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Assessing the Validity of the Exclusion of Night-time Thermal Comfort in Tourism Climate Indices

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Assessing the Validity of the Exclusion of Night-time Thermal Comfort in Tourism Climate Indices

Zandizoloyiso Mnguni



Source: *TripAdvisor.com*

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MSc (Research) in Geography

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September 2024

DECLARATION

I declare that this dissertation is my own, unaided work, except where otherwise acknowledged. It is being submitted for the Degree of Master of Science (Geography) at the University of Witwatersrand. It has not been submitted before for any degree or examination at this or any other university.



Date: 09/09/2024

ABSTRACT

Biometeorological indices are instruments that can be used to streamline complex climatic information for economic and other decision-making. Indices hold inherent assumptions where the use of an index is only reliable and valuable if those assumptions are true. The Holiday Climate Index (HCI) is presented as the improved version of the TCI, with a key difference being the removal of night-time thermal comfort due to the assumption that air conditioning is ubiquitous throughout Europe. This study investigated the validity of this exclusion of night-time thermal comfort in tourism climate indices, particularly for the HCI using the six European cities for which the index was developed – Barcelona, Stockholm, London, Istanbul, Paris and Rome. The assumption of ubiquitous air conditioning was investigated using *Booking.com* accommodation listings, the night-time economy and prevalence of night-time activities outside of each accommodation establishment, and whether tourists experienced adverse thermal comfort during the night through posted reviews. Without the air conditioning filter applied, the proportion of listings categorized as offering air conditioning ranged from 28.8% for Stockholm to 98.9% for Rome. With the filter applied, the proportions ranged from 96.4% for Stockholm and 99.0% for Paris. A total of 24,252 *TripAdvisor* reviews were also examined for both accommodation establishments and night-time tourist activities. The reviews were manually examined for the mention of weather, climate, night-time temperature and air conditioning. The findings of this study exhibit a range of night-time activities, many of which are outdoors, where tourists did comment on night-time thermal comfort. The research disproves the claim of the original authors, and it was found that air conditioning is not ubiquitous. Therefore, the assumption that the HCI is based on is problematic, and the index should be used with caution. Moreover, a similar approach in index validity testing should be performed prior to future studies seeking to apply indices.

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LIST OF ACRONYMS

ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers

BCI – Beach Climate Index

CO_2 – Carbon Dioxide

CCI – Camping Climate Index

CIT – Climate Indec for Tourism

CTC – Complexity Theory in Cities

EU – European Union

EWE – Extreme Weather Events

GDP – Gross Domestic Product

GHGs – Green House Gases

GLA – Greater London Authority

HCI – Holiday Climate Index

HCI_{Beach} – Holiday Climate Index: Beach

HCI_{Urban} – Holiday Climate Index: Urban

HVAC – Heating, ventilation and air conditioning

IAQ – Indoor air quality

IPCC – Intergovernmental Panel on Climate Change

ISTAT – Italian National Institute of Statistics

LST – Land Surface Temperature

NCEI – National Centers for Environmental Information

PET – Physiological Equivalent Temperature

PPD – Predicted Percentage Dissatisfied

PMV – Predicted Mean Vote

TCI – Tourism Climate Index

UHI – Urban Heat Island

UK – United Kingdom

UNWTO – United Nations World Tourism Organization

WHO – World Health Organization

CHAPTER 1: INTRODUCTION

1.1. Background

One of the most important natural resources we possess is arguably the climate, which plays a significant role in our daily life (de Freitas, 2005; Pörtner *et al*., 2023). Climate controls ecosystem processes, thus sustaining all life on Earth (Pandy and Rogerson, 2018; Pörtner *et al*., 2023). Several economic sectors are impacted by climatic variability, especially tourism (Fitchett *et al.,* 2017; Doğru *et al*., 2019; Aygün Oğur and Baycan, 2023). Additionally, to assist in decision making, climatic suitability information is required for tourists to decide on the most appropriate time period to travel (de Freitas, 2005; Zhou *et al*., 2024).

The impact of climate on the tourism sector is multifaceted as outdoor tourist activities are largely dependent on favourable conditions (Amusan, 2017; van der Walt and Fitchett, 2020). Not all people experience climatic conditions the same, giving rise to the complexity of tourism climatology (Becken and Wilson, 2013; Fitchett and Hoogendoorn, 2019). It is undeniable that favourable weather encourages travel, whereas unfavourable weather deters travellers (Amusan, 2017; Gössling and Scott, 2024). Consequently, to enable seasonal adaptation, tourism stakeholders have focused on expanding and diversifying their offerings (Amelung *et al.,* 2007; Hoogendoorn *et al.,* 2021; Loehr and Becken, 2021). An increasing body of research indicates that land-based extreme weather events (EWE) are becoming more frequent and intense due to human-induced climate change (Mpandeli and Maponya, 2013; Kirchmeier-Young and Zhang, 2020; Williams *et al.*, 2020; Magnan *et al.*, 2021)

Tourism sectors are a large economic contributor on global and national scales (Mahtabi and Tarani, 2018; Gössling and Scott, 2024). Due to the rise in tourism in the 1960s and 1970s, researchers began to study the relationship between destination climate and tourism (Demiroglu *et al*., 2020). The first quantitative index developed was the Tourism Climate Index (TCI), which determined the climatic suitability of a destination as a function of thermal comfort, sunshine hours, rainfall and wind (Mieczkowski, 1985). This index went on to be the most widely used internationally (Scott *et al.*, 2016a; Adiguzel *et al.*, 2022), applied in Europe (Nicholls and Amelung, 2008; Perch-Nielsen *et al.*, 2010; Kovács and Unger, 2014), the Mediterranean (Amelung and Viner, 2006), southern Africa (Fitchett *et al.*, 2016, 2017; Noome and Fitchett, 2019, 2021; Mushawemhuka *et al.*, 2020), Algeria (Derradji *et al.*, 2020), Australia (Amelung and Nicholls, 2014), China (Fang and Yin, 2015; Huang *et al.*, 2018; Zhong *et al.*, 2019; Qiang, 2020), Egypt (Mahmoud *et al.*, 2019), Georgia (Amiranashvili *et al.*, 2018), Hungary (Németh, 2013) and Turkey (Abbasnia *et al.*, 2019).

Over the past decade, a much wider range of tourism climate indices have emerged, originating from the critiques of the Tourism Climate Index (TCI; Saarinen *et al*., 2022). These include the Beach Climate Index (BCI; Morgan *et al.*, 2000), Climate Index for Tourism (CIT; de Freitas *et al.*, 2008), Holiday Climate Index (HCI; Scott *et al.,* 2016a) and the Camping Climate Index (CCI; Ma *et al.*, 2020). While some of these indices are tailored for a specific touristic setting, such as the beach or camping, a number of these indices are purported improvements of the original TCI (Scott *et al*., 2016a). Although the HCI includes the Physical, Aesthetic and Thermal Comfort facets of the TCI, the major distinction of this index is the removal of night-time thermal comfort in both the HCI_{Beach} and HCI_{Urban} indices (Scott *et al.*, 2016a). The justification for the removal of night-time thermal comfort was because “in the 30 years since

the TCI was developed, air conditioning has become almost universal in tourist accommodations in developed countries and major tourism destinations in developing countries" (Scott *et al.*, 2016a: pp 16). However, it has never been empirically demonstrated that air conditioning is indeed 'almost universal' in these European cities, and for destinations outside of Europe this is seldom the case (Mushawemhuka *et al.*, 2020).

1.2. Rationale

For an index to provide meaningful and accurate outputs, it must represent conditions experienced in reality (Olya and Alipour, 2015a). The HCI is presented as the improved version of the TCI and argued to be more appropriate as it based on literature on tourists' climatic preferences (Scott *et al.,* 2016a; Krishnannair *et al.,* 2022). However, the validity of the HCI_{Urban} needs to be examined by investigating whether the inherent assumptions hold true, both for the six European cities for which it was developed, and globally. As the key difference between the TCI and HCI is the removal of night-time thermal comfort, the assumption of ubiquitous air conditioning must be tested alongside the prevalence of night-time activities that take place outside of hotel establishments and reviews of tourists pertaining to their thermal comfort. This will determine whether, for the European cities for which the HCI_{Urban} was developed, this index would provide accurate outputs on the climatic experiences of tourists, and whether it should be used in place of the TCI.

1.3. Aim and objectives

The aim of this study is assess the validity of the HCI_{Urban} with consideration of the elimination of night-time comfort in this index. This will be achieved through the following objectives:

1. To determine the proportion of air-conditioned hotel accommodation establishments in the six European cities for which the index was developed through an analysis of online hotel listings on *Booking.com*.
2. To explore the frequency of comments on night-time thermal comfort and discomfort in tourist reviews on the hotel listings on *TripAdvisor.*
3. To explore the night-time economies and activities that take place outside of hotel rooms at night in each of the six European cities through the analysis of tourist recommendations and activity listings on *TripAdvisor* and *Booking.com*.

1.4. Structure of dissertation

Following this introduction, Chapter Two examines the existing literature and published research on thermal comfort, tourism and climate as well as tourism climate indices. The chapter begins with an explanation of thermal comfort (indoor and outdoor) and the importance of understanding this concept as temperatures are projected to rise due to climate change. This is followed by the examination of how researchers are studying evening thermal comfort through sleep studies and thermal comfort indices.

Chapter Three expands on the study site for this research – Barcelona, Stockholm, Istanbul, Paris, London and Rome. The climate and tourism statistics are provided. Chapter Four outlines the methodology used for this research. This study is grounded in in netnographic research through the use of online platforms i.e. *TripAdvisor* and *Booking.com* (Abrahams *et al.,* 2022). The data collection involved examining the hotel accommodation establishments on *Booking.com* for air conditioning units as well as extracting reviews from *TripAdvisor* to identify weather/climate mentions.

Chapter Five of this dissertation presents the analyses of the results obtained, starting with the data collected from *Booking.com*. The chapter goes on to display the mentions of climate, weather, night-time thermal comfort and air conditioning from hotel accommodation establishments and night-time activities reviews. Furthermore, the night-time economy of the study locations are mapped, with the chapter concluding with climate data obtained for the time period 1992-2022.

Chapter Six provides a discussion of the results obtained and compares them with existing literature. This chapter examines the implications the results have on the validity of the HCI_{Urban}, socio-economical developing regions, the physical and psychological harms of neglecting night-time thermal comfort and the traps of citing invalidated indices to various locations. The chapter also examines the limitations of the study. Chapter Seven concludes this dissertation by assessing the degree to which the aim and objectives of the study were achieved.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The relationship between thermal comfort and tourism has been of interest to researchers for many years (Matzarakis *et al.,* 1999; Scott *et al.,* 2012a). With the impacts of climate change becoming increasingly apparent, understanding how temperature and other climatic factors affect tourist behaviour and satisfaction is becoming more important (Amelung and Nicholls, 2014; Fitchett and Hoogendoorn, 2018; Peeters *et al.,* 2024). Furthermore, various tourism climate indices have been developed to assess the potential impacts of climate change on tourism (e.g. Morgan *et al.,* 2000; de Freitas *et al.,* 2008; Ma *et al.,* 2020). These indices provide a quantitative measure of the perceived climate conditions for tourism and can be used to assess the suitability of different locations for tourism activities (Fitchett *et al.,* 2017; Muñoz *et al.,* 2023). In recent years, there has been a growing interest in the intercomparisons of these indices to determine their reliability and validity (Ma *et al.,* 2020; Rutty *et al.,* 2020). This literature review aims to explore the existing research on the impacts that daytime and evening thermal comfort have on human beings and their wellbeing; the importance of the tourism-climate relationship; the development and application of tourism climate indices; and index intercomparisons to assess their validity and applicability.

2.2. Tourism and climate

The beginnings of modern tourism can be traced back to the early 19th century, when wealthy Europeans began to travel for leisure and pleasure (Smith, 1998; Davenport and Switalski, 2006; Gilbert and Hancock, 2006). Due to technological advancements and accessibility to climatically diverse regions, tourism began to grow in popularity (Davenport and Davenport,

2006; Lohmann and Duval, 2011; Mammadov, 2012; Hopkins, 2020). By the early 20th century, tourism had become a mass phenomenon, with millions of people traveling to destinations with comfortable climates such as Europe, North America, Asia and beyond (Becken, 2005; Scott *et al.,* 2012b; Sezgin and Yolal, 2012; Zajac, 2016). The relationship between tourism and climate has a long and complex history, with the investigation of this relationship dating back to the 1960s (Scott and Lemieux, 2010; Scott *et al*., 2012a; Jeurig, 2017; Loehr and Becken, 2021; Scott and Gössling, 2022a).

The discourse surrounding the tourism sector have been increasingly dominated by the idea of sustainability since the mid-1990s due to the increase in climate change induced extreme weather events (Weaver, 2011; Pandy and Rogerson, 2018; Friedrich *et al.,* 2020; Lopes *et al.,* 2022). In the 1970s, the link between economic benefits of tourism, the promotion of local cultures as tourist attractions and destination weather was identified (Liu, 2003; Lu and Nepal, 2009; Weaver, 2011; Hall, 2016; Gössling and Scott, 2024). As tourism has grown into the largest economic sector in the world, the connection between tourism, climate and environment has become increasingly significant as climate change continues to pose serious threats to the global tourism market (de Freitas, 1990, 2005; Pang *et al.,* 2013; Njoroge, 2015; Scott and Gössling, 2022b; Gössling and Scott, 2024). The connection between the two themes is recognized as a vital component to many countries' economies (de Freitas, 2005; Scott *et al.,* 2007; Gössling *et al.,* 2012; Scott and Gössling, 2022a, b; Peeters *et al.,* 2024). Climate is a major factor in attracting tourists to many parts of the globe, and as such, it contributes significantly to the region's base of natural resources for tourism (de Freitas, 2005; Scott *et al.,* 2012a; Hall, 2018; Pörtner *et al*., 2023). Furthermore, the tourist demand, visitor behaviour and offer of tourist activities is dependent on the weather conditions that

are experienced in a particular region (Becken, 2005; de Freitas, 2015; Stockigt *et al.,* 2018; Aygün Oğur and Baycan*,* 2023; Steiger *et al.,* 2023).

2.3. Thermal comfort

The phenomenon of thermal comfort refers to the subjective perception of the thermal environment (Höppe, 2002; Kumar and Sharma, 2020), and is described by Hensen (1991) as a condition in which there are no inclinations to change one's behaviour in order to improve the environment, including the psychological, thermophysiological and heat balance of the body. Thermal comfort is affected by a variety of factors such as air temperature, humidity, wind, and personal factors like clothing, activity level, and metabolic rate (Lin and Deng, 2008; Djongyang and Tchinda, 2010; van Hove *et al.,* 2015). Other personal factors that can influence thermal comfort include age, with studies demonstrating that elderly people have a lower sensitivity to a change in temperature than younger people, which has resulted in different thresholds for the elderly (Hughes *et al.,* 2019; Borghero *et al.,* 2023).

Thermal comfort is an important aspect of human well-being and productivity (Djongyang and Tchinda, 2010; Khodakarami and Nasrollahi, 2012; Kawakubo *et al.,*2023) and has been the subject of extensive research in the field of environmental psychology, architecture, engineering and health sciences (Lomas and Giridhavan, 2012; Lan *et al.,* 2017; Hughes *et al.,* 2019; Borghero *et al.,* 2023). The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) defines thermal comfort as a state of consciousness that displays pleasure with regard to the thermal environment (Olesen and Brager, 2004). The ASHRAE Standard 55 is an Adaptive Comfort Standard that is used to identify if thermal comfort has been reached, and based on the ASHRAE definition, the thermal comfort zone

occurs when 80% of occupants find the environment thermally comfortable (Epstein and Moran, 2006; Ahmed *et al.,* 2021). This definition highlights the subjective nature of thermal comfort, emphasizing that it involves perception rather than an objective measurement (Zhao *et al.,* 2021).

Exposure to uncomfortable thermal conditions can cause stress and anxiety, leading to decreased productivity, lower job satisfaction, and higher rates of absenteeism (Ormandy and Ezratty, 2012; Zheng *et al.,* 2022). Studies have found that individuals who work in thermally comfortable environments have higher job satisfaction, better mental health, and improved overall well-being (Khodakarami and Nasrollahi, 2012; Lomas and Giridhavan, 2012; Kawakubo *et al.,* 2023). In addition, thermal comfort can affect mood and cognitive performance (Ko *et al.,* 2020; Jiao *et al.,* 2023; Yan *et al.,* 2023). High temperatures have been found to impair cognitive function, while cooler temperatures have been found to improve cognitive functioning (Haselsteiner, 2021; Lam *et al.,* 2021).

The threat of climate change has highlighted the connection between economic growth, energy and environmental pollution (Santos *et al.,* 2022). Moreover, the increase in global temperatures has caused severe heat stress for human beings which have led to serious health conditions such as dehydration, heat exhaustion, and heat stroke (Kavgic *et al.,* 2012; Jamei *et al.,* 2016; Zölch *et al.,* 2019*;* Kumar and Sharma, 2020). Many studies have been conducted in the health sciences and bioclimatic agricultural disciplines to better understand the importance of thermal comfort (McCartney and Humphreys, 2002; Feriadi *et al.,* 2003*;* Santos *et al.,* 2022). Researchers have also highlighted the connection between indoor air quality (IAQ) and thermal comfort (Pereira *et al.,* 2014; van Hove *et al.,* 2015; Aghniaey *et al.,*

2019), which has given rise to the identification of some of the most common health concerns relating to thermal discomfort (Epstein and Moran, 2006). Some of the diseases identified include respiratory diseases (i.e. asthma), diabetes, core schizophrenia, dementia symptoms and cardiovascular disease (Epstein and Moran, 2006; Mendes *et al.,* 2013; Borghero *et al.,* 2023).

Another important relationship identified in the environmental science discipline is between the energy crisis, building envelope and thermal comfort (Barbhuiya and Barbhuiya, 2013; Zhu *et al.,* 2016; Zomorodian *et al.,* 2016; Azzi *et al.,* 2024). The dependence on fossil fuels for energy production has contributed to both the increase in greenhouse gases (GHGs) and unpredictable power outages in regions such as Africa and Europe (Dodoo and Ayarkwa, 2019; Santos *et al.,* 2022). Furthermore, the most common solution to reducing indoor heat is the installation of heating, ventilation and air conditioning (HVAC) systems but these have resulted in increased energy usage demand (Lomas and Giridharan, 2012; Jamei *et al.,* 2016; Gao *et al.,* 2020). As energy costs continue to rise, many occupants resort to natural ventilation strategies, such as opening the windows, but these are not always appropriate in the winter months or very effective in the summer months (Kavgic *et al.,* 2012; Hughes *et al.,* 2019; Ahmed *et al.,* 2021).

The thresholds of thermal comfort include the combination of temperature, humidity, wind, and radiant heat resulting in thresholds of 'effective temperature' that humans find comfortable (Candas and Dufour, 2005; Karimi *et al.,* 2020). These thresholds vary depending on a variety of factors such as age, sex, activity level, clothing, and acclimation to the environment (Schellen *et al.,* 2012; Wang *et al.,* 2018; Amaripadath *et al.,* 2023). Although

there is no absolute standard for thermal comfort (Ogbonna and Harris, 2008), the World Health Organization (WHO) recommended an effective temperature range for indoor environments – a minimum of 18°C and a maximum of 24°C for all rooms (Adesina *et al.,* 2020) but a tighter range of 20-21°C if occupied by the elderly (WHO, 1987). ASHRAE (1992) identified that thermal comfort or heat stress will differ in separate seasons i.e. acceptable ambient temperatures would be higher in summer at 23-27°C and lower in winter at 20-25°C, due to the changes in clothing through the seasons. Similarly, three parameters highlighted by Fanger (1970) include that the body will be free from perspiration if the core temperature ranges from 36.5-37.5°C, the skin temperature is between 30-34°C at the body's stem and head, and the extremities are all within that small range (Hensel and Schaffer, 1984). The human body will experience thermal discomfort if these threshold are reached (Epstein and Moran, 2006; Wang *et al.,* 2023).

Over the years, the field of thermal comfort study and practice has proven to not be static and has grown since the introduction of air conditioning into the built environment (van Hoof *et al.,* 2010). Since the development of the Predicted Mean Vote (PMV; Fanger, 1970), scientists have utilized this index as a basis for indoor thermal comfort indices. The PMV index includes the six primary factors that affect thermal comfort: air temperature, mean radiant temperature, air velocity, relative humidity, metabolic rate, and clothing insulation (Ricciu *et al.,* 2018; Hughes *et al.,* 2019). These factors are then inputted into a formula to generate a number between -3 and +3; a value of zero represents thermal neutrality, while negative and positive values indicate a feeling of coolness or warmth, respectively (Han *et al.,* 2014; Yau and Chew, 2014; Ruivo *et al.,* 2021). The combination of this index and HVAC ensure the measure of mean thermal sensation for a large group of people within one space and

adequate installation of cooling systems (Aghniaey *et al.,* 2019; Espejel-Blanco *et al.,* 2022). Additionally, the Predicted Percentage Dissatisfied (PPD) is an index that is often utilized with the PMV and provide the most useful outputs when used together (Yao *et al.,* 2009; Pourshaghaghy and Omidvari 2012; dos Reis *et al.,* 2022). The PPD accounts for the human psychology element by predicting the percentage of occupants who are likely to be dissatisfied with the thermal conditions based on the distribution of thermal sensation in a group of occupants (Yau and Chew, 2014). Researchers have frequently used thermal comfort indices to understand the effects of climate on tourism (Lin and Matzarakis, 2008; Nasrollahi *et al.,* 2017; Salata *et al.,* 2017; Shang *et al.,* 2020; Karimi and Mohammad, 2022). Moreover, Lopes *et al.* (2021) used several thermal comfort indices – Physiological Equivalent Temperature (PET), Thermal Sensation Vote (TSV), Thermal Preference Vote (TPV) – to characterise the tourists in Portugal and determine the influence the microclimate has on the tourist experience. This study found that tourists have a greater tolerance for variations in temperatures as they experience those conditions for a finite amount of time (Lopes *et al.,* 2021).

The PET is one of the more popular thermal comfort indices which considers the combined effects of temperature, humidity, and air movement on human physiology (Höppe, 1999). The concept of a model of equivalent temperature, or the temperature that would result in the same degree of heat stress as the actual environmental conditions, serves as the foundation for the index (Matzarakis *et al.,* 1999). This index is a useful tool for assessing thermal comfort in both indoor and outdoor environments because it takes into account air temperature, humidity, wind speed, and solar radiation, to predict the level of heat stress experienced by occupants (Mayer, 1993; Höppe, 1999; Matzarakis *et al.,* 1999; Zhao *et al.,* 2021). The PET

also considers physiological factors that affect human heat exchange, such as skin temperature, core temperature, sweat rate, and metabolic rate (Gulyás and Matzarakis, 2009; Chen *et al.,* 2020; Thorsson *et al.,* 2021).

To describe the sensations of the average human in hot, humid weather, Canadian meteorologists Masterton and Richardson (1979) developed an index named Humidex. Humidex is a calculation-based indicator that is based on air temperature and humidity to determine the level of discomfort experienced by individuals in a given environment (Masterson and Richardson, 1979; Rainham and Smoyer-Tomic 2003; Chebana *et al.,* 2013; Ho *et al.,* 2016). This index has proven to be particularly useful in Canada, where high humidity levels can exacerbate the discomfort of high temperatures (Rainham and Smoyer-Tomic, 2003; Jay and Kenny, 2010; Orosa *et al*., 2014). By taking into account both temperature and humidity, the humidex provides a more accurate assessment of thermal comfort than traditional thermal comfort indices that only consider air temperature (Masterson and Richardson, 1979; Alfano *et al*., 2011). The level of physical exertion can significantly affect how comfortable or uncomfortable an individual may feel in hot and humid weather which impacts the output scores produced (Masterson and Richardson, 1979; Zhou *et al.,* 2023).

2.4. Evening thermal comfort

Thermal comfort is equally important in the daytime and the evening as these both offer unique experiences and have potential impacts on human well-being (Höppe, 1991; Johansson and Emmanuel, 2006; Anand *et al.,* 2017; Vellei *et al.,* 2023). The thermal environment of the evening differs to that of the day because the outdoor temperature typically drops, changing the thermal conditions indoors (Lomas and Giridharan, 2012;

Emmanuel, 2005; Kuczyński *et al.,* 2021; Dharmasastha *et al.,* 2023). Thermal comfort requirements for outdoor and indoor evening activities can be expected to be similar to climatic conditions required for daytime activities including socializing, sleeping, and relaxing (Song *et al.,* 2020; Minor *et al.,* 2022)

Thermal comfort research often ignores the thermal environment in bedrooms, but sleep science has demonstrated that temperatures between 22-24°C with a relative humidity of 40-60% is ideal for sleeping (Lan *et al.,* 2017; Caddick *et al.,* 2018). Yan *et al.* (2016) conducted a behavioural study on thermal responses in rural China by utilizing questionnaire surveys, a hot-wire anemometer to measure air velocity and a globe thermometer to measure globe temperature data. The study demonstrated that people preferred air speeds below 0.15 m/s for activities like reading and watching television, whereas higher speeds were favoured for physical activity (Yan *et al.,* 2016). The decrease in temperature from daytime to evening has implications on the human body, affecting sleep patterns and sleep quality (Lan *et al.,* 2017; Song *et al.,* 2020; Buguet *et al*., 2023). The conditions are generally cooler than what is experienced during the day which allows the body's core temperature to naturally decreases during the evening hours in preparation for sleep (Kräuchi, 2007; Thun *et al.,* 2015; Tsang *et al.,* 2021). However, studies demonstrate that even mild heat or cold exposure can dramatically reduce sleep quality due to the human body's extreme sensitivity to air temperature (Lin and Deng, 2008; Lan *et al.,* 2017; Wang *et al.,* 2023).

The study of evening thermal comfort involves several methods that help researchers understand how individuals perceive and respond to different thermal conditions, especially during their sleep (Lan *et al.,* 2017; Caddick *et al.,* 2018; Liguori *et al.,* 2023; Ellis *et al.,* 2024).

One of the primary methods used in the study of evening thermal comfort is subjective assessments, which involves asking individuals to rate their thermal comfort levels in a given environment (Wong *et al.*, 2002; Xi *et al.,* 2012; Lan *et al.,* 2014; Benz *et al.,* 2023). Alternatively, researchers can use the PMV-PPD or PET index, which is a standardized method used to determine thermal comfort levels based on physical environmental factors (Aghniaey *et al.,* 2019; Hughes *et al.,* 2019). The measurement of physical environmental factors can also be obtained through the use of thermal sensors placed in indoor locations to investigate the change in the thermal comfort from daytime to evening temperatures (Hong *et al.,* 2019; Martins *et al.,* 2022). Researchers can also explore evening thermal comfort using physiological data in addition to subjective evaluations and thermal sensors by tracking how the body reacts to various heat situations (Kovács and Németh, 2012; Yang *et al.,* 2013; Wu *et al.,* 2024). To monitor variations in skin temperature – which may be a sign of the body's thermal comfort level – researchers can employ skin temperature sensors that collect data at various times of the day and during different seasons (Clear *et al.,* 2013; Xiong *et al.,* 2020; Wu *et al.,* 2024). Additionally, most sleep thermal comfort studies are conducted in labs where heart rate, perspiration rate, core body temperature and other physiological parameters can be monitored (Vanos *et al.,* 2010; Lan *et al.,* 2014; Hong *et al.,* 2019; Topalidis *et al.,* 2023).

2.5. Tourism climate indices

According to the United Nations World Tourism Organization (UNWTO), international tourist arrivals reached 1.4 billion in 2018, and the industry accounts for 10.4% of the global Gross Domestic Product (GDP) and 319 million jobs (UNWTO, 2018). However, tourism is also highly sensitive to weather and climate conditions, and climate change is increasingly seen as a

major threat to the sustainability of the industry (Scott *et al.,* 2012a, 2019; Gössling *et al.,* 2012; Amusan, 2017; Zhong *et al.,* 2019; Shang *et al.,* 2023). Tourism climate indices were developed to assist the tourism industry in understanding and managing the potential impact of weather and climate on tourism activities (Mieczkowski, 1985; Morgan *et al.,* 2000; de Freitas *et al.,* 2008; Scott *et al.,* 2016a; Ma *et al.,* 2020; Demiroglu *et al.,* 2021). Tourism climate indices can help researchers in determining future risk, such as extreme events and temperature change (Fitchett *et al.,* 2016; Hoogendoorn *et al.,* 2016, Hoogendoorn and Fitchett, 2018; Demiroglu *et al.,* 2021), or evaluating seasonal tourism periods (Noome and Fitchett, 2019, 2021; Muñoz *et al.,* 2023). These indices provide a standardized way to evaluate climate conditions at a destination, taking into account factors such as temperature, humidity, precipitation, wind speed, and other variables that can influence visitor comfort and satisfaction (Amelung and Nicholls, 2014; Fitchett *et al.,* 2017; Rutty *et al.,* 2020; Noome and Fitchett, 2021). By providing a clear and objective measure of climate conditions, tourism climate indices can help tourism planners, destination managers, and other stakeholders make informed decisions about marketing, infrastructure development, and other aspects of tourism management (Scott *et al.,* 2016b; Perkins and Debbage, 2016; Hoogendoorn and Fitchett, 2018; Sharma and Chaudary, 2020; Gössling *et al.,* 2024).

The inception of tourism climate indices were due to the rise in tourism in the 1960s - 1970s and increased investigations of the tourism-climate relationship (Fergusson, 1964; Davis, 1968; Murray, 1972; Harlfinger, 1991; Becker, 1998). Mieczkowski (1985) initially developed the TCI, which is arguably the most widely used index to date (Scott *et al.,* 2016a; Alonso-Pérez *et al.,* 2021; Adiguzel *et al.,* 2022). The TCI is a tool used to measure the suitability of a particular climate for tourism, taking into account several factors, such as temperature, wind,

rain, amount of sunshine and humidity, which combine to determine both the thermal and aesthetic suitability for tourism (de Freitas, 1990; Gómez-Martín, 2005; Amelung and Nicholls, 2014; Faraj *et al.,* 2023).

The TCI represents the climatic suitability of a destination for a wide range of casual outdoor tourist pursuits (Alonso-Pérez *et al.,* 2021) and has been applied in various locations since it was first developed, such as Europe (Scott *et al.,* 2016a), South Africa (Fitchett *et al.,* 2016, 2017), Lesotho (Noome and Fitchett, 2019), Zimbabwe (Mushawemhuka *et al.,* 2020), Cyprus (Olya and Alipour, 2015a), the Mediterranean (Amelung and Viner, 2006; Moreno, 2010), Turkey (Deniz, 2011) and many tourism destinations. The quantification of climatic suitability has been instrumental in assessing the impact of climate change on outdoor or nature-based tourism for the development of climate adaptation strategies for the tourism industry (Scott and McBoyle, 2001; Dubois *et al.,* 2016; Mushawemhuka *et al.,* 2020; Nourmohammadi and Gómez-Martín*,* 2024). Researchers have identified several limitations of the TCI, which has led to the development of several indices that address the shortcomings of this index (Morgan *et al.,* 2000; de Freitas *et al*., 2004, 2008; Scott *et al.,* 2016a; Ma *et al.,* 2020; Rutty *et al.,* 2020; Demiroglu *et al.,* 2021).

Morgan *et al.* (2000) identified the climatic-sensitivity of beach use and developed a specific beach climate index that had the same components as Mieczkowski's (1985) TCI, with the exclusion of the daily thermal component (i.e. thermal sensation, precipitation, sunshine and wind; Moreno and Amelung, 2009). A major critique highlighted by researchers is that the TCI was based only on expert judgement and neglected tourists' climatic preferences (Morgan *et al.,* 2000; Scott *et al.,* 2016a; Amiranashvili *et al.,* 2021a, b). Morgan *et al.* (2000) addressed

this limitation by conducting surveys on actual beach users in Europe and based the rating and weighting system on the tourists' opinions. However, the BCI adopted the weighting methodology of the TCI that is comprised of small sub-indices that add up to a maximum score of 100 (Morgan *et al.,* 2000; Moreno and Amelung, 2009). Although the BCI is still applied in locations such as Iran (Lashaki *et al.,* 2022; Baeilashaki *et al.,* 2024), it has not been extensively used for quantifying climate suitability for coastal areas around the world (Rutty and Scott, 2013; Gao *et al.,* 2022).

The CIT is also called the second generation of TCI but is founded on survey data rather than climatic statistics and is tailored for a particular type of tourism, namely 3S (sun, sea, and sand) outdoor tourism (De Freitas *et al.,* 2008; Amengual *et al.,* 2012; Li *et al.,* 2018). To determine a climate satisfaction rating that varies from very poor (1 = unacceptable) to very good (7 = optimal), CIT integrates the thermal, aesthetic, and physical aspects of weather (de Freitas *et al.,* 2004, 2008). The CIT provides greater application flexibility than the TCI because it takes into account thermal sensation using the ASHRAE scale and acknowledges the overriding influence of certain weather conditions on thermal and aesthetic aspects (de Freitas *et al.,* 2008; Noome and Fitchett, 2019; Cardell *et al.,* 2023).

