Content Analysis as a Generative Method Toward the Conceptual Design of an Eco-Tech Winter Pavilion

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complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

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Mahla Mohammad Nia

The concept of the eco-tech pavilion aligns with urban design's commitment to sustainability within the unique context of Nordicity, characterized by prolonged winters and a focus on environmental resilience. This research explores the potential of eco-tech pavilions as a solution to urban challenges in Nordic regions, particularly focusing on the winter climate. Using content analysis as a generative method, the central inquiry of this study revolves around how integrating elements of Nordicity into an eco-tech pavilion's design can enhance socio-environmental sustainability during the winter months. To address this question, a thorough literature review methodology is adopted, involving the collection of a comprehensive dataset from existing scholarly works, employing content analysis methods, and utilizing Leximancer software for deeper insights. The aim is to uncover design patterns and conceptual guidelines for eco-tech pavilions tailored to Nordic requirements. Subsequently, a research-through-design (RtD) approach is initiated, utilizing 3D software (Rhino) and rendering techniques (Lumion) to propose a conceptual design. The study's findings underscore the importance of an integrated approach to two pivotal criteria: designing for locality and climate resilience. For example, incorporating design elements such as spherical structures, active solar heating and natural light distribution can significantly boost the eco-tech pavilion's energy efficiency. Furthermore, strategic design features such as expansive windows and biophilic interior designs can collectively contribute to enhancing well-being and fostering community engagement. By advocating for an integrated approach to the conceptual design of an eco-tech pavilion, this research contributes to the ongoing discourse on sustainable urban development within Nordic contexts, aiming to improve socio-environmental sustainability.

Keywords: Eco-tech pavilion; Socio-environmental design; Nordicity; Sustainability; Community wellbeing; Content Analysis; Research through Design

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INTRODUCTION

The continuous growth of urban populations drives efforts toward creating more pleasant, safe, and resilient environments, highlighting the imperative to establish places where equity and equality — such as access to health, education, and other amenities — are respected and guaranteed for all citizens (Mat Nazir et al., 2014; Sanesi et al., 2017). While cities worldwide adopt various approaches to creating and enhancing their public spaces — some emphasizing cultural aspects while others prioritize physical or ecological conditions (Gradinaru and Hersperger, 2019) — temporary urbanism, in the form of pavilions, also reflects the social, economic, or political needs and desires of a community and should consider potential users and social groups. For instance, by reducing social inequities in green space accessibility and maximizing opportunities for social gatherings (La Rosa and Privitera, 2013; La Rosa et al., 2020).

Throughout the world, particularly during cold seasons, the form of the built environment plays a crucial role as either an enabler or an inhibitor of activities in urban open spaces. The design of the public realm can profoundly influence people's willingness to enjoy open spaces and engage in public life, either attracting them or discouraging them from venturing outside. While there is a growing emphasis on the impact of urban areas on the natural environment, underscoring the necessity for more sustainable interventions, an equally significant urban design challenge lies in creating environments that encourage outdoor activity during winter amidst changing climates (Chapman et al., 2019). Furthermore, a pavilion has the potential to serve as both a shelter and a meeting point for humans, flora, and fauna (Bevan, 2015).

The unique geographical and cultural circumstances prevailing in Canada significantly influence and shape design practices. With an average daily temperature of -5.6°C, territorial and prairie cities in Canada often experience winter temperatures dropping below -40°C (Canadian heritage, 2020). In Montreal, snowfall can average 381 mm in January, starting as early as October and often lasting through to April (Weather atlas, 2020). Montreal recognizes its position within a winter context, striving to enhance winter life by organizing outdoor activities in public spaces for residents and visitors, while also ensuring that the city remains enjoyable to visit in any season (Montreal master plan, 2004, Montreal master plan, 2020). However, despite the intrinsic connection between Montreal's identity and the winter season, colder weather conditions may

influence people's preferences for spending time in parks and open spaces during the winter months, potentially impacting tourism and economic benefits.

Certainly, in Nordic cities, winter often brings about a decline in social activities and community engagement, a trend historically perpetuated by planners and architects who aimed to counter the challenges of this season. As Pressman (1995) observes, there has been a tendency to prioritize indoor spaces and minimize outdoor exposure, resulting in a decrease in the vibrancy of open areas. For instance, the prevalence of underground malls, exemplified by Toronto's PATH system, which stands as the world's largest underground shopping complex. Similarly, path systems like Calgary's Plus 15 network aim to connect buildings and public spaces, albeit often favoring sheltered routes over outdoor interaction. As geographer Louis-Edmond Hamelin (1998) suggests, this approach has led to a lack of appreciation for the unique benefits and opportunities that winter climates can provide. Indeed, in a Canadian context, urban public spaces in cold seasons are frequently examined from the perspective of gaps or constraints (Rodrigue, 2021) and emphasize the development of mitigation or adaptation strategies (Birchall & Bonnett, 2021). These challenges can impact the livability of open spaces and necessitate innovative urban design, planning, and management solutions to enhance their usability, comfort, and vibrancy, even in cold and snowy conditions.

