is measured by a Lux meter (figure 3.6) and predicted through the use of Ecotect, a computer simulation that shows the light contour of a surface by a given light fixture. The other primary data is the observation of the lighting condition of retail. Such observations were made at night between 1 pm -2 pm LT. Such observations on the streets gave a chance to observe the reaction of pedestrian toward artificial light. The observation is also evaluated by lighting variables like brightness, color temperature, and glare.

FIGURE 3. 6 LUX METER

Source: Google

3.2.1.3 Data collection.

The data is collected using a lux meter. The lux meter is used to measure the distribution of lighting from the retail frontage. The measurement was taken at night from 1 pm-2 pm and two times a month (March 17 and 29) based on the phase of a moon (see appendix A). The floor of the retail frontage is divided into several equal squares of an average 1.5m length. The measurement is done by standing at the center of each square by holding the device sensor in two directions, upward and sideways.

3.3 Perception Assessment of Passers-by

3.3.1 Method and Material Used for the Second Objective.

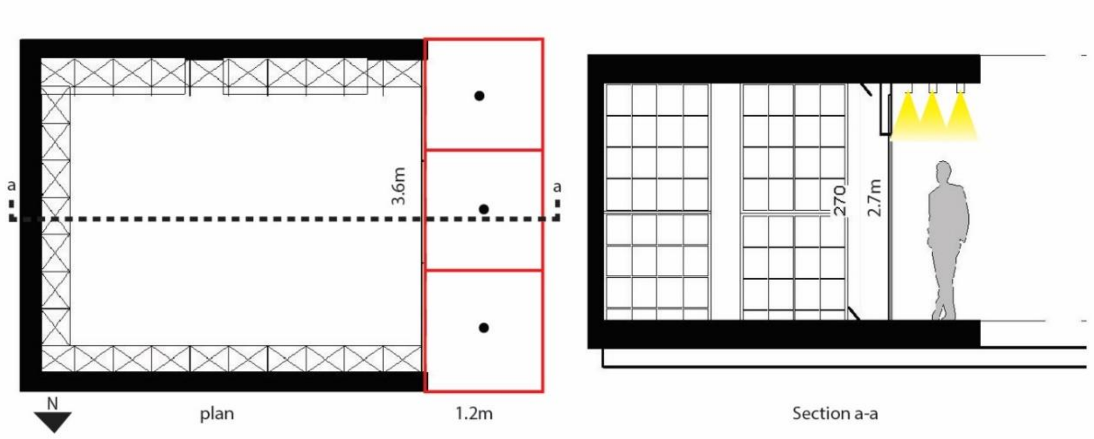

FIGURE 3. 7 PLAN AND SECTION VIEW OF SHOP 1

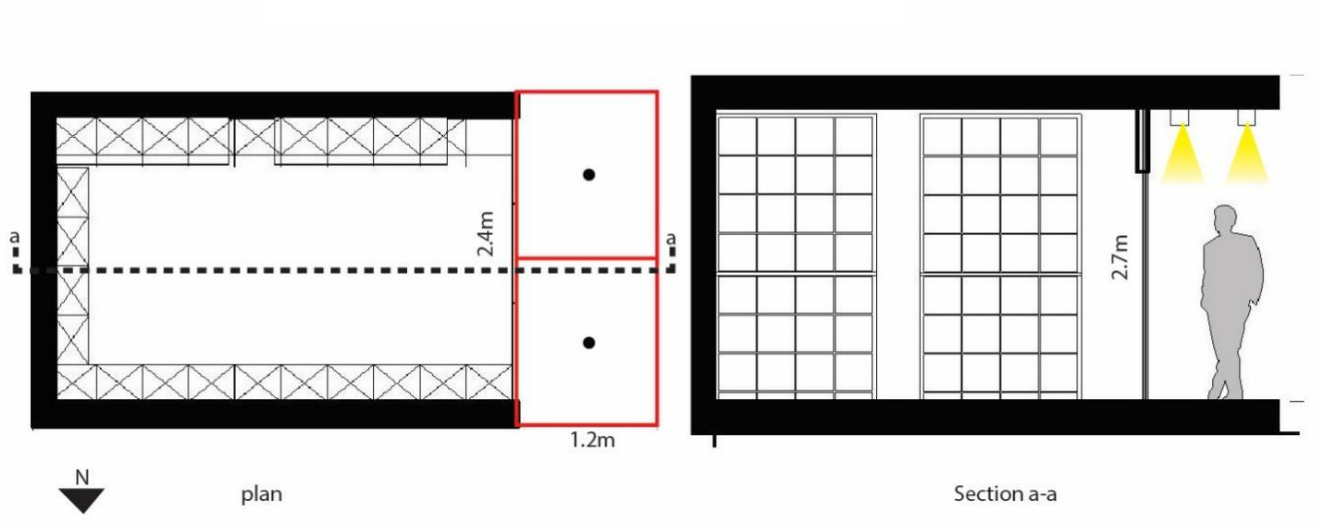

FIGURE 3. 8 PLAN AND SECTION VIEW OF SHOP 2

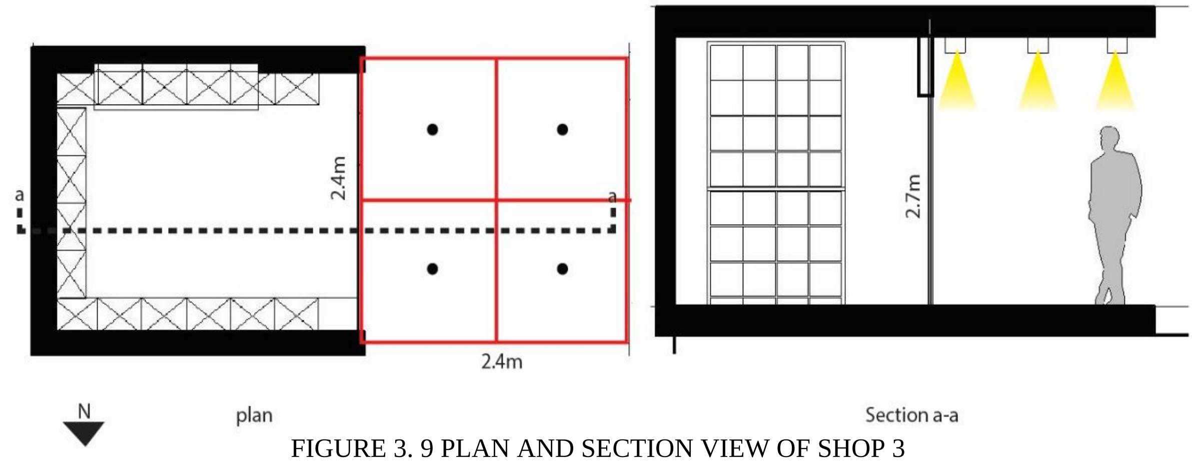

FIGURE 3. 9 PLAN AND SECTION VIEW OF SHOP 3

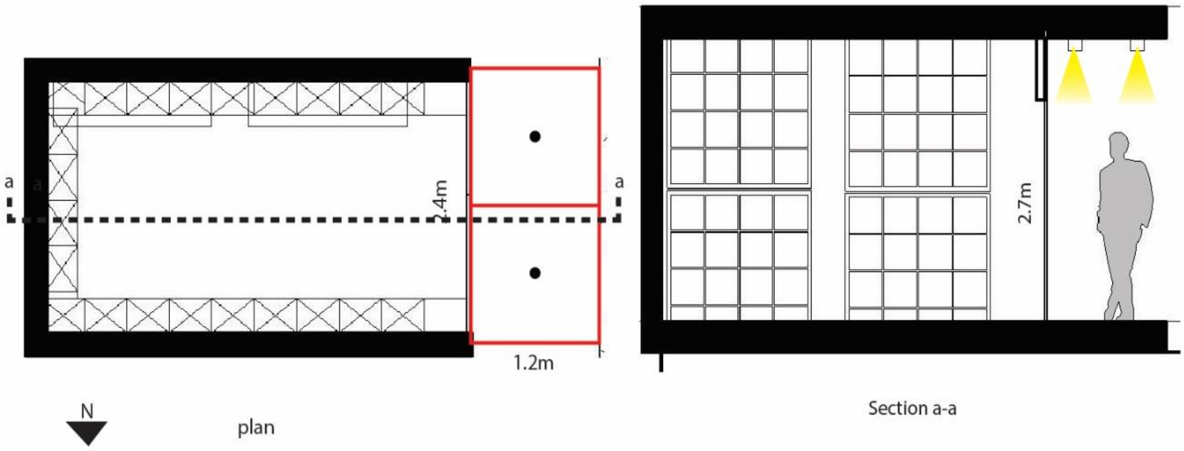

FIGURE 3. 10 PLAN AND SECTION VIEW OF SHOP 4

<u>3.3.1.1 Sampling.</u>

The target population for this specific objective is the customers using the sidewalks of the commercial corridor at night. So, to estimate the pedestrian volume a short-duration manual counting method is used. A mid-block manual count of a pedestrian using the selected road section in direction of the selected shops is done by using a manual tally counter phone application. The counter stations are at the side of the building not to disturb the flow of pedestrians. The short-duration counting is made for a week. Each day at the peak- hour of the night time, counting is done for 15-minute (see appendix A). The sum of the daily count is the total population number and using Yamane, 1967 formula the sample is generated.