The CCI builds on and provides three significant improvements over earlier indices, making it particularly well-suited for outdoor tourism activities such as camping (Ma et al., 2020; Ma *et al.,* 2021a). First, the CCI utilized a series of iteration correlation and tourist surveys to determine the weighting and rating schemes that eliminated ratter subjectivity (Ma *et al.,* 2020, 2021b). Second, the CCI was developed and validated by utilizing camping occupancy and monthly visitations data in the United States (Ma *et al.,* 2021a, b, c; Ma *et al*., 2023).

Lastly, the index recognizes the destructiveness and frequency of catastrophic weather events by integrating these conditions into the formula to indicate that a single extreme climate event would make camping unsuitable, regardless of how favourable the other climatic variables might be (Ma *et al.,* 2020). The reintroduction of evening thermal comfort is apparent in this index and has been included as one of the extreme weather thresholds (Ma *et al.,* 2020). The specificity of the index allows an in-depth analysis of the contributing factors, such as temperature and occupancy, so this well detailed index can be distinguished from the others thus attempting to close the literature gap in tourism climatology (Ma *et al.,* 2020; Fitchett and Meyer, 2023). Ma *et al.* (2020) encountered a few challenges in lack of climatic data for the study period, except for daily sunshine hours which were calculated based on incoming solar radiation values. The CCI has not yet been applied globally, it has only been applied in the global North - particularly the United States (Ma *et al.,* 2021c). Regardless of the method used in developing tourism climate indices, Fitchett and Meyer (2023) argue the importance of objectively evaluating the validity, applicability and suitability of biometeorological indices before their widespread application.

The four key limitations of the TCI include: (1) the subjective rating and weighting system of climatic variables; (2) it ignores the potential overriding influence of physical climatic parameters (such as rain and wind); (3) the low temporal resolution of climatic data (i.e., monthly data) has limited relevance for tourist decision-making; and (4) it ignores the varied climatic requirements of key tourism segments and destination types (de Freitas *et al.,* 2008; Scott *et al.,* 2016a; Rutty *et al.,* 2020). The HCI was created with two main tourism segments and destination types in mind to address the critiques identified – namely $HCI:_{Urban}$ (Scott *et al.,* 2016a) and $HCI:_{Beach}$ (Rutty *et al.,* 2020). Scott *et al.* (2016a) devised an index that arguably

more accurately assessed the climatic suitability of urban tourism destinations by designing a variable rating scores based on the available literature on tourist climatic preferences and one that has been applied in various geographic locations (Figure 2.1). Furthermore, comparing mean monthly HCI_{Urban} scores with hotel occupancy in Paris enabled researchers to empirically test the HCI (Scott *et al.,* 2016a). The HCI index includes the aesthetic, physical and thermal (de Freitas, 2003) facets of climate utilised in the TCI. Each climatic factor is given a score between 0 and 10, and the total HCI_{Urban} index score ranges from 0 (possibly dangerous for tourists) to 100 (ideal for tourism), which is consistent with the TCI descriptive categories (Scott *et al.,* 2016a; Demiroglu *et al.,* 2020; Yu *et al.,* 2022). However, the major advancement of the index is the elimination of evening thermal comfort to represent that air conditioning has become a universal standard in both major tourist sites in developing countries and lodgings for travellers in developed countries (Scott *et al.,* 2016a). The HCI_{Urban} has grown in popularity and has been applied in various locations (Noome and Fitchett, 2021; Samarasinghe *et al.,* 2023; Figure 2.1).

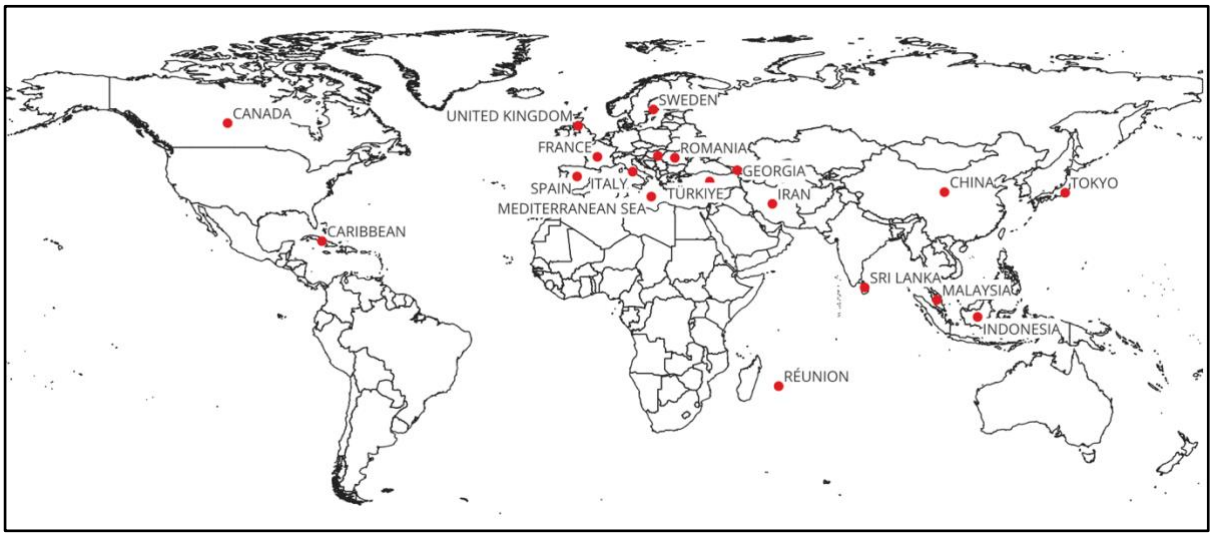


Figure 2.1: Map showing the applications of the HCI.

According to Rutty *et al.* (2020), the HCI:$_{Beach}$ provides the first assessment of a climate index based on visitors' stated climatic preferences for coastal-beach tourism. (i.e., a sun-sand-surf or 3S travel market). The validity of this index was further tested by comparing the monthly outputs of the TCI and HCI:$_{Beach}$ for Caribbean destinations (Rutty *et al.,* 2020), which allowed for the application of this index (Figure 2.1) in the Mediterranean (Demiroglu *et al.,* 2020); China (Yu *et al.,* 2021; Gao *et al.,* 2022) and Sri Lanka (Samarasinghe *et al.,* 2023). The HCI:$_{Beach}$ and HCI:$_{Urban}$ both eliminate the weighting of evening thermal comfort but beach tourists stated their preference of warmer temperatures and importance of cloud cover which warrants the exclusion of night-time temperatures (Rutty *et al.,* 2020; Ma *et al.,* 2021b). The difference between the TCI, HCI:$_{Urban}$ and HCI:$_{Beach}$ is highlighted when tourists' climatic preferences and climatic requirements for touristic activities are compared, resulting in different rating schemes in the three climatic facets (Scott *et al.,* 2016a; Demiroglu *et al.,* 2020; Ma *et al.,* 2020; Rutty *et al.,* 2020). Furthermore, by giving a score of 0 or even a bad rating, if the predetermined thresholds are crossed, HCI takes into consideration the dominating effects of physical aspects (Scott *et al.,* 2016a; Rutty *et al.,* 2020).

The HCI has been promoted for use worldwide as a more appropriate version of the TCI and has become one of the most widely adopted tourism climate index in the Northern Hemisphere (Ma *et al.,* 2021a; Noome and Fitchett, 2021; Samarasinghe *et al.,* 2023; Figure 2.2). Researchers, however, have identified a few weaknesses with the HCI (Urban and Beach) – 1. the subjective judgments about what constitutes "ideal" climate conditions may not align with the preferences or needs of all tourists, along with disparities between reported tourists' preferences and actual behaviours (Craig and Feng, 2018; Craig, 2019); 2. the non-linear, dominant influence of physical elements may not be accurately reflected by the additive

method used to aggregate climate components (de Freitas, 2003; Ma *et al.,* 2021b) and; 3. indices based on surveys could have an unreliable response bias (Bigano *et al.,* 2006; Ma *et al.,* 2021a). Moreover, the application of the HCI in the Southern Hemisphere and hot/dry regions (i.e. Iran, Zimbabwe and Namibia) yields unrepresentative results due to the lack of air conditioning in accommodation establishments (Hejazizadeh *et al.,* 2019; Mushawemhuka *et al.,* 2020; Noome and Fitchett, 2021; Figure 2.2). The intensification of air conditioning in major tourist destinations may result in evening thermal comfort becoming irrelevant (Demiroglu *et al.,* 2020; Ellis *et al.,* 2024) but the widespread installation of air conditioning units is not apparent (Yang *et al.,* 2014; Hejazizadeh *et al.,* 2019; Mushawemhuka *et al.,* 2020).

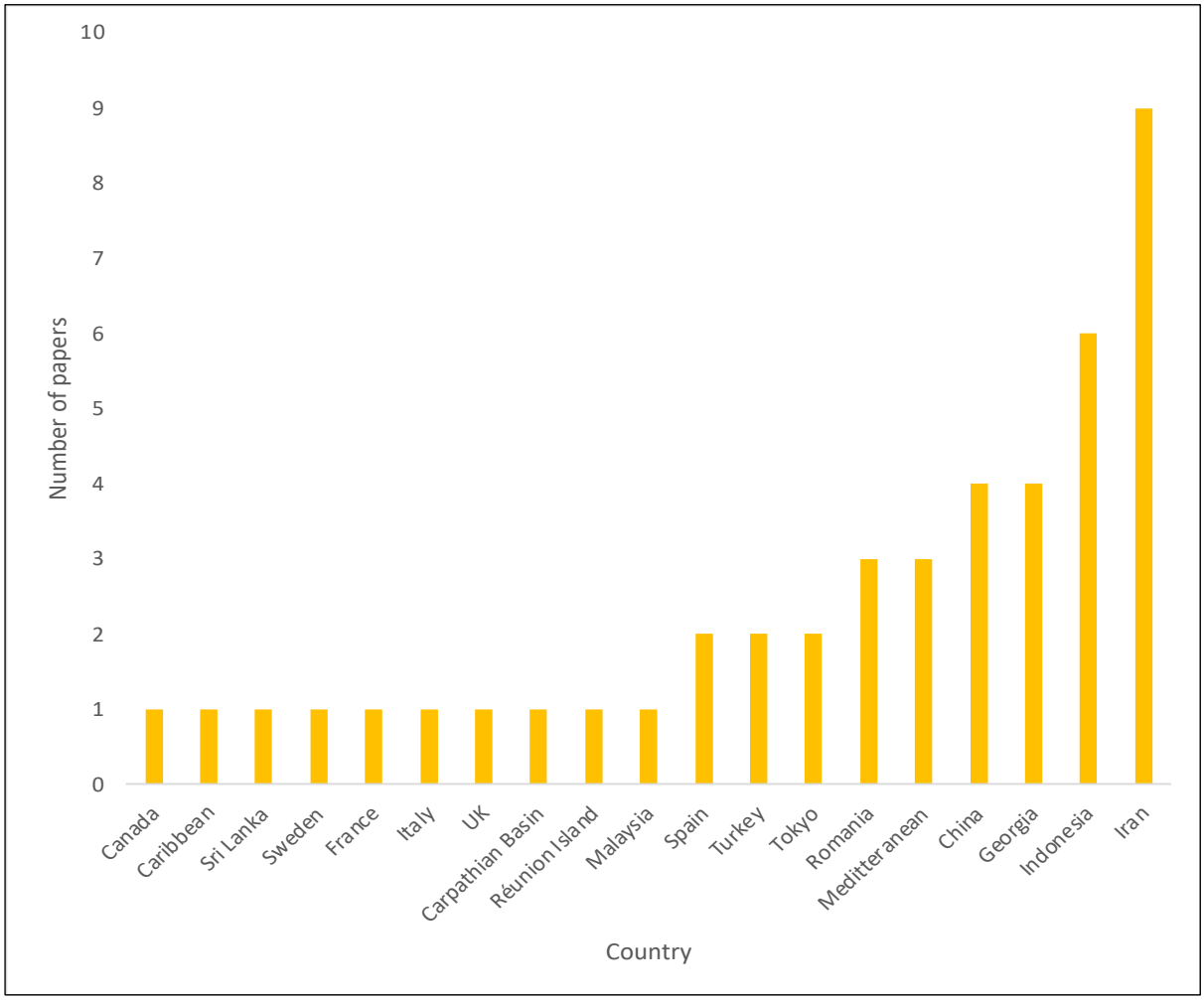


Figure 2.2: Number of HCI:$_{Urban}$ and HCI:$_{Beach}$ applications since their development.

The elimination of evening thermal comfort from the $HCI:_{Urban}$ can affect the scores produced in the locations that it was based on as well as other locations across the globe (Hejazizadeh *et al.,* 2019; Mushawemhuka *et al.,* 2020). Ma *et al.* (2020) identified the potential importance that evening thermal comfort has on the overall comfort of a location by including an extreme weather threshold for minimum temperature in the CCI. Scott *et al.* (2016a) states that evening temperatures do not impact sleep comfort but sleep scientists have identified that this is not the case (Lan *et al.,* 2017; Caddick *et al.,* 2018; Minor *et al.,* 2022). The paucity of air conditioning in tourist accommodation is prevalent due to the energy crises (Zhu *et al.,* 2016; Raihan, 2023) with rolling black-outs (Bonga and Sithole, 2020; Mushawemhuka *et al.,* 2020; Toftum, 2023) in regions such as southern Africa (Heffner *et al.,* 2010), Europe (Gilbert *et al.,* 2021; Owens, 2022) and Pakistan (Sajid and Javaid, 2018). Furthermore, the HCI_{Urban} used daytime temperatures as a substitute for early-evening circumstances, ensuring that high daily thermal comfort scores represent thermal comfort for the majority of the time when tourism activities are conducted (Scott *et al.,* 2016a). The higher thermal tolerance of leisure tourists identified by comparison to TCI scores fulfilled the thermal component of the research but lacked evidence that evening thermal comfort should be completely removed (Scott *et al.,* 2016a).

2.6. Index intercomparisons

To ensure that tourism climate indices are reliable and accurate, researchers use various methods to test their validity (de Freitas *et al.,* 2004). The first method researchers may use to test the validity of indices is to conduct a literature review to identify existing indices, their components and in some cases, determine if tourists' perceptions are widely available (Scott

et al., 2016a; Demiroglu *et al.,* 2020; Ma *et al.,* 2020; Rutty *et al.,* 2020). This step allows researchers to determine the most relevant factors that affect the climate of a tourist destination especially when it comes to outdoor tourism (Olya and Alipou, 2015b; Dubois *et al.,* 2016; Fitchett *et al.,* 2017). The inclusion of components of indices depend on the tourism sector that the index is developed for i.e. temperature, precipitation, humidity, wind speed, sunshine hours and/or cloud cover (de Freitas *et al.,* 2005).

The second method that is utilized in index validity testing is identifying the most appropriate statistical methods, with the most commonly used statistical techniques including correlation analysis, factor analysis, and regression analysis (Mieczkowski, 1985; Anđelković *et al.,* 2016; Ma *et al.,* 2020). Correlation analysis is used to examine the relationship between the index and other variables (Fitchett *et al.,* 2016; Noome *et al.,* 2019; Masoudi, 2021), such as tourist arrivals, while factor analysis is used to identify the underlying dimensions of the index, such as temperature, precipitation, and humidity (Dwyer *et al.,* 2004; Gooroochurn and Sugiyarto, 2005). Regression analysis is used to identify the variables that best predict the index (Ma *et al.,* 2020; Rutty *et al.,* 2020; Gao *et al.,* 2022). Researchers usually collect data from the target tourist destination using various sources, including meteorological stations, tourist surveys, and tourism statistics (Scott *et al.,* 2016a; Rutty *et al.,* 2020; Ma *et al.,* 2020; Fitchett and Meyer, 2023). Meteorological data is used to calculate the output scores, while tourist surveys provide information on the tourists' preferences and perceptions of the climate to create a well-rounded index (Scott *et al.,* 2016a; Fitchett and Hoogendoorn, 2018; Pashkov *et al.,* 2023). Tourism statistics provide information on the number of tourist arrivals, which is used to evaluate the relationship between the index and tourist demand (Amelung and Viner 2006; Li *et al.,* 2018; Rutty *et al.,* 2020).

The climate of a location can vary significantly, and some indices need to be adapted to specific locations to ensure their validity and comparability of scores across tourist destinations (Fitchett *et al.,* 2016; Hejazizadeh *et al.,* 2019; Faraj *et al.,* 2023; Fitchett and Meyer, 2023). Adapting an index to different locations may include several methods (Dubois *et al.,* 2016). Firstly, a literature review may be utilised to determine the components of the index and their relevance to the target location as it may not be appropriate to apply that index i.e. adapting the TCI for a snowy region, where a ski tourism climate index would be more appropriate and well suited for those weather conditions (Noome and Fitchett, 2019; Demiroglu *et al.,* 2021). Secondly, the data sources is important to consider, the unavailability of the required data may result in index components removed or researchers may need to acquire proxy data i.e. remote sensing data to measure climate variables such as cloud cover and sunshine hours for indices like the TCI and CCI (Fitchett *et al.,* 2016; Fitchett and Meyer, 2023). Thirdly, a statistical analysis may be performed on the target region to determine if the index components and the change in location still relate with each other i.e. the consideration of factors pertaining to land-surface characteristics, vegetation, microclimatic processes, slope and aspect of locations is crucial to adequately reflect the climate suitability (Demiroglu *et al.,* 2020).

To ensure that indices maintain their validity, adaptation without completely altering the index is important (Aygün Oğur and Baycan, 2023; Fitchett and Meyer, 2023). It is demonstrated that an index that is valid for one location may not be valid for another location with different climatic conditions i.e. the HCI_{Urban} would not be appropriate for humid climates that do not possess air conditioning units (Scott *et al.,* 2016a; Hejazizadeh *et al.,* 2019;

Mushawemhuka *et al.,* 2020; Samarasinghe *et al.,* 2023). The Intergovernmental Panel on Climate Change (IPCC) is a scientific body established by the United Nations to assess the scientific, technical, and socio-economic aspects of climate change (Alcamo *et al.,* 2007). There are over 165 thermal comfort and tourism climate indices that have been developed and are compared to each other to assess their accuracy, reliability, and usefulness (de Freitas and Grigorieva, 2015, 2017; Dubois *et al.,* 2016). The perceptions of tourists are frequently used to evaluate the validity of indices and to determine suitability before applying them to various locations (de Freitas *et al.,* 2008; Demiroglu *et al.,* 2020; Rutty *et al.,* 2020). Furthermore, several new indices are developed based on tourists' perceptions and tourist occupation data (Ma *et al.,* 2020; Rutty *et al.,* 2020; Muñoz *et al.,* 2023). There have been substantial efforts made to create "improved" tourism climate indices that are meant to replace those that were previously utilized i.e. the HCI is encouraged over the TCI (Scott *et al.,* 2016a; Noome and Fitchett, 2021; Krishnannair *et al.,* 2022; Prinsloo and Fitchett, 2024). Instead of examining the causes of the differences and the information each index conveys, inter-comparisons of tourism climate indices are typically undertaken to support the replacement of older indices with newer ones (Dubois *et al.,* 2016; Fitchett and Meyer, 2023).

Rescaling indices requires modifying the numerical values of the index to correspond to the local climate (e.g. Scott *et al.,* 2016a; Rutty *et al.,* 2020). This involves adjusting the numerical values of the TCI based on the weather parameters that are most relevant to the location under consideration (Matthews *et al.*, 2021). Rescaling may also involve adjusting the weighting of the weather parameters used in the calculation of the index and the relative importance of each weather parameter in the TCI calculation (Morgan *et al.,* 2000; Scott *et al.,* 2016a; Ma *et al.,* 2020). Rescaling may require adjustments to both the numerical values

and weighting adjusting the importance of the weather parameters (de Freitas *et al.,* 2008; Ma *et al.,* 2021a). Reweighting may be necessary if the climatic conditions of the location under consideration differ significantly from the region or country for which the index was originally developed or if the new index considers the overriding effects of extreme weather events (Scott *et al.,* 2016a; Ma *et al.,* 2020). The concept of rescaling and reweighting weather components based on existing indices is a complex process that requires the use of statistical and mathematical techniques (Amelung and Viner, 2006; de Freitas *et al.,* 2004, 2008). Researchers may use regression analysis or other statistical methods to identify the weather parameters that are most relevant to the location under consideration (Kovács and Unger, 2014; Dubois *et al.,* 2016; Matthews *et al.,* 2021). For many biometeorological indices, data availability challenges are ones that cannot be adapted to resulting in the inapplicability and unsuitability of that index in locations outside of where it was created (Fitchett *et al.,* 2016; Alonso-Pérez *et al.,* 2021). Although, the CCI utilized camping occupancy data from campsites in the United States and resolved their data availability challenges by calculating sunshine hours using incoming solar radiation values (Ma *et al.,* 2020), other locations may not be equipped with such climatic information. The subjective perceptions of tourists' is crucial to validate the index but the empirical evidence that the index is based on needs to be apparent (Olya and Alipour, 2015b; Mushawemhuka *et al.,* 2020).

The development of tourism climate indices are based on the identified limitations and strengths of previous indices along with the intercomparisons of their output scores (Scott *et al.,* 2016a; Ma *et al.,* 2020; Rutty *et al.,* 2020). The IPCC recognises the valuable information these indices have contributed to the tourism-climate literature but the differing methodology, limitations and data sources are important to note (Marengo *et al.,* 2010; Scott

et al., 2023). The IPCC examines the output scores of various tourism climate indices in order to pinpoint their advantages and disadvantages as well as to increase their dependability and accuracy (Zhao, 2011; Jayasankar *et al.,* 2015; Wang and Sun, 2023). The first technique used in output score comparisons is the examination of tourism climate index methodologies, including the analysis of weather parameters, allowing for the identification of the most useful climatic indicators (Perch-Nielsen, 2010). The second is examining the data sources or products used, to analysis the validity and reliability of the data used i.e. comparing the difference between climatic data from weather stations and data from climate models (Scott *et al.,* 2015; Alexander *et al.,* 2020). Lastly, the IPCC compares the limitations by analysing the assumptions made by each index and the uncertainties associated with their calculations (Perch-Nielsen, 2010). Some indices take into account the possibility that travellers may alter their travel plans in response to the weather, others make the assumption that visitors have the same preferences and behaviours regardless of the weather (Fitchett and Hoogendoorn, 2019; Muñoz *et al.,* 2023). The intercomparisons of tourism climate indices are important but are administered to justify the replacement of older tourism climate indices with newer ones rather than examining the causes of the discrepancies and the information each index conveys (Saarinen *et al*., 2022).

2.7. Conclusion

In conclusion, this literature review highlights the intersection of climate change, thermal comfort, and tourism. Research highlights the impact of thermal comfort on human health and well-being across diverse settings, emphasizing its subjectivity and the changing climatic needs of individuals (Hughes *et al.,* 2019; Kawakubo *et al.,* 2023). Evening thermal comfort, in particular, has been identified as essential for ensuring high sleep quality, which influences

the climatic suitability of tourist destinations (Minor *et al.,* 2022; Weeding *et al.,* 2024). The review identifies a gap in knowledge—the need for rigorous comparison and validation of new and old indices to address inconsistencies and enhance their reliability. The assumption that air conditioning is universally available, as embedded in current indices, requires critical examination (van Hoof *et al.,* 2010). This gap suggests a need for studies to validate the practical applicability of these indices in various global contexts, particularly in assessing the necessity of evening thermal comfort for tourists in reality.

CHAPTER 3: STUDY SITE

3.1. Introduction

This study aims to assess the validity of the HCI_{Urban} with consideration of the elimination of night-time comfort in this index.. The focus of this project will be on the six European cities that Scott *et al.* (2016a) used to develop the HCI_{Urban} and subsequently applied this index to, namely Barcelona, Istanbul, Rome, London, Paris and Stockholm (Figure 3.1).

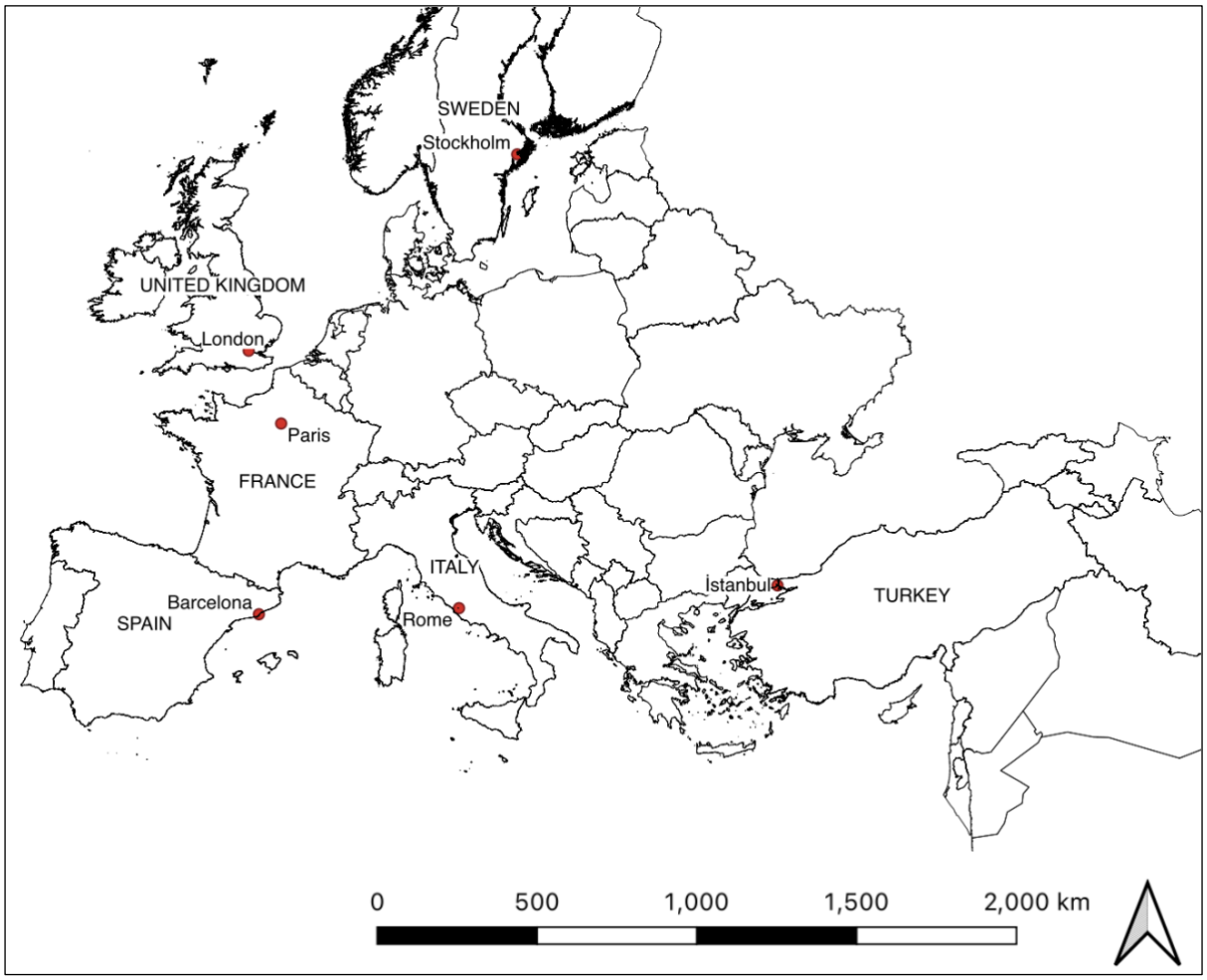


Figure 3.1: Map of the six European cities used by Scott *et al.* 2016 in developing the HCI_{Urban}, and for which this study is focused.

These six cities were deemed as one of the most popular destinations by the researchers when selecting the study locations (Scott *et al.,* 2016a). Europe accounts for more than half of international travel and is an important global tourism destination (Scott *et al.,* 2016a; Steiger *et al.,* 2023). The urban tourism sector is the prominent drawcard across these six locations, each city offers unique and varied tourist attractions. Additionally, five of these urban cities are ranked in the top 10 most visited cities in Europe. The six cities span a range of climate zones (Table 3.1). This chapter will discuss the overall climate as well as the tourism in each city.

Table 3.1: Information on the six European cities.

Location	*Koppen Geiger climate classification*	*Mean temperature (°C) Jun' 22 – Jum'23*	*Annual precipitation (mm) Jun '22 – Jun '23*	*Tourism ranking in 2022*	*Urban Heat Island Intensity scores(°C)*
Rome	Csa	19.6	672	5	-0.1 – 3.4
Paris	Cfb	14.1	612	2	1.46 – 3.8
Barcelona	Csa	19.8	296.6	5	2.0 – 7.0
Istanbul	Csa	18.2	720	3	6.0 – 8.0
London	Cfb	13.8	655.2	1	8.0
Stockholm	Cfb	8.5	521.2	11	2.0

3.2. Barcelona

With a population of over 1.6 million and a metropolitan area of 3.2 million, Barcelona (41°23'24.7"N, 2°9'14.4"E; Figure 3.2) is the most dense Mediterranean coastal city in the northeastern regions of Spain (IDESCAT, 2019). The morphology is defined by the Mediterranean Sea on the southeast boundary and the mountain range known as "Serra de

Collserola,". The valleys of the rivers Llobregat and Besós border the metropolitan area to the southwest and northeast, respectively (Salvati *et al.,* 2017).



Figure 3.2: Map of Barcelona, Spain.

The city is classified by Köppen-Geiger as Csa, which is characterised by a dry summer mediterranean climate (Kottek *et al.* 2006; Table 3.1). Weather is dry, with relatively warm summers, wet and mild winters, and long periods of sunshine all year-round (Rodríguez-Algeciras and Matzarakis, 2016; Rodríguez-Algeciras *et al.*, 2020). Mean annual temperatures are approximately 19.8°C (Table 3.1). The warmest months are July and August with maximum temperatures ranging from 22-29°C and minimum temperatures from 22-23°C. The coldest months are January and February with an average maximum temperature of 15°C and an

average minimum temperature of 9°C. The average relative humidity is 62.5% per year (Rodríguez-Algeciras *et al.,* 2020) and the accumulated rainfall for the study period is 296.6mm (Table 3.1). Barcelona has a moderate Urban Heat Island (UHI) intensity of 2°C and a maximum of 7°C, suggesting that the city experiences some urban heat effects, though less pronounced than in larger metropolitan areas (Martin-Vide and Moreno-Garcia, 2020; Table 3.1).

One of the most popular facets of the Spanish economy is the tourism industry (Gómez-Martín, 2006). More than 50 million tourists visited Spain per year between 2012 and 2013 (Rodríguez-Algeciras *et al.,* 2020). In 2014, the number of visits increased to 65 million, of which 86.5% were for the purpose of leisure and vacation (FRONTUR, 2015). Furthermore, Catalonia received more than 16 million foreign visitors in 2014 (FRONTUR 2015; Rodríguez-Algeciras *et al.,* 2018). The top 5 destinations in terms of overall visitor numbers were reported by the UNWTO: France (86.9 million), Spain (81.8 million), USA (75.9 million), China (60.7 million), and Italy (58.3 million; UNWTO, 2018). Barcelona has a wide range of tourism sectors including business (Hughes, 2018), cultural and leisure tourism that attract more than 30 million visitors a year (Rico *et al.,* 2019). Eurostat Tourism Statistics reports that in 2019 Spain was the most popular European Union (EU) destination for international tourists, with 299 million nights spent in accommodation establishments, 22% of the EU's total (EUROSTAT, 2021; Elorrieta *et al.,* 2022). The most visited cities in Spain are Barcelona and Madrid, with 21,361,391 and 20,850,283 overnight visits, respectively (Elorrieta *et al.,* 2022).

3.3. Stockholm

Stockholm County is the largest metropolitan region in Sweden (Pan *et al.,* 2020). It includes the Swedish capital Stockholm, which is located on islands where the western coast of the Baltic Sea meets Lake Mälaren (Markakis *et al.,* 2016). Stockholm is located in southeastern Sweden (Figure 3.3) with a population of 1.4 million people. Stockholm County is located in the boreonemoral mixed-forest biome (Elmhagen *et al*., 2015) and its landscape includes urban areas (approximately 35% of total regional area), urban green spaces (7%), open water (both lakes and sea, 23%), arable land (7%) and mixed coniferous/deciduous forests (4%), and coniferous (24%; Goldenberg *et al.,* 2017; Pan *et al.,* 2020). In 2018, the population of Stockholm County was 2,315,612, representing 22.3% of Sweden's total population (Pan *et al.*, 2020).