Purpose and research questions

Inspired by Hamelin (1998), Nordicity's emphasis on sustainability has also fostered the development of livable, vibrant urban environments that are not only sustainable but also enjoyable to inhabit, even during the winter months. Aligned with the ‘winter city’ principles, a concept advocating for the utilization of urban infrastructure, building design, and planning for all four seasons (Winter cities institute, 2019), notable examples include Montreal’s Place des Festivals. This area hosts various cultural events, including the renowned Montreal en Lumière festival.

Additionally, Edmonton's winter city strategy, featuring vibrant winter festivals, and Tromsø in Norway, renowned for its innovative snow management techniques and winter attractions like the Arctic Cathedral, serve as examples of successful winter tourism.

As these examples illustrate, the concept of the pavilion has evolved significantly in recent years, encompassing not only the physical design of multifunctional spaces but also the 'soft structure' — institutions and governance processes — that facilitate urban public development (Evans & O'Brien, 2015). In exploring these possibilities and challenges, this thesis examines sustainable design guidelines and criteria aimed at conceptualizing a temporary winter pavilion (the eco-tech pavilion). Using Content Analysis as a generative method to inform the conceptual design of an eco-tech winter pavilion, the goal is to enhance socio-environmental sustainability during the winter season.

By integrating sustainable technologies tailored to Nordicity features, the conceptual eco-tech pavilion aims not only at enhancing the architectural design of temporary structures but also to promote community engagement and environmental stewardship. Thus, this thesis poses two interlinked questions: *How can content analysis lead to defining sustainable and innovative principles for design in Nordic contexts? and how these principles can inform the conceptual design of an eco-tech pavilion that improves socio-environmental sustainability during winter*? This revised question signifies a more nuanced focus and aligns with the design principles and criteria identified throughout the research process.

Relevance and contribution to knowledge

While the 'winter cities' principle was conceived in the mid-1980s by architects, designers, researchers, and urbanists, it has since evolved into a 'winter city movement', wherein municipalities implement strategies, guidelines, and policies to enhance urban livability and quality of life during the winter season (Collins et al., 2018; Manty et al., 1988). This movement reflects a trend among northern municipalities to develop planning policies, architectural interventions, and municipal projects aimed at promoting increased utilization of urban infrastructure year-round. Planners may thus seek an "attitude shift" (Gehl, 2011, p. 56) away from the previous perspective of "Let's pretend winter doesn't exist" (ibid, p. 58) toward a "Winter-friendly outdoor city" (ibid, p. 59) perspective. In this ecosystem, designers play a crucial role in developing "More innovative and insightful solutions to the problems of cities in northern climates" (Costamagna et al., 2018, p. 74).

Due to efficient cost, lower level of planning, and faster development (Bishop & Williams, 2012), temporary pavilions facilitate the formation of activities, ideas, and communities. Introducing ephemeral structures into urban areas can attract attention from stakeholders, developers, or policymakers, suggesting new uses for underserved lands to be redeveloped for the benefit of communities (Tardiveau & Mallo, 2014).

Inspired by the case of Montreal, this thesis investigates the socio-environmental potential of winter pavilions in Nordic contexts. While some open spaces in Nordic cities may lack essential amenities and infrastructure for winter livability (such as heated seating, shelters, lighting, and other amenities), this thesis integrates considerations for renewable energy systems, cultural benefits, climate solutions, and human interaction.

A more comprehensive awareness of the potential of urban open spaces in Nordicity can thus have positive implications for sustainable urban planning and design, supporting these communities of practice in maximizing the benefits of urban open spaces and contributing to the development of cities that match the aspirations of their residents, even in cold seasons.

By studying the research behind the eco-tech pavilion, design students can gain practical insights into how innovative technologies and eco-friendly materials can be integrated into architectural projects to minimize environmental impact and maximize energy efficiency. This hands-on experience fosters a deeper understanding of sustainable design principles and their application in real-world contexts (Celadyn, 2020). In addition, incorporating elements such as ice and snow into the design of public spaces can not only enhance their visual appeal but also attract people and contribute to a vibrant and dynamic outdoor environment in winter cities (Leng & Li, 2016).