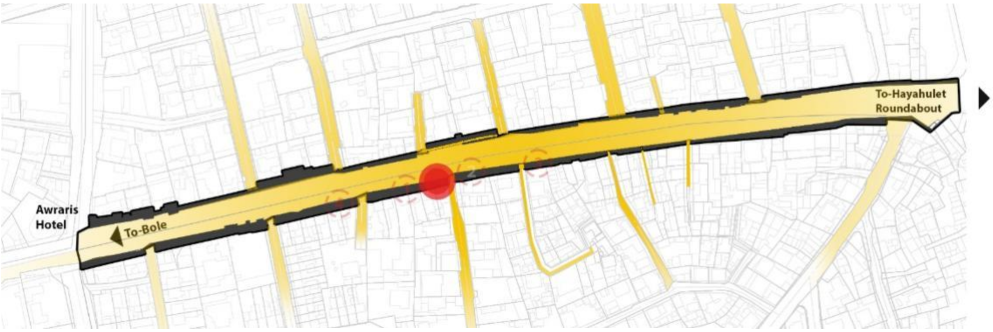

FIGURE 3. 11 COUNTING STATION

3.3.1.2 Data.

The resident's perception data is collected using a questionnaire. The questionnaire is structured by two variables which are lighting and atmosphere. The lighting variables are independent variables namely brightness, color temperature, and glare, which are used to quantify the perceived lighting condition of retail frontages. Volges (2008) atmospheric questionnaire is used to measure the perceived atmosphere. The perceived atmosphere is described by three variables (dependent variables) which are Coziness, tenseness, and liveliness. The terms representing the three atmospheric and lighting variables are displayed in table 3.2.

Table 3. 2 Lists of variables

Factors	**Atmospheric variable (Dependent)**	**Lighting variable (independent)**
	Cozy	Brightness
Terms	Lively	Glare
	Tense	Color temperature (CT)

Note: From "The effects of retail lighting on atmosphere perception" Custers et al.,2008.

These variables are used to formulate the perception questionnaire to assess each retail with their corresponding night photograph of the frontage (see appendix D).

3.3.1.3 Data collection.

The well-structured questionnaire contains the photography of the retail frontage of each shop to evaluate them based on the attributes given for pedestrians passing along the study area at night from 12:30 -2:00 pm LT. The data of 339 sample informants were collected randomly. The questionnaire was prepared in English language and then translated into the Amharic language.

3.4 Analysis Techniques

3.4.1 Lighting Data Analysis.

The measured lighting data on different days in a month was recorded carefully and compared with each other finally lighting simulation was made with the Ecotect software. The average lighting data of each shop is compared with the standard lighting level on Model outdoor lighting (MLO, 2011). MOL is selected because it is an international guide line developed by extensive efforts of IDA and IES. They also intended to clarify issues of various audience like city officials, engineers, citizens and others.

3.4.2 Perception Data Analysis.

After the data collection, the variables are coded on SPSS V22 and a reliability test is made to check the consistency of the data. To understand the relation between the variables, it used bivariate analysis. By displaying variables side by side, the relationship is shown by doing correlation, and finally linear multiple regression is made to investigate which independent variable is affecting dependent variables more. The score of shops evaluated by variables is made in a descriptive statistics manner (Bar graph). After testing the significance of the finding, the inferential of the study is drawn.

3.5 Ethical Consideration

Ethical approval is obtained from the Department of Architecture. Both oral and written informed consent is obtained from each study participant after thoroughly explaining the objectives and benefits of the study. To ensure confidentiality, any personal identifying information on participants is not collected. Data collected for this study is not used for another study without the approval of each participant.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Result for Measurement of the Lighting Intensity at the Corridor

4.1.1 Lighting Level Result.

4.1.1.1 Shop 1.

The overall size of the retail frontage is 3.6m in length and 1.2 in width and 2.7 m in height. It has 6 LED lamps. The recorded data on each subdivide spot of 1.2m x 1.2m is listed below. The 3D and plan view of shop 1 lighting contour is shown in Figures 4.3 and 4.4 below. As shown in table 4.1, the average vertically recorded lighting level is 1587 lux, and the average horizontally recorded is 485 lux. In the general, in the full moon phase, the light intensity level is higher compared to the other period, and a lower lighting intensity level is recorded on march 29th when there is no moon.

FIGURE 4. 1 FRONT VIEW PHOTO OF SHOP 1

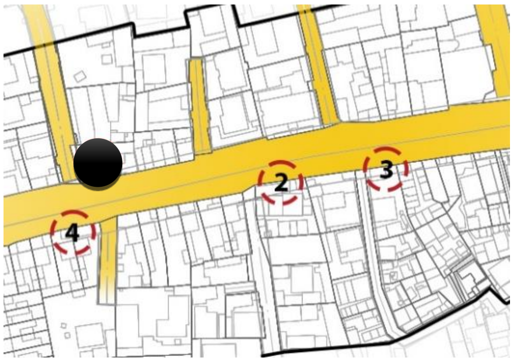

FIGURE 4. 2 LOCATION OF SHOP 1

Table 4. 1 Lighting intensity data of shop 1

Shop 1	**March 17**		**March 29**	
	Full moon; Clear sky		No moon; partial	
	Hours- 1: 37 pm LT		Hours- 1: 12 pm LT	
	Vertical (lux)	Horizontal (lux)	Vertical (lux)	Horizontal (lux)
Spot 1	1602	575	1221	299
Spot 2	1530	846	1132	560
Spot 3	1630	867	1235	597
Average	**1587**	**763**	**1196**	**485**

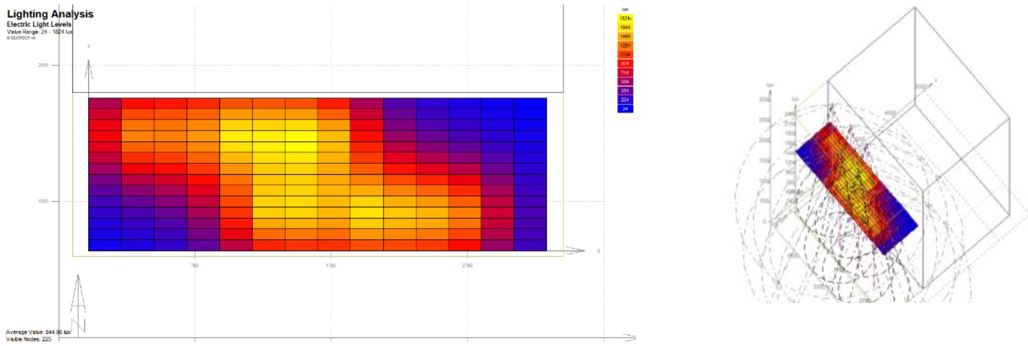

FIGURE 4. 3 LED LIGHT CONTOUR ON GROUND OF SHOP1 FRONTAGE

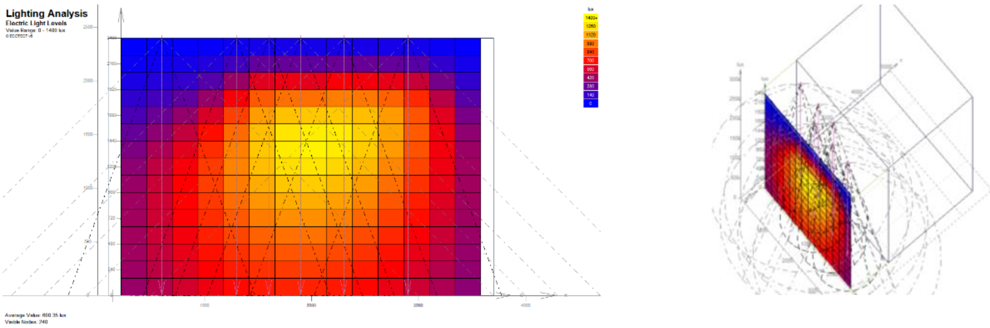

FIGURE 4. 4 LED LIGHT CONTOUR ON ELEVATION OF SHOP1 FRONTAGE

4.1.1.2 Shop 2.

The overall size of the retail frontage is 1.2 m in length and 2.4 in width and 2.7 m in height. It has 8 LED lamps. The recorded data on each subdivide spot of 1.2m x 1.2m is listed below. The 3D and plan view of shop 2 lighting contour is shown in Figures 4.7 and 4.8. As shown in table 4.2 the average maximum vertical and maximum horizontal recording are respectively listed as 1755 lux and 1035lux.