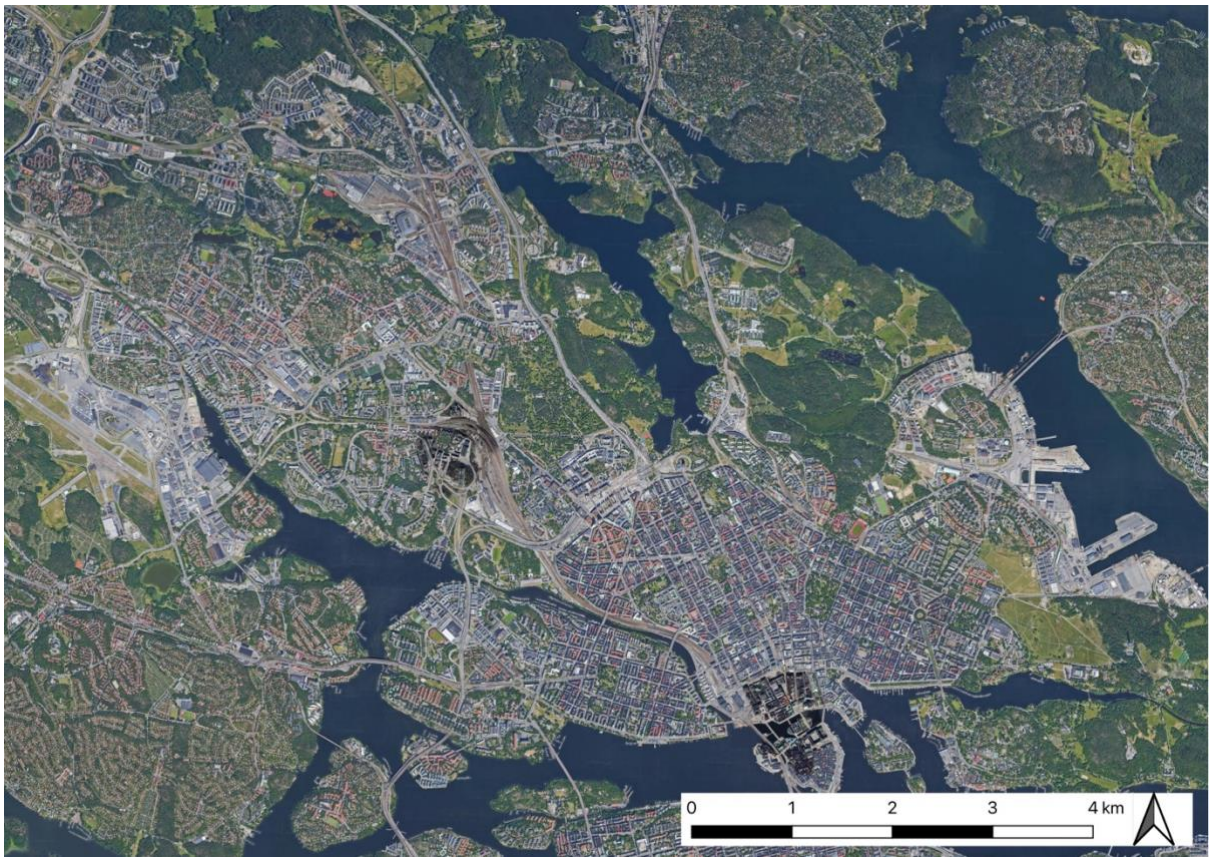


Figure 3.3: Map of Stockholm, Sweden.

Stockholm has an annual mean temperature of 8.5°C, 521.2mm annual precipitation (Table 3.1) and a humid climate (Rocha *et al.,* 2020). The warmest month is July, with an average temperature of 17.2°C and the coldest month is February, with an average temperature of −3.0°C (Rocha and Holzkämper, 2023). Typically, precipitation is highest during July and August, and snowfall occurs mainly from December to March (Rocha and Holzkämper, 2023). The UHI intensity was found to be 2°C in the morning (Gustavsson *et al.,* 2001).

Sweden had 18.8 million foreign tourist arrivals in 2013. In 2009, the tourism industry produced an annual turnover of 252 billion kr (€26.29 billion; Svensk Turism AB, 2010) and generated around 160,000 full-time jobs (Gössling *et al.,* 2016). The Swedish tourism aimed to produce a turnover of c. €46 billion and an additional 100,000 person years of employment by 2020 (Svensk Turism AB, 2010; Gössling *et al.,* 2016). The most popular months for Sweden are the summer months of June, July and August, with 43% of tourists visiting in those times (IBIS, 2014). Stockholm is the most populous region in Sweden and has emerged as a second home tourism city (Marjavaara, 2007), which also provides musical tourism (Bolderman and Reijnders, 2017).

3.4. London

London, the capital city of the United Kingdom (UK), is situated in southeastern England along the River Thames (Figure 3.4). It is one of the largest cities in Europe and has a population of over 8.2 million. It is the largest metropolis in the UK with a city size of 1,572 km^2.



Figure 3.4: Map of London, UK.

London has a temperate oceanic/subtropical highland climate (Table 3.1), experiencing warm summers without a dry season. The warmest month is July with an average temperature of 19°C and the coldest month is January with a 5°C average temperature (Table 3.1). The August 2003 heatwave recorded a maximum temperature of 38.5°C and resulted in 2,091 deaths during this period (Johnson *et al.,* 2005). Recent studies in the UK exhibit a maximum UHI intensity in summer of 8 °C (Levermore *et al.,* 2018; Table 3.1).

The rise of theatre in London as a tourist attraction (Hughes, 1998), along with the growth of sporting, business, historical, and leisure tourism (Maxim, 2019), has contributed to the tourism sector accounting for 12% of the city's GDP (Maitland and Newman, 2009). Nearly

60% of the approximately 17 million foreign visitors to the capital each year are return tourists (Greater London Authority (GLA) and Complexity Theory in Cities (CTC), 2015). The total number of domestic tourists visiting the capital is estimated at 12 million annually, with day visitors accounting for an estimated 274 million visits each year (London and Partners, 2015). London was ranked the world's the third most popular travel destination in 2017 (Robino, 2019). More than 25% of all tourism-related spending in the country takes place in London (Office for National Statistics, 2014), making this industry the second most significant one in the city after the financial services industry (Maitland and Newman, 2009).

3.5. Istanbul

Istanbul spans Asia and Europe, with this study focusing only on the European portion of the city. The coastal city of Istanbul (28° 57’ 53’’E and 41° 01’ 07’’N; Figure 3.5), the biggest city in Turkey, is located in the northwest of the country (Toros *et al.,* 2017). It is also one of the most populous cities in the world. Istanbul borders the Black Sea to the north and the Marmara Sea to the south. The city has a population of 16 million and produces 30.5% of the country’s total GDP (US$857.57 billion; Yazar and York, 2023).



Figure 3.5: Map of Istanbul, Turkey.

The climate in Istanbul is a combination of Mediterranean and Black Sea types with cold and wet winters; and hot and humid summers (Ünal *et al.,* 2020). The southern parts of the city are warmer than other areas and have more of a Mediterranean climate (Ögce and Erdem Kaya, 2024). Istanbul also has more rain and cooler temperatures than other southern Mediterranean regions because of the northerly winds (Ögce and Erdem Kaya, 2024). The Bosphorus that runs through the city, the Black Sea, and the Marmara all influence the climate experienced (Ögce and Erdem Kaya, 2024). The estimated UHI of 8°C during the daytime and 6°C for night-time was based on land surface temperature (LST) at the most urbanized locations of Istanbul (Ünal *et al.,* 2020; Table 3.1).

Istanbul is widely known as a culinary, cultural (Seyitoğlu**,** 2021), medical and historical destination (Safaei *et al.,* 2020). Istanbul receives 33.03% of the total number of tourists coming to all of Turkey per year, i.e. 8 to 9 million tourists per annum (European Commission, 2019). There are 66 historic schools, 64 historic mosques, 63 museums, 17 palaces, 49 historic churches and one historic synagogue in Istanbul (Safaei *et al.,* 2020). This city hosted 128 international meetings in 2012 and 146 in 2013, ranking 8th in convention delegate statistics according to the International Congress and Convention Association (Lowry, 2017).

3.6. Paris

Paris is the capital city of France and is located in the administrative region of Île-de-France, in north-central, along the Seine River (Figure 3.6). The city is the most populous city in France with a population of around 2.2 million inhabitants in the municipality and up to 12 million in its urban area. Paris is also the fourth largest city in the EU.

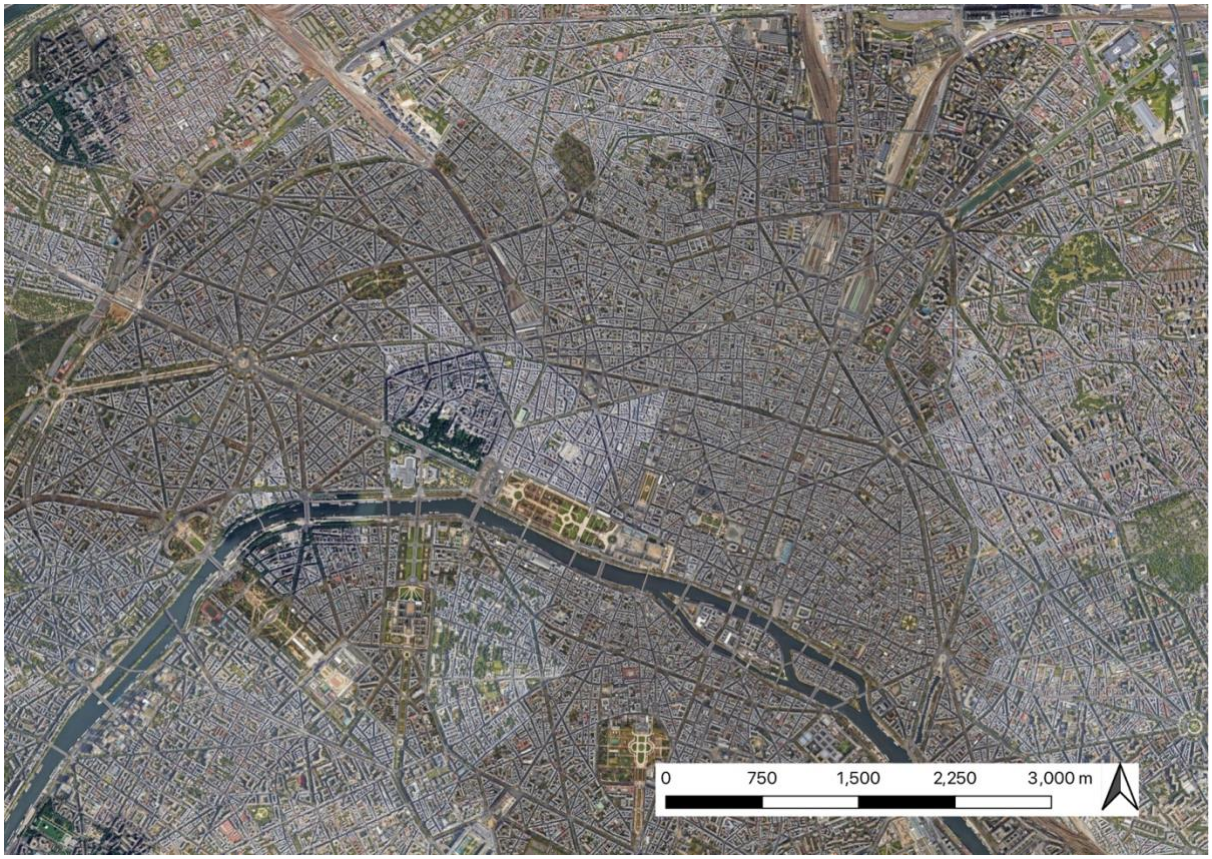


Figure 3.6: Map of Paris, France.

Paris has a oceanic/subtropical temperate climate with warm summers and cool winters, without a dry season (Table 3.1). The hottest month is July, with an average temperature of 20°C and the coldest moth is experienced in January with an average temperature of 5°C. Paris experienced a heatwave in August 2003, with average maximum temperatures of 38.1°C and average minimum temperatures of 23.4°C at night (Canoui-Poitrine *et al.,* 2005). The hot temperatures caused nearly 15,000 deaths in France (Fouillet *et al.*, 2006). In July 2019, another heatwave occurred in Europe with a temperature of 42.6°C reached on 25 July in Paris (Ma *et al.,* 2024). The UHI intensity of the city exhibited 1.46°C during the daytime and 2.2°C - 3.8°C during night-time (Pal *et al.,* 2012; Table 3.1).

With several tourist destinations and a global tourism sector ranking of first, France welcomed about 90 million tourists in 2017 (Vu *et al.,* 2020). In 2016, visitors in France spent an average of US$13 billion (Statista, 2024). There are several tourist attractions in Paris, including monuments, museums, and festivals. The city is also well-known for being a romantic destination, a city of fine art and culture, and a destination for luxury shopping. Paris had 14.3 million nights spent in accommodation establishments in 2021 (Eurostat, 2021).

3.7. Rome

Rome, the capital of Italy, is the most populous city in Italy and the third in the EU with a population of 2.83 million (Italian National Institute of Statistics, 2020) and more than 4.36 million people in the metropolitan area (Zinzi *et al.,* 2018). It is located in the central-western part of the Italian Peninsula (Figure 3.7). It borders the anti-Apennine group of the Monti della Tolfa and Monti Sabatini to the northwest, the Lazio sub-Apennines to the east, the Alban Hills to the southeast and the Tyrrhenian Sea to the west (Cecilia *et al.,* 2023).



Figure 3.7: Map of Rome, Italy.

Rome has a Mediterranean climate (Csa; Table 3.1) with mild winters and warm to hot summers and maximum temperatures during summer can exceed 32°C (Cecilia *et al.,* 2023). During summer, the WSW sea breeze reduces the daytime temperatures resulting in sunny and stable days. The effects of the sea/land breeze, are more prominent in the western regions of Rome, resulting in a temperature difference of up to 3°C between the eastern and western parts of the city (Di Bernadino *et al.,* 2021; Cecilia *et al.,* 2023). Rome exhibits a relatively low UHI intensity, indicating moderate variation in heat retention within the urban area (Table 3.1). The UHI intensity exhibits a minimum of − 0.1°C in the morning and reaches a maximum of 3.4°C at midnight (Cecilia *et al.,* 2023; Table 3.1).

Rome is the location of the Vatican and other historic architecture that has been around for more than 3000 years (Mrozek, 2023). This city has a diverse tourism sector that offers cultural, religious, historical, coastal, heritage and culinary tourist attractions (Valeri, 2015; Cocco and Brogna, 2018; Kim and Kim, 2019). In 2022, 10.5 million visitors stayed in Italian campgrounds and vacation villages, a 11% rise from the year before (Mrozek, 2023). This translated to 73 million nights, with 75% of the guests primarily from Germany, Austria, Switzerland, the Netherlands, and Denmark, staying an average of seven nights (Mrozek, 2023). Approximately 40 million foreign visitors come to Italy each year.

3.8. Conclusion

While Scott *et al*. (2016a) pre-selected their study locations to facilitate comparative analysis, these sites exhibit a diverse array of climatic and touristic traits. In contrast, African destinations like Zimbabwe and Namibia are heavily dependent on nature-based activities and offer a different tourism experience,. This variation presents unique challenges for the application of standard tourism climate indices, which may not account for the extreme conditions or the specific climatic preferences of tourists engaging in nature-based activities. Moreover, the reliance on natural environments for tourism in African developing countries necessitates a consideration of seasonal weather patterns, which can affect accessibility and the viability of touristic activities. The application of $HCI:_{Urban}$ needs careful adaptation to accurately reflect the needs and expectations of tourists in these diverse climatic and touristic environments.

CHAPTER 4: METHODS

4.1. Introduction

The methodology for this study is grounded in netnographic tourism research, which is defined as a technique for performing ethnographic research online through the use of social media platforms (Abrahams *et al.,* 2022). The introduction of Web 2.0 has allowed travellers to interact and share their opinions on a global scale thus promoting tourism by providing credible recommendations (Amaral *et al.*, 2014; Fitchett and Hoogendoorn, 2018). The methods were developed off of web-based profile analytics that have been previous used (Prinsloo and Fitchett, 2023). Due to the successful application of the analysis of *TripAdvisor* review for tourism and climate change research in the southern African context, this study will follow the approach outlined by Fitchett and Hoogendoorn (2018, 2019) to measure visitor climatic sensitivity in the six study locations. The study considers *TripAdvisor* reviews posted over the period June 2022 – June 2023. Furthermore, the hotel accommodation establishments considered for air conditioning prevalence were taken from the *Booking.com* website.

4.2. Data collection

The first stage of data collection involved identifying the prevalence of air conditioning in hotel accommodation establishments in each of the six cities. All hotel accommodation establishment listings in each of the six cities were reviewed on *Booking.com* (Figure 4.1). For each, the name of the hotel accommodation establishment, location in the city, and the presence, partial presence or absence of air conditioning was noted.

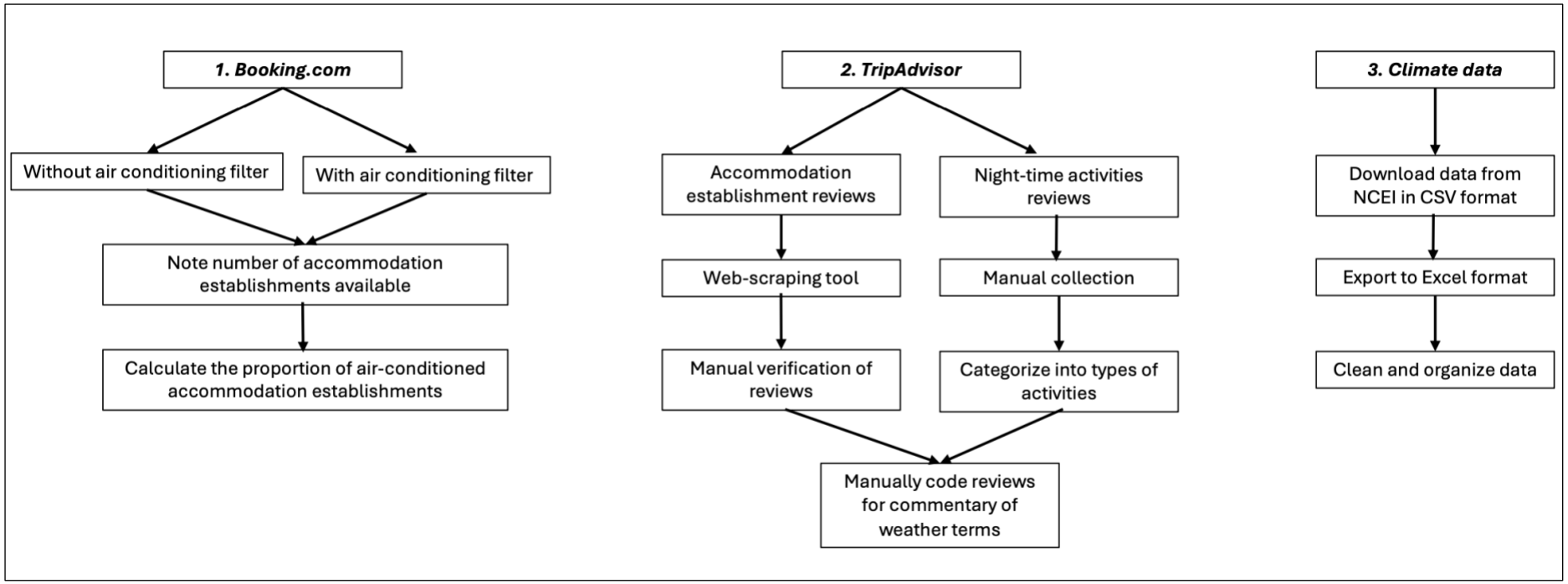


Figure 4.1: Data collection process followed.

The current rating of each hotel accommodation establishment on *Booking.com* was also recorded (Table 4.1). For each of the six locations, *TripAdvisor* reviews were consulted, with particular interest in comments relating to the functioning of air conditioning in hotel accommodation establishments, thermal comfort during the night, and any mention of night-time activities outside of the hotel. The hotel accommodation establishments examined included a sample of the hotel accommodation establishments listed on *Booking.com* as offering air conditioning, spanning a range of review scores on *Booking.com* for each of the six cities (Table 4.1). A minimum of twenty hotel accommodation establishments per location was considered for the *TripAdvsior* reviews.

Table 4.1: Total number of hotel accommodation establishments reviewed on the *Booking.com* website and the review scores

Location	*Number of hotel accommodation establishments reviewed on Booking.com*	*Range of review scores*
Barcelona	1,242	3.0 – 10
Stockholm	556	1.0 – 10
London	2,006	1.0 – 10
Istanbul	1,618	4.0 – 10
Paris	1,525	1.0 – 10
Rome	1,306	3.0 – 10

The map feature was used on *Booking.com* and on *TripAdvisor* to ensure that only hotel accommodation establishments and night-time attractions on the European side of Istanbul were considered. To minimize potential bias from local travellers, foreign language reviews

were included and were translated into English. However, the majority of reviews were originally written in English.

A web-scraping tool was utilized to extract all the comments for hotel accommodation establishments from *TripAdvisor* for the study period (Figure 4.1). The *Booking.com* platform is largely utilised as a booking website for hotel accommodation establishments as it has more comprehensive information on the amenities provided and available facilities. *Booking.com* also allows guests to post reviews but *TripAdvisor* is widely regarded as the world's leading platform for travel-related information and advice, representing the largest global network of tourists. The web-scraping process begins with the identification of the hotel accommodation establishments whose reviews are to be analysed and the date of stay (i.e. June 2022 – June 2023). These hotel accommodation establishments are selected based on locations relevant to the study – i.e. Barcelona, Stockholm, London, Istanbul, Paris and Rome. The URLs of these hotel accommodation establishments' *TripAdvisor* pages are gathered manually. This collection of URLs serves as the entry point for the automated scraping process. The technical setup of the scraper involves the use of Python programming language, supplemented by key libraries such as Requests and Beautiful Soup. Requests are utilized to send HTTP requests to the hotel accommodation establishment URLs, retrieving the HTML content of the pages. Beautiful Soup is then employed to parse this HTML content, transforming it into a navigable tree structure that allows for efficient data extraction. To automate the scraping process, the script includes logic to handle pagination on *TripAdvisor*. It detects and follows the 'next page' links and continues to scrape reviews until it reaches the predefined limit of at least 1000 reviews per hotel or exhausts all available pages. During the development phase, the HTML structure of the *TripAdvisor* review sections is manually

inspected using browser developer tools. This inspection is crucial as it helps identify the HTML tags, classes, and IDs that contain the necessary review information such as text, date of stay and hotel accommodation establishment name. Data extraction is executed through loops in the script that parse each page's HTML, extracting the needed elements identified previously. This data is initially stored in CSV format. Post-extraction, a manual verification of the scraped data was performed by cross-checking a random selection of reviews against the actual reviews displayed on *TripAdvisor* to ensure the accuracy and reliability of the scraping tool. This verification helps in confirming that the tool functions correctly and that the data collected is both accurate and complete. Based on the findings from the verification step, necessary refinements to the scarping script was performed to address any discrepancies, bugs, or errors identified. The final extracted data was converted and stored as Excel files. Furthermore, the legal considerations and copyright restraints were followed throughout this process. The data captured only included the date of stay due to time constraints as the web-scraping tool needs sufficient time to run. The reviews were manually read and coded to determine whether climate, thermal comfort, air conditioning and night-time activities outside of the hotel rooms were mentioned. Finally, quotes that mentioned these components were captured and utilised.

In addition to the listing of hotel accommodation establishments, *TripAdvisor* has recently introduced listings of touristic attractions and activities. A list of a minimum of twenty night-time activities reviews on *TripAdvisor* were manually captured for each of the six cities (Figure 4.1). These reviews of night-time activities were manually read and coded for any mention of weather, night-time thermal comfort and air conditioning. Furthermore, a categorisation of

types of night-time activities was performed on all the activities listed on *TripAdvisor.* Relevant quotes were extracted together with the date of visit and the name of the activity.

The night-time activities obtained from *TripAdvisor* were used in conjunction with activities listed on *Viator.com* to show the distribution of nocturnal activities (Figure 4.1). Climate data was sourced for the study locations, except for London, Istanbul and Rome due to insufficient data, from the *National Centers for Environmental Information* (NCEI) website for the period 1992-2022. The average minimum, maximum, and annual temperature data was downloaded in CSV format from the website. To handle any missing data, the values before and after the missing data points were averaged to create a continuous dataset. An explorative analysis of a range of air temperatures was performed to determine the thresholds used. The prevalence of hot and cold temperatures overtime was then determined by observing the number of months that surpassed the exploratory thresholds. (Figure 4.1).

4.3. Data Analysis

The first stage of data analysis involved capturing the number of hotel accommodation establishments in each of the six cities and calculating the proportion of hotel accommodation establishments that offer air conditioning. These were calculated as percentages from the *Booking.com* database.

The analysis of the *TripAdvisor* reviews first involved the calculation of the proportion of reviews that specifically made reference to or mentioned climate (Fitchett and Hoogendoorn, 2018), night-time thermal comfort, air conditioning units and night-time activities taking place outside of the hotel room in the accommodation establishment. For those reviews that

mentioned weather and thermal comfort in the hotel accommodation establishment, thematic analysis was conducted on the collection of extracted quotes to identify commonalities in complaints. Content analysis was employed to further classify whether the concerns relate to hot or cold thermal discomfort. The data was further explored to identify whether there are any patterns that emerged relating to the time of the year of the tourist's visit (Fitchett *et al.,* 2020).

The data from the reviews of hotel accommodation establishments was analysed for mention of activities outside of these establishments at night-time. The proportion of these mentions were calculated. Any mentions of such night-time activities that reference thermal comfort at night outside of the hotel accommodation establishments was explored thematically. *TripAdvisor* reviews from night-time activities were explored through content analysis, following the same approach adopted for the hotel accommodation establishments, recording the proportion of mentions of thermal comfort, whether hot or cold conditions are mentioned, and thematically analysing the quoted material. Similarly, mentions of weather and air conditioning were also analysed. Again, patterns in the timing of these posts were explored.

The categories from the night-time activities were used to create a map for each city to display the night-time activities that occur indoors, outdoors or a combination of both. The coordinates of the activities were provided by the *TripAdvisor* and *Viator.com* websites. Similarly, the climate data was used to create graphs to depict climatic variability and temperature thresholds overtime.

4.4. Ethical Considerations

The data used in this study is in the public domain and did not include the users' screen names, to ensure the protection of individual posters' anonymity. Moreover, data on hotel air conditioning listings was aggregated. An application was made to the Human Non-Medical Ethics board of the University of the Witwatersrand for an ethics waiver in this regard. The web-scraping tool adhered to all copyright considerations. The use of *TripAdvisor* data by third parties remains quite a 'grey' area but due to the content-rich nature, it is critical forthis study.

4.5. Conclusion

The methodology adopted for this study was based on prior research that used netnographic tourism research (Fitchett and Hoogendoorn, 2018, 2019; Abrahams *et al.,* 2022; Prinsloo and Fitchett, 2023). The extraction of *Tripadvisor* reviews for both hotel accommodation establishments and nocturnal activities allowed for the analysis of tourist's preferences and experiences without in-person interviews and from people around the world. The reviews also demonstrated the experiences tourists had with air conditioning units that are deemed "almost universal" by Scott *et al.* (2016a). The exploration of hotel accommodation establishments on *Booking.com* allowed for the analysis of air conditioning proportions for all six locations. Furthermore, the collection climate data allowed for a detailed exploration of the relationship between perceptions of thermal comfort through the *TripAdvisor* reviews and weather.

CHAPTER 5: RESULTS

5.1. Introduction

Over the past decades, tourism climatology has been largely studied with researchers considering the opinions and overall satisfaction of tourists. A large part of the tourist experience is the accommodation establishment they choose to book and the tourist activities they partake in. This chapter presents an analysis of air conditioning availability in hotel accommodation establishments across Istanbul, Barcelona, Rome, Stockholm, London, and Paris. Using *Booking.com* listings, this study examines variations in air-conditioned hotel accommodation establishments, using both the filter on the website and manual verification methods. *TripAdvisor* comments are analysed to investigate tourists' thoughts on the overall weather conditions, thermal comfort and air conditioning within the hotel accommodation establishments. Night-time activities are also examined through *TripAdvisor* comments, assessing how weather and thermal comfort affect tourists outside of the hotel accommodation establishments. Furthermore, this study also examines climate data for the respective locations, over a 30 year period.

5.2. Evaluating the prevalence of air conditioning in hotel accommodation establishments

This section explores the availability of air conditioning across hotel accommodation establishments within the six European cities through an analysis of their listings on *Booking.com*. This investigation aims to critique the assumption that "in the 30 years since the TCI was developed, air conditioning has become almost universal in tourist accommodations in developed countries and major tourism destinations in developing countries" (Scott *et al.*,

2016a: pp 16), through determining whether air conditioning is indeed ubiquitous in the selected study cities on which the HCI_{Urban} was built.

The analysis begins with the recording of the total number of hotel accommodation establishments in each city listed on *Booking.com*, as well the number presented alongside the air conditioning filter on the site without applying it. Barcelona has the largest proportion of hotel accommodation establishments that are listed as having air conditioning (93.1%; n=1464) and the second smallest number of hotel accommodation establishments listed on *Booking.com* (Table 5.1). Conversely, the smallest number of air-conditioned hotel accommodation establishments recorded is for Stockholm (19.9%; n=473; Table 5.1). The data for London reveals that this city has the second largest number of hotel accommodation establishments viewed (23.4%; n=4571) but revealed a small proportion of air-conditioned hotel accommodation establishments (Table 5.1). Istanbul has the third largest proportion of air-conditioned hotel accommodation establishments (89.5%; n=4546; Table 5.1). Paris has the fourth highest percentage of air-conditioned hotel accommodation establishments (43.8%; n=3599), as well as the fourth largest total number of hotel accommodation establishments viewed (Table 5.1). Lastly, Rome has the largest number of overall hotel accommodation establishments viewed (n=5762) and hotel accommodation establishments fitted with air conditioning listed on the website (n=5309) but has the second largest proportion of air-conditioned hotel accommodation establishments (Table 5.1).

Table 5.1: The total number of hotel accommodation establishments, and the number and percentage of hotel accommodation establishments listed under the air conditioning filter on *Booking.com*.

Location	*Total number of hotel accommodation establishments*	*Air conditioning filter*	*Percentage of listings with air conditioning*
Stockholm	473	94	19.9
London	4571	1071	23.4
Istanbul	4546	4069	89.5
Paris	3599	1576	43.8
Barcelona	1464	1363	93.1
Rome	5762	5309	92.1

Stockholm, Paris and London have the smallest proportion of hotel accommodation establishments listed as offering air conditioning, not surpassing 50% of the total (Table 5.1). However, over 89% of the hotel accommodation establishments listed on *Booking.com* for Istanbul, Barcelona, and Rome are categorised as offering air conditioning (Table 5.1).

Secondly, a manual verification of the full listing for all of the hotel accommodation establishments listed for each city is performed to determine the actual proportion of hotel accommodation establishments categorised as offering air conditioning without the air conditioning filter. The viewing of each hotel accommodation establishment available on the website was performed to verify the presence or absence of air conditioning units. The manual verification indicates a larger proportion of air conditioning availability than initially listed, especially in London and Paris, with a percentage difference of 32.6% and 27.5% respectively (Table 5.2). For Stockholm, the proportion of air-conditioned hotel accommodation establishments stated under the filter is 19.9% and through manual verification the proportion increases to 28.8% (Table 5.1 and 5.2). The proportions of air-

conditioned hotel accommodation establishments displayed for Istanbul, Barcelona and Rome (89.5%, 93.1% and 92.1%; Table 5.1) are similar to the proportions revealed in the manual verification – 98.7%, 96.6% and 98.9%, respectively (Table 5.2). These three locations have a small proportional difference, which reveals that the number of hotel accommodation establishments represented alongside the air conditioning filter is similar to those manually verified (Table 5.2).

Table 5.2: Manual verification of total hotel accommodation establishments listed and the number of hotel accommodation establishments listed as offering air conditioning on *Booking.com*.

Location	*Number of hotel accommodation establishments viewed*	*Number of air-conditioned hotel accommodation establishments*	*Percentage*	*Percentage difference*
Stockholm	473	136	28.8	8.9
London	984	552	56.0	32.6
Istanbul	867	856	98.7	9.2
Paris	800	570	71.3	27.5
Barcelona	712	688	96.6	3.5
Rome	750	742	98.9	6.8

This manual verification prompted the verification of the hotel accommodation establishments considered to have air conditioning to confirm the validity of information for tourism use. It is important to note that the number of hotel accommodation establishments that were able to be viewed were limited and duplicated on the website thus producing numbers that were well below the overall number displayed by the website (Table 5.1 and 5.2).

A manual verification process was also implemented to assess the accuracy of the air conditioning filter when it is selected on the booking platform and whether the hotel accommodation establishments that appear when this filter is applied actually have air conditioning listed on their page. The filter was applied to four out of the six cities – Stockholm, London, Istanbul and Paris – as the website was not functional for the other two cities at the time. However, since more than half of the cities were successfully verified, accurate conclusions could still be drawn from the four cities that were analysed. The number of hotel accommodation establishments viewed for Stockholm is comparatively smaller to those viewed for the other three cities (n=83; Table 3). London has the largest number of viewed hotel accommodation establishments and the second largest proportion of air-conditioned hotel accommodation establishments (96.5%; n=1020; Table 3). Istanbul followed with the second largest viewed hotel accommodation establishments and the largest proportion of air-conditioned hotel accommodation establishments (99.6%; n=751; Table 3). Lastly, Paris has the second smallest number of air-conditioned hotel accommodation establishments viewed but the second largest proportion of air-conditioned hotel accommodation establishments (99.0%; n=725; Table 3).