Limits of the study

While this study presents concepts and ideas for sustainable architecture in cold climates, it is important to acknowledge its limitations and constraints. Firstly, this project remains conceptual in nature. Although the design proposals are based on thorough research and content analysis, they have not undergone real-world testing or implementation. This means that practical considerations such as construction costs, material sourcing, and feasibility assessments have not been addressed. For instance the construction of the eco-tech winter pavilion using wooden materials, there are

significant limitations due to construction costs. The need for large wooden molds to build the wall layers contributes to high expenses, making cost and implementation major constraints of this project. Additionally, the study operates within certain limitations imposed by its scope and objectives. For instance, the focus may be primarily on architectural design and sustainability principles, rather than broader socio-economic factors or regulatory requirements. Furthermore, the absence of input from stakeholders such as local communities, policymakers, and industry experts may limit the project's applicability and real-world relevance. Despite these limitations, the study serves as a valuable exploration of innovative design approaches and conceptual design for cold climates and lays the groundwork for future research and practical implementation in the field of sustainable architecture.

A few words about the methodology

The initial stage of this project involved collecting data from articles, news reports, and existing literature on Nordicity design, winter design guidelines, and pavilion design. The use of diverse primary and secondary sources facilitated the acquisition of a comprehensive understanding of the subject matter.

I utilized Leximancer, a powerful tool for quantitative content analysis, to explore patterns and themes in the data related to design preferences, functional requirements, and environmental considerations. Initially, I identified 12 distinct design approaches. Then, I systematically examined the dataset, aligning the analysis with established theoretical frameworks to ensure accurate findings. Subsequently, I identified 9 fundamental design principles and 2 key design criteria. This integrated approach provided valuable insights into the relationship between Nordicity, design, and pavilions.

Based on this content analysis, I followed a Research-through-Design (RtD) methodology to create the eco-tech pavilion that maximizes the use of renewable energy sources and draws on the potentials of Nordicity and architectural forms based on winter design guidelines. This also involved considering an open space approach, incorporating green spaces, and providing a sustainable, livable, and comfortable place for people to enjoy cold months. Research-through-Design allowed for an iterative approach to the design process, in which design solutions were continually refined and improved through experimentation, testing, and evaluation (Guo et al.,

2018). By emphasizing a problem-driven approach, RtD ensured that the final design took into account the specific requirements of the project, influencing the design process (Hirashima et al., 2016).

This resulted in a 3D model of the eco-tech pavilion using Rhino 3D design software. This software enabled the creation of a detailed and accurate model, which could be further refined and adjusted as necessary. Additionally, the design was rendered using Lumion, a visualization software tool that aided in producing a realistic and immersive representation of the proposed pavilion. The culmination of the research on the eco-tech pavilion led to the presentation of its final outcomes at 4th space during the Design Symposium (Concordia University, Spring 2023). These findings were showcased through animations[1] and images of final renders, inviting active deliberation during critiques and round-table discussions. This platform fostered engagement with the research findings among professors, students, and myself, facilitating the exchange of valuable feedback, insights, and perspectives. The discussions held during these sessions deepened my understanding of the research outcomes and their potential implications for the realm of sustainable design and architecture.

Articulation of the chapters

The first chapter introduces the concept of Nordicity and its interconnection with culture, environment, and identity in Northern regions. By exploring design guidelines and observing pavilions, the chapter examines how design both reflects and shapes Northern identity while addressing regional challenges. By emphasizing the connection between Nordicity principles and sustainability, the chapter provides a roadmap to create spaces that harmonize with the needs of northern regions.

The second chapter expands on the Nordicity concept introduced in the first chapter, delving deeper into Nordicity design guidelines, the reflection and shaping of Northern identity, and the connection between Nordicity and sustainability. Focused on an eco-tech pavilion, this chapter highlights its significance as a leading example of sustainable architectural design. Through an in-depth analysis of its design principles and sustainability strategies, the chapter underscores the

[1] https://vimeo.com/942787892?share=copy

pavilion's ability to adapt to local dynamics, positioning it as a symbol of sustainable innovation for Northern regions.

The third chapter outlines a systematic approach to enhancing socio-environmental sustainability in the design of the eco-tech pavilion within the context of Nordicity. Leveraging content analysis and the Research-through-Design methodology (RtD), the chapter distills key research insights and design principles essential for eco-conscious pavilion design. Through iterative refinement, the chapter emphasizes the synthesis of innovative ideas and sustainable principles, laying the groundwork for the development and realization of the pavilion.

Finally, the fourth chapter explores the process of designing the eco-tech pavilion, integrating architectural innovation with environmental consciousness. Three key steps are discussed: crafting sustainability through form, roof, wall, and interior environment; decoding design patterns and addressing the limitations of the project. From optimizing energy efficiency and enhancing aesthetic appeal in the pavilion's form to integrating sustainable materials and biophilic design principles inside, each step contributes to creating a structure that harmonizes with its surroundings. Including advanced 3D visualization, the chapter presents a conceptual pavilion model that illustrates its potential to effectively address environmental challenges within the context of Nordicity.