FIGURE 4. 5 FRONT VIEW PHOTO OF SHOP 2

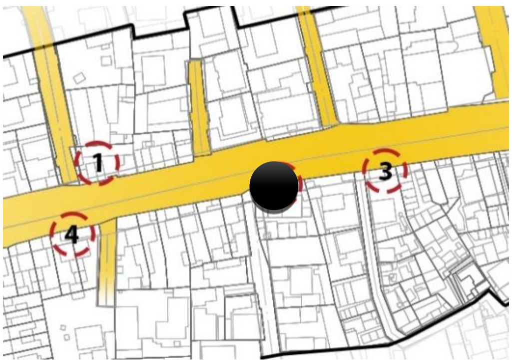

FIGURE 4. 6 LOCATIONS OF SHOP

Table 4. 2 Lighting intensity data of shop 2

Shop 2	March 17- full moon		March 29- no moon	
	Full moon; Clear sky		No moon; partial	
	Hours- 1: 37 pm LT		Hours- 1: 12 pm LT	
	Vertical (lux)	Horizontal (lux)	Vertical (lux)	Horizontal (lux)
Spot 1	1549	835	1866	692
Spot 2	1961	1235	1440	1041
Average	**1755**	**1035**	**1653**	**886**

In full moon phase, the light intensity level is higher compared to the other period, and the lower lighting intensity level is recorded on march 29th when there is no moon.

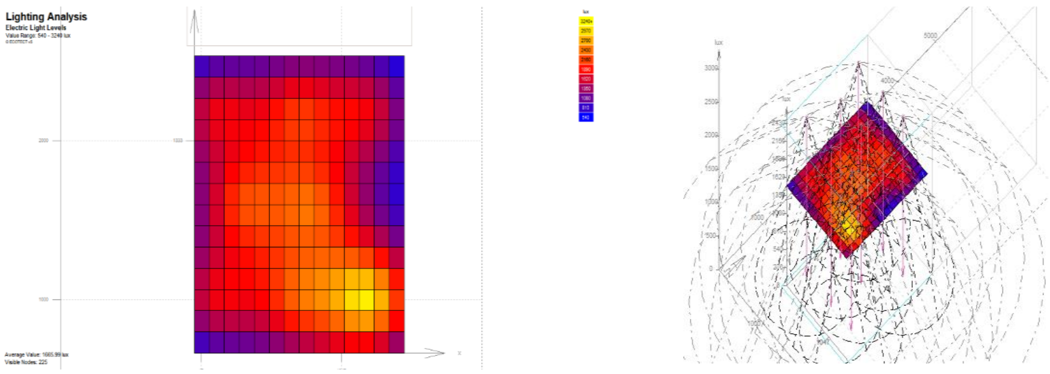

FIGURE 4. 7 LIGHT CONTOUR ON GROUND OF SHOP 2 FRONTAGE

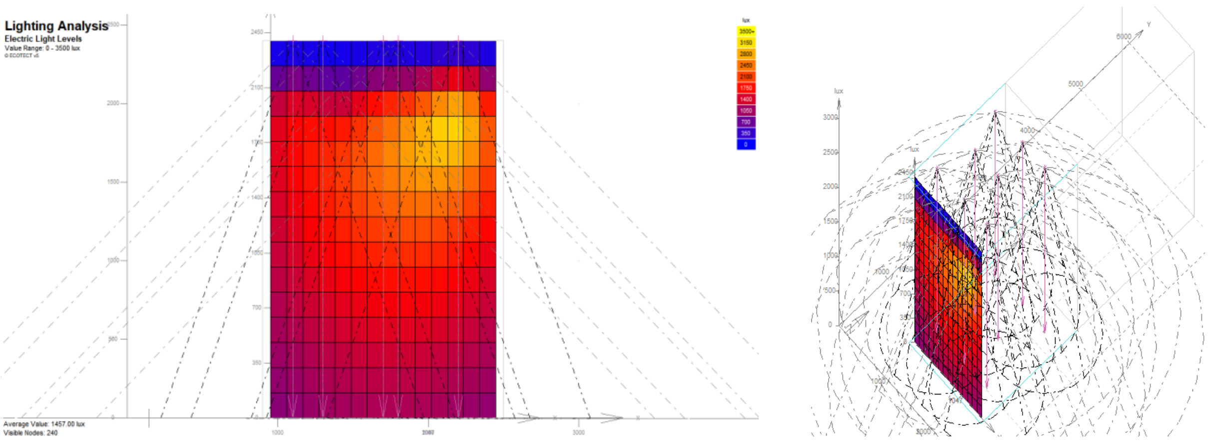

FIGURE 4. 8 LIGHT CONTOUR ON ELEVATION OF SHOP2 FRONTAGE

4.1.1.3 Shop 3.

The overall size of the retail frontage is 2.4 m in length and 2.4 in width and 2.7 m in height. It has 12 LED lamps. The recorded data on each subdivide spot of 1.2m x 1.2m is listed below. The 3D and plan view of the shop 3 lighting contour is shown in the figure. As shown in table 4.3 and the figure the average maximum vertical recorded lighting intensity is 1978 lux and the maximum horizontal is the horizontally recorded intensity of 1376 lux.

FIGURE 4. 10 FRONT VIEW PHOTO OF SHOP 3

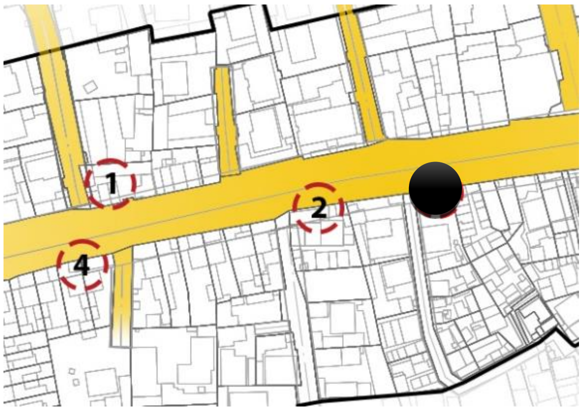

FIGURE 4.9 LOCATION OF SHOP 3

In full moon phase, the light intensity level is higher compared to the other period, and the lower lighting intensity level is recorded on march 29th when there is no moon.

Table 4. 3 Lighting intensity data of shop 3

Shop 3	**March 17- full moon**		**March 29**	
	Full moon; Clear sky		No moon; partial	
	Hours- 1: 37 pm LT		Hours- 1: 12 pm LT	
	Vertical (lux)	Horizontal (lux)	Vertical (lux)	Horizontal (lux)
Spot 1	2331	1400	2140	939
Spot 2	1961	1235	1718	733
Spot 3	1767	1415	1576	958
Spot 4	1854	1453	1654	990
Average	**1978**	**1376**	**1772**	**905**