Table 5.3: Manual verification of hotel accommodation establishments under the air conditioning filter and the number of hotel accommodation establishments verified to have air conditioning units as an amenity.

Location	*Number of hotel accommodation establishments viewed*	*Number of air-conditioned hotel accommodation establishments*	*Percentage*
Stockholm	83	80	96.4
London	1020	984	96.5
Istanbul	751	748	99.6
Paris	725	718	99.0

This filter proved to be more accurate and had small margins of error for the four cities, with all the cities demonstrating more than 95% of the hotel accommodation establishments as offering air conditioning (Table 5.3). This step was important in investigating whether this filter on *Booking.com* is accurate and dependable. The total number of hotel accommodation establishments alongside the air conditioning filter on the website (Table 5.1) are comparatively larger to the number of hotel accommodation establishments manually verified with the air conditioning filter applied (Table 5.3). For example, the number of hotel accommodation establishments displayed on the website for Istanbul and Paris (n=4069 and 1576; Table 5.1) are larger than when the filter is applied (n=751 and n=725; Table 5.3). However, there is a difference in the number of manually verified air-conditioned hotel accommodation establishments (Table 5.2) and the number of manually verified hotel accommodation establishments when the filter is applied (Table 5.3). For example, the number of verified air-conditioned hotel accommodation establishments for Stockholm and Istanbul (n=136 and n=856; Table 5.2) are comparatively larger than the hotel accommodation establishments verified under the filter (n=80 and n=748; Table 5.3). Conversely, London and

Paris demonstrated larger numbers of hotel accommodation establishments under the filter (n=984 and n=718; Table 5.3) than those manually verified without the filter (n=552 and n=570; Table 5.2).

On the basis of this analysis of the current listing of hotel accommodation establishments listed on *Booking.com* in the six cities for which the HCI_{Urban} was developed, the assertion that air conditioning is almost universal in tourist accommodation establishments is clearly inaccurate. While there are disparities in the availability of air conditioning among hotel accommodation establishments and cities analysed, a very small proportion of hotel accommodation establishments in cities such as London and Stockholm have air conditioning. Nonetheless, a key assumption in the development of the HCI, which led to the exclusion of night-time thermal comfort as a variable computed in the index, is proven to be based on conjecture.

5.3. Investigation of weather, night-time thermal comfort and air conditioning terms mentioned in *TripAdvisor* reviews

While it has been proven that air conditioning is not almost universal in the six cities for which the HCI_{Urban} was developed, it is possible that widespread air conditioning may not be important or necessary in these cities. The findings may suggest that the necessity of air conditioning may be based on more than just climatic conditions, including cultural preferences and the evolving expectations of tourists. This next section explores the comments made by tourists about the thermal comfort or discomfort that they encountered

in the hotel accommodation establishments in each of the six cities, to determine whether the exclusion of night time thermal comfort from the HCI_{Urban} is consistent with tourist experiences.

TripAdvisor reviews are explored, focusing on guest experiences concerning thermal comfort at night and weather conditions throughout the day. The presence and effectiveness of air conditioning, and the variety of night-time activities mentioned outside the hotel rooms is also examined. This will offer an understanding of guest preferences and experiences in the different climatic contexts, and determine whether night time thermal comfort is an important measure of tourist satisfaction of the climate of a destination. The reviews considered were only if the “date of stay” occurred during the time period June 2022-June 2023, with a minimum of 20 hotels and 1000 reviews for each location to allow for effective comparative analysis. The “place of origin’ and “date of review” was omitted from the analysis because the web scraping tool was programmed to prioritize the "date of stay" due to time constraints. Additionally, some tourists did not provide their “place of origin”, which would have resulted in incomplete data.

5.3.1. Trends in hotel reviews

The investigation of the number of hotel reviews per month for the six cities is valuable for identifying a pattern in tourist visitation or the inclination to leave reviews based on their travel experiences. The proportion of reviews for each city is dependent on various factors, such as seasonal travel patterns, events that influence tourist numbers and review-writing behaviours. The minimal fluctuations of the reviews may suggest that the tourism is

complimented by seasonality and that tourists are attracted evenly throughout the year in each of these cities.

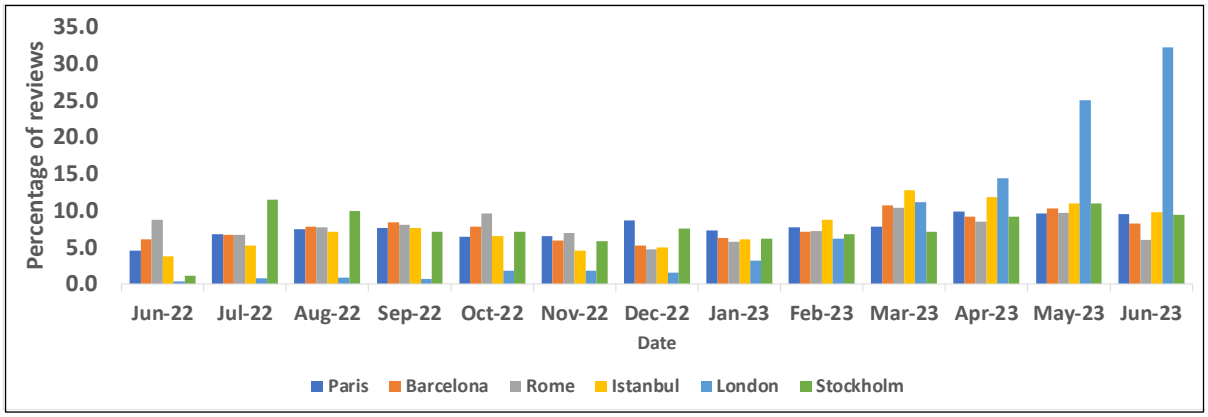


Figure 5.1: Trends in hotel reviews across the six European cities.

Paris has a steady proportion of reviews throughout the study period, with most reviews occurring in December 2022 and April 2023 suggesting a burst of tourist activity in winter and spring (Figure 5.1). The percentage of reviews for Barcelona demonstrate a large amount in March 2023 and May 2023 (Figure 5.1). This may reflect a seasonal preference for the city, with spring and summer being more popular for tourists. Stockholm has a steady percentage of reviews throughout the study period (Figure 5.1). London has a large proportion of reviews in April 2023, May 2023 and June 2023, which may indicate that tourism increased in those months or tourists were more inclined to leave reviews (Figure 5.1). Conversely, there are nearly no reviews in June 2022. The large proportion of reviews for Istanbul in March 2023 could be due to favourable weather during the spring and early summer in Istanbul (Figure 5.1). Rome also has a stable proportion of reviews throughout the time period (Figure 5.1).

5.3.2. Barcelona

The analysis of 1911 reviews reveals minimal concern over weather and night-time thermal comfort, with only 55 mentions (2.9%) of weather conditions and 14 (0.7%) of night-time thermal comfort. This suggests that guests generally found the climate satisfactory during their stay or that these factors did not significantly impact their overall tourist experience. A review states:

> " The bed only had a sheet an not a blanket which is a problem when one person is always warm and the other is always cold. It meent that one could not sleep beacuse it was cold or the other one could not sleep because that person was warm. If there was was a blanket that would not be a problem " (June 2022).

The comments that speak about night-time thermal comfort mostly mention the lack of blankets or make reference to the thickness of the sheets or duvets – a tourist states:

> "They have no blankets, only sheets and thin bedspreads." (May 2023).

There are seven reviews that mention both air conditioning and night-time thermal comfort – one review states:

> "No duvet only a sheet but it's summer so that's fine. Air con effective and not too fierce as some can be." (August 2022).

Conversely, tourists can experience thermal discomfort at night but not want to utilise the air conditioning unit:

> "We don't like using aircon and it was very warm overnight so we wanted to keep the windows open." (October 2022)

The terms 'hot', 'heat' and 'warm' are most commonly used to describe the weather in Barcelona (42.9%), particularly during summer (Figure 5.2). The frequency of weather-related terms peaks in the summer months, with June and August recording the largest number of

climatic mentions at 16 and 18 respectively. Guests expressed a need for cooler periods, as seen in comments like

"Respite from the heat" (August 2022)

and

" The rooftop pool was perfect for the afternoon heat" (August 2022).

Moreover, remarks such as

"We went in November which was still warm enough to use the rooftop area to relax in during the afternoon but it was too cold for the infinity pool " (November 2022) and

"belting rain" (December 2022)

illustrate the variability in weather perceptions. Few mentions of ‘sun’, ‘sunny’, ‘sunlight’, ‘rain’ and ‘winter’ highlight the variability of weather conditions experienced (Figure 5.2). In contrast, larger mentions of 'cold’ and ‘cool' (18.6%) suggest that cooler temperatures were prevalent during the time of visit (Figure 5.2).

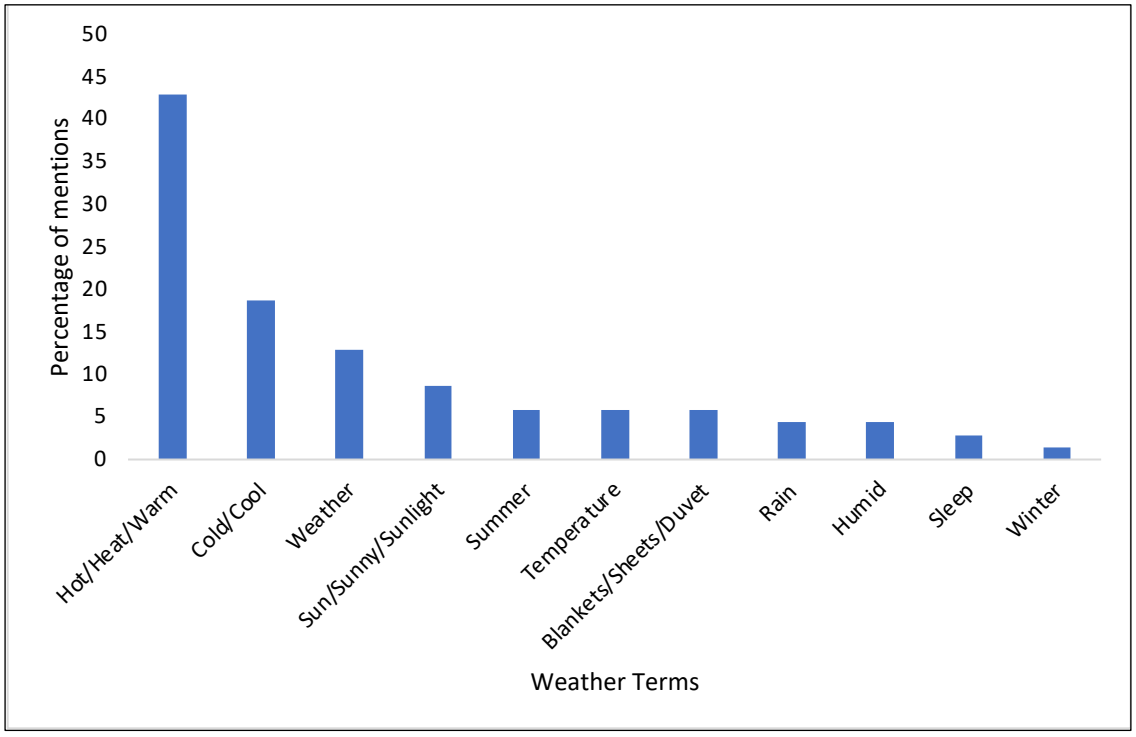


Figure 5.2: Proportion of commentary related to weather mentioned for Barcelona.

Air conditioning is mentioned in 81 reviews (4.2%), indicating a moderate concern among guests. Comments range from

> "the air con was a godsend in the Barcelona heat " (July 2022) to
>
> "we could not get the air con to work but the staff was really quick to come to the rooms to resolve the issue" (February 2023).

The functionality of air conditioning units varied, as noted in comments such as,

> “The air conditioning was pretty weak as well but it cooled the room slightly” (June 2023) and
>
> “perfect AC system, this is a major plus in any European hotel in summer” (June 2022).

Guests also mentioned issues, like

> " My air conditioning wasn’t working at all in my room, whole it was working in my friends rooms," (July 2022) and
>
> "Unfortunately aircon doesn’t seem to be working well but opening the window during winter was effective enough " (December 2022)

This highlights that even where air conditioning is listed on booking websites, it may not be fully operational.

It is also important to recognise that the removal of night time thermal comfort in the HCI_{Urban} based on assumption that hotels have air conditioning is coupled with an assumption that tourists spend their nights entirely in the air-conditioned spaces of the hotel. Several guests included night-time activities in their comments (7.7%; n=147). The guests mostly commented on activities that they could partake in at the hotel, but which may not be in air-conditioned spaces. For instance, several tourists mentioned the ‘rooftop terrace’, ‘rooftop bar’, ‘restaurant’ or their bedroom balconies in the various hotel accommodation establishments.

There was only one review that mentioned air conditioning outside of the hotel room, the guest writes:

> "The small downsides for American travellers were little air-conditioning in the ground floor" (August 2022).

This comments highlights the role that a tourists' home country's climate may play in their acclimatization in various destinations.

Air conditioning related mentions are also higher during the warmer months, peaking in August (21 mentions), correlating with the high occurrence of 'hot' and 'heat' mentions (Figure 5.3). Other terms like 'roof terrace', 'restaurant' and 'bar' are mentioned throughout the year, with 'dinner' mentioned in 25.9% of the reviews (Figure 5.3). The largest frequencies of these terms appear in the summer months, May (19 mentions) and June (19 mentions), emphasizing the role of these amenities in the overall guest experience (Figure 5.3).

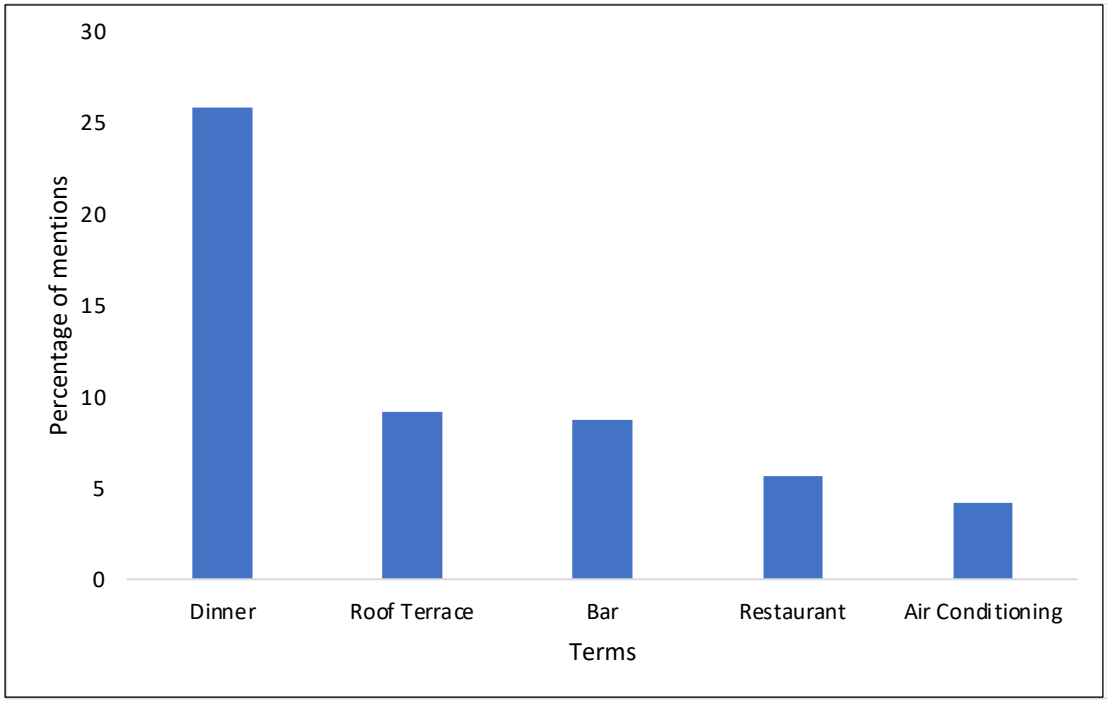


Figure 5.3: Proportion of air conditioning and outdoor mentions for Barcelona.

5.3.3. Stockholm

From 1847 reviews, mentions of weather and night-time thermal comfort are notably low, with only 15 comments (0.8%) relating to the weather and 11 comments (0.6%) mentioning night-time thermal comfort. This suggests that the weather was not a major concerns for guests in Stockholm. Some reviewers that mentioned the hot temperature in the rooms at night noted that there was no air conditioning and either had to open a window or request a fan from reception. One tourist states:

> “I went downstairs to get a fan and request that the heating was turned off. We spent the next 3 days and 2 nights unable to be comfortable or sleep.” (June 2023).

Another tourist comments:

> " it was quite hot despite being February so opened the window but had to close it during the early hours of Sunday morning due to noise of party goers! Not a problem on subsequent nights though." (February 2023)

There were four tourists who referred to both the overall weather and night-time temperatures – one tourist notes not only the temperature but the humidity as well

> “… it was in the high 30°C plus humidity when I was there. It was warm. Quite warm.” (July 2022).

Additionally, comments like

> "The temperature inside them is freezing" (October 2022) and
>
> "Excellent weather during the week" (August 2022)

indicate varied thermal experiences.

Weather-related terms largely occur during the summer months with the terms ‘hot’, ‘warm’, ‘heat’, ‘heatwave’ and ‘temperature’ appearing most frequently (Figure 5.4). The mention of ‘cold’, ‘cool’ and ‘freezing’ appearing at a lower frequency might reflect a seasonal variation

in guest experiences or potentially fewer occurrences of such conditions during the time of stay (Figure 5.4). The term ‘weather’ has a moderate mention as it is a more generic term (Figure 5.4). The low frequency of ‘humidity’ indicates that, while warmth is a favourable condition, extreme heat or humidity is less commonly experienced or less frequently mentioned (Figure 5.4). The low mentions of ‘stuffy’, ‘duvet’, ‘blanket’ and ‘sleep’ may suggest that conditions for sleeping were satisfactory or the tourists’ were not greatly affected by night-time temperatures during the period of stay (Figure 5.4). However, comments such as

> "It was too warm and it got pretty stuffy overnight" (December 2022) and
>
> " Slept in an upgraded south facing superior room with ZERO air conditioning with temperature of 25 to 28 degrees Celsius (about 80 F)… We spent the next 3 days and 2 nights unable to be comfortable or sleep" (June 2023)

highlight issues that arise with night-time thermal comfort.

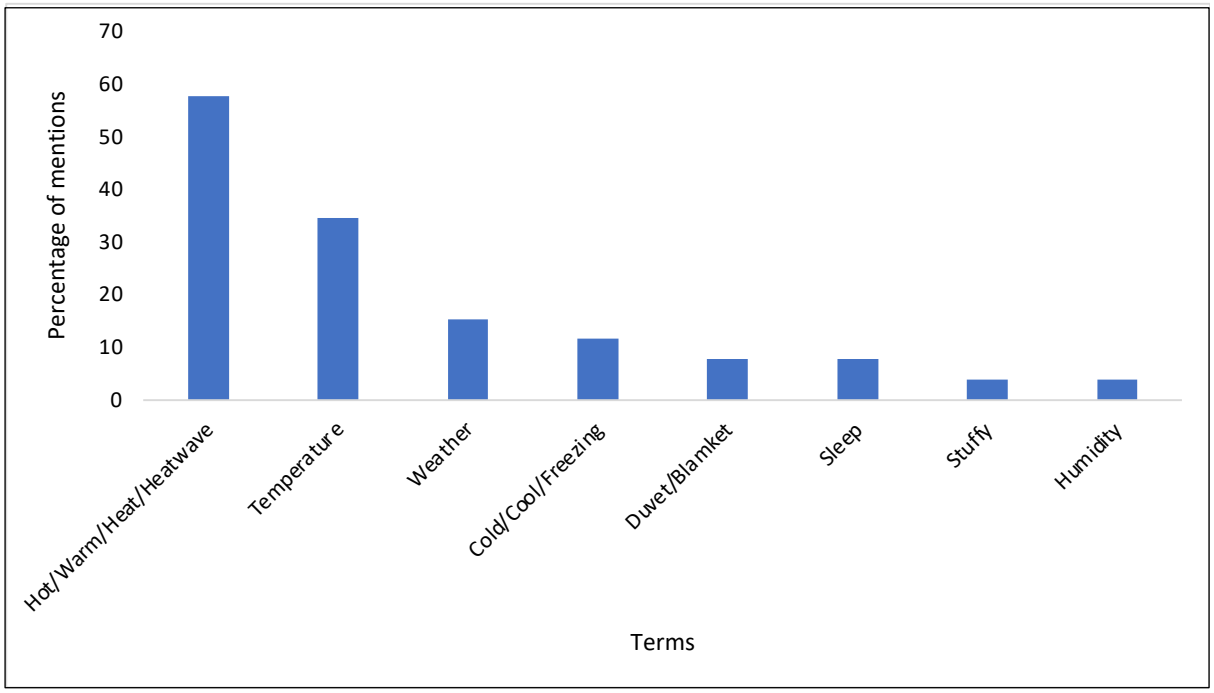


Figure 5.4: Proportion of commentary related to weather mentioned for Stockholm.

Air conditioning was not a prevalent topic among the reviews, with only 55 tourists (3.0%) mentioning it explicitly. A guest positively mentioned,

> "The rooms are great too, for the summer they hace AC so we didnt feel hot inside the room" (July 2022)

indicating satisfactory air conditioning. This contrasted with another guest's observation that

> "they not have any air conditioning in the rooms and no windows to open.. 30 degrees plus in the rooms and they just offered a couple of fans when we complied" (June 2022)

pointing to potential issues with the functionality or control of the air conditioning systems in some hotel accommodation establishments. Another tourist notes

> “I always check for air-conditioning because not all hotels in Europe have this. The hotel advertises it is airconditioned but If you book call the hotel and make sure they booked you in an airconditioned room because a majority of them will not be airconditioned” (June 2023)

which furthers confirms the need to verify the number of air-conditioned rooms and spaces within hotel accommodation establishments (Table 5.1, 5.2 and 5.3). Further concerns include remarks like

> "The AC was not working " (May 2023) and
>
> "… your air conditioner is not working i got cold" (December 2022)

underscoring variability in air conditioning efficacy.

A number of guests (n=78; 4.2%) commented on the evening excursions and dining experiences. Dining outdoors, particularly on terraces with views, was frequently mentioned,

> “We went up to the rooftop for dinner sitting on the terrace over the Bosphorous River. We went back each night and even had a light meal on the rooftop under the heat lamps.” (October 2022).

Two other guests commented

> “If you enjoy a good bar, there are two at the Bank - one downstairs that serves great cocktails and wine plus dinner as well and another rooftop one with both inside and outside seating options.” (September 2022)

and

> "They had reserved the terrace for hotel guests at midnight to see the fireworks which was nice." (December 2022).

One comment highlighted that tourists do not spend their entire visit inside the hotel accommodation establishments, particularly at night,

> "We don't normally eat dinner at a hotel but we did here and I'm glad we did." (July 2022).

In regards to amenities, air conditioning is a prominent topic among guests, particularly in the warmer months, with 37 mentions July, which indicates a heightened importance of indoor climate control during this time. This aligns with the 'hot' and 'temperature' mentions (Figure 5.4), emphasizing the need for effective thermal regulation indoors. 'Dinner' is frequently mentioned, with 'restaurant' having moderate mentions, indicating that these amenities are appreciated and may be as critical to the guest experience as the need for a comfortable indoor climate (Figure 5.5). 'Rooftop' and 'balcony' are less frequently mentioned, suggesting they are less influential factors in the guest's overall satisfaction (Figure 5.5).

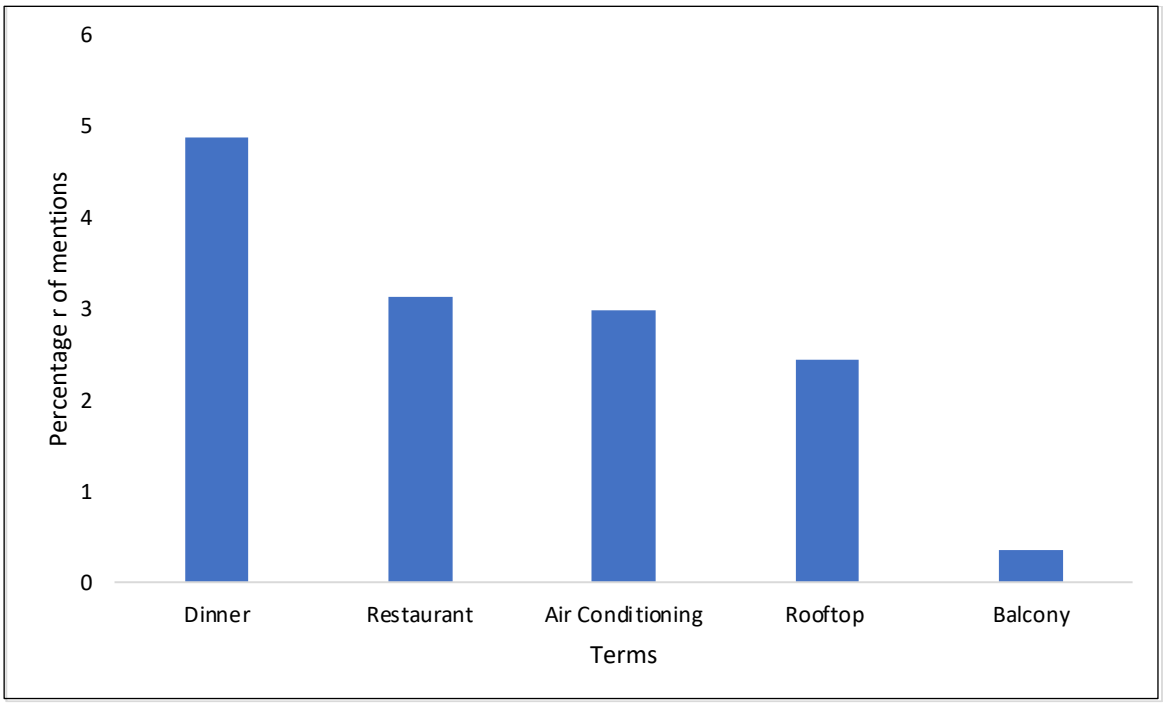


Figure 5.5: Proportion of air conditioning and outdoor mentions for Stockholm.

5.3.4. London

In an analysis of 2816 reviews of London, 76 included mentions of guests (2.7%) reflecting on the climatic conditions during their stay. Night-time thermal comfort was addressed in 29 reviews (1.0%), revealing some guests encountered challenges in achieving comfortable sleep due to the temperature. A comment mentioned,

> “We didn’t like just having a blanket to sleep with in case it became hot.” (June 2023).

Other comments like

> “Heatwave” (June 2023)
>
> “Room was hot all of the time” (June 2023) and
>
> “Temperature was showing as 26 deg C (too warm)” (June 2023)

further emphasize the impact of temperature on guests’ experiences and their quality of sleep. The frequent mention of heat, as noted in comments like

> "Very hot day" (June 2023) and

"the room was still hot like an oven" (May 2023)

highlights the need for effective climate control solutions.

‘Hot’, ‘warm’ and ‘roasting’ stand out, being mentioned in 56.2% of comments where weather terms were used (Figure 5.6). The high mention of 'temperature' reinforces the focus on thermal conditions (Figure 5.6). ‘Cool’, ‘cold’ and ‘freezing’ are less frequently mentioned, which could indicate either a warmer climate or that the reviews were predominantly from guests visiting during warmer seasons (Figure 5.6). Other weather-related terms such as ‘humid’, ‘wet’, ‘rain’, and ‘wind’ are relatively less mentioned (Figure 5.6). Notably, ‘sun’ and ‘sunny’ is infrequently mentioned, which might imply that guests often expect sunny conditions or that it is a less critical aspect of their experience (Figure 5.6). Terms related to indoor thermal comfort at night, like ‘duvet’, ‘comforter’ and ‘sleep’, are minimally mentioned (Figure 5.6).

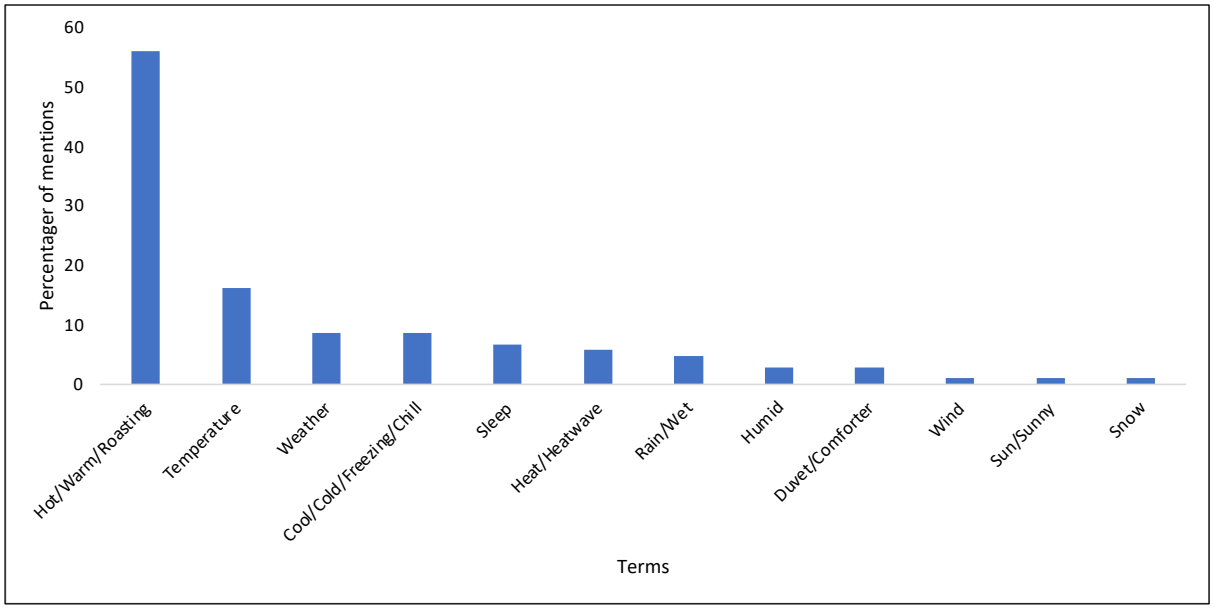


Figure 5.6: Proportion of commentary related to weather mentioned for London.

Air conditioning is mentioned in 100 reviews (3.5%)– “The effectiveness of the air conditioning was a game-changer during a particularly hot spell,” a guest noted, highlighting the positive impact of functional air conditioning. However, not all experiences were favourable, with a review stating,

> “The guests who from far-east like us, no air conditioning is a nightmare. Even though we opened all windows, the room was still hot like an oven” (May 2023)

and another adding,

> “They should get all their rooms air-conditioned as soon as possible for the summer season.” (June 2023).

Comments such as

> “no air con in the room and only 2 very small windows that hardly opened” (June 2023) and
>
> “We stayed on one of the hottest days of the year and the air-conditioning in our room was not functioning” (June 2023)

further emphasize the role of air conditioning in ensuring comfort.

Evening activities in London are captured in 111 reviews (3.9%). A visitor shared,

> “we also booked tickets for a show in the evening which was approximately a 10 minute walk” (April 2023)

illustrating the popularity of night-time adventures outside of the hotel environment and in spaces that are not temperature-controlled. Another detailed,

> “In the summer there is access to a roof terrace and from some windows you can get a panoramic view of London - at night you can easily pick our the London Eye and The Shard” (January 2023).

These accounts are mostly positive and suggest that the outdoor and night-time experiences in London generally meet or exceed visitors' expectations. Only two tourists mention the lack of air conditioning outside the hotel room –

"The lobby and restaurants were hot as well" (June 2023) and

"no cooling or ventilation in the hotel - not the bedrooms, not the lobby, not the bar/restaurant." (June 2023)

Air conditioning was the most frequently mentioned in June, with 97 mentions, which align with the large number of 'hot', 'warm' and 'roasting' mentions (Figure 5.6). The mentions of 'bar', 'dinner', and 'restaurant' were present throughout the year, with 'restaurant' being an important part of the guest experience (Figure 5.7). These three terms are equally mentioned, indicating that dining experiences are of significant importance to guests staying in London (Figure 5.7). However, there is a lower emphasis on air conditioning compared to 'dinner' and 'restaurant', suggesting that while climate control is important, the overall guest experience is more heavily influenced by dining opportunities.

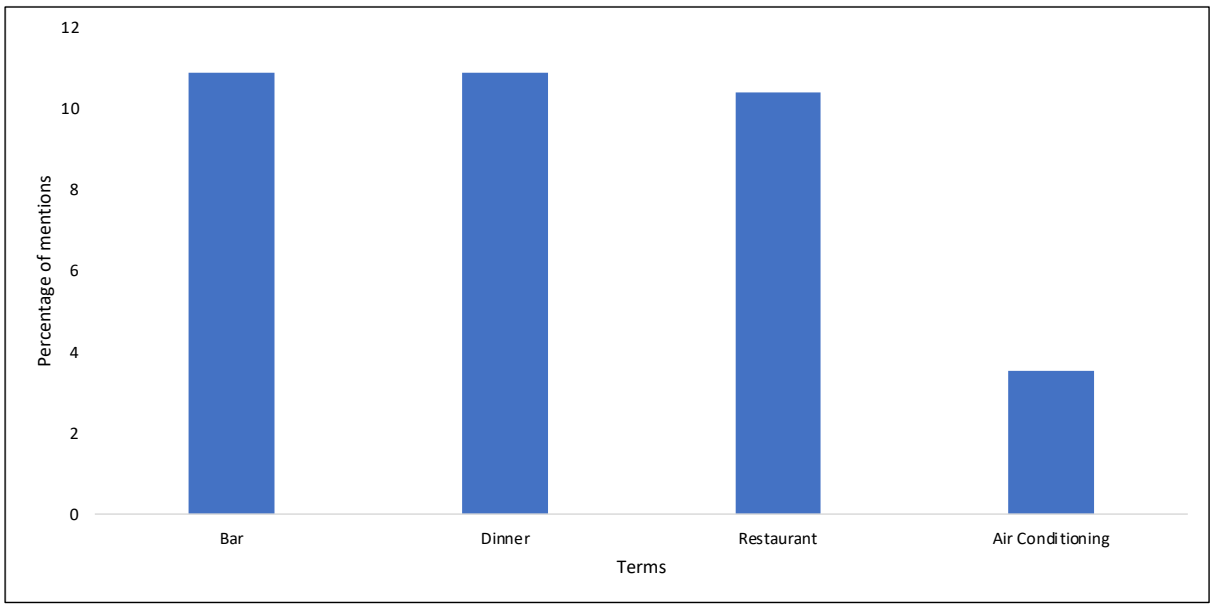


Figure 5.7: Proportion of air conditioning and outdoor mentions for London.

5.3.5. Istanbul

In a dataset of 4063 reviews, Istanbul showed minimal concern for weather and night-time thermal comfort, with only 27 (0.7%) and four mentions (0.1%), respectively, suggesting effective climate adaptation by hotels or overall guest satisfaction with the conditions. The comments that mention night-time temperature and weather state,

> “The thermometers don’t go below 18.5°C and the windows don’t open, so while this is maybe fine for the winter, the rooms don’t cool during warm sunny summer days, making sleeping difficult as there is only a down comforter.” (June 2023),
>
> “Hotel HVAC system only would heat room. Room was 24.5c and too hot to sleep comfortably” (March 2023),
>
> “… the rooms temperature to 27 degrees, for some reasons even when it was switched off. We had to sleep witht the balcony door open…”(October 2022) and
>
> “Since the first night we noticed that the atmosphere of the room was uncomfortable and really hot we couldn’t sleep at all” (December 2022).

Another tourist comments that they arrived,

> “during wicked weather” (February 2023)

in Istanbul and were forced to spend their time inside the hotel. Additionally, a guest described the heat as,

> "Really hot we couldn’t sleep at all; They fixed the room temperature and it was ok for only two nights then the nightmare started again... so hot we couldn’t sleep again." (December 2022).

Only six tourists mentioned air conditioning and weather in the same comment, with five of these commenting on the functionality of the units. The use of air conditioning was impactful for some guests:

> “…we enjoyed the amenities and air conditioning (a must in Turkish summer)” (September 2022) and
>
> “…it was a bit hot when I got there, but the AC worked well and got the temperature down to a comfortable level.” (June 2023)

‘Weather’ is by far the most frequently mentioned term, followed by ‘hot’, ‘warm’ and ‘rain’ suggesting that guests experience diverse climatic conditions (Figure 5.8). The frequent use of ‘summer’, ‘hot’ and ‘warm’ highlights the warm weather experienced, likely contributing positively to the overall guest experience (Figure 5.8). ‘Cold’, ‘cool’ and ‘chilly’ are moderately mentioned, possibly indicating weather variability that were impactful enough to be included in the reviews (Figure 5.8). Terms such as ‘wind’ and ‘temperature’ have the least mentions, suggesting these conditions are either infrequent or not impactful on the guests' experiences (Figure 5.8).

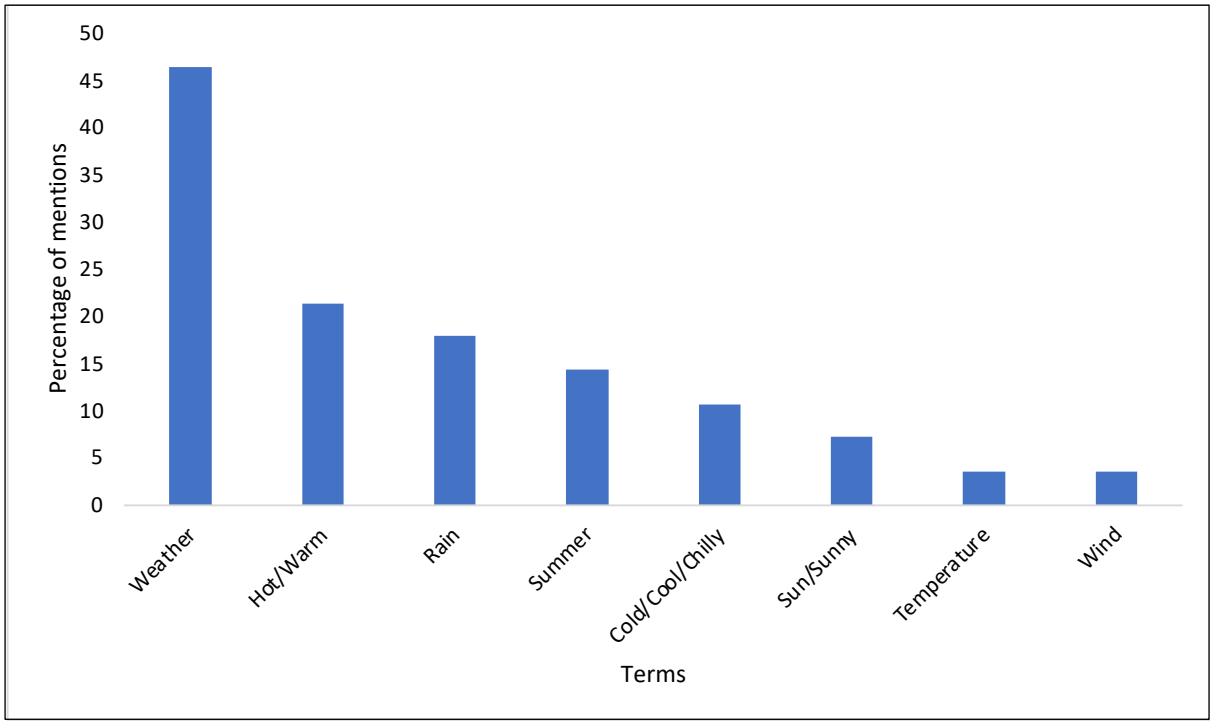


Figure 5.8: Proportion of commentary related to weather mentioned for Istanbul.

Very few guests (n=23; 0.6%) mentioned air conditioning, indicating it is not a significant concern. A guest remarks

" good AC which cooled us down from the heat outside." (June 2022).

Another guest notes that air conditioning units are present in every room at the Sofitel Istanbul Taksim hotel. The acclimatization of guests is further highlighted by a tourist who mentions

"… the air conditioning, which is difficult to lower to American standards." (May 2023).

Only one comment mentions the functionality of both the air conditioning unit and heater which was most likely used as the tourist visited in the winter month of November –

"…AC & heater worked good" (November 2022).

Other comments reflect on operational issues, such as

"Air conditioner, so difficult to fix" (June 2023) and

"…the final straw was the air con not working" (September 2022)

indicating variability in the functionality of these units. The large proportion of air-conditioned hotel accommodation establishments (Table 5.2) and the small number of air conditioning mentions may mean the units are fully functional and/or guests do not feel the need to mention that.

The night-time activities of the city were reflected in 154 comments. A reviewer recommends

" he view of the Bosphorus bridge was outstanding" (May 2023).

Due to the large cuisine tourism in Turkey, the comments largely comprise of guests having dinner on the 'terrace' or at the 'restaurant', with one mention of activities taking place outside of the hotel establishment -

"… on our third night having a night walk after dinner in the beautiful neighborhood." (September 2022).

Notably, none of the night-time activity comments mentioned any night-time thermal comfort or temperature. 'Dinner' has the largest proportion of mentions among the hotel amenity terms, indicating that dining experiences are a significant aspect of guest stays (Figure 5.8).

The relatively low mention of air conditioning compared to ‘dinner’ might suggest that guests are either satisfied with the climate control provided or that the weather conditions are favourable (Figure 5.9). ‘Rooftop’, ‘restaurant’, and ‘terrace’ reveal that tourists partake in activities outside of their hotel rooms (Figure 5.8).

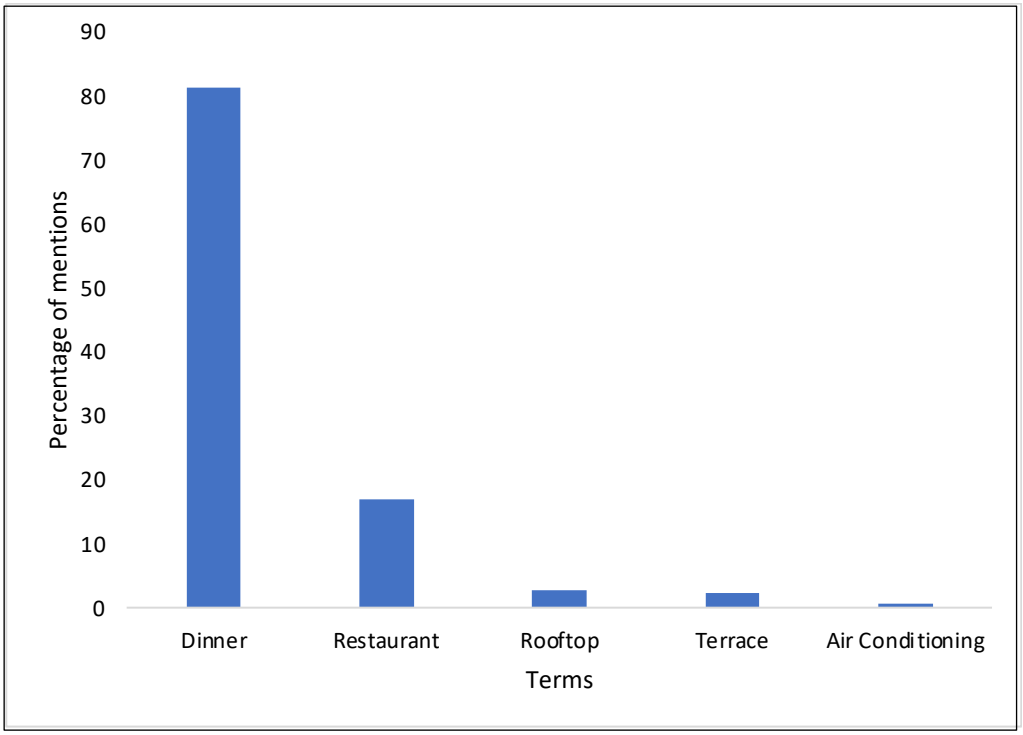


Figure 5.9: Proportion of air conditioning and outdoor mentions for Istanbul.

5.3.6. Paris

The examination of 2013 reviews for Paris included 57 (2.8%) with weather conditions mentioned. The variability of the weather, ranging from "very hot" summers to ‘cold’ winters, was frequently noted. A guest described their stay as having

> "hot and humid summer days" (June 2023)

emphasizing the challenge of coping with the heat. Another mentioned,

> "Room warm when Paris was very cold" (March 2023)

pointing to the necessities of adjusting to the cold temperatures inside the hotel rooms. Additional quotes like

"perfect weather" (May 2023) and

"heat wave" (June and July 2022)

further illustrate the impact of the weather on their stays.

Night-time thermal comfort was addressed in 19 reviews (0.9%). Two tourists that visited Paris in July of 2022 referenced the ‘heat wave’ but made no comment on how that specifically affected them at night. However, a year later (July 2023) one review remarks,

"terrible sleep due to the heat" (June 2023)

indicating the significant discomfort experienced during warmer nights and the consistency in summer temperatures experienced in Paris. Another guest chose to

"sleep with the balcony door open in the end just to get some cool air in the room" (April 2023)

showcasing the lengths some had to go to find relief from the heat.

‘Hot’, ‘warm’, ‘heat’ and ‘heatwave’ are the most mentioned term in the reviews, indicating that heat is a significant aspect of the guests' experiences (Figure 5.10). Additionally, ‘cool’, ‘cold’, ‘freezing’ and ‘chilly’ are also frequently mentioned, suggesting that there is a proportional distribution of guests visiting during cold and warm weather periods (Figure 5.10). Other terms such as ‘rain’, ‘sun’, ‘sunny’ and ‘humid’ show that guests do address a variety of weather conditions, but to a lesser extent compared to the prevalence of warmer weather (Figure 5.10). ‘Weather’ and ‘temperature’ are mentioned as general terms but ‘temperature’ is more used more frequently (Figure 5.10). Seasonal terms like ‘summer’ and ‘winter’ are less regularly used, which may reflect the seasonal travel patterns (Figure 5.10).

The term ‘blanket’ has relatively fewer mentions than ‘sleep’ which might imply that the hotel accommodation establishments supply the guests with adequate covering for sleep (Figure 5.10).

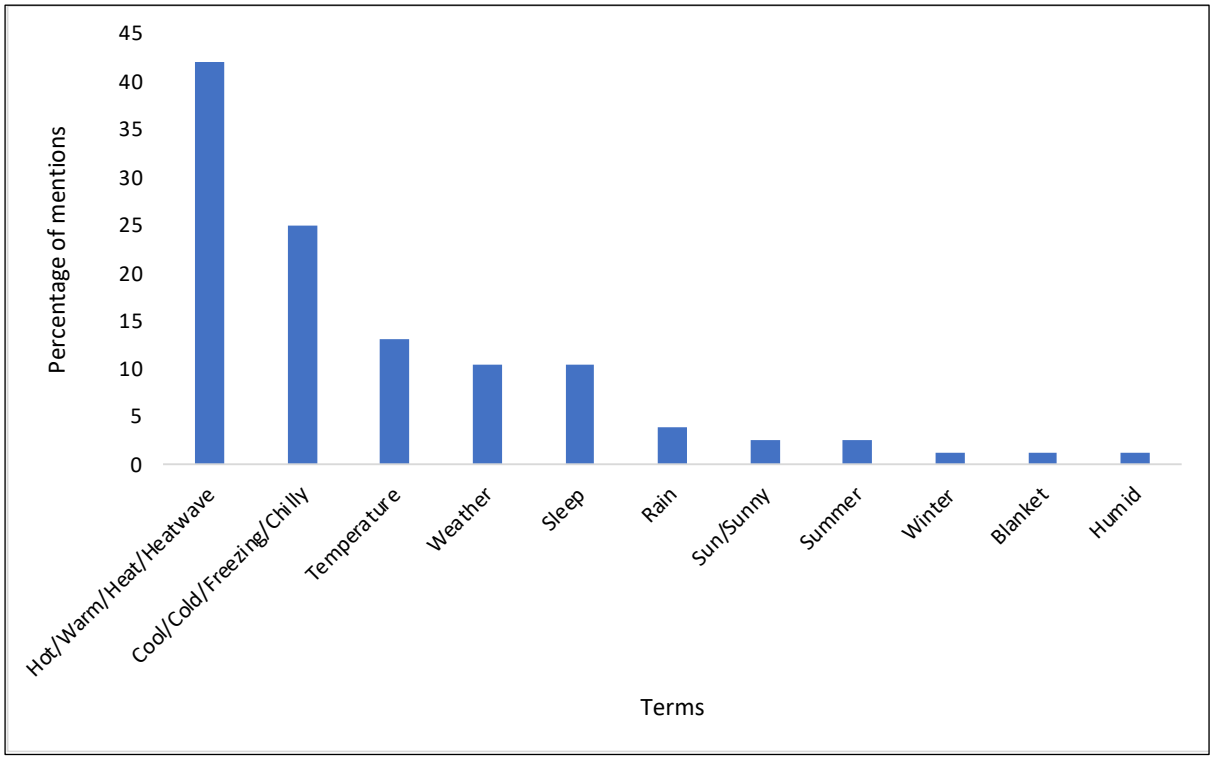


Figure 5.10: Proportion of commentary related to weather mentioned for Paris.

Air conditioning was discussed in 76 reviews (3.8%). Guests expressed varied experiences with the air conditioning units, with one praising the

> "best of all, great air conditioning for the hot and humid summer days" (June 2023)

that contributed to a comfortable stay. However, challenges were also mentioned,

> “The air conditioning wasn't working the room was sooo hot!couldn't open windows because of noise” (November 2022)

highlighting dissatisfaction with the cooling provided. Several comments noted the lack of air conditioning units in the hotel accommodation establishments, which further highlights the

small proportion of air-conditioned hotel accommodation establishments on *Booking.com* (Table 5.2). Additional comments such as

> "Air conditioning was weak, but that could also be because of the oppressive heat"(July 2022) and
>
> "air conditioner in the room worked well" (June 2023)

reveal a range of experiences with climate control.

Few guests commented on the night-time activities (n=118 reviews; 5.9%), with majority of these comments mentioning activities taking place outside of the hotel. For example, one tourist remarks

> "… afternoon/evening snacks at other Astotel properties in the city while we were out touring" (June 2023)

whilst one tourist comments on the safety of the area –

> "Safe to walk around even late into the night." (June 2022).

Notably, only three guests remark on the temperature at night and partaking in night-time activities, which occurred during autumn and winter (December 2022, January 2023 and April 2023). The guests commented:

> "Upon checking in, the rooms (we had two) were incredibly hot. We let AC run while at dinner and came back to discover no change" (April 2023),
>
> "Even in the cold December evening, it was amazing sitting out there to stare at the tower" (December 2022) and
>
> "Staff was amazing helping me contact the restaurant where we had dinner the night before to inquire about a lost beanie (found!). Room was just the right temperature for sleeping on those cold mid-January nights during the week we spent in Paris" (January 2023).

‘Dinner’ and ‘restaurant’ have most mentions, reinforcing the importance of evening dining experiences (Figure 5.11). ‘Bar’ is also frequently used, as it account for 6.0% of mentions (Figure 5.11). Outdoor amenities like ‘terrace’, ‘balcony’, and ‘courtyard’ have the least mentions suggesting that these features are appreciated but not as important to the guest experience as the dining options (Figure 5.11). The small proportion of air conditioning mentions could suggest that while climate control is necessary, it may not be a major issue for guests or it is adequately provided by the hotel (Figure 5.11).

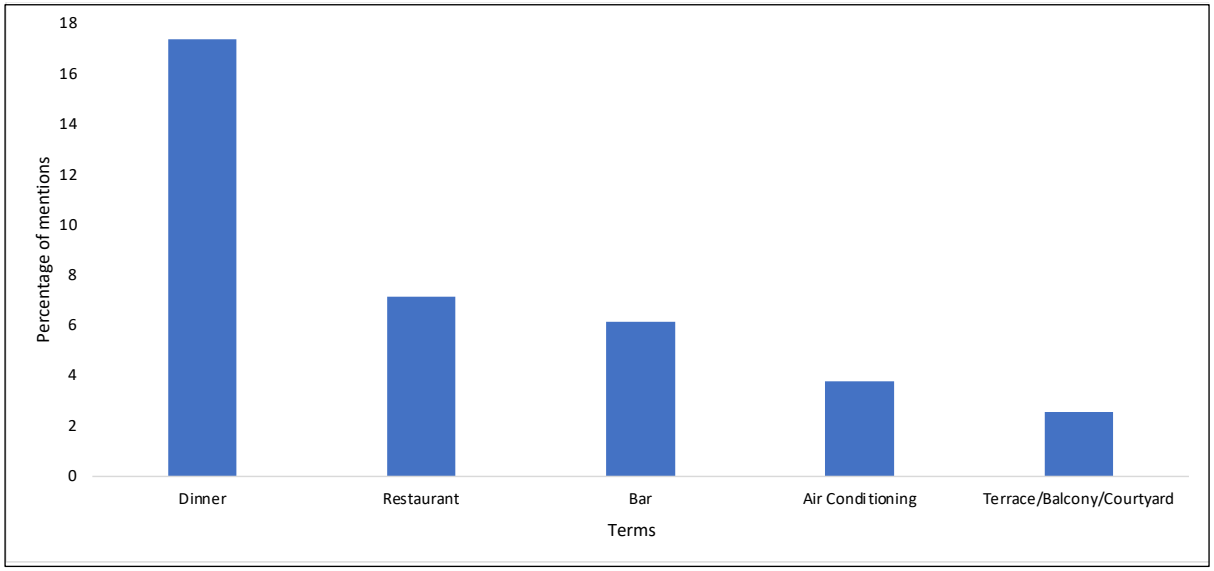


Figure 5.11: Proportion of air conditioning and outdoor mentions for Paris.

5.3.7. Rome

The analysis of the Rome dataset revealed 87 mentions (3.5%) of weather from 2467 reviews. The comments ranged from dealing with

“record heatwave” (August 2022)

to

“pouring down rain” (April 2023),

suggesting varied experiences based on the season of travel. One guest describes the challenges of hot weather,

> “We wandered around Rome but it was incredibly hot and decided to check back at the hotel at 1:00.” (August 2022).

Further emphasizing the variability, another remarked,

> “Rome was hot this August” (August 2022)

while yet another noted,

> “It was brutally hot” (June 2022).

Some guests commented on cooler conditions as well, such as,

> “The only slight negative for me was that the room was pretty cold” (March 2023) and
>
> “it rained three of our four evening” (April 2023)

Night-time thermal comfort was highlighted in 18 reviews (0.8%). A notable mention was,

> "At night the room get’s very cold and no option to warm it” (November 2022).

Other guests found night-time conditions challenging yet manageable with adjustments, one explained,

> "the window opened onto a bus depot that was active all through the night" (March 2023)

and another wrote,

> "on the 3rd and 4th day heating system was NOT working on our floor so it wasn't comfortable in the evenings” (November 2022).

Some noted the discomfort experienced during sleep:

> " It was warm during stay and bed, while comfortable, could have used a light sheet vs the comforter which was a bit heavy," (July 2022)
>
> "There was no air conditioning in April and that caused the room to be uncomfortably warm some nights" (April 2023) and
>
> “The room never did cool off making it very hard to sleep” (September 2022).

The terms ‘hot’, ‘sweltering’, ‘warm’, ‘heat’ and ‘heatwave’ are largely mentioned, suggesting that experiences of hot weather is most impactful among guests (Figure 5.12). The mentions of ‘weather’, ‘cool’, ‘cold’, ‘freezing’ and ‘chilly’ are moderate, highlighting these as relevant but less extreme conditions (Figure 5.12). The mention of ‘summer’ and ‘winter’ suggest seasonal references (Figure 5.12). Terms like ‘sleep’, ‘blanket’ and ‘duvet’ have the least mentions but are still significant as they indicate the importance of thermal comfort during rest (Figure 5.12).

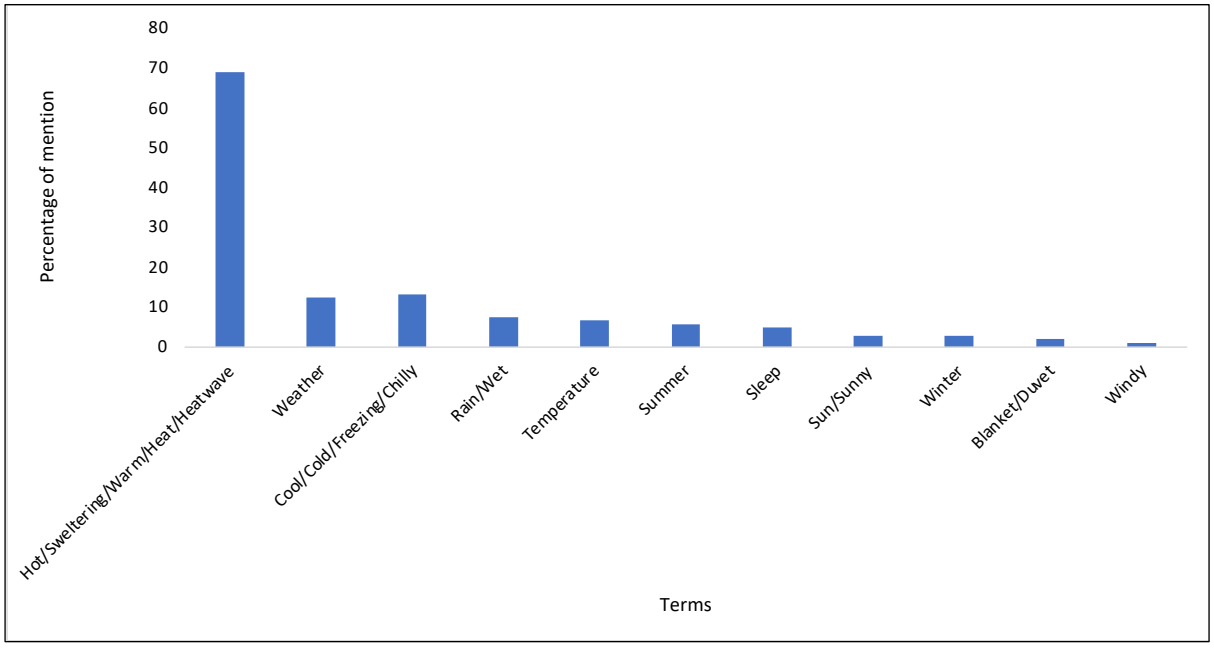


Figure 5.12: Proportion of commentary related to weather mentioned for Rome.

Air conditioning is mentioned in 140 reviews (5.7%). Positive experiences were shared, with one review stating,

> "The A/C worked great as we had 90 degree + days” (August 2022)

highlighting the relief provided by effective air conditioning. However, there were also grievances, such as in a review that noted,

> "AC wasn't very effective" (March 2023).

Additional comments include,

> "The air conditioning worked perfectly," (July 2022) and
>
> "AC was very strong" (August 2022)

reflecting varied experiences with the air conditioning systems.

There are 100 comments (4.1%) that mentioned evening activities in Rome. The majority of the remarks include dinner on the rooftop of the various restaurants and 'cocktails' after a long day or sightseeing. Conversely, one guest spent one night inside their hotel room –

> "Used room service once when we arrived for evening food which was great (tacos and totts)" (March 2023)

but made no reference to the air conditioning unit or temperature of the room. The term 'dinner' is significantly used, indicating that the dining experience is a central aspect of guest stays (Figure 5.13). 'Rooftop', 'restaurant', 'terrace', 'balcony' and 'courtyard' have fewer mentions, which suggests that these amenities are secondary to the guests' need for comfortable climate control and dining experiences (Figure 5.13).

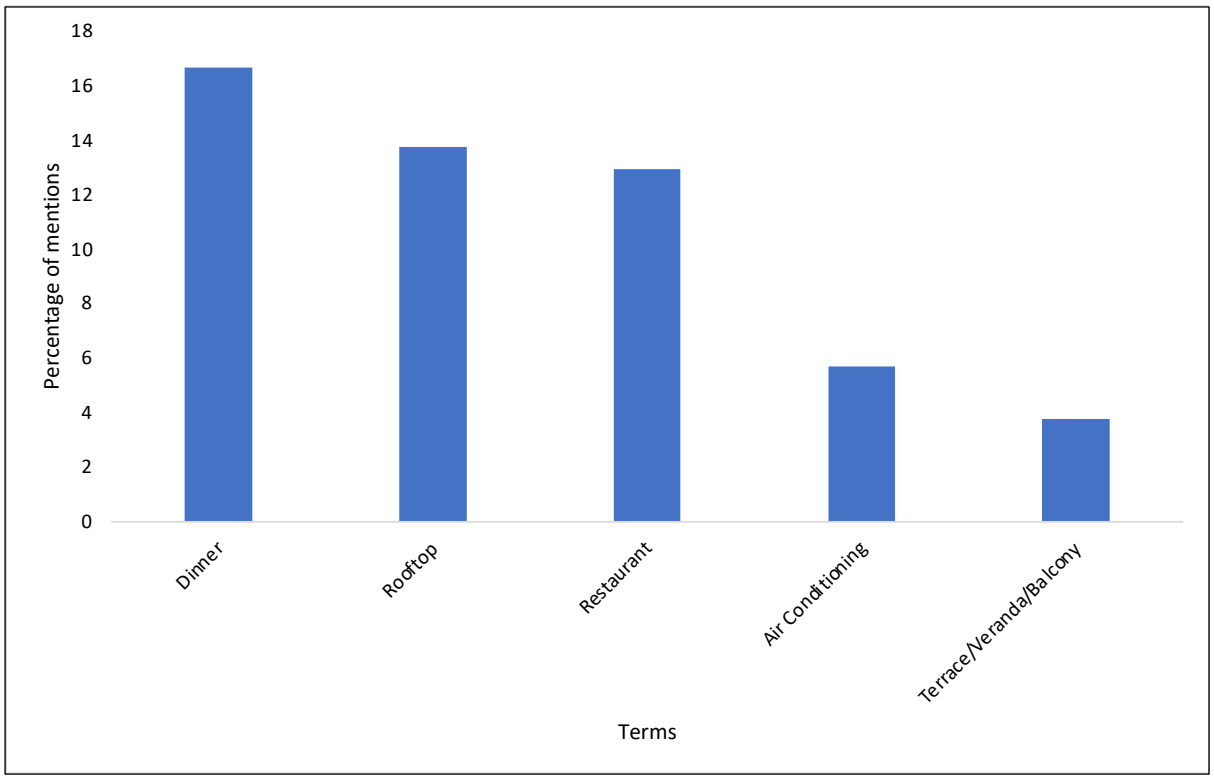


Figure 5.13: Proportion of air conditioning and outdoor mentions for Rome.

5.4. Distribution of indoor and outdoor night-time activities

While an hotel accommodation establishment might have indoor air conditioning, the locations of outdoor activities might not. Moreover, the frequency of mentions of night-time activities outside of the hotel in *TripAdvisor* reviews of hotel accommodation establishments encouraged a deeper analysis of night-time activities. The analysis of nocturnal economies and night-time activities in the six European cities offered insights into the range of experiences available to tourists, from cultural activities to culinary experiences. The spatial distribution of these activities are noted, with each city offering a mix of indoor, outdoor, and hybrid experiences. The examination of *TripAdvisor* reviews will focus on thermal comfort during the night-time and the impact of daily weather conditions on patrons. Furthermore,

how the weather affects participation of nocturnal activities pursued outside hotel accommodation establishments will also be examined. The reviews were only considered if the “date of visit” occurred during the time period June 2022 – June 2023, with a minimum of 20 activities and 1000 reviews to allow for an effective comparative analysis.

5.4.1. Barcelona

The city of Barcelona offers activities that cover a wide range of interests, representative of the culture. The spatial organization of the city allows for a distribution of indoor, outdoor, and hybrid activities, particularly close to the Balearic Sea coastline (Figure 5.14). Specific offerings, like the ‘Barcelona Tapas and Wine Experience Small-Group Walking Tour’ and the ‘Flamenco Show at Tablao Flamenco Cordobes Barcelona’, are examples of venues accommodating both indoor and outdoor settings. Moreover, the ‘Barcelona Tapas, Taverns’, ‘Gothic Quarter History Tour’, ‘Gothic Quarter’ and ‘Las Ramblas’ demonstrate the varied nocturnal activities.

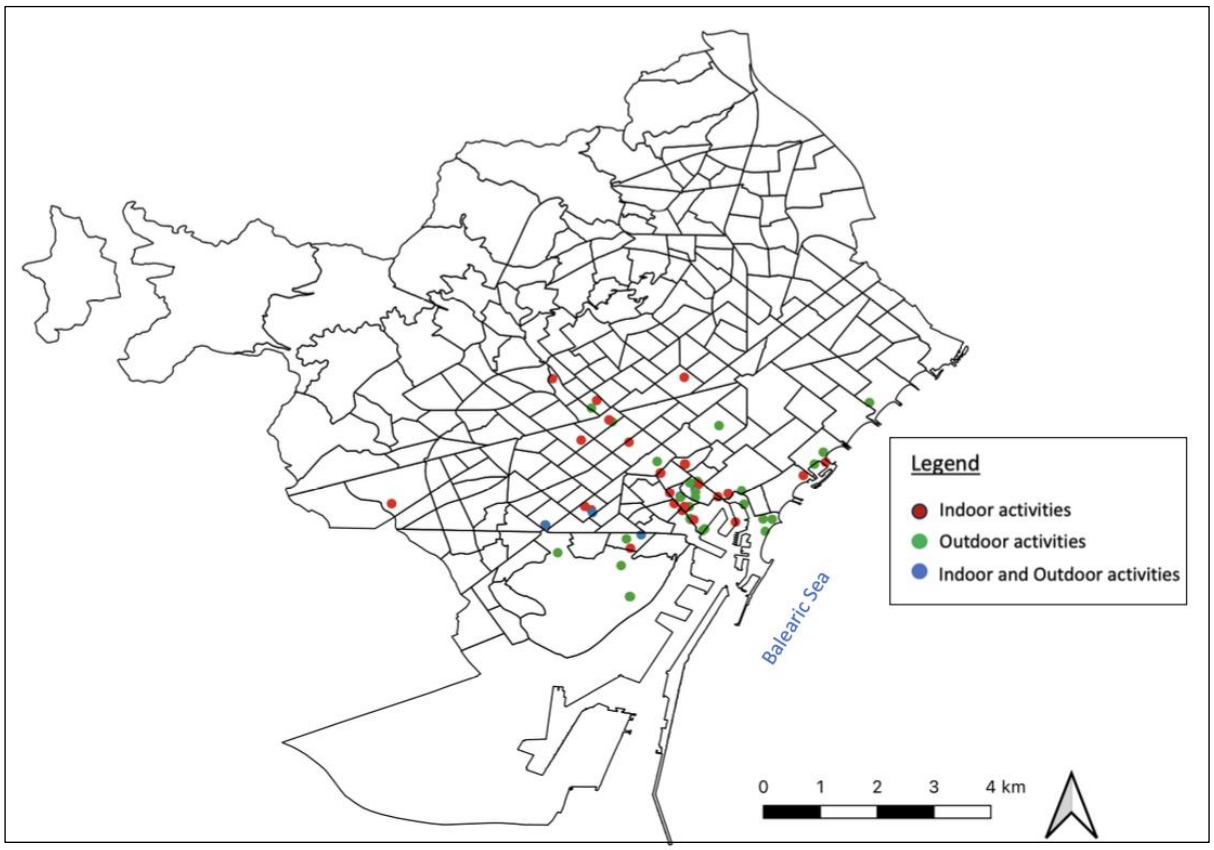


Figure 5.14: Night-time activities in the city of Barcelona listed on *TripAdvisor* and *Viator.com*.