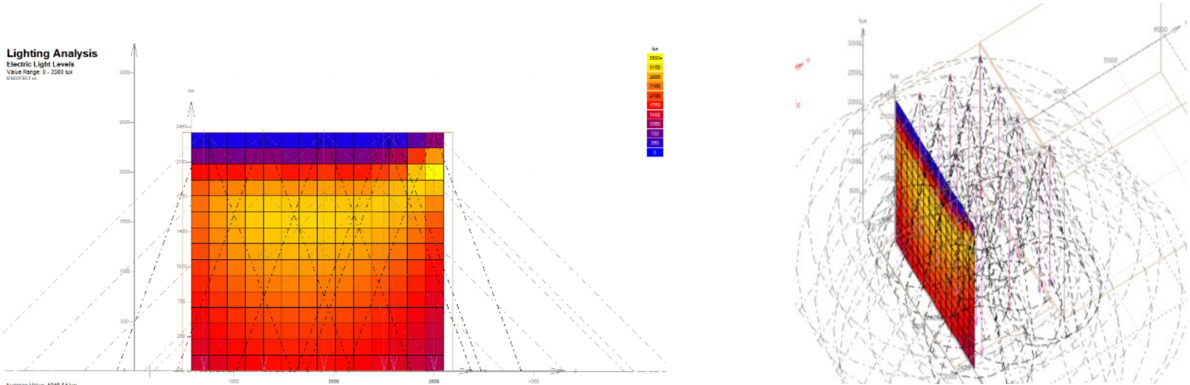

FIGURE 4. 11 LIGHT CONTOUR ON ELEVATION OF SHOP3 FRONTAGE

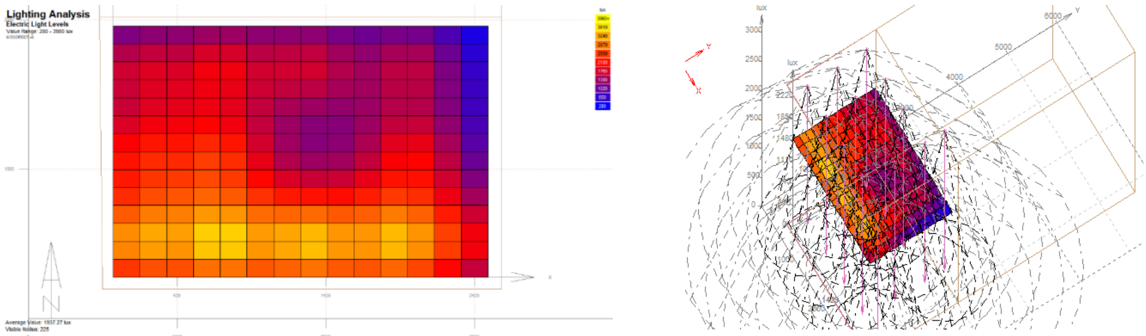

FIGURE 4. 12 LIGHT CONTOUR ON GROUND OF SHOP3 FRONTAGE

4.1.1.4 Shop 4.

The overall size of the retail frontage is 2.4m length and 1.2m width and 2.7 m eight. It has 18 LED lamps. The recorded data on each subdivide spot of 1.2m x 1.2m is listed below. The 3D and plan view of shop 4 lighting contour is shown on figure. As shown in the table 4.4 and figure the average maximum vertically recoded lighting intensity is 4505 lux and the maximum horizontally is the recorded intensity of 2540 lux.

FIGURE 4. 13 FRONT VIEW PHOTO OF SHOP 4

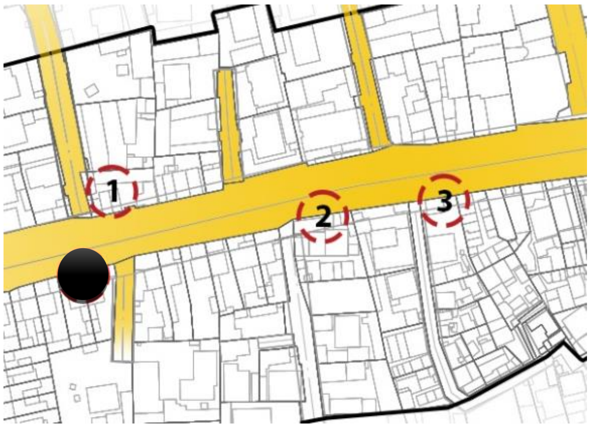

FIGURE 4. 14 LOCATION OF SHOP 4

Table 4. 4 Lighting intensity data of shop 4

Shop 4	March 17- full moon		March 29	
	Full moon; Clear sky Hours- 1: 37 pm LT		No moon; partial Hours- 1: 12 pm LT	
	Vertical (lux)	Horizontal (lux)	Vertical (lux)	Horizontal (lux)
Spot 1	4550	2610	4330	2240
Spot 2	4460	2470	4240	2100
Average	**4505**	**2540**	**4285**	**2170**

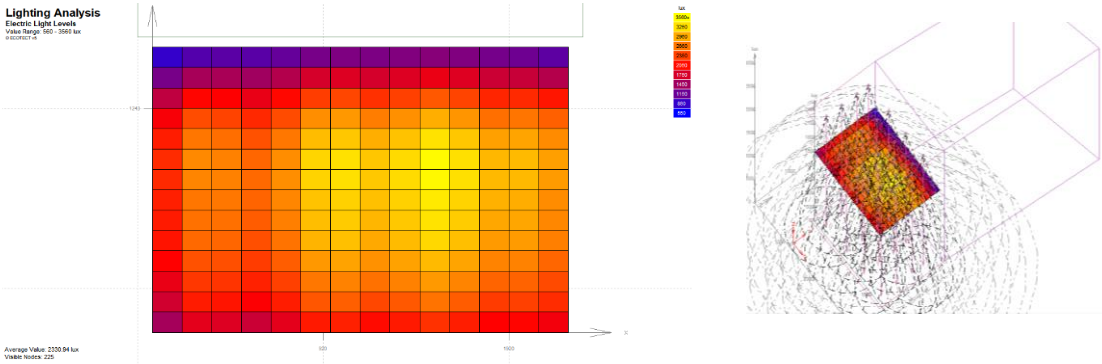

FIGURE 4. 15 LIGHT CONTOURS ON GROUND OF SHOP 4 FRONTAGE

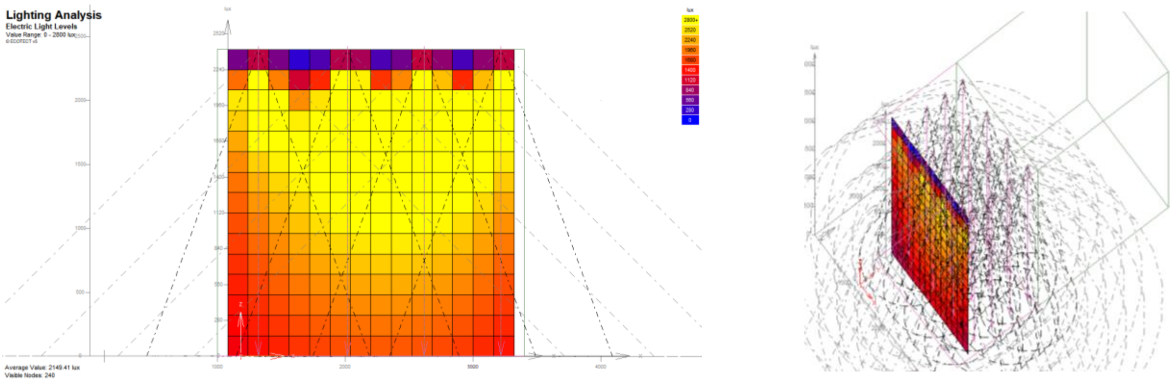

FIGURE 4. 16 LIGHT CONTOURS ON ELEVATION OF SHOP 4 FRONTAGE

<u>4.1.2 Discussion.</u>

The analysis of the result is based on the Model lighting ordnance (MLO, 2011). According to MLO (2011) the study area of the research is Zone 3. This zone is related to areas with moderately high lighting levels. This area includes commercial corridors, high-intensity suburban commercial areas, a town center, and mixed-use areas with high night time activity with active exterior retail areas. To regulate over-lighting base of the character zones, there is an additional lumens allowance for outdoor sales facilities only (see appendix F).

This allowance is for linearly arranged shop frontag immediately adjacent to the principal viewing location, so to use this allowance, Luminaries must be located at the frontage of the outdoor sales area (MLO,2011).

Table 4. 5 Average of March measurements

Shops	Average vertical Lux	Average horizontal Lux
Shop 1	1391	624
Shop 2	1704	960
Shop 3	1875	1140
Shop 4	4395	2355

So, the allowance intensity for zone 3 (study area) is 1500 lux. The average vertical intensity of lighting from shops 2, 3, and 4 is above the allowed lighting level. As table 4.5 shows the measured lighting intensity for shop 4 is 4395 lux vertically and 2355 lux horizontally. This shows that the result exceeds 2895 for the vertical which is almost doubles the level compared to the standard allowed lighting intensity.

4.2 Result for Perception Assessment of Passers-by

4.2.1 Internal Consistencies of Factors.

The internal consistency of the six variables was calculated with a Cronbach’s Alpha for all respondents of all 4 shops as shown in table 4.6.

Table 4. 6 Cronbach’s Alpha value of reliability test

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.653	.623	6

The average Cronbach’s Alpha indicates acceptable (> 0.60) to good (>0.80) internal consistencies, which means the different scores can be averaged to get one score for every shop. Below the atmospheric variables score of each shop is illustrated with a table by averaging the result of corresponding variables under them.

The survey questionnaire structured by different attributes was used to gather information related to the perception of customers towards the night time lighting condition of the urban corridor. This section presents the procedure for measuring atmosphere and lighting variables, which are used to represent the perceived environment (Atmosphere) and lighting conditions in the urban corridor.

4.2.2 Coziness.

Table 4.7 shows, from the total 339 participants' responses the coziness of shop 1 is 55.8% very high, 15.3% high, 13.9% medium, 9.4%low and 5.6% very low

Table 4. 7 Coziness of shop 1

Shop 1 [Coziness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	19	5.6	5.6	10.9
	low	32	9.4	9.4	15.0
	medium	47	13.9	13.9	28.9
	high	52	15.3	15.3	44.2
	very high	189	55.8	55.8	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.8 shows, from the total 339 respondents stated the coziness of shop 2 is 49.6% low, 10.9 %very low. 17.1% very high, 2.4% high, and 20.1% medium.

Table 4. 8 Coziness of shop 2

Shop 2 [Coziness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	37	10.9	10.9	10.9
	low	168	49.6	49.6	60.5
	medium	68	20.1	20.1	80.5
	high	8	2.4	2.4	82.9
	very high	58	17.1	17.1	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.9 shows from the total 339 respondents state the coziness of shop 3 is 1.5% high, 26.8% medium, 55.8% low, and 15.9% very low.

Table 4. 9 Coziness of shop 3

Shop 3 [Coziness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	54	15.9	15.9	15.9
	low	189	55.8	55.8	71.7
	medium	91	26.8	26.8	98.5
	high	5	1.5	1.5	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.10 shows from the total 339number of respondents who state the coziness of shop 4 are 5.0% high, 18.3% medium, 15.9% low, and 60.8% very low.

Table 4. 10 Coziness of shop 4

Shop 4 [Coziness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	206	60.8	60.8	60.8
	low	54	15.9	15.9	76.7
	medium	62	18.3	18.3	95.0
	high	17	5.0	5.0	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.3 Liveliness.

Table 4.11 shows, from the total 339 samples the liveliness of shop 1 is 3.2% very high, 6.2% high,7.1% medium, 22.7% low, and 60.8% very low.

Table 4. 11 Liveliness of shop 1

Shop 1 [Liveliness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	206	60.8	60.8	60.8
	low	77	22.7	22.7	83.5
	medium	24	7.1	7.1	90.6
	high	21	6.2	6.2	96.8
	very high	11	3.2	3.2	100.0
	Total	339	100.0	100.0	

Table 4.12 illustrated below, from the total 339 samples the liveliness of shop 2 is 23.9% very high, 49.3% high, 20.6% medium, 2.4% low, and 3.8% very low.

Table 4. 12 Liveliness of shop 2

Shop 2 [Liveliness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	13	3.8	3.8	3.8
	low	8	2.4	2.4	6.2
	medium	70	20.6	20.6	26.8
	high	167	49.3	49.3	76.1
	very high	81	23.9	23.9	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.13 is illustrated below, from the total 339 samples, the liveliness of shop 3 is 47.2% very high, 25.1% high, 15.6% medium, 9.1% low, and 2.9% very low.

Table 4. 13 Liveliness of shop 3

Shop 3 [liveliness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	10	2.9	2.9	2.9
	low	31	9.1	9.1	12.1
	medium	53	15.6	15.6	27.7
	high	85	25.1	25.1	52.8
	very high	160	47.2	47.2	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.14 is illustrated below, from the total 339 samples, the liveliness of shop 4 is 56.3% very high, 16.5% high, 12.7% medium, 7.7% low, and 6.8% very low.

Table 4. 14 Liveliness of shop 4

shop4 [Liveliness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	23	6.8	6.8	6.8
	low	26	7.7	7.7	14.5
	medium	43	12.7	12.7	27.1
	high	56	16.5	16.5	43.7
	very high	191	56.3	56.3	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.4 Tenseness.

Table 4.15 is illustrated below, from the total 339 samples the tenseness of shop 1 is 8.3% very high, 8.8% high, 7.1% medium, 19.8% low, and 56.0% very low.

Table 4. 15 Tenseness of shop 1

shop 1[Tenseness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	190	56.0	56.0	56.0
	low	67	19.8	19.8	75.8
	medium	24	7.1	7.1	82.9
	high	30	8.8	8.8	91.7
	very high	28	8.3	8.3	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.16 is illustrated, from the total 339 samples the tenseness of shop 2 is 47.8% very high, 20.1% high, 19.5% medium, 5.9% low, and 6.8% very low.

Table 4. 16 Tenseness of shop 2

Shop 2 [Tenseness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	23	6.8	6.8	6.8
	low	20	5.9	5.9	12.7
	medium	66	19.5	19.5	32.2
	high	68	20.1	20.1	52.2
	very high	162	47.8	47.8	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.17 is illustrated below, from the total 339 samples, the tenseness of shop 3 is 49% very high, 26.8% high,7.1% medium, 8.8% low, and 8.3% very low.

Table 4. 17 Tenseness of shop 3

shop 3[Tenseness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	28	8.3	8.3	8.3
	low	30	8.8	8.8	17.1
	medium	24	7.1	7.1	24.2
	high	91	26.8	26.8	51.0
	very high	166	49.0	49.0	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.18 is illustrated below, from the total 339 samples the tenseness of shop 4 is 63.7% very high, 18.9% high, 6.2% medium, 5.6% low, and 5.6% very low.

Table 4. 18 Tenseness of shop 4

shop 4 [Tenseness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	19	5.6	5.6	5.6
	low	19	5.6	5.6	11.2
	medium	21	6.2	6.2	17.4
	high	64	18.9	18.9	36.3
	very high	216	63.7	63.7	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.5 Brightness.

Table 4.19 is illustrated below, from the total 339 samples the brightness of shop 1 is 5.3% very high,4.4% high, 15.3% medium, 22.7% low, and 52.2% very low.

Table 4. 19 Brightness of shop 1

shop 1[Brightness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	177	52.2	52.2	52.2
	low	77	22.7	22.7	74.9
	medium	52	15.3	15.3	90.3
	high	15	4.4	4.4	94.7
	very high	18	5.3	5.3	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.20 is illustrated below, from the total 339 samples the brightness of shop 2 is 47.5% very high, 22.1% high, 14.2% medium, 11.8% low, and 4.4% very low.

Table 4. 20 Brightness of shop 2

Shop 2 [Brightness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	15	4.4	4.4	4.4
	low	40	11.8	11.8	16.2
	medium	48	14.2	14.2	30.4
	high	75	22.1	22.1	52.5
	very high	161	47.5	47.5	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.21 is illustrated below, from the total 339 samples the brightness of shop 3 is 44.5 % very high, 26.0% high,13.6% medium, 11.2% low, and 4.7% very low.

Table 4. 21 Brightness of shop 3

shop 3 [Brightness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	16	4.7	4.7	4.7
	low	38	11.2	11.2	15.9
	medium	46	13.6	13.6	29.5
	high	88	26.0	26.0	55.5
	very high	151	44.5	44.5	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.22 is illustrated below, from the total 339 samples the brightness of shop 4 is 67.8% very high, 26.5% high, 3.5% medium, and 2.1% low.

Table 4. 22 Brightness of shop 4

shop 4 [Brightness]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	low	7	2.1	2.1	2.1
	medium	12	3.5	3.5	5.6
	high	90	26.5	26.5	32.2
	very high	230	67.8	67.8	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.6 Glare.

Table 4.23 shows, from the total 339 samples, the glare from shop 1 is 5.0% very high, 8.0% high, 7.4% medium, 25.4% low, and 54.3% very low.

Table 4. 23 Glare from shop 1

shop 1 [Glare]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	184	54.3	54.3	54.3
	low	86	25.4	25.4	79.6
	medium	25	7.4	7.4	87.0
	high	27	8.0	8.0	95.0
	very high	17	5.0	5.0	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.24 is illustrated below, from the total 339 samples, the glare from shop 2 is 45.7 % very high, 28.9% high, 7.4% medium, 4.4% low, and 13.6% very low.

Table 4. 24 Glare from shop 2

shop 2 [Glare]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	46	13.6	13.6	13.6
	low	15	4.4	4.4	18.0
	medium	25	7.4	7.4	25.4
	high	98	28.9	28.9	54.3
	very high	155	45.7	45.7	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.25 is illustrated below, from the total 339 samples, the glare from shop 3 is 47.8% very high, 26.8% high, 11.8% medium, 5.9% low, and 7.7% very low.

Table 4. 25 Glare from shop 3

Shop 3 [Glare]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	26	7.7	7.7	7.7
	low	20	5.9	5.9	13.6
	medium	40	11.8	11.8	25.4
	high	91	26.8	26.8	52.2
	very high	162	47.8	47.8	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.28 is illustrated below, from the total 339 samples, the glare from shop 4 is 56.6% very high, 22.1% high, 5.0% medium, 11.8% low, and 4.4% very low.

Table 4. 26 Glare from shop 4

shop4 [Glare]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	15	4.4	4.4	4.4
	low	40	11.8	11.8	16.2
	medium	17	5.0	5.0	21.2
	high	75	22.1	22.1	43.4
	very high	192	56.6	56.6	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.7 Color temperature.

Table 4.27 is illustrated below, from the total 339 samples the Color temperature of shop 1 is 4.4% very high, 11.2% high, 14.2% medium, 21.2% low, and 49.0% very low.

Table 4. 27 Color temperature of shop 1

shop 1[CT]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	166	49.0	49.0	49.0
	low	72	21.2	21.2	70.2
	medium	48	14.2	14.2	84.4
	high	38	11.2	11.2	95.6
	very high	15	4.4	4.4	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.28 shows, from the total 339 samples the Color temperature of shop 2 is 44% very high, 23.9% high, 19.5% medium, 5.9% low, and 6.8% very low.