The analysis of 1259 reviews revealed that 63 tourists addressed the weather and 12 mentioned night-time thermal comfort. A patron of 'Casa Milà - La Pedrera' and 'La Barceloneta' both comment on their luck as it pertains to the weather

> "… we were lucky with sunny weather so we could visit the roof" (September 2022) and
>
> "Luckily we visited on a sunny day, with occasional clouds!" (May 2023).

This reveals that although the climate does not need to be favourable for this activity to take place, it does help tourist satisfaction. Similarly, a tourist on the 'Catamaran Orsom' warns patrons to

> "Bring a light jacket depending on the weather as it can get a little chilly" (June 2022).

Another tourists remarks the change in weather –

> “MY weather forecast did NOT predict rain, but rain it did… I was very sad thinking about my own umbrella and rain jacket” (May 2023).

Further emphasizing the variability of the weather, one review noted,

> "The weather was beautiful so really enjoyed out sitting and taking it all in," (August 2022)

while another highlighted,

> "It was really choppy and cold." (March 2023).

Air conditioning was mentioned twice, both for the ‘Tablao Flamenco Cordobes’– one tourist states

> “Before booking I also called to confirm there was no smoking, had good air conditioning” (August 2022)

and the other comment highlights the malfunctioning of the air conditioning unit by saying

> "Facility was a little warm this August as it seemed the ac could not keep up even though we went to the 10:30 pm show" (August 2022).

The lack of air conditioning mentions for the other indoor facilities may suggest that the climate was bearable for patrons or that they were completely operational. There was no mention of heating systems either.

The term ‘hot’, ‘heat’ and ‘warm’ dominate the terms mentioned, indicating that temperature-related comfort is a significant aspect of the reviewers’ experiences (Figure 5.15). These terms surpass the others, with 30.6% of mentions, which could reflect the occurrence of warm weather in the area or possibly a period of hot temperatures (Figure 5.15). Conversely, generic terms such as ‘weather’ and ‘temperature’ are mentioned less frequently, suggesting that specific conditions, rather than the general climate, are more impactful on the tourists’ experiences (Figure 5.15). The small number of mentions of ‘clothing’ indicates that tourists do not commonly refer to attire adjustments in response to

weather conditions, which could imply that weather impacts were either as expected or did not require special attire (Figure 5.15). There is a moderate number of mentions for 'sunny', 'sun', 'wind', 'cool', and 'rain' (Figure 5.15). The presence of 'sunny' and 'sun' aligns with the mentions of 'summer' and 'sun', 'sunny' and 'sunlight' previously mentioned by tourists (Figure 5.2 and 5.15). Alternatively, 'wind', 'cool', and 'rain' receive fewer mentions, which could suggest that such conditions are less significant factors for visitors or occur less frequently during popular visiting times (Figure 5.15).

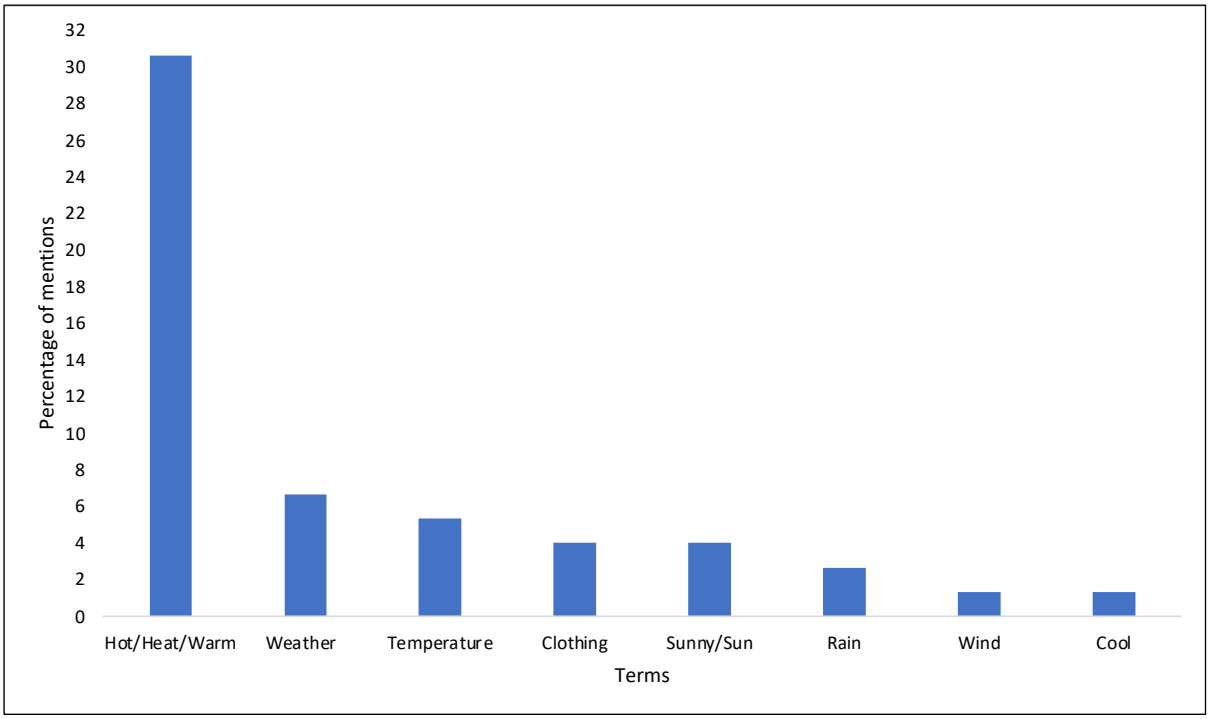


Figure 5.15: Proportion of commentary related to weather mentioned for Barcelona.

5.4.2. Stockholm

The spatial arrangement of Stockholm offers a central distribution of activities that integrate indoor and outdoor experiences (Figure 5.16). Stockholm has a selection of museums and cultural institutions that engage indoor activities. Nightlife in Stockholm tends to favour

outdoor activities such as the ‘Stockholm Archipelago Cruise with Guide’, the ‘Original Stockholm Ghost Walk and Historic Tour’. Culinary opportunities on offer such as the ‘Stockholm Private Food Tour’ is positioned along the waterways for outdoor pursuits and proximate to food markets for indoor explorations (Figure 5.16).

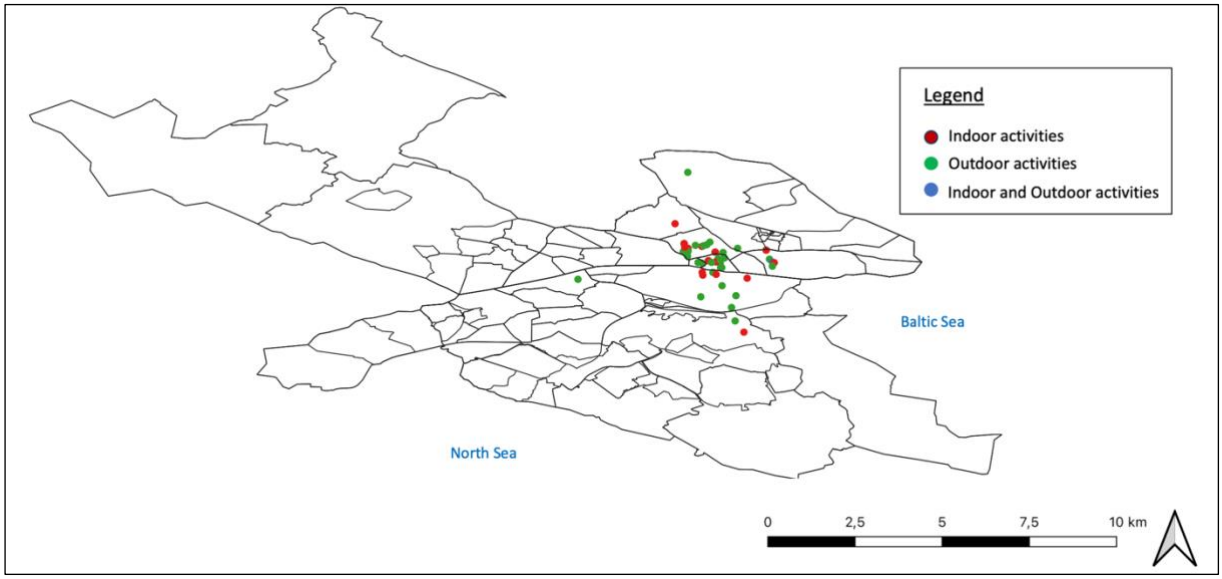


Figure 5.16: Night-time activities in the city of Stockholm listed on *TripAdvisor* and *Viator.com*.

The low number of reviews (n=758) yielded for Stockholm was due to the lack of tourist comments on the platform, with many of the activities’ last comment occurring in 2020. The climate emerged as an important factor, with 53 reviews directly highlighting guests’ awareness of weather conditions during their visits. For instance, one visitor noted the pleasure of walking throughout the area

> "for an entire day" (August 2022)

thanks to the pleasant weather, and another described the view of Stockholm at dusk as

> "breathtaking," (November 2022)

despite the cold. This indicates that, while the climate is an important aspect of the experience, visitors are willing to endure and even enjoy certain weather conditions.

There were no specific mentions of night-time thermal comfort or air conditioning within the analysed reviews, suggesting that these aspects were not a major concern or did not significantly impact the overall experience. For example, a tourist commented on finding an

"excellent place to spend many hours and avoid cold winter weather" (December 2022)

which implies that suitable indoor alternatives are available and utilized. Weather-related comments varied, encompassing descriptions such as ‘sunny,’ ‘rain,’ ‘cold,’ ‘wind,’ ‘temperature,’ and ‘heat,’ reflecting the diverse climatic conditions experienced by visitors.

‘Weather’ and ‘cold’ are the most frequently mentioned term, accounting 39.6% and 26.4% respectively, of all weather term mentions (Figure 5.17). This suggests that the cold, whether due to low temperatures or the perception of coldness, is a significant factor in the experiences of reviewers. The mention of ‘weather’ as a general term indicates that while specific conditions are often discussed, the overall concept of weather plays an important role for tourists, as seen in experiences ranging from

"dirty black particles that rained on us" (June 2022)

during a boat trip to

“a very sunny day" (June 2022)

in the city's historical centre. Conversely, ‘hot/heat’, ‘winter’, and ‘summer’ are moderately mentioned at 3.8%, 7.5% and 1.9%, respectively (Figure 5.17). Comments containing temperature-related feedback, such as enjoying the

"changing of the guards even though it was pouring with rain" (May 2023) or

"We went in the cold of winter" (December 2022)

to visit a Christmas village, displays an awareness of seasonal weather conditions by reviewers. 'Summer' and 'snowy' are the least mentioned terms, suggesting that these conditions might be less impactful or less memorable to the visitors during their activities (Figure 5.17).

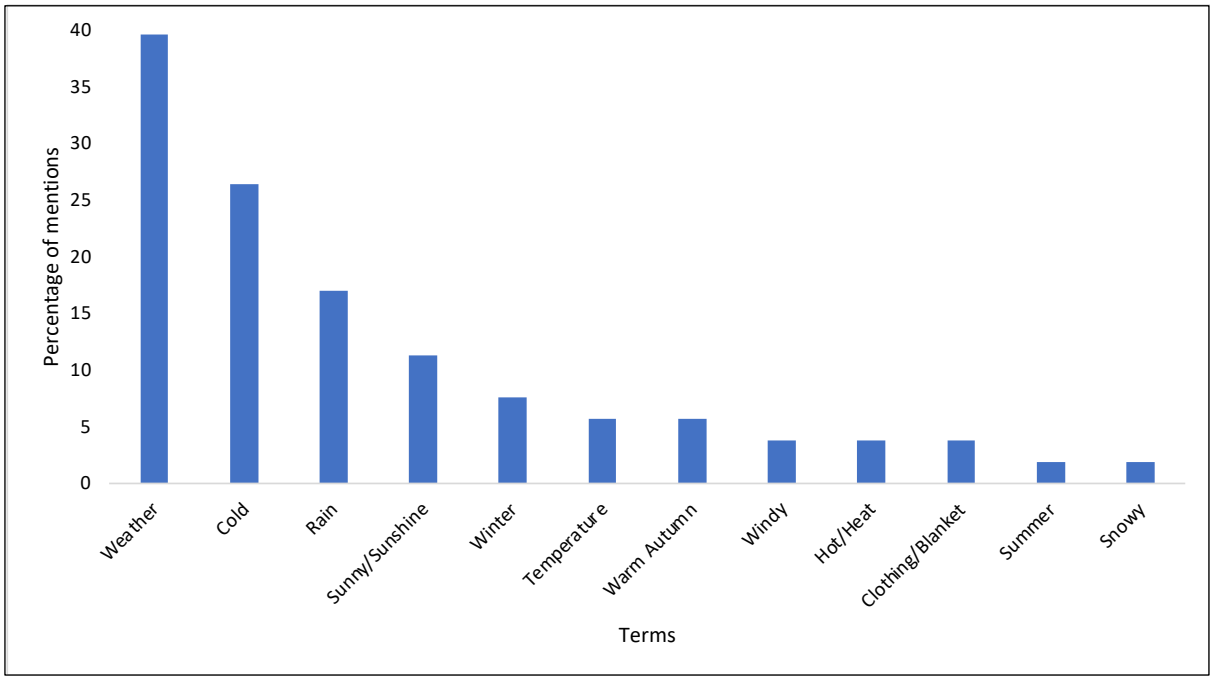


Figure 5.17: Proportion of commentary related to weather mentioned for Stockholm.

The low percentage of 'clothing' and 'blanket' mentions, appearing at a combined 3.8%, is reflected in a visitor's description where they

"Had a blast " (June 2023)

at ICEBAR despite needing to wear a big coat, suggesting that while the weather is a point of discussion, it is not always a barrier to customer satisfaction. (Figure 5.17). 'Rain' comprises of 17.0% of the mentions, reflecting their presence in the visitors' experiences (Figure 5.17).

5.4.3. London

The nocturnal activities in London are largely concentrated in the central area (Figure 5.18). The attractions on offer include historical buildings, parks, an assortment of museums, and a range of theatres. Popular nocturnal attractions of London include activities such as the 'London by Night Sightseeing Tour - Open top bus' and 'The Ghost Bus Tours,' starting at the Ritz Hotel adjacent to Green Park and the London Eye. Tours on offer include the 'Jack the Ripper Tour with 'Ripper-Vision'' and 'Ghastly Ghost Walking Tour', providing outdoor experiences of historical events. This tourist city is largely dominated by outdoor activities (Figure 5.18).

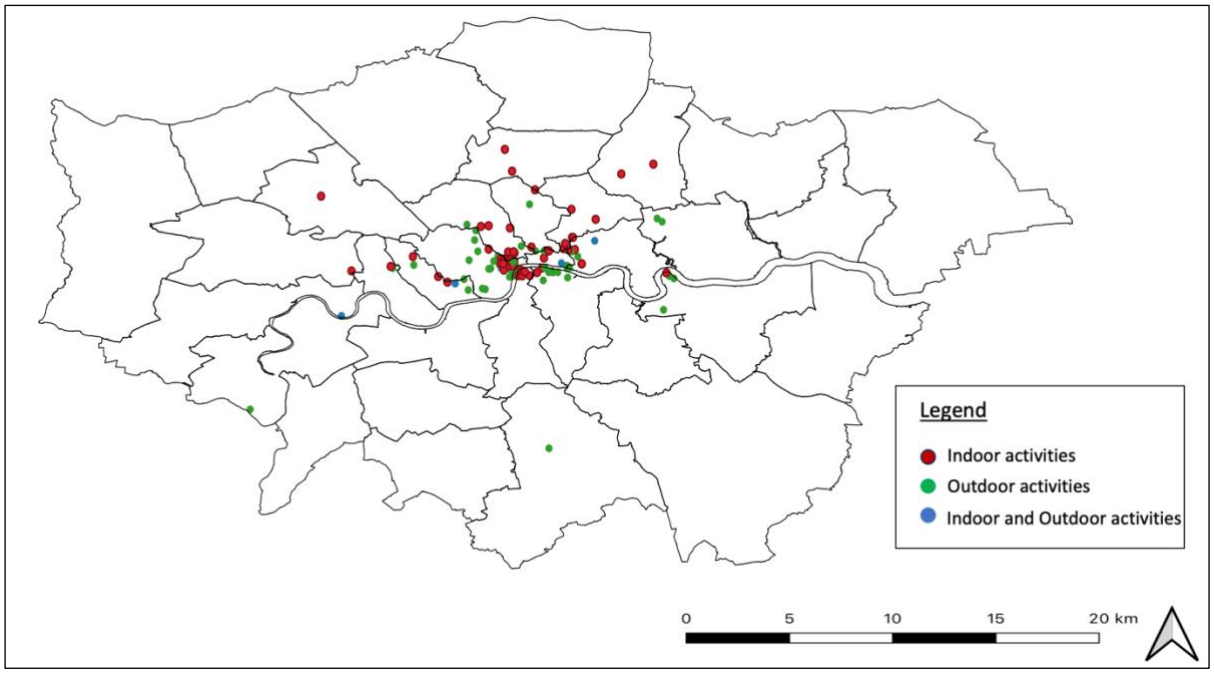


Figure 5.18: Night-time activities in the city of London listed on *TripAdvisor* and *Viator.com*.

In a comprehensive analysis of the dataset for London, a total of 2265 reviews is examined, revealing an awareness of weather conditions, night-time thermal comfort, and air conditioning amenities. Weather was mentioned in 55 reviews, indicating that visitors were

highly attentive to climatic conditions during their stay in London. One customer makes reference to the age of one their party's age and the effect the weather had on them:

> "very uncomfortable for one of our party who is 77 years old and now has a heavy cold due to the inclement weather" (May 2023)

which highlights the importance of tourism climate for people of all ages.

Night-time thermal comfort was a notable concern among guests, with 10 reviews specifically addressing the temperature and comfort levels during the evening. Comments such as

> " My only criticism is the venue: food and drink areas are open with little seating and with sub zero temperatures last night and no heaters, it was bitterly cold and uncomfortable waiting for doors to open" (December 2022).

at the Abba Arena and

> "The interior is chilly in winter as it's ventilated to the outdoor temperature, but small blankets are provided" (December 2022)

at the Sky Garden highlight the challenges experienced by visitors with thermal comfort on a night out.

Air conditioning emerged as a critical aspect of comfort for six reviewers, underscoring its importance in managing the indoor climate. Positive feedback like

> "…there is a bar and air conditioning which were both welcome on a hot Friday night" (August 2022)

showcases the impact of functional air conditioning units on enhancing the customer experience during warmer periods. However, not all experiences were positive, with some guests encountering challenges in achieving a comfortable indoor temperature, as shown by comments like

"The air conditioning is not able to keep up with all the people in the arena (It was about 80 degrees outside that day)" (June 2023).

These remarks highlight operational challenges and the essential role of air conditioning in ensuring a comfortable visit.

The terms ‘cold/chilly’ and ‘hot’ are the most frequently mentioned, each comprising 12.3% of all weather-related comments (Figure 5.19). This suggests that both high and low temperatures or the perception of heat or the cold are particularly important to reviewers. ‘Rain/wet’ and ‘weather’ are moderately mentioned, with 7.7% and 4.6% of the mentions, respectively (Figure 5.19). While rainfall is a notable aspect of the London climate, the cold or chilly weather seems to be more impactful on the visitors' experiences. Terms such as ‘sunny’, and ‘cloudy’ are much less prevalent, with each accounting for only 1.5% of the mentions (Figure 5.19). This lower frequency suggests that while these aspects are part of the weather narrative, they may be overlooked by the more impactful weather conditions highlighted by other terms. ‘Winter’ and ‘temperature’ are moderately mentioned at 3.1% each, indicating that sunny days are experienced but winters are a notable season for reviewers (Figure 5.19). Comments related to specific temperatures and the necessity for clothing or blankets are not as prevalent.

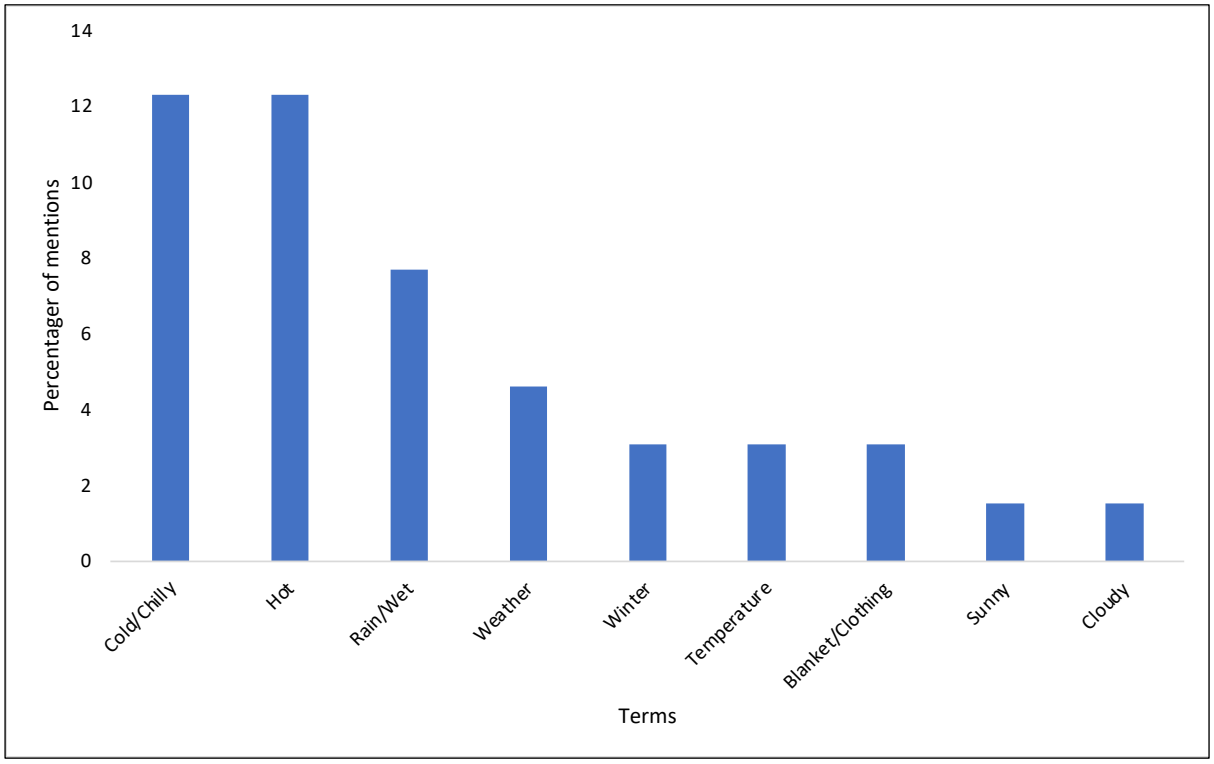


Figure 5.19: Proportion of commentary related to weather mentioned for London.

'Weather' received 4.6% of mentions, which indicates that weather as a general concept is of low importance in the tourist experience (Figure 5.19). The lower percentage for 'blanket' and 'clothing' mentions might imply that while weather conditions are mentioned, they do not frequently lead to reviews related to protective or thermal attire (Figure 5.19). This could suggest that visitors are generally well-prepared for the expected weather conditions or that the weather does not significantly disrupt outdoor activities.

5.4.4. Istanbul

The tourist attractions in Istanbul integrate both indoor and outdoor activities, situated mostly around the historical peninsula (Figure 5.20). The placement of indoor venues in proximity to the Sea of Marmara include institutions like the Grand Bazaar as well as other museums and markets (Figure 5.20). The nightlife predominantly focuses on culinary and cultural

experiences. Notable among these are the ‘Bosphorus Dinner Cruise’ and ‘Turkish Night Show’, alongside the ‘Istanbul Bosphorus Sunset Cruise on a Luxury Yacht’, all providing an outdoor experience. For indoor adventures, the performance of the ‘Whirling Dervishes at Hodjapasha’ demonstrates the spiritual offerings in Turkey.

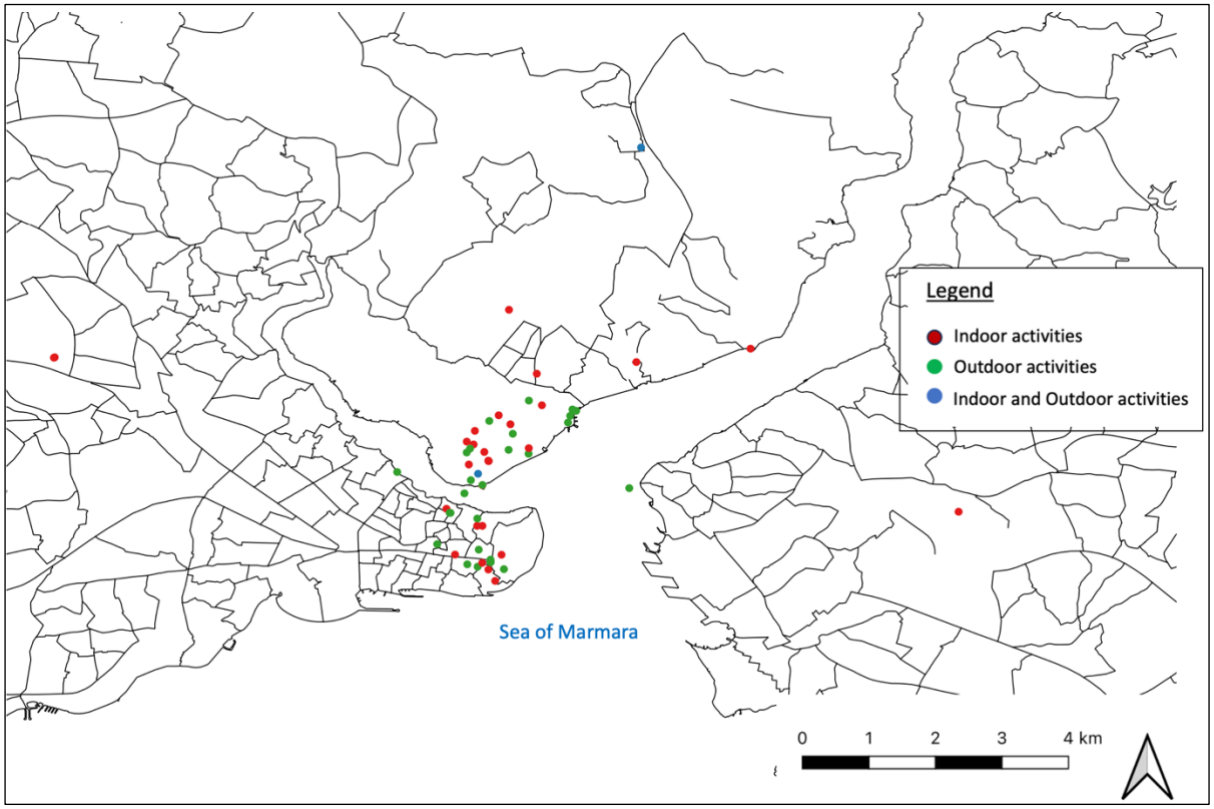


Figure 5.20: Night-time activities in the city of Istanbul listed on *TripAdvisor* and *Viator.com*.

The 22 reviews that mentioned the climate of the city gave balanced reviews with references to ‘cold weather’, ‘cool days’ and ‘sunny days’. For the 1616 reviews, only one visitor remarks about the cool temperatures at night

> “… it gets very cold in the evening” (October 2022)

and none made direct reference to air conditioning. The absence of air conditioning comments suggest that this was not a primary concern for visitors or that indoor venues met

visitors' expectations for thermal comfort. One review conveyed their experience during less ideal weather:

> "We sat inside as the weather was cool and overcast. Seats were comfortable and a good bar service..." (May 2023).

Another highlighted the advantage of favourable conditions,

> "Well worth the time. We rented a private yacht for a 2-hour cruise. The weather was great in the afternoon" (June 2022).

These contrasting experiences indicate that visitors' activities and enjoyment can be influenced by the weather.

The terms 'hot, 'heat' and 'warm' are most frequently used (39.1%), indicating that the warmth or high temperatures affect the reviewers' experiences in Istanbul (Figure 5.21). A visitor documents,

> "Going from the crowded and hot streets to the cool and quiet building..." (March 2023)

The terms 'cold' and 'chilly' also feature prominently with just over 25% mentions, reflecting the impact of cooler temperatures on the activities and possibly a seasonal variation in weather experiences (Figure 5.21). A reviewer describes getting out of bed on a

> "cold rainy day for this exquisite experience" (April 2023)

emphasizing that weather conditions are impactful.

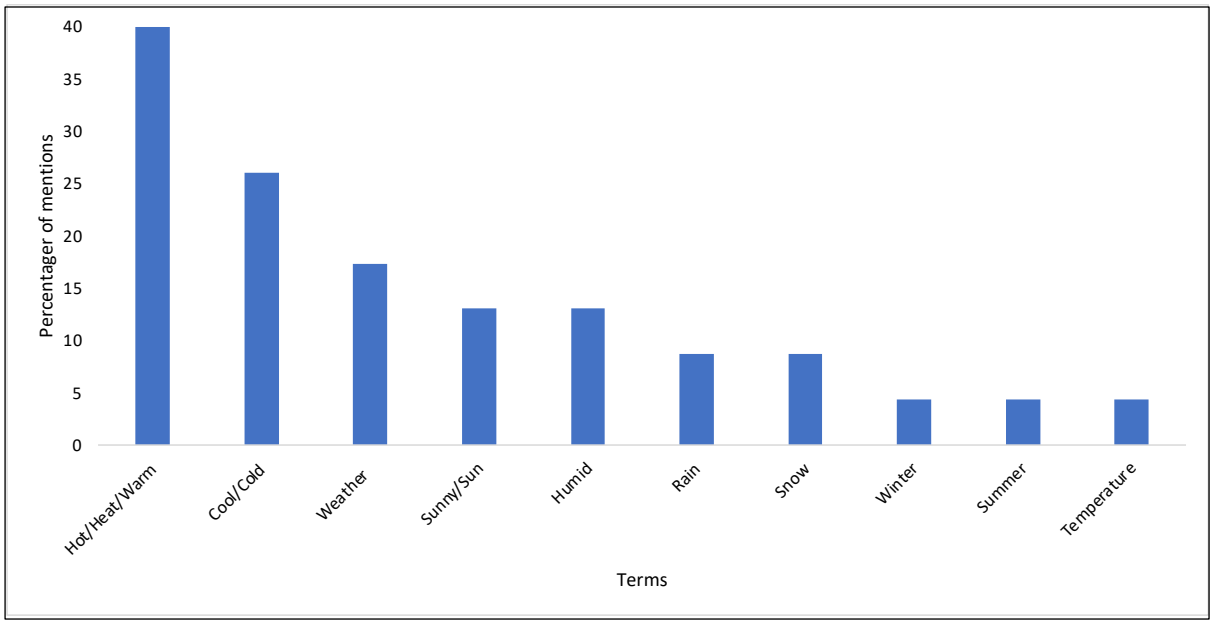


Figure 5.21: Proportion of commentary related to weather mentioned for Istanbul.

'Sunny', 'sun', 'humid', 'snow' and 'rain' are less frequently mentioned suggesting that while important, they may not define the weather experience as strongly as other temperature-related terms do (Figure 5.21). 'Winter', 'summer' and 'temperature' have the fewest mentions, indicating these are not the predominant focus of the reviewers' comments (Figure 5.21). This could be due to the nature of the activities reviewed or a lesser emphasis on these specific conditions within the reviews.

5.4.5. Paris

The high density of both indoor and outdoor activities within the central area of the city highlight the availability of cultural and historical activities in this area (Figure 5.22). The outdoor adventures largely comprise of pedestrian tours of the public gardens, historical monuments and architectural features. Conversely, the indoor pursuits include a diverse range of cultural institutions such as museums and theatres. This city offers unique experiences such as the nocturnal tour of the Eiffel Tower via lift mechanism, and cuisine cruises along the Seine

River with musical performances (Figure 5.22). Furthermore, the Louvre Museum provides limited night-time access, allowing for an indoor/outdoor experience.

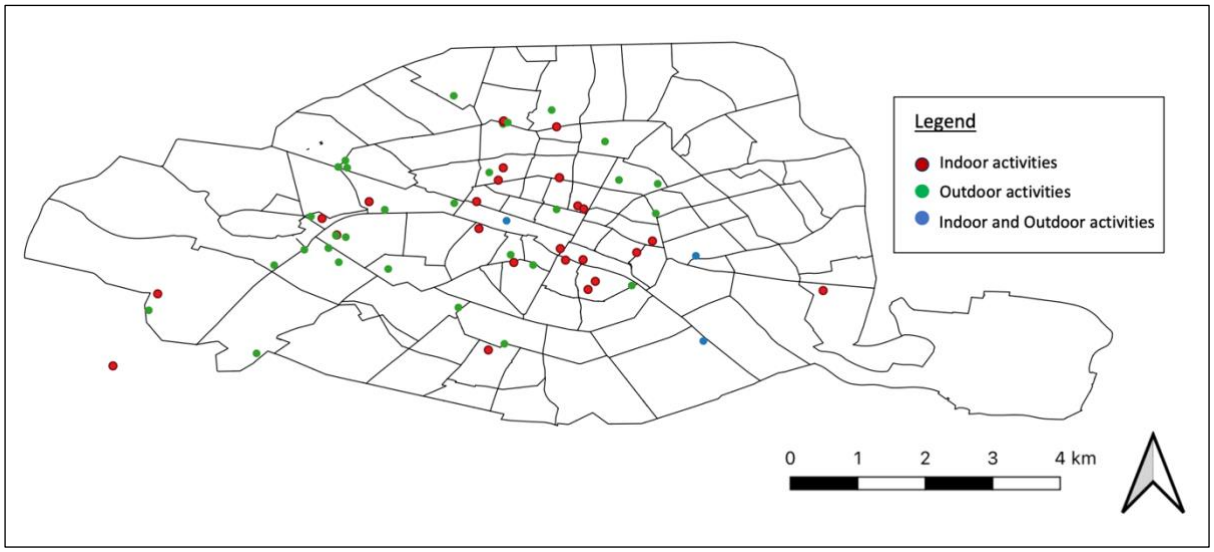


Figure 5.22: Night-time activities in the city of Paris listed on *TripAdvisor* and *Viator.com*.

In an analysis 1871 reviews for Paris, the city climate was featured in 90 reviews. The weather played a crucial role in shaping visitors' experiences, with many reflecting on how it impacted their satisfaction of outdoor attractions and evening activities. For example, one patron states:

> "The weather was warm" (August 2022)

but another visitor on the same 'Bateaux Parisiens Seine River Gourmet Dinner & Sightseeing Cruise' in the same month remarks

> "it was too cold on the boat (lucky me, I got a blanket from our waiter)" (August 2022).

Another reviewer highlights the crucial role of idea weather conditions for the outdoor tourist attraction 'Eiffel Tower' –

> "Go up at least once but wait for good weather" (May 2023)

There were 15 counts of night-time thermal comfort, which suggest that the visitor's overall satisfaction was not impacted by the minimum temperatures. For example, one visitor enjoyed the evening despite the weather, remarking,

> "Weather was balmy and ideal for viewing the city at night" (May 2023).

Another stated,

> "We boarded on a cold, rainy night, and felt snug, warm, and pampered the entire evening" (December 2022).

These accounts illustrate that, although the climate is acknowledged, visitors generally found the indoor climates of venues to be acceptable. A guest expressed contentment with the indoor atmosphere despite the less than ideal weather outside,

> "It was raining and chilly the night of the cruise. Despite that, the atmosphere on board was warm and inviting" (December 2022).

This sentiment is shared by another tourist:

> "We were so looking forward to this trip we sat by a window which was amazing for the view but a bit chilly which we could put up with" (December 2022).

Air conditioning was mentioned 11 times, highlighting the fact that guests may not have found the climates to be problematic at the venues, as suggested by a tourist who noted,

> "The only small negative was there was no AC. Since the temps were in the low 90s outside, it was very hot in the building (sweating level hot). However, most of Paris has no AC and the fantastic evening was well worth the heat, especially with a fan and some sort of portable air conditioning unit" (August 2022)

For the most part, visitors found the indoor climates of venues to be acceptable or that it did not strongly influence their overall impressions of the city. One visitor on a Seine dinner cruise noted,

> "the dining room gets HOT... the AC, if there was an AC system, couldn't keep up" (June 2023)

Another expressed disappointment not only with service but also mentioned that the

"AC was broken and it was very hot" (August 2022)

The combined terms ‘heatwave’, ‘hot’, ‘heat’ and ‘warm’ have the largest proportion, accounting for 36.2% of all weather-related comments, closely followed by ‘weather’ at 25.7% (Figure 5.23). This dominance indicates that warm temperatures significantly influence visitors’ experiences in Paris, potentially affecting their comfort and activity choices. The next most significant category is ‘rain’, ‘chilly’ and ‘cold’, accounting for 21% of the weather-related mentions, suggesting that precipitation and cooler temperatures are a common consideration for visitors (Figure 5.23). Other terms like ‘clothing’, ‘blanket’, and ‘temperature’ are mentioned less frequently, highlighting that these are not as significant in the reviews or are perhaps overshadowed by more extreme weather experiences (Figure 5.23). ‘Summer’ has the lowest mention percentage at 1.0%, which might suggest that specific temperature values are less impactful on visitors’ experiences or that they are simply not mentioned as explicitly as other, more qualitative descriptions of weather (Figure 5.23).

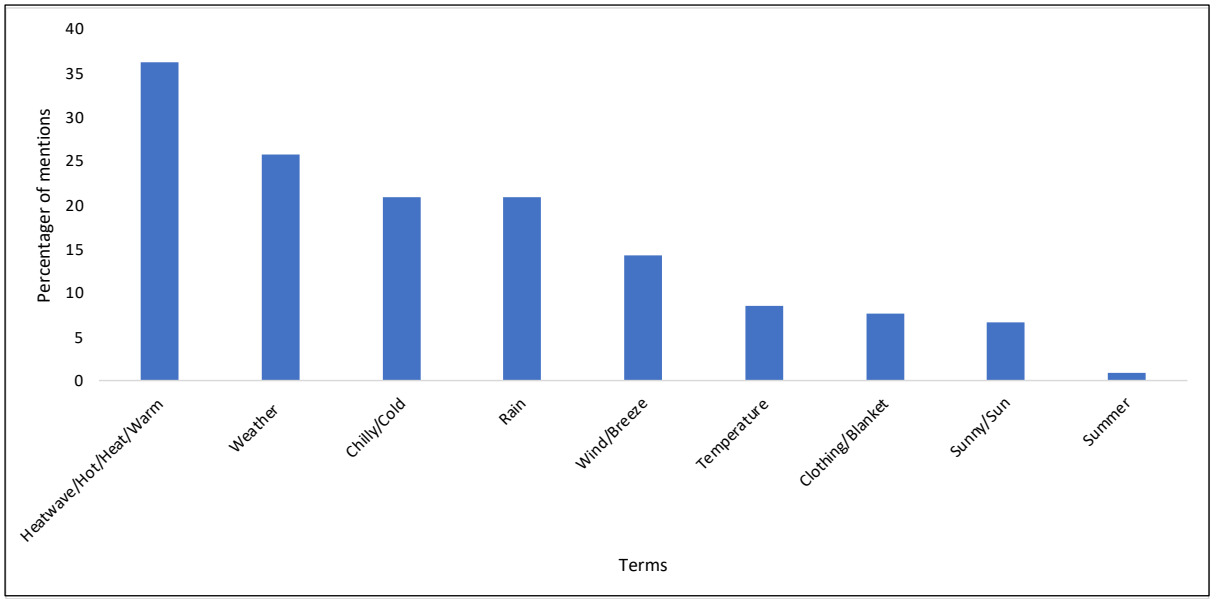


Figure 5.23: Proportion of commentary related to weather mentioned for Paris.

5.4.6. Rome

The nocturnal offerings of the city highlight the historical, religious and culinary tourism of the city incorporated within indoor, outdoor and hybrid activities (Figure 5.24). Some of these attractions include the Vatican Museums, Sistine Chapel and St. Peter's Basilica Tour. The outdoor activity of the 'Rome Colosseum by Night Guided Tour' is widely popular in the city Conversely, culinary adventures are experienced indoors during the 'Rome Twilight Trastevere Food Tour by Eating Europe' and '3 in 1 Cooking Class in Piazza Navona featuring Fettuccine, Ravioli, and Tiramisu'. Additionally, the 'Rome by Night with Pizza and Gelato tour', merges both indoor and outdoor spaces.

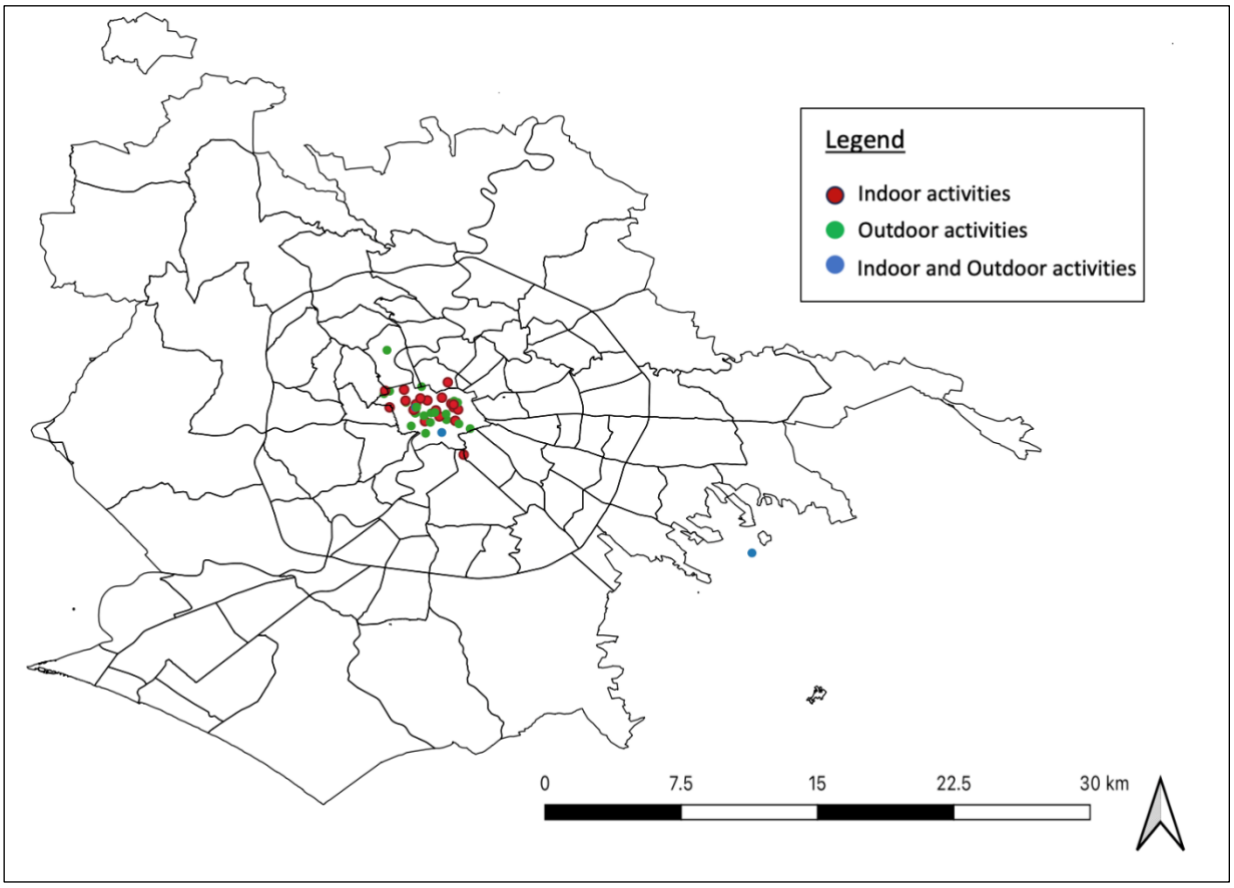


Figure 5.24: Night-time activities in the city of Rome listed on *TripAdvisor* and *Viator.com*.

Weather was a factor for visitors, with 22 mentions out of 1366 comments indicating a high sensitivity to climatic conditions during their stay. A comment from the reviews states:

> "We got lucky that the weather was nice, it was a few hours of walking outdoors between Campo di Fiore with the outdoor market" (April 2023).

This comment highlights how warm nights affect the experience of the cultural and historical offerings. Another visitor described their experience as exceeding expectations due to the pleasant evening weather:

> "A high quality and emotional performance of lovely Italian arias on an exceptionally beautiful rooftop terrace of Rome, overlooking San Pietro from afar, with the added sound of birds singing and church bells ringing in a soft breeze under the sunset skies of the eternal city" (May 2023)

This sentiment is further exemplified by another visitor who found the backdrop of Rome in the evening sun

> "perfetto" (October 2022)

during an opera performance. Comments like

> "This famous piazza has so much to offer... Probably the best time to go would be late afternoon when the temperature has cooled and the crowds have thinned" (May 2023)

underline the strategic planning that visitors engage in to enhance their experience. Such sensitivity to the weather conditions shows how integral the climate is to enjoying outdoor spaces and activities in Rome.

Night-time thermal comfort emerged as a significant aspect of visitors' experiences for six tourists. Comments such as

> "I know the weather was nice at that time and it was an evening over spring break" (March 2023)

emphasize the pleasure derived from warmer temperatures during nocturnal activities. Another guest remarked that an evening bike ride was the highlight of their Rome visit, stating

> "This ride was the best! To see so many Roman sites in the cool of the evening was incredible!" (October 2022).

Similarly, a tourist comments on the aesthetics of the weather in combination with the nocturnal activity,

> "This is a nice square with bars and restaurants; plus some entertainment. The sun is lovely in the evening. However, it is very busy and pretty expensive to drink etc" (October 2022).

Although air conditioning was not explicitly discussed in the reviews, managing indoor climate is a concern for all major cities which aim to satisfy visitors' climatic requirements. The low volume of comments indicate that venues in Rome generally meet visitors' expectations for thermal comfort, allowing them to focus on the nocturnal attractions or visitors did not deem it important enough to mention.

A considerable emphasis is placed on the terms 'hot' and 'weather', which comprises 38.1% and 28.6% of all weather mentions, respectively (Figure 5.25). This indicates that heat is an aspect of the experiences shared by visitors, potentially reflecting the climate of the city during peak tourist seasons or during an event of warm temperatures. The 'sun' is also prominent in the dataset, with 19% of the mentions (Figure 5.25). 'Cool' temperatures comprise of 9.5% of the weather mentions, which may highlight tourism during the cooler times of the year or the evenings when temperatures drop (Figure 5.25). 'Rain' and 'hail storm' are also an important part of the weather narrative in Rome, each accounting for 9.5% of the mentions, suggesting that precipitation is a relevant factor of visitors' experiences (Figure

5.25). The mentions of ‘summer’ at 4.8% show the recognition of the season, possibly related to vacation timing and expectations for the weather (Figure 5.25). The low percentages for ‘breeze’ and ‘temperature’, each at 4.8%, indicate that these conditions are not as important for reviewers or that they do not highly influence the activities as other terms do (Figure 5.25).

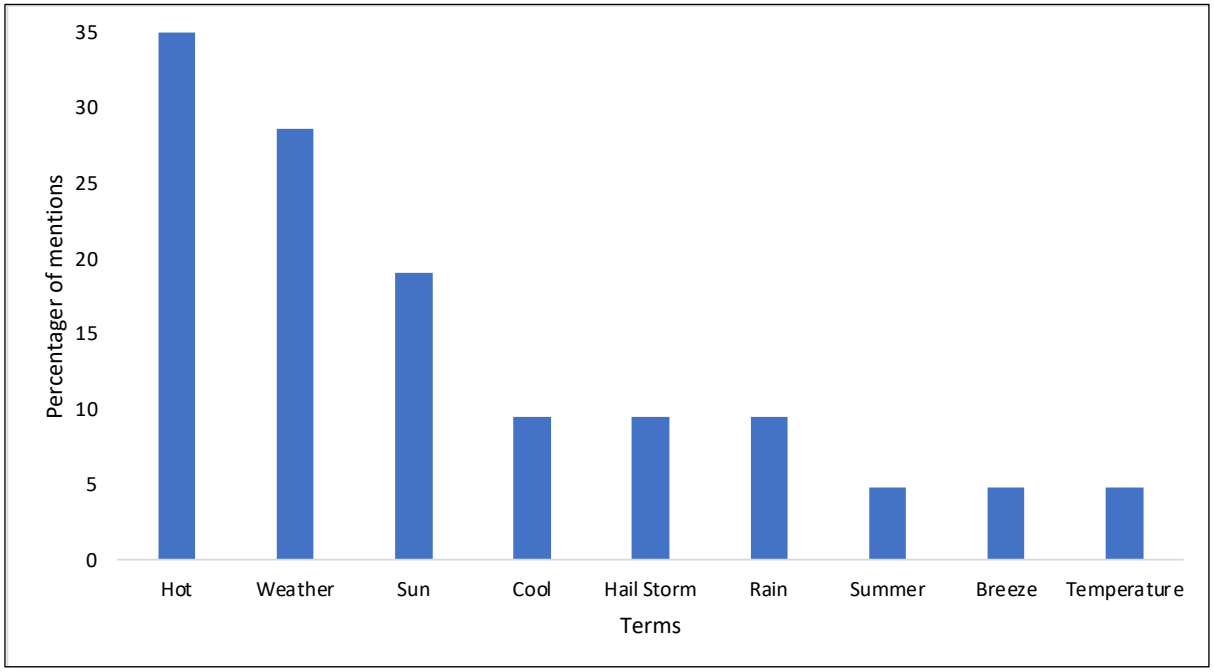


Figure 5.25: Proportion of commentary related to weather mentioned for Rome.

Although climate is not frequently mentioned in reviews, where it is, the presence of and functionality of air conditioning does come up, as does night-time thermal comfort. Moreover, reviews indicate that people do not spend their nights confined to their hotel rooms. Therefore, even if an hotel accommodation establishment is listed as having air conditioning, it is still worth including night-time thermal comfort in the HCI_{Urban}.

5.5. Evaluation of climate variability using previous climate records

This section focuses on variations in temperature, especially at night, and the implications for thermal comfort. Climate data for each city, for the time period 1992-2022 was analysed to extract key temperature readings. The 30-year climate data was included to illustrate the historical variations in climate and to identify extreme events that may have impacted tourism during those periods. The consideration of minimum temperatures also gives insight into past night-time thermal comfort scenarios. This long-term analysis provides essential context for understanding potential influences on tourist behaviour. Due to the lack of adequate data for the most recent six months of the study period (January 2023 - June 2023), the focus was placed on the more comprehensive historical dataset. The highest maximum and lowest minimum temperatures, the number of months surpassing certain warmth exploratory thresholds (15°C, 20°C, and 25°C), and the frequency of temperatures falling below cold exploratory thresholds (5°C, 0°C, -5°C, and -10°C) is identified. Additionally, the analysis determined the number of months experiencing certain diurnal temperature ranges (>10°C, >15°C, and >20°C), highlighting the variability between day and night temperatures. Notably, London, Istanbul and Rome were not included in this section due to the limited maximum and minimum temperature recordings which would not provide meaningful insights.

5.5.1. Barcelona

The highest and lowest maximum temperature recorded was 32.8°C in August 2003 and 10.3°C in December 2010 (Figure 5.26). The highest and lowest minimum temperature experienced was 24°C in July 2015 and 1.9°C in February 2012 (Figure 5.26). In Barcelona, out of 372 months analysed, 143 months (38.4%) experienced minimum temperatures above 15°C (Figure 5.26). Conversely, minimum temperatures above 20°C were less frequent,

occurring in 61 months (16.4%) of the observed period (Figure 5.26). Minimum temperatures below the 5°C threshold is observed for 28 months, affecting only 7.5% of the time period (Figure 5.26). The diurnal temperature range, representing the difference between the highest and lowest temperatures of the day, stayed below 10°C for 365 months. Notably, there were no instances where the diurnal temperature range exceeded 15°C or 20°C, signifying a relatively stable temperature variation throughout the day.

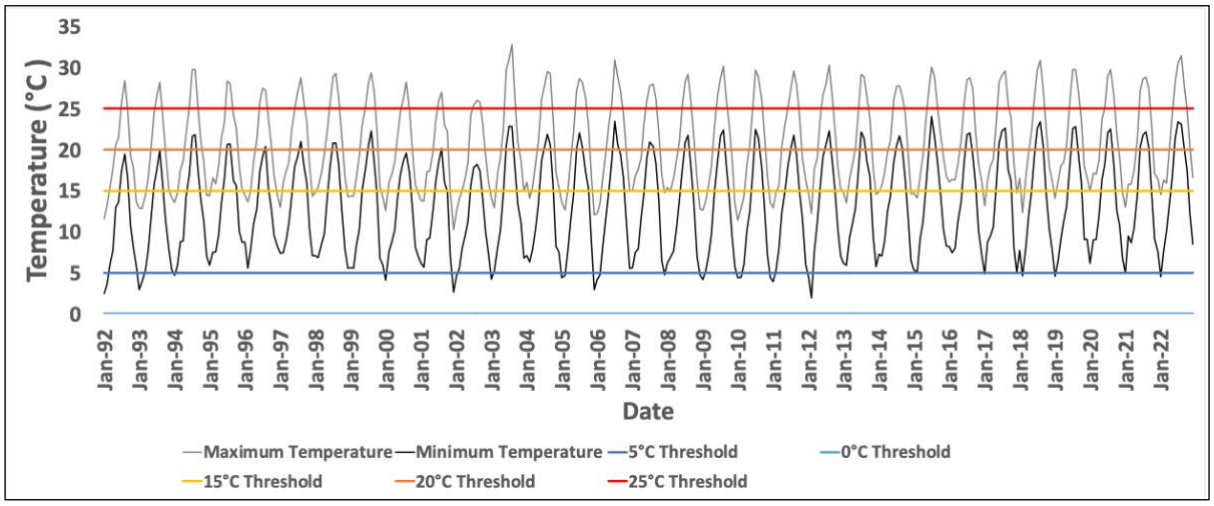


Figure 5.26: Temperature trends overtime for Barcelona.

5.5.2. Stockholm

Stockholm observed a mean minimum temperature of approximately 3.6°C, with the lowest and highest recorded minimum temperatures being -11.3°C in February 1996 and 16.2°C in July 2010, respectively (Figure 5.27). The lowest and highest maximum temperature reached was -5°C in January 2010 and 27.7°C in July 1994, respectively (Figure 5.27).

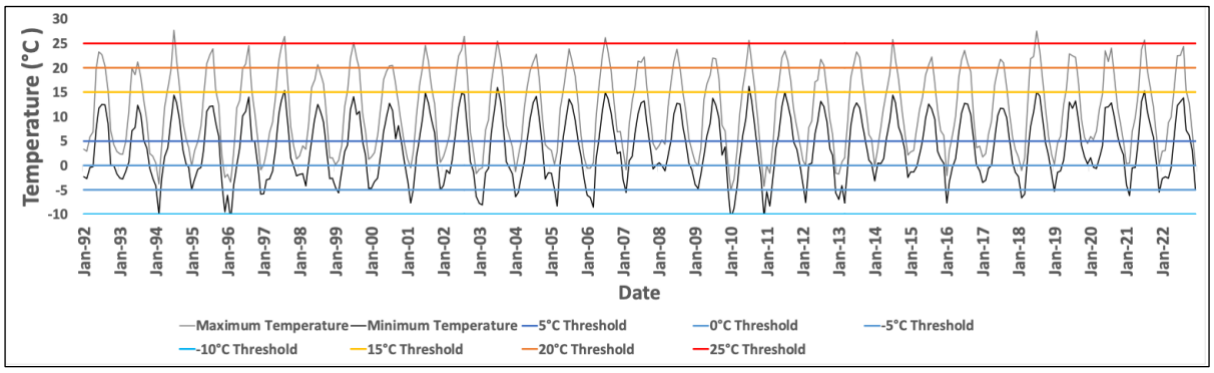


Figure 5.27: Temperature trends overtime for Stockholm.

During the observed period, temperatures rarely reached warmer thresholds at night. Specifically, only six months experienced minimum temperatures above 15°C, accounting for 1.6% of the time period, with no instances of night temperatures warmer than 20°C or 25°C (Figure 5.27). Colder nights are frequently observed: 212 months had temperatures below 5°C (Figure 5.27). More severe nights, with temperatures dropping below 0°C, occurred in 126 months (33.9%) and even colder conditions, below -5°C, were recorded for 34 months (9.1%; Figure 5.27). Extremely cold nights, with temperatures below -10°C, were rare, observed only for three months (0.8%; Figure 5.27).

The analysis also highlighted significant day-to-night temperature shifts in Stockholm, with 65 months (17.5%) experiencing a diurnal temperature range of less than 5°C (Figure 5.27). However, 84 months (22.6%) experienced diurnal ranges greater than 10°C (Figure 5.27). Despite this variability, the temperature range never exceeded 15°C or 20°C (Figure 5.27).

5.5.3. Paris

The recorded temperatures in Paris fluctuated between a low of 2.6°C in December 2010 to a high of 30.5°C in July 2006, demonstrating the diversity in maximum temperatures experienced (Figure 5.29). The highest and lowest minimum temperature recorded was 17.9°C in July 2006 and -1.93°C in January 1997, respectively (Figure 5.29).

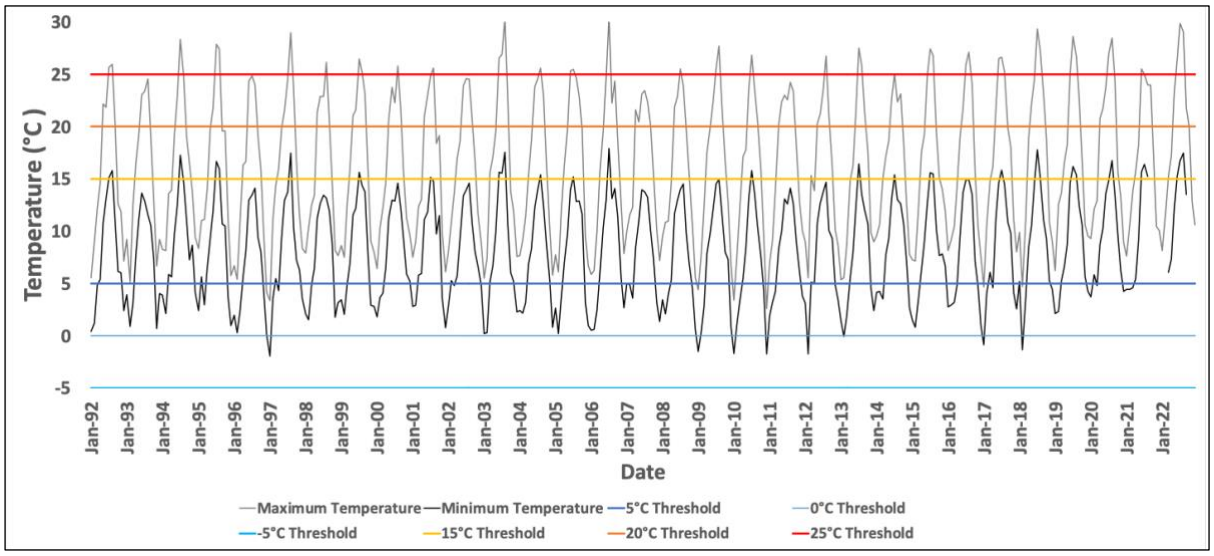


Figure 5.28: Temperature trends overtime for Paris.

Among the months analysed, only 31 experienced minimum temperatures over 15°C, demonstrating relatively few warm nights throughout the year (Figure 5.29). Conversely, colder conditions were more common – 122 months (33.6%) recorded minimum temperatures below 5°C and eight months dropped below 0°C (Figure 5.29). This data indicates that Paris faces a large amount of cold weather.

The variability in daily temperatures is further evidenced by the diurnal temperature range – 108 months had ranges exceeding 10°C. Meanwhile, 25 months (6.9%) had diurnal ranges under 5°C (Figure 5.29).

From the records accessible, 69 months presented minimum temperatures above 15°C, accounting for 34.2% of the time period (Figure 5.30). This indicates that more than a third of the time, nights in Rome tend to be warm. Warmer nights, with temperatures surpassing 20°C, occurred in eight months, representing 4.0% of the time period (Figure 5.30).

Cold conditions were less frequently, where 43 months (21.3%) experienced temperatures below 5°C. The diurnal temperature range exceeding 10°C was presented for 83 months (Figure 5.30). However, extreme day-to-night temperature shifts were rare, only one month (0.5%) had a diurnal range over 15°C and there were no occurrences of ranges beyond 20°C (Figure 5.30).

Stockholm, characterized by frequent cold nights, contrasts with the warmer temperature readings of other cities, where minimum temperatures frequently exceed 15°C, indicating warmer nights. Paris experiences colder nights with significant temperature variability and more frequent cold temperatures, while Barcelona observes warmer nights. Barcelona also has evidently warmer winters and relatively stable day-to-night temperature variations, with most months experiencing diurnal temperature ranges of less than 10°C. The diurnal temperature ranges reveal that Paris exhibits greater variability in day-to-night temperatures compared to Stockholm and Barcelona, which show more stable temperature ranges.

The data spanning a 30-year period reveals that the temperature variances experienced across these European cities can be quite pronounced and subject to significant fluctuations. This observation emphasises the critical role of climate in shaping the thermal environment of indoor spaces, and consequently, the crucial function that air conditioning systems serve in regulating these conditions. The importance of the climate extends beyond comfort within indoor settings, it also influences the patterns of social and recreational activities, particularly in the evenings. While the direct impact of climate on nocturnal activities might seem less apparent, it can dictate the willingness of individuals to engage in such pursuits. Pleasant evening temperatures can enhance the appeal of outdoor events and cultural experiences, which are often crucial components of the tourist experience. Conversely, if the evenings are too cold or uncomfortably hot, it may deter people from participating in nightlife and outdoor events, shifting the focus towards indoor activities where climate control is manageable.

The climate of a region is an important factor in destination selection as it affects the date of visit as well as tourist activities participation. It is crucial to consider temperatures throughout both the daytime and night-time. Many of these cities offer tourist activities that are the sole reason for tourist visits' and occur after sunset when the temperatures have dropped. An analysis of climatic suitability for tourism needs to be cognisant of night-time tourist activities to be able to provide prospective visitors with climatic information that may affect their experience and overall satisfaction.

5.6. Conclusion

The findings from this chapter show that the exclusion of night-time thermal comfort Scott *et al.* (2016a) in their analysis was incorrect and oversimplistic. The study highlights a variability

in air-conditioned hotel accommodation establishments across Istanbul, Barcelona, Rome, Stockholm, London, and Paris, disputing the assumption that air conditioning is even widely available in the locations the HCI_{Urban} was based on. These six cities do not offer reliable air conditioning, as evidenced by *Booking.com* data and *TripAdvisor* reviews, where tourists express concerns over the functionality of air conditioning and night-time thermal comfort in hotel accommodation establishments. Furthermore, it is crucial to recognize that tourists often partake in a variety of activities outside their hotel accommodation establishments during the night, which are also influenced by climatic conditions. The analysis emphasizes the importance of considering diurnal temperature ranges when investigating climatic suitability of a tourist destination to determine how these factors affect both indoor and outdoor night-time tourist experiences.

CHAPTER 6: DISCUSSION

6.1. Introduction

This study sought out to determine if the exclusion of night-time thermal comfort in the HCI index developed by Scott *et al.* (2016a) was based on valid assumptions and aligned with tourists' experiences. The literature review (Chapter 2) examines the relationship between tourism and climate, tourism climate indices, indoor and outdoor thermal comfort as well as the intercomparisons between indices. The results obtained in this study demonstrate that air conditioning is not as ubiquitous in the European cities for which the HCI was developed as claimed by Scott *et al.* (2016a), and that climate during both the day and night are important to travelers. The results also demonstrate the wide diversity of night-time activities that take place outside of hotels in these cities. This study demonstrates the necessity of validating indices, and that it is possible through a netnographic approach to develop more accurate tourism climate indices.

This discussion chapter first reflects on how air conditioning is not ubiquitous in the six study locations and the implications this has on the validity of the HCI. The reviews from *TripAdvisor* and the results obtained from *Booking.com* suggest that the scores produced from the HCI_{Urban} are unrepresentative for both developing and developed countries as thermal discomfort at night is experienced in both. The potential harms that can arise from ignoring night-time thermal comfort in the tourism sector are then examined. The disregard of thermal comfort can result in serious health risks such heat stress, dehydration and lack of sleep. The literary traps of indices are also discussed. The use of indices without validation and prior testing of applicability is a problem that researchers have identified, which results in

inaccurate data communicated to tourism stakeholders and tourists. Finally, the limitations to this study are examined.