Table 4. 28 Color temperature of shop 2

shop 2 [CT]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	23	6.8	6.8	6.8
	low	20	5.9	5.9	12.7
	medium	66	19.5	19.5	32.2
	high	81	23.9	23.9	56.0
	very high	149	44.0	44.0	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.29 is illustrated below, from the total 339 samples the Color temperature of shop3 is 49.6% very high, 8% high, 13.3% medium, 19.5% low, and 9.7% very low.

Table 4. 29 Color temperature of shop 3

Shop 3 [CT					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	33	9.7	9.7	9.7
	low	66	19.5	19.5	29.2
	medium	45	13.3	13.3	42.5
	high	27	8.0	8.0	50.4
	very high	168	49.6	49.6	100.0
	Total	**339**	**100.0**	**100.0**	

Table 4.30 is illustrated below, from the total 339 samples the Color temperature of shop 4 is 51.6% very high, 21.2% high, 6.2% normal, 10.6% low, and 10.3% very low.

Table 4. 30 Color temperature of shop 4

shop 4 [CT]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very low	35	10.3	10.3	10.3
	low	36	10.6	10.6	20.9
	medium	21	6.2	6.2	27.1
	high	72	21.2	21.2	48.4
	very high	175	51.6	51.6	100.0
	Total	**339**	**100.0**	**100.0**	

4.2.8 Average Scoring.

The chars below are the average score of each variable for each shop. It is used to compare each shop concerning different attributes.

4.2.8.1 Coziness.

As shown in figure 4.17 below, the frontage of shop 1 creates the coziest and most comfortable atmosphere, and shop 4 is the most uncomfortable.

FIGURE 4.17 COZINESS SCORE OF SHOPS

4.2.8.2 Liveliness.

As the response of participants shown in figure 4.18 below shop 4 is the most stimulating and lively, and shop 1 is the lowest shop to evoke excitement.

FIGURE 4. 18 LIVELINESS SCORE OF SHOPS

4.2.8.3 Tenseness.

Regarding the participant's response, shop 4 took the highest place in bringing tenseness to the atmosphere. Shop 3 and 2 got almost similar result. Shop 1 is the lowest terrifying frontage as shown in figure 4.19.

FIGURE 4.19 TENSENESS SCORE OF SHOPS

4.2.8.4 Brightness.

As shown in figure 20 below, the frontage of shop 4 creates the brightest atmosphere, and shop 1 is the lowest brightness.

FIGURE 4. 20 BRIGHTNESS SCORE OF SHOPS

4.2.8.5 Glare.

Based on the participant's response, the frontage of shop 4 has the highest glare. Shop 1 has the lowest glare from frontage as shown in figure 4.21.

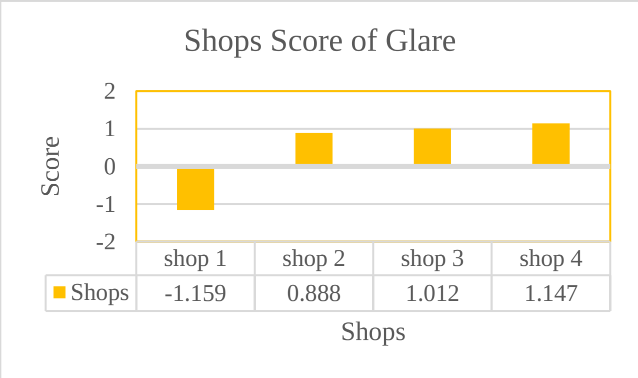

FIGURE 4. 21 GLARE SCORE OF SHOPS

4.2.8.6 Color temperature.

In response to participants shown in figure 4.22 below, shop 4 is the coolest and most modern character, and shop 1 has the warmest look.

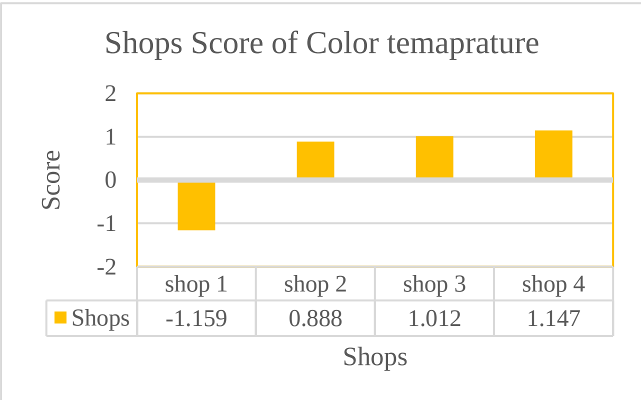

FIGURE 4. 22 COLOR TEMPERATURE SCORE OF SHOPS

4.2.9 Correlation (Cronbach's Alpha) Inter Factor Correlation.

Pearson's *r* varies between +1 and -1. The strength of the relationship between variables is strong 0.7 and above, moderate 0.4-0.69, week 0.1-.39, and no relationship if the value is 0 to 0.1. In the below table, the relationship under their variable category is highlighted. The maximum value under the dependent variable except for identical factors is 0.576 which is between Tenseness and Liveness. For the independent, 0.697 value is between brightness and color temperature. Coziness has a negative value with both liveliness and tenseness Which means there is an inverse relation between them (See table 4.31).

Table 4. 31 Correlations between scores of variables (Cronbach's Alpha)

Correlations		**Dependent variables**			**Independent variable**		
		Coziness	Liveliness	Tenseness	Brightness	Glare	CT
Coziness	Pearson Correlation	1	-.462**	-.422**	-.534**	-.338**	-.417**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	1356	1356	1356	1356	1356	1356
Liveliness	Pearson Correlation	-.462**	1	.576**	.463**	.490**	.407**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	1356	1356	1356	1356	1356	1356
Tenseness	Pearson Correlation	-.422**	.576**	1	.613**	.650**	.631**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	1356	1356	1356	1356	1356	1356
Brightness	Pearson Correlation	-.534**	.463**	.613**	1	.409**	.697**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	1356	1356	1356	1356	1356	1356
Glare	Pearson Correlation	-.338**	.490**	.650**	.409**	1	.478**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	1356	1356	1356	1356	1356	1356
CT	Pearson Correlation	-.417**	.407**	.631**	.697**	.478**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	1356	1356	1356	1356	1356	1356

**. Correlation is significant at the 0.01 level (2-tailed).

4.2.10 Cause and effect result.

4.2.10.1 Coziness.

The result for the criterion (dependent variable) Coziness is displayed below. The analysis is to test if the independent variable (predictors) brightness, glare, and color temperature account for the variance in coziness.

In the table below, the R square of the model summary is the measure of the amount of variance in the dependent variable that is caused by the independent variable (predictors) when taken as a group. R^2=0.303; taken as a set, the predictors (independent variable) Brightness, glare, and color temperature are responsible for 30% of the variance in coziness.

Table 4. 32 Regression predicting coziness

Model Summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.551[a]	.303	.302	1.1562	.303	196.039	3	1352	.000

a. Predictors: (Constant), shop [CT], Shop [Glare], shop [Brightness]

The ANOVA table below is a test of where the above R^2 is significantly greater than zero. The overall regression model was significant, F (3,1352) =196.039, p<0.001, R^2=0.303.

Table 4. 33 ANOVA test for coziness

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	786.140	3	262.047	196.039	.000[b]
	Residual	1807.231	1352	1.337		
	Total	**2593.371**	**1355**			

a. Dependent variable. Shop [Coziness]
b. Predictors (Constant), shop [CT], shop Glare], shop [Brightness]

The coefficients table 4.34 indicates, the effect of each of the predictors individually and checks where the given predictor is significant on its own. Seeing at the P-values of the predictors, brightness (B= -.421; p=.000), glare (B= .032; p=.272), and CT (B=. -.120; p=.000) tested each at Alpha = .05. The negative beta value for all variables indicates that a brighter front of the shop leads to a less cozy perceived atmosphere. Brightness and color temperature emerge as significant predictors. But the change in glare was not significant.

Table 4. 34 Beta coefficients of coziness

Coefficientsa						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.055	.034		-1.626	.104
	shop [Brightness]	-.421	.030	-.454	-14.233	.000
	Shop [Glare]	-.032	.029	-.036	-1.098	.272
	shop [CT]	-.120	.023	-.134	-5.161	.000

4.2.10.2 Liveliness.

In the below tables, the result for the criterion (dependent variable) liveliness is presented. The analysis is to test if liveliness is affected by the independent variable (predictors) brightness, glare, and color temperature. R^2=0.324; indicates, that the predictors (independent variable) Brightness, glare, and color temperature are responsible for 32.4% of the variance in liveliness when taken as a group (See table x).

Table 4. 35 Regression predicting Liveliness

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.569[a]	.324	.322	1.2276	.324	215.649	3	1352	.000

The ANOVA table below is a test of where the above $R^{2\ is}$ significantly greater than zero. The overall regression model was significant, F (3,1352) =324.964, p<0.001, R^2=0.324

Table 4. 36 ANOVA test for Liveliness

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	974.891	3	324.964	215.649	.000[b]
	Residual	2037.347	1352	1.507		
	Total	**3012.238**	**1355**			

a. Dependent variable. Shop [Liveliness]
b. Predictors (Constant), shop [CT], shop Glare], shop [Brightness]

In the coefficients displayed in table 4.37, the regression model for glare was not significant (B= .028 p=.362). The other regression model which includes brightness and CT was significant (B= .115; p=.000), and, (B=. 0.341; p=.000), tested each at Alpha = .05.

Table 4. 37 Beta coefficients of Liveliness

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.097	.036		2.699	.007
	shop [Brightness	.297	.031	.297	9.459	.000
	Shop [Glare]	.028	.031	.030	.911	.362
	shop [CT]	.341	.025	.355	13.822	.000

a. Dependent Variable: Shop [Liveliness]

4.2.10.3 Tenseness.

In the below tables, the result for the criterion (dependent variable) Tenseness is presented. The analysis is to test if the independent variable (predictors) brightness, glare, and color temperature bring variance in Tenseness. As the R square of the model summary illustrates in table x, R^2=0.594; taken as a group of predictors (independent variable) Brightness, glare, and color temperature is responsible for 59.4% of the variance in liveliness (See table 4.39).

Table 4. 38 Regression predicting Tenseness

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.771a	.594	.593	.9976	.594	1	.771a	.594	.593

The ANOVA table below is a test of where the above $R^{2\ is}$ significantly greater than zero. The overall regression model was significant, F (3,1352) =26.078, p<0.001, R^2=0.594.

Table 4. 39 ANOVA test for Tenseness

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1966.689	3	655.563	658.787	.000[b]
	Residual	1345.384	1352	.995		
	Total	**3312.073**	**1355**			

a. Dependent variable. Shop [Tenseness]
b. Predictors (Constant), shop [CT], shop Glare], shop [Brightness]

The coefficients table below indicates the effect of each of the predictors individually and checks where the given predictor is significant on its own. Seeing at the P-values of the predictors, brightness (B= .115; p=.000), glare (B= .366; p=.000) , and Color temperature (CT) (B= -.038; p=.000) tested each at Alpha = .05 each of them was significant because P < 0.05.

Table 4. 40 Beta coefficients of Tenseness

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.098	.029		3.352	.001
	shop [Brightness	.288	.026	.274	11.272	.000
	Shop [Glare]	.235	.025	.236	9.341	.000
	shop [CT]	.428	.020	.425	21.372	.000

a. Dependent Variable: Shop [Tenseness]

4.2.11 Discussion.

To quantify the perception of the customers about the shops, 339 participants were asked and rated 3 atmospheric terms and 3 lighting terms for their applicability to the atmosphere of the shops. The reliability analysis indicates that the perception questionnaire is a reliable method to measure the perceived atmosphere of the space. The result shows that retail lighting has a significant effect on the perceived atmosphere.

4.2.11.1 Perceived atmospheric variable assessment.

for measuring the atmospheric perception an adapted version of the instrument of Vogels (2008) was used. This measurement consisted of a questionnaire that was filled in participants looking at the shops. The questionnaire resulted in a score for each shop on each of the three perceived atmospheric variables, coziness, liveliness, and tenseness.

Most of the respondents choose shop 1 as cozy. For the coziness of both 2^{nd} and 3^{rd} shops, respondents perceive the situation as low cozy. Shop 4 which has a higher number lamps of is the lowest cozy among the others. Most of the participants give a negative response to shop 4 in terms of coziness.

Liveliness is the quality of an atmosphere of is stimulating. Each shop is scored by this variable to evaluate how stimulating the retail frontage is. Most of the participants give a higher value for Shop 4 as being the most stimulating and lively retail and shop 1 is the lowest stimulating and exciting shop from other. This shows that as the number of LED increase, the excitement of customers increases. The owner of shop 1 claimed that they are even trying to add LED lights at their frontage.

The tenseness in the atmosphere which is creating anxiety and nervousness. This attribute is used to quantify how much anxiety the shops are creating. More than half of the respondents said shop 4 which has a larger number of LED lights creates anxiety in them and they lack satisfaction when looking at shop 4. But shop 1 with lower LED lights at the frontage is less anxious so they said they are not worried to enter or pass along the retail.

4.2.11.2 Lighting variable assessment.

For characterizing the lighting, a Questionnaire was developed. In a retail environment, this questionnaire is filled by pedestrians to measure 3 attributes: brightness, glare, and color temperature. The results consisted of the score for each shop on the 3 lighting attributes.

As stated in the literature, Brightness is the quantity of light emitted from the source. It was so easy for the respondent to identify which shop is the brightest. Since the selected shops have an almost similar outlook, the result for comparing the brightness base on the number of LEDs was easy. But some respondents were claiming that they are also distracted by the brightness from the inside of the shops.

In addition to this other respondents’ states that they are really sensitive to Over-lighting and others said they are adapted to It so they can look at brighter lights even if the shops are different in their brightness level. So, the result showed as shop 4 is the brightest when compared to shop 1 which has the lowest number of LED lights at the front.

Glare is the horizontal shine of lights. As observed from the study area, glare has a relationship with the material of the ceiling or the wall on which the LED is fixed. When the material is more reflective and whiter in color, the more it adds to the glairiness of the atmosphere. When seeing the result, the respondents seem to measure the related positive value of airiness for shops 2, 3 and shop 4.

Color temperature was a little bit confusing variable. Most of the respondents seek further briefing to quantify the color temperature of each shop. So, they have described what the color temperature is concerning its cooler and warm look. Based on this, highest CT has a cooler and more modern, than lower CT of warmer look. As the result indicates, the larger number of LED lights makes shop 4 evoke a cooler and modern environment. Except for shop 1 other shops almost got a similar score in having a higher color temperature.

To conclude, evaluating the shops with lighting variables was not an easy task for most of the participants. This could be because the variables are a bit hard to explain in the Amharic language, and most of the respondents are not familiar with these lighting variables.

4.2.11.3 Cause and effect assessment.

After the perceived atmospheric variables and lighting variables were quantified, multiple regression analysis was performed to calculate how much the perceived atmosphere is being affected by lighting variables, for each atmospheric attribute, three different regression analyses were made. By doing this, the studies find out that retail lighting had a significant contribution to the change in the perceived atmosphere.

The result for the Correlation of independent and dependent variables showed how much the variables are related. Coziness is negatively related to brightness, glare, and color temperature. Liveliness is positively related to all the lighting variables but it’s more related to color temperature. Tenseness is more related to lighting variables than liveliness does. Color temperatures are a lighting variable in greater relation to tenseness. When we see the relationship between the lighting variables, brightness is more related to glare.

The regression model showed the different effects of lighting variables on the perceived atmosphere: a brighter shop creates an atmosphere that is perceived as less cozy and more stimulating or lively. The other lighting variable that become a significant predictor was glare. More glare from the retail frontage evokes an atmosphere that is perceived as more tense and terrifying.

These results are more related to (Custers et al., 2008), and few differences from Van Erp (2008), who found that higher brightness is perceived as less cozy and less tense. The only difference is the effect on tenseness is reversed. As Custers (2008) states the reason behind this might be the study of Van Erp (2008) done in an experimental room without my context rather than a field study on real-life shops. The related finding of different research papers shows the precision and strength of the results.

CONCLUSION AND RECOMMENDATION

5. CONCLUSION

This study provides an insight into how night lighting from retail frontage is related to the change in the perceived urban environment. It also helps, urban planners, policymakers, and lighting experts to consider the level of artificial night lighting when building the city.

To get the lighting level of artificial night lights of retail frontages, a Lux meter is used two times a month based on the phase of the moon. The recoded lighting level of all 3 shops except shop 1 is higher than the allowed intensity for outdoor sales frontage of zone 3. Surprisingly, Shop 4 with 18 LED lights is 3 times over-lighted than the standard. This lighting situation is affecting the perception of passers-by and customers. The research compares four shops based on different variables. The variables are categorized as lighting variables, which evaluate the lighting condition of the frontages. This includes brightness, glare, and color temperature. On the other side atmospheric variables are used to measure the perceived atmosphere condition which is influenced by lighting variables. Coziness, Liveliness, and Tenseness are the factors under atmospheric variables.

As the score for shops indicates, shop 1 scores the highest in coziness and lowest in stimulating users when they are around. The frontage of shop 4 is the most stimulating but at the same time, users perceive it as the most terrifying. Since the above two shops have the lowest (6 LED lights) and highest (18 LED lights), the number of lighting fixtures used at the retail frontages has a direct relation with evoking excitement, coziness, and also terrifying the customers. Furthermore, the inter factor correlation showed that coziness is negatively correlated with liveliness and tenseness. The relationship between tenseness and liveliness is positive, which means the more it's stimulating, the more it could be terrifying. The research identified that brightness is the most affecting variable of coziness. In addition, color temperature is the main factor that increases the excitement and also tenseness of customers.