6.2. Evaluating the validity of the index

In developing the HCI, a critical assumption was made regarding the availability of air conditioning in hotels, which was argued to negate the need for the inclusion of night-time thermal comfort: "in the 30 years since the TCI was developed, air conditioning has become almost universal in tourist accommodations in developed countries and major tourism destinations in developing countries" (Scott *et al.,* 2016a: pp 16). This assertion has previously been challenged in the southern African countries of Zimbabwe and Namibia, where air conditioning is particularly scarce, and electricity is often interrupted (Noome and Fitchett, 2019; Mushawemhuka, 2021). However, until now it has been taken as fact that air conditioning is indeed 'almost universal' in the six cities for which Scott *et al.* (2016a) used to develop this index. This study is the first to interrogate this, and the results reveal that air conditioning is not ubiquitous in any of the six cities. This discrepancy has significant implications for the validity of the index on a local and global scale.

Through exploring the hotel accommodation listings across the six European cities, the data demonstrate that between 28.8% for Stockholm and 98.9% for Rome of hotel accommodation establishments have air conditioning (Table 5.1, 5.2 and 5.3). This undermines the assumption that night-time thermal comfort is not necessary to include in the HCI_{Urban}, or indeed any tourism climate index, because air conditioning would allow tourists to control their indoor thermal environment (Randazzo *et al.,* 2020; Chung, 2024). This finding regarding the relative presence and absence of air conditioning across tourism

accommodation establishments in the six cities which Scott *et al.* (2016a) explored in developing the HCI_{Urban} indicates that the concerns regarding the validity of the index in regions of southern Africa are a much broader concern to the use of the index globally. Indeed, it demonstrates that the assumption only holds true, and therefore the index outputs are only valid, in instances where tourists are staying in hotel accommodation establishments that do have air conditioning, and where such air conditioning extends to the individual bedrooms of the hotel to ensure night-time thermal comfort.

Depending on the way a tourist uses the *Booking.com* and similar booking sites, they will receive different information on the availability of air conditioning. For example, the air conditioning filter (Table 5.3) yields different results to a manual investigation of all listings for mention of air conditioning if the filter is not applied. The variation exhibited on the website can be an indication that air conditioning availability, in reality, is also not uniform. In addition, it further limits the ability of tourists to effectively select hotel accommodation for which their night-time thermal comfort would indeed not be a problem. For these reasons, indices that incorporate night-time thermal comfort, whether directly through an inclusion of a night-time variable, or more indirectly through the inclusion of a 24-hour variable, are indeed more accurate in evaluating the climatic suitability of a destination, both in the six European cities of interest, and more broadly (Prinsloo and Fitchett, 2024).

The assumption regarding the universality of air conditioning is further problematic, in that for it to secure night-time thermal comfort, it would require that tourists spend their evenings in their air-conditioned hotel rooms. If individuals are predominantly confined to their hotel rooms, the role of in-room amenities, such as air conditioning, becomes even more important

(Kashif *et al.,* 2017). However, in exploring *TripAdvisor* reviews, this notion is similarly disproven. Tourists reflect on a wide range of activities that are on offer outside the hotel room that take place at night (Section 5.4). The night-time economy of these six cities largely contributes to their GDP and is a prominent draw-card for tourists all around the world (Nofre *et al.,* 2020). This includes activities ranging from night-time walks to restaurants and theatres. Not all of these attractions will have indoor air conditioning, and in travelling to and from the attraction, the tourist might not have access to any kind of thermal regulation assistance. The inherent assumption that individuals spend all their time in their hotel rooms does not capture the diversity of the activities in the cities as well as the preferences of the tourists during the night-time (Nofre, 2021). It is essential to consider that hotel guests do engage in various activities outside their rooms, which the index does not account for, ultimately yielding unrepresentative scores for tourists predominantly interested in the city night life. This calls for a more integrated approach to incorporating and understanding the full extent of the tourists' experiences.

Without a clear methodology, it is challenging to assess the accuracy of the responses and the conclusions drawn from them (de Freitas, 2003). The assumptions regarding air conditioning availability and night-time thermal comfort may have been influenced by biased or incomplete data (Bigano *et al.,* 2006; Ma *et al.,* 2021a). The overall weighting and variables included in the index are also problematic. The index assigns weights to various factors that influence comfort levels, but these weights may not accurately represent their impact (Mushawemhuka *et al.,* 2020; Mushawemhuka, 2021). Additionally, the selection of variables included in the index was based on tourism literature that conducted surveys but may not have fully captured all the factors that contribute to satisfactory climatic suitability for

modern urban tourism. A more comprehensive and balanced approach to weighting and variable selection is needed to improve the accuracy and applicability of the index. The HCI deemed thermal comfort – a combination of mean relative humidity (%) and daily maximum temperature (˚C); cloud cover (%); and a combination of precipitation (mm) and wind speed (km/h) as important for urban tourism (Scott *et al.,* 2016a).

While the index purports to be more accurate than Mieczkowski's (1985) TCI in that it considered tourists' experience by means of a questionnaire, the exclusion of night-time thermal comfort suggests that people do not have complaints relating to temperature during the night-time or might not have been considered by the authors at the time. The results of the *TripAdvisor* analysis reveal that temperature is indeed an important factor for guests especially at night when trying to sleep. Through the comments on *TripAdvisor,* it is revealed that many tourists were not satisfied with the thermal conditions, both hot and cold, during the night. Several tourists commented on the lack of blankets, warm sheets and heating systems which led to a lack of or uncomfortable sleep during their stay. Moreover, tourists also complained about hot temperatures at night as well and the thermal discomfort they experienced due to malfunctioning air conditioning units. This suggests that not only is night-time thermal comfort important but that the questionnaire responses may not have captured all of the views of the tourists (Craig and Feng, 2018; Craig, 2019). *TripAdvisor* in no way captures all tourists' views, but the reviews, which are self-directed provide valuable insight into the tourist experience.

Where air conditioning is available, reliability of these systems may be an issue (Pezzutto *et al.,* 2016; Ni and Bai, 2017; Randazzo *et al.,* 2020). The results indicate that even if the hotel

accommodation establishments are fitted with air conditioning, some units did not function properly. This inconsistency impacts the comfort and satisfaction levels of individuals, reducing the assumed benefits of air conditioning availability (Cardoso *et al.,* 2012). The malfunctioning or diminished performance of air conditioning systems introduces a critical variable that must be accounted for in the index. The assumption that air conditioning presence equates to enhanced comfort is therefore flawed if the systems are unreliable (Sekhar, 2016; Xia *et al.,* 2019; Zhang *et al.,* 2022). This highlights the need for a more detailed examination of not just the presence of air conditioning but also the operational efficacy.

Through the analysis of hotel accommodation booking sites and tourists reviews, this research demonstrates that the key assumption of Scott *et al.* (2016a) in excluding night-time thermal comfort from the HCI_{Urban} is indeed invalid, thus compromising the index as a whole. Air conditioning is not ubiquitous in the European cities for which the index was developed and even if it was, this assumption requires that the air conditioning functions at optimal levels consistently and that tourists spend their entire evenings inside. This is in contradiction with tourists' self-reported experiences. Moreover, the absence or malfunctioning of the air conditioning units could lower comfort and satisfaction scores (Kwok *et al.,* 2017; Zhang *et al.,* 2022, 2023), while favorable night-time temperatures could potentially increase them.

6.3. Implications for the use of the HCI in Socio-economically Developing Regions

There has been a significant uptake in the use of the HCI since its development, including countries such as Canada and the Caribbean (Rutty *et al.,* 2020), China (Haomin *et al.,* 2020; Yu *et al.,* 2021, 2022), Georgia (Amiranashvili *et al.,* 2021a, b), Iran (Arbabi *et al.,* 2018; Hejazizadeh *et al.,* 2019; Sobhani and Danehkar, 2023) and the Mediterranean (Demiroglu *et*

al., 2020). While the TCI and other indices such as the CCI which include night-time thermal comfort remain in use, it is important to reflect on the potential impact of the use of an index that omits a key variable. Mushawemhuka (2021) adopts a multi-index approach comparing the TCI and HCI to explore the climatic suitability for Zimbabwe, and with the use of interview responses, determined which index between the two is the most appropriate to use. The study found that the HCI over-estimated the climatic suitability for this African country and many of the accommodation establishments did not have widespread access to air conditioning units (Mushawemhuka *et al.,* 2018, 2020; Mushawemhuka, 2021). Hejazizadeh *et al.* (2019) also applied the TCI and HCI for Iran and found that although the indices produced similar scores in certain months, the HCI is not an appropriate index to use in a hot desert region. These regions often experience extreme temperatures throughout the year, particularly during the summer months. The lack of air conditioning units in such regions, due to their economic status, means that the population must rely on natural ventilation or other less effective means to manage heat (Kashif *et al.,* 2017; Pavanello *et al.,* 2021; Sherman *et al.,* 2022). Consequently, the assumption that air conditioning is universal and functioning in all locations undermines the applicability of the index in these contexts.

In regions such as Zimbabwe, Iran and South Africa, where daytime temperatures can rise to high levels, the absence of air conditioning units exacerbates the heat stress experienced by individuals especially due to the need to cool down at night (Heidari *et al.,* 2015; Mushore *et al.,* 2017; Ngwenya *et al.,* 2018; Ncongwane *et al.,* 2021). The lack of consideration of air conditioning units and night-time temperatures means that the HCI_{Urban} cannot be applied on a global scale, especially in hotter impoverished countries (Mushawemhuka, 2021). Even if these countries have air conditioning, blackouts are an issue currently experienced in

southern African countries such as South Africa (Bonga and Sithole, 2020; Mushawemhuka *et al.,* 2020; Aweke and Navrud, 2022). The HCI tends to over-exaggerate the scores produced due to the high temperatures experienced in various regions, resulting in more ideal scores than what is experienced. This inflation occurs because the index does not adequately account for the extreme heat conditions prevalent in regions where the healthcare systems are less developed and ones that cannot afford to install air conditioning (Mushawemhuka, 2021). By assuming that air conditioning is universally available, the HCI_{Urban} provides a skewed perception of thermal comfort, suggesting higher comfort levels than what is truly experienced by individuals in hotter climates. This leads to: the exclusion of heat stress on vulnerable populations that do not have access to air conditioning; challenges in areas with air conditioning that face power failures during heat events thus rendering air conditioning systems useless; the reliance on air conditioning also has environmental impacts such as the contribution of GHGs which in turn exacerbates climate change and increases temperatures; the promotion of air conditioning by this index can also exacerbate the urban heat island (UHI) effect thus increasing outdoor thermal discomfort. Moreover, the promotion of the HCI needs be analyzed as it is mostly argued as a more appropriate index by the same authors who developed it (Noome, 2020; Rutty *et al*., 2020, 2021).

The lack of night-time thermal comfort in the HCI is a challenge but if it were to be reincorporated into the index, it ostensibly reverts back to the TCI (Mieczkowski, 1985; Scott *et al.,* 2016a). The TCI focuses on the overall tourist experience, which includes various factors beyond thermal comfort, such as nature-based activities (Mieczkowski, 1985). By contrast, the HCI aims to provide a more focused measure of thermal comfort, particularly during the hottest parts of the day (Scott *et al.,* 2016a). Night-time temperatures can indeed be lower

and more comfortable, but they do not mitigate the extreme heat experienced during the day (Ibsen *et al.,* 2022). The aim of the HCI was to differentiate from the TCI but it only assesses daytime thermal comfort, particularly in hotter regions where daytime heat stress is a significant concern and neglects night-time thermal comfort (Scott *et al.,* 2016a; Rutty *et al.,* 2020).

The exclusion of night-time thermal comfort also poses risks to the destination image and long-term sustainability of tourism destinations (Scott *et al.,* 2012b; Stepchenkova and Mills, 2010; Leković *et al.,* 2020). The scores produced by the HCI_{Urban} and indices that exclude night-time thermal comfort do not accurately reflect the actual thermal conditions experienced by tourists, particularly during the night. Tourists then arrive with expectations that do not match the reality due to the unrepresentative scores produced (de Freitas *et al.,* 2008; Buzinde *et al.,* 2010). This misrepresentation can lead to negative perceptions and experiences, which are often shared on platforms such as *TripAdvisor* and through word of mouth, damaging the reputation of the tourist destination (Jalilvand *et al.,* 2012; Papadimitriou *et al.,* 2018; Widayati *et al.,* 2020). Platforms like *TripAdvisor* amplify these negative experiences and can deter future visitors. A decline in tourist arrivals will have economic impacts for the destination, affecting local businesses and the broader tourism sector (Liang and Xue, 2021). Ensuring that climate indices accurately reflect all aspects of thermal comfort, including night-time conditions, is crucial for maintaining a positive destination image and ensuring long-term viability.

Scott *et al.* (2016a) placed significant emphasis on tourist questionnaires that were used to gather data for the development of the index. However, they did not provide detailed

information on how these questionnaires were conducted or how the assumptions of the resulting assumptions were formulated. This lack of transparency raises questions about the validity and reliability of the data collected (Perch-Nielsen, 2010; de Freitas and Grigorieva, 2017; Fitchett and Meyer, 2023), particularly as these results are not consistent with self-reported experiences of tourists posted on *TripAdvisor*.

6.4. Harms of neglecting night-time thermal comfort

The exclusion of night-time thermal comfort in the HCI has significant implications for the overall assessment of climatic suitability for tourism (Mushawemhuka, 2021). Night-time thermal comfort is crucial for tourists' overall experience, particularly as it affects sleep quality and subsequent daytime activities (Song *et al.,* 2020; Tsang *et al.,* 2021). The inability to sleep comfortably due to high night-time temperatures can lead to a range of negative health outcomes, including both physical and mental health issues such as anxiety, depression and inability to sleep (Coccolo *et al.,* 2016; Afonso *et al.,* 2017; Zhang *et al.,* 2017; Song *et al.,* 2020). The exclusion of this variable results in misleading conclusions about the climatic suitability for tourism.

The health risks associated with extreme heat at night vary due to various factors such as age, gender and geographical location (Obradovich *et al.,* 2017; Buguet *et al.,* 2023). Persistent exposure to high temperatures at night prevents the body from cooling down, exacerbating heat stress and increasing the risk of heat-related illnesses such as heat exhaustion and heat stroke (Lan *et al.,* 2017; Caddick *et al.,* 2018). Sleep loss is experienced more in lower-income countries, older adults as well as in females (Minor *et al.,* 2022). Due to anthropogenic climate change and expansion of the UHI, night-time temperatures are affecting sleeping quality far

more (Cao *et al.,* 2021; Minor *et al.,* 2022). The subsequent psychological effects of inadequate sleep can impair cognitive function, reduce emotional regulation, and increase susceptibility to stress (Alhola and Polo-Kantola, 2007; Ko *et al.,* 2020). Therefore, ensuring thermal comfort at night is essential for maintaining tourists' overall health and well-being. This also affects the level of enjoyment tourists will experience in daytime activities due to sleep deprivation. The magnitude, frequency, and duration of heatwaves has increased over recent years and are expected to be further exacerbated (Meehl and Tebaldi, 2004; Luo and Lau, 2021; Wu *et al.,* 2023). Furthermore, He *et al.* (2022) found that the frequency and intensity of hot nights will increase by 2100s which will lead to heat-related deaths.

Along with sleep deprivation, studies have found several heat-related illnesses such as heat cramps, which are painful muscle spasms that lead to a loss of electrolytes through sweating (Eichner, 2008). These cramps may be a precursor to more severe heat-induced illnesses and usually affect the abdomen, arms, or calves (Coris *et al.,* 2004). Heat exhaustion happens when the body overheats and cannot cool down through sweating due to dehydration, environmental heat, or excessive clothing and can lead to heat stroke (Bouchama and Knochel, 2002). Heat stroke occurs when the core body temperature regulation rises above 40°C due a lack of sweating regulation, with symptoms that include hot and dry skin, rapid heartbeat, confusion, agitation, slurred speech, seizure, and coma (Bouchama and Knochel, 2002; Coris *et al.*, 2004; Hifumi *et al.,* 2018). Dehydration is “the process of losing fluid, which would typically produce a state of hypohydration (lower-than-normal body water volume; Akerman *et al.,* 2016: pp. 413) and results from heat stress. Thermal stress can exacerbate chronic conditions such as cardiovascular disease (Zhang *et al.,* 2016), diabetes mellitus (Kenny *et al.,* 2016), respiratory disease (Anderson *et al.,* 2013) and obesity (Podstawski *et*

al., 2022). These illnesses have been found to be symptoms of thermal discomfort in various instances, such as outdoor labour (Derakhshanjazari *et al.,* 2021) and sports (Eichner, 2020) but can also be experienced in tourism if exposed to heat stress for long enough.

Acclimatization is the process of adapting to climates that are different to the conditions in one's home country, which may affect some tourist more than others (de Freitas and Grigorieva, 2009, 2014; Dhillon, 2012; Li *et al.,* 2018; Grigorieva, 2019, 2021). Tourists often arrive at destinations without being acclimatized to the local climate, which further exacerbates the challenges associated with extreme heat, particularly at night (Hanna and Tait, 2015). However, tourists generally spend only a short period at their destinations, which does not allow sufficient time for acclimatization (Lam *et al.,* 2018; Grigorieva, 2019, 2021). This lack of acclimatization means that tourists are more susceptible to the adverse effects of extreme temperatures and have a higher risk of developing heat illnesses (Lam *et al.,* 2018; Grigorieva 2019). For instance, unacclimatized individuals are more likely to experience heat stress and its associated symptoms, such as fatigue, dehydration, and heat cramps (Bartman *et al.,* 2022). The inability to acclimatize also means that tourists may find it more difficult to engage in outdoor activities, particularly during periods of high heat (Keith *et al.,* 2021; Lam *et al.,* 2021).

The choices tourists make to prepare for travel are compromised when climatic suitability information is inaccurate. Accurate climate information is essential for tourists to pack appropriate clothing, plan suitable activities, and choose the right type of accommodation (Gómez-Martín, 2005; Scott and Lemieux, 2010). For example, tourists who expect mild night-time temperatures might pack lighter clothing and plan outdoor evening activities, only to

find that the nights are uncomfortably hot or extremely cold. This discrepancy can lead to frustration and a diminished travel experience. When night-time events are outdoors and involve walking, running or other forms of exertion, the thermal discomfort can exacerbate thermal stress and pose serious health risks. Moreover, the type of accommodation that tourists book is heavily influenced by climatic expectations (Coles *et al.,* 2015; Gössling and Lund-Durlacher, 2021). Tourists who are unaware of high night-time temperatures might opt for accommodation establishments without adequate cooling systems, leading to uncomfortable nights and poor sleep quality (Xiong *et al.,* 2020; Gössling and Lund-Durlacher, 2021). This not only affects their immediate satisfaction but also impacts their overall perception of the destination. Negative experiences related to accommodation comfort are particularly damaging, as they are a fundamental part of the travel experience and can significantly influence a tourist's overall impression of a destination (Chahal and Devi, 2015; Pestana *et al.,* 2020). There is also a risk of climatic conditions considered as favourable under the HCI but have weather events that are not accounted for, as is the case for Réunion Island where tropical cyclones can occur during months that are classified as “very good” or “excellent” (Prinsloo and Fitchett, 2024). Due to such events, the CCI has automatic “3” scores assigned to variables that exceed the thresholds determined: Tmin (less than 8°C), Tmax (more than 34°C), Precipitation (more than 10mm) or Wind (more than 23km/h; Ma *et al.,* 2020).

6.5. Broader considerations of the limitation of indices

The application of tourism climatic indices can present some challenges, particularly when these indices are utilized without prior verification for the geographic location in question (Fitchett and Meyer, 2023). While these indices are intended to provide a standardized

measure of climatic suitability, their application can often lead to misleading outcomes if not properly modified to local environmental conditions. This then creates a trap as these tourism climate indices are cited by various researchers but may not be relevant for that destinations' climate. Many studies have applied and cited the HCI but in recent years, critiques of this index have been identified as researchers have noticed the unrepresentative scores that it can produce if the applicability is not verified (Fitchett *et al.,* 2016; Mushawemhuka, 2021; Faraj *et al.,* 2023). Furthermore, this leads to providing inaccurate data for tourism marketers and accommodation providers to make decisions that impact tourist experiences and safety.

Researchers highlight the issue that indices developed under specific climatic conditions are widely generalized and applied to different climate zones without appropriate adaptation (Dubois *et al.,* 2016; Nassiri *et al.,* 2017; Almeida and Porto, 2019). For example, the HCI_{Beach} has been used to determine the climatic suitability of coastal cities but is not applicable for China because the index does not factor in air pollution (Gao *et al.,* 2022). The consideration of air pollution is important in the Chinese context because it is of more concern to tourists as air quality has had adverse effects on the people in China (Gao *et al.,* 2022). Furthermore, the literary gap in tourism climate indices has allowed researchers like Anđelković *et al.* (2016), Ma *et al.* (2020) and Demiroglu *et al.* (2021) to create indices that are more sector specific.

The accuracy of these index results is very important, as these stakeholders often rely on such indices to create marketing strategies and implement mitigation plans. If the indices suggest more ideal conditions than what is actually experienced, tourists may be inadequately prepared for the climatic conditions, potentially leading to negative health outcomes (i.e.

heat or cold stress). Conversely, if the indices present less than ideal conditions of a location, it might deter potential visitors. The effects of using unverified indices on a local scale may influence infrastructure development and long-term investment in tourism amenities. Researchers and stakeholders must exercise due diligence in the validation of indices by verifying if the variables incorporated align with the local climatic reality. This may also ensure the sustainability of the tourism sector worldwide especially as temperatures are increasing due to climate change. Therefore, more interactive engagement needs to be practised with tourism stakeholders, to best adapt an index to local settings and then communicate the findings.

Under the guidance of tourism climate indices, accommodation establishment providers may decide against installing air conditioning units to avoid the high costs associated with them especially in developing countries. However, due to increasing temperatures, customers may automatically expect such amenities and not verify if the accommodation establishment is fitted with cooling systems before booking. The reputation of the accommodation establishment and tourist destination may be affected as a whole. Moreover, the lack of mitigation against hot and cold conditions may pose health risks for vulnerable populations such as the elderly or those with chronic health issues (Morabito *et al.,* 2015; Lundgren-Kownacki *et al.,* 2018). The long-term economic impact of such decisions may actually counteract the initial savings from not installing air conditioning, as poor reviews and decreased repeat business can result from guest dissatisfaction (Jalilvand *et al.,* 2012; Giraldi, 2016; Guo and Pesonen, 2022).

The reliance on climatic indices that primarily assess conditions during daytime hours has led to significant oversight in the consideration of night-time conditions in tourist accommodations. Ma *et al.* (2020) reintegrated night-time temperatures and identified them as one of the overriding variables, with the explanation that bitterly cold conditions negatively influence the camping experience. However, Demiroglu *et al.* (2021: pp. 767) did not include night-time thermal comfort in the Ski Climate Index (SCI) due to "accounting for the effects of relative humidity sub-diurnally only during the actual ski time". This index does not necessarily need to consider night-time temperatures because: (1) tourists visiting ski destinations will probably assume that conditions are cold during both day and night; (2) ski activities may not be safe and popular during the night-time; (3) the accommodation establishments at ski destinations are well equipped for the cold temperatures experienced.

Future iterations of the HCI_{Urban} index should incorporate a variable that accounts for the availability and usage of air conditioning in tourist accommodations since these units will be largely utilised in the future to regulate extreme heat. This could be achieved by integrating data on air conditioning prevalence from local surveys or accommodation databases. The index could also reintroduce night-time thermal comfort into the equation to better reflect the experiences of modern tourists. Additionally, the development of a new index could include specific thresholds for night-time temperatures that consider both the presence and absence of air conditioning, thereby providing a more accurate assessment of thermal comfort for tourists in diverse climates. The consideration of climate and tourist experiences in hot, developing countries that do not have air conditioning units is crucial to ensure the development of a comprehensive and globally applicable index.

Several thermal comfort indices have been developed and applied in various locations. de Freitas and Grigorieva (2017) evaluated 165 human thermal climate indices, emphasizing the necessity of accurate and appropriate indices. This study further highlights that although there are multiple indices available, the utilization of an index is dependent on the local climatic conditions and type of study required. The indices were graded using the six criteria: comprehensiveness, scope, sophistication, transparency, usability, and validity, with the idea that indices should be compared with similar indices (de Freitas and Grigorieva, 2017).

6.6. Limitations to this study

There are key limitations that should be considered when examining the findings of this study. This study used the online platform *Booking.com* when identifying the ubiquity of air conditioning. While this is one of the largest global accommodation booking sites, it does not purport to have a comprehensive listing of all hotel accommodation establishments in a given location, as providers need to opt-in to being listed on the website. There is also a limit to the number of hotel accommodation establishments one is permitted to view. For example, the total number of hotel accommodation establishments listed for Rome was 5,762, but it was only possible to view comprehensive listings for 750 of these. An in-person verification of the hotel accommodation establishments and their amenities could be considered but the aggregated results from the information presented on *Booking.com* is not expected to be significantly different. *Booking.com* is a highly reputable website that is frequently used by local and international tourists. Likewise, the use of *TripAdvisor* for tourists' comments may be argued to limit the study as they are not as accurate as in person interviews. However, the online platform allows tourists to comment on their experience even after leaving the destination. The option of anonymity also allows travellers to speak as freely as they desire.

Due to time constraints, the number of reviews and study period was limited for each location as to allow for thorough analysis. The webscraping tool used could have collected more reviews over a longer time period but the copyright policies prohibit the collection of vast amounts of reviews in a session. However, this tool allowed for more time to read and examine each review individually. The tool also requires sufficient time to collect and export the data, which would be possible in a study with fewer time constraints. The accuracy of the time stamp extracted, however, is a benefit of this method as it allows individuals to verify reviews themselves on *TripAdvisor*.

Whilst unlikely, an event in which many hotel accommodation establishments that were excluded from this study did have air conditioning or more satisfied tourists, would not negate the fact that even a few hotel accommodation establishments without air conditioning contradict the assumption of Scott *et al.* (2016a). The presence of some outdoor activities negates the implied assumption that people spend their nights indoors in their air-conditioned rooms. Additionally, if there were a few dissatisfied tourists included in the questionnaire, their opinions were ignored. Therefore, this research finds that this index is problematic in terms of its key assumptions and should be used with caution.

CHAPTER 7: CONCLUSION

7.1. Introduction

This study aimed to critique the exclusion of night-time thermal comfort in the HCI_{Urban}, that was implemented due to the assumption that air conditioning is present in all accommodation establishments in developed countries and major tourist cities in developing countries (Scott *et al.,* 2016a). Since this index was developed, it has been promoted as the improved version of the 1985 TCI and urged to be used when calculating climatic suitability for urban tourism (Scott *et al.,* 2016a; Mushawemhuka *et al.,* 2020; Krishnannair *et al.,* 2022; Prinsloo and Fitchett, 2024). Scott *et al.* (2016a) detailed that they used tourist questionnaires to determine the weighting of the new index but did not demonstrate how they arrived at the conclusion of removing the consideration of night-time thermal comfort. The validity of this index is therefore questioned as the assumptions it is based on is inherently not true.

7.2. Synthesis of study

The proportion of air-conditioned hotel accommodation establishments varied amongst the cities. Without the air conditioning filter applied, the proportion of listings categorized as offering air conditioning ranged from 28.8% for Stockholm to 98.9% for Rome. The filter proved to be more accurate, with proportions ranging from 96.4% for Stockholm and 99.0% for Paris. There are indeed night-time outdoor activities on offer in all six of the cities, which tourists commented on their attendance and in some instance encouraged potential tourists to partake in. Furthermore, several tourists complained about the night-time temperatures and lack of air conditioning both in the hotel accommodation establishments and night-time activities reviews. Some tourists cautioned other visitors against the weather conditions and

suggested that they pack warm clothing. This reveals that tourists do experience unsuitable climatic conditions that they were perhaps not ready for. This may be due to unrepresentative scores that did not take low temperatures at night into account. Therefore, the inherent assumption that the HCI_{Urban} is based on is not valid – the overestimations demonstrated by Mushawemhuka (2021) for Zimbabwe could occur even in Europe, and the rest of the world.

The removal of night-time thermal comfort has several implications such as health impacts, tourist satisfaction as well as unrepresentative scores for countries in hot regions such as Zimbabwe and Iran. The assumption of ubiquitous air conditioning also fails to take the night-time economies of tourist destinations into account. For example, the six cities included all have various night life activities that are pull factors for international and domestic visitors. Furthermore, this index assumes that visitors spend all their time in hotel rooms which has been proven to not be true as shown in the *TripAdvisor* reviews. The assumption that air conditioning is available at the six European cities was also found to not be true by investigation of hotel accommodation establishments on *Booking.com*. If air conditioning was proven to indeed be ubiquitous, it is irrelevant in the climate control of outdoor activities. Some tourists complain of lack of air conditioning during a heatwave in Paris and Rome, which reveals the inadequate mitigation strategies of accommodation providers for extreme temperatures due to climate change.

7.3. Achievement of aim and objectives

The aim of this study is to assess the validity of the HCI, with consideration of the elimination of night-time comfort in this index. A netnographic study was conducted using two online

platforms, namely *TripAdvisor* and *Booking.com.* The following sections will discuss each objective individually and examine the degree to which the objective was achieved.

i. ***To determine the proportion of air-conditioned hotel accommodation establishments in the six European cities for which the index was developed through an analysis of online hotel listings on Booking.com***

This was examined in three stages: the first was to determine how many hotel accommodation establishments were available on the website and how many were listed as having air conditioning next to the filter; the second stage was manually verifying how many hotel accommodation establishments were listed as having air conditioning without applying the filter; and lastly, a manual verification was performed with the air conditioning filter applied to determine the accuracy of the filter. The proportion of air-conditioned hotel accommodation establishments varied in the six cities, with Stockholm exhibiting the lowest proportion and Rome exhibiting the largest proportion.

ii. ***To explore the frequency of comments on night-time thermal comfort and discomfort in tourist reviews on the hotel listings on TripAdvisor.***

A total of 15,117 reviews were collected and examined across the six cities for the mentions weather/climate and night-time thermal comfort/discomfort. Terms pertaining to weather climate were mentioned in 55 comments for Barcelona, 15 comments for Stockholm, 76 comments for London, 27 comments for Istanbul, 57 comments for Paris and 87 comments for Rome. Mentions of night-time thermal comfort/discomfort were present in 14 comments for Barcelona, 11 comments for Stockholm, 29 comments for London, four comments for Istanbul, 19 comments for Paris and 18 comments for Rome. Notably, tourists also remarked

on the functionality and/or offer of air conditioners in the hotel rooms and the amenities or activities on offer outside the hotel room such as roof terraces, balconies, restaurants etc.

iii. To explore the night-time economies and activities that take place outside of hotel rooms at night in each of the six European cities through the analysis of tourist recommendations and activity listings on TripAdvisor and Booking.com

The night-time activities listed on *Tripadvisor* were used to create maps of indoor and outdoor activities for all six cities to demonstrate the variety of activities offered in each city. A total of 9,135 comments were then collected and examined for the mentions of weather/climate and night-time thermal comfort/discomfort. Barcelona had 63 mentions of weather/climate and 12 mentions night-time thermal comfort/discomfort, Stockholm had 53 mentions of weather/climate, London had 55 mentions of weather/climate and 10 mentions of night-time thermal comfort/discomfort, Istanbul had 22 mentions of weather/climate and one mention of night-time thermal comfort/discomfort, Paris had 90 mentions of weather/climate and 15 mentions of night-time thermal comfort/discomfort and Rome had 22 mentions of weather/climate and six mentions of night-time thermal comfort/discomfort. Air conditioning was not largely mentioned in these comments, with only two mentions for Barcelona, six mentions for London and 11 mentions for Paris.

7.4. Avenues for future research

More research needs to be conducted for the removal of night-time thermal comfort from tourism climate indices. The studies that have applied the HCI_{Urban} should go back and check the ubiquity of air conditioning and the night-time economy of those locations to reflect on the veracity of their findings. Future studies need to perform a preliminary evaluation of the

applicability, suitability and validity of not just the HCI but all indices to confirm that all assumptions are true.

For the development of the HCI, the European cities chosen were those of developed countries and none from developing countries. Future research should consider the climate of developing countries as well as the needs of tourists that visit those countries. In order for this index to be applicable in a global context, the consideration of cooling systems amongst tourists and the importance they place on them needs to be further studied. Researchers needs to re-examine the weighting variables for the HCI so it is representative for more places than just the six cities it was based on. Going forward, night-time thermal comfort should be re-introduced into tourism climate indices and ideally use a multi-index approach to ensure that the climatic suitability is adequately calculated.

Another study that could occur is examining *TripAdvisor* comments from before and after 2016, which is when the HCI was developed, to determine what tourists have said about weather and night-time thermal comfort. Comments should also examined from developing countries in Africa, where the climate is hotter, to determine the difference in tourist satisfaction as well as the prevalence of air conditioning. The contrast in economic statuses may also inform the need for a new urban tourism index. Moreover, more research needs to be conducted on tourists experiences of night-time thermal comfort.

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