6. RECOMMENDATION

1. Ethiopia as a county didn’t include a proclamation and standard for the outdoor artificial night lighting levels for different zones like residential, commercial, mixed-use, industrial, and other institutions. To reduce the issue of artificial night lighting, there should be an incentive to study the night time lighting and adapt other countries' standards to develop night time lighting regulations and laws.
2. Impact of night time artificial lighting on the environment like fauna and flora in addition to human beings should be studied by a different organization that works on environmental protection.
3. For the urban commercial corridors which are already built, different low-cost redesigning of retail frontage could be done to reduce the effect. This method includes adjusting a lightweight material on the ceiling to decrease the brightness and glare.
4. The newly constructed commercial areas and corridors should be built with responsibility when adjusting LED lights at the retail frontage. This means the owners should be awarded of how night time lighting could affect themselves, as the well as customers and passers-by.
5. This paper focused only on over-lighting or clutter; with is an excess grouping of lighting in the urban commercial corridors. So further research should be done on other types of light pollution like sky glow and lighting trespass.
6. There are variables that this research didn’t include. These are contrast, lighting installation, and decorative lighting. Also, how the different demographic groups perceived the lighting situation.
7. Examining the perception of passers-by in a real-life environment is difficult because many variables can destruct participants and influence the atmosphere. So, keeping this variable constant by doing a repeated measuring and visiting the study area to check if there are changes that influence the result.

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APPENDIX

Appendix A- Passers-by counting form

Location-Djibouti Street (Hayahulet round about upto Awraris Hotel)							
	April 16 Saturday	April 17 Sunday	April 18 Monday	April 19 Tuesday	April 20 Wednesday	April 21 Thursday	April 22 Friday
Time	1:15-1:30	1:15-1:30	1:15-1:30	1:15-1:30	1:15-1:30	1:15-1:30	1:15-1:30
	346	260	279	314	344	480	350

Appendix B- Lighting level data form

Date	Day	Hours	Study Area							
			Shop 1		Shop 2	Shop3	Shop 4	Moon Phase	Sun set time	Cloud cover
17/3/22	Thursday		H							
			V							
29/3/22	Sunday		H							
			V							

Appendix C- Preliminary analysis

1-Where do you live________________

2-Do you think Addis Ababa is becoming brighter by over-lighting?

Yes / no

3. Which type of lighting device is you think pollutes the most?

- LED lamps, Advertisement screens, street lights, Car light, and Security lamps

4. which zone of the city is emitting higher night light?
   - commercial, residential, office,
5. Dose the commercial area of a city has higher night time activity?

   Yes / no
6. which type of commercial activity have higher contribution in over-lighting the city?

- Light fixture shop, boutiques, electronics shop, other

7. which commercial character has higher night lighting.?
    - Corridor, Amphitheatre, indoor, scattered, other
8. In Addis Ababa which places are the most over-lighted by night time commercial activity?
    - Mexico
    - Bole
    - Mercato
    - 22-mazoria
    - Megenagna
    - Piassa

Appendix D- Lighting level data form

Adama science and technology university

school of civil engineering and architecture

Department of urban planning and design

MSc program

Dear respondent, thank you in advance for your time.

This questionnaire is designed to gather data for research purposes to the fulfillment of MSc in the field of Urban Planning and Design Accordingly, your genuine responses are extremely important for this research, so please be free and respond to all the closed ended questions.

Part-1- The specific propose of this part is to assess the perception of experts on the lighting and atmospheric condition of 4 shops and it will be evaluated by 3 atmospheric and 3 lighting Variables. The Night photograph of the shop frontage will be presented to evaluate by each lighting variable.

- Gender A) male B) female

- Profession ___________________
- Age A) Below 18 B) 18-50 C) above 50

Shop 4 					
	Very Low	Low	Medium	High	Very high
	-2	**-1**	**0**	**1**	**2**
Atmospheric variable					
Coziness					
Liveliness					
Tenseness					
Lighting variable					
Brightness					
Glare					
Color temperature					

Shop 3 					
	Very Low	Low	Medium	High	Very high
	-2	**-1**	**0**	**1**	**2**
Atmospheric variable					
Coziness					
Liveliness					
Tenseness					
Lighting variable					
Brightness					
Glare					
Color temperature					

Shop 2 					
	Very Low	Low	Medium	High	Very high
	-2	**-1**	**0**	**1**	**2**
Atmospheric variable					
Coziness					
Liveliness					
Tenseness					
Lighting variable					
Brightness					
Glare					
Color temperature					

Shop 1 					
	Very Low	Low	Medium	High	Very high
	-2	**-1**	**0**	**1**	**2**
Atmospheric variable					
Coziness					
Liveliness					
Tenseness					
Lighting variable					
Brightness					
Glare					
Color temperature					

Appendix E- Lighting Zone- MLO, 2011

Zone	Recommended Uses or Areas	Zoning Considerations
LZ-0	Lighting Zone 0 should be applied to areas in which permanent lighting is not expected and when used, is limited in the amount of lighting and the period of operation. LZ-0 typically includes undeveloped areas of open space, wilderness parks and preserves, areas near astronomical observatories, or any other area where the protection of a dark environment is critical. Special review should be required for any permanent lighting in this zone. Some rural communities may choose to adopt LZ-0 for residential areas.	**Recommended default zone for wilderness areas, parks and preserves, and undeveloped rural areas.** Includes protected wildlife areas and corridors.
LZ-1	Lighting Zone 1 pertains to areas that desire low ambient lighting levels. These typically include single and two family residential communities, rural town centers, business parks, and other commercial or industrial/ storage areas typically with limited nighttime activity. May also include the developed areas in parks and other natural settings.	**Recommended default zone for rural and low density residential areas.** Includes residential single or two family; agricultural zone districts; rural residential zone districts; business parks; open space include preserves in developed areas.
LZ-2	Lighting Zone 2 pertains to areas with moderate ambient lighting levels. These typically include multifamily residential uses, institutional residential uses, schools, churches, hospitals, hotels/motels, commercial and/or businesses areas with evening activities embedded in predominately residential areas, neighborhood serving recreational and playing fields and/or mixed use development with a predominance of residential uses. Can be used to accommodate a district of outdoor sales or industry in an area otherwise zoned LZ-1.	**Recommended default zone for light commercial business districts and high density or mixed use residentialdistricts.** Includes neighborhood business districts; churches, schools and neighborhood recreation facilities; and light industrial zoning with modest nighttime uses or lighting requirements.
LZ-3	Lighting Zone 3 pertains to areas with moderately high lighting levels. These typically include commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses and shipping and rail yards with high night time activity, high use recreational and playing fields, regional shopping malls, car dealerships, gas stations, and other nighttime active exterior retail areas.	**Recommended default zone for large cities' business district.** Includes business zone districts; commercial mixed use; and heavy industrial and/or manufacturing zone districts.
LZ-4	Lighting zone 4 pertains to areas of very high ambient lighting levels. LZ-4 should only be used for special cases and is not appropriate for most cities. LZ-4 may be used for extremely unusual installations such as high density entertainment districts, and heavy industrial uses.	**Not a default zone.** Includes high intensity business or industrial zone districts.

Appendix F- Lumen allowances-MLO, 2011

	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Additional allowances for sales and service facilities. No more than two additional allowances per site, Use it or Lose it.					
Outdoor Sales Lots. This allowance is lumens per square foot of uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale, and may not include driveways, parking or other non sales areas. To use this allowance, luminaires must be within 2 mounting heights of sales lot area.	0	4 lumens per square foot	8 lumens per square foot	16 lumens per square foot	16 lumens per square foot
Outdoor Sales Frontage. This allowance is for lineal feet of sales frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. In order to use this allowance, luminaires must be located between the principal viewing location and the frontage outdoor sales area	0	0	1,000 per LF	1,500 per LF	2,000 per LF
Drive Up Windows. In order to use this allowance, luminaires must be within 20 feet horizontal distance of the center of the window.	0	2,000 lumens per drive-up window	4,000 lumens per drive-up window	8,000 lumens per drive-up window	8,000 lumens per drive-up window
Vehicle Service Station. This allowance is lumens per installed fuel pump.	0	4,000 lumens per pump (based on 5 fc horiz)	8,000 lumens per pump (based on 10 fc horiz)	16,000 lumens per pump (based on 20 fc horiz)	24,000 lumens per pump (based on 20 fc horiz)

Appendix G- Criteria and elements used in selecting study site

Selection Criteria	**Elements**
Urban character	Urban typology: Street side Spatial element: Path, corridor
Lighting purpose	Decorative lighting, commercial lighting
Lighting infrastructure	Ceiling lamp
Type of lights	LED
Lighting characteristics	Direct and indirect distribution of flux
Lighting effect	Visual guidance, Decoration
Illuminance intensity	Low, Medium, High intensity
Lighting color	Cool colors, cool white