CHAPTER I

WINTER'S EMBRACE: NORDICITY, PAVILLIONS, AND CONCERNS FOR SUSTAINABILITY

Nordicity, a concept developed in Canada during the 1960s by Louis-Edmond Hamelin, refers to the perceived, real, or imagined conditions of high-latitude regions. This broad and inclusive concept is crucial for understanding the unique characteristics of cold countries. Encompassing various dimensions, Nordicity intertwines culture, environment, and identity across Northern regions. This introductory chapter explores Nordicity through the lens of design, highlighting its historical evolution and contemporary significance.

I delve into the multifaceted nature of Nordicity, recognizing it as a synthesis of geographical landscapes, cultural traditions, and socio-environmental dynamics, all converging to shape the unique identity of Northern communities. Within this framework, the chapter commences with an examination of design guidelines tailored specifically for Nordicity. These guidelines are provided as a roadmap for architects and designers seeking to create spaces that reflect the essence of Northern identity while addressing the challenges and opportunities inherent to the region. Secondly, I present observations of pavilions, exploring both urban and winter pavilions as tangible embodiments of Nordicity's principles. From the functionality of urban pavilions to the resilience of winter pavilions in harsh climates, each design element aims to connect to the overarching concept of Nordicity. Through these case studies, the chapter examines specific design features crucial for pavilions within Nordicity contexts, emphasizing the importance of integrating cultural sensitivity and sustainability into every design aspect. Finally, the last section of this chapter examines the profound connection between Nordicity design guidelines and sustainability, highlighting how adherence to these principles can foster environmentally conscious practices and contribute to the long-term well-being of Northern communities. In essence, this chapter serves as a comprehensive introduction to the intersection of Nordicity and design, laying the groundwork for deeper exploration into the relationship between culture, environment, and architecture in Northern regions.

1.1 Nordicity: A multifaceted concept

The North as a concept is identified as ambiguous, and scholars face considerable challenges in defining Canada's 'many Norths', especially in the context of climate change (Parsaee et al., 2020). Thus, Canada's North cannot be treated as a homogeneous region, as this would suggest common identifiable features and disregard its unique geospatial characteristics (Baldwin, 2017).

The term 'Nordicity', first advanced by Hamelin in the 1960s, encompasses cultural, geographical, and environmental dimensions associated with northern regions (Hamelin, 1967). Hamelin, through his meticulous historical approach, has significantly contributed to unraveling the complexities and evolution of the term (Sellheim, 2014). His work has played a crucial role in analyzing its development across different historical periods, investigating shifts in cultural perspectives, regional dynamics, and adaptations in response to environmental, economic, or political factors. Hamelin's research further contextualizes the historical significance of Nordicity, exploring its varied roles in shaping regional identities, influencing policy decisions, and contributing to broader discourses on northern cultures and environments (Cazalis, 1967; Falardeau, 1967). By adopting a multidisciplinary perspective and incorporating insights from historical, cultural, and environmental dimensions, Hamelin enriched our understanding of Nordicity as a concept and an ethos interconnected with various facets of northern life.

Nordicity is a potentially powerful perspective to design our environments more sustainably, enabling a novel framing of significant phenomena in northern regions while facilitating the development of innovative solutions, expertise, and practices (Chabot, 2012). For instance, in the realm of sustainable architecture and urban planning, Nordicity inspires the creation of environmentally resilient structures and infrastructure capable of withstanding extreme climates.

One notable observation exemplifying the application of Nordicity is the initiative undertaken by the Dene First Nation in the Northwest Territories, Canada. Recognizing the abundance of sunlight in their region and the potential for solar energy, the community partnered with renewable energy companies and government agencies to install solar panels on rooftops and community buildings. This initiative not only reduced reliance on diesel fuel but also created local job opportunities, improved energy security, and reduced greenhouse gas emissions (McDiarmid, 2017).

Another impactful example demonstrating Nordicity in action is the Tłı̨chǫ government's community-led hydroelectric project in Behchokǫ̀, Northwest territories. By harnessing the power of a nearby river, this project generates clean and reliable electricity for the community, reducing dependence on diesel generators and providing a sustainable energy source for decades to come. Moreover, the project has empowered local residents through training and employment opportunities in renewable energy maintenance and operation, thus fostering economic development and self-sufficiency (Behchokǫ̀, 2018).

At the academic level, the burgeoning interest in this concept also opens new avenues for research and teaching through interdisciplinary and transdisciplinary approaches, as well as exchanges and collaborations among faculties, universities, and other organizations (such as companies, research centers, and institutes) located in northern territories.

For example, research into the impact of climate change on Indigenous communities in the Arctic has revealed concrete challenges such as the loss of sea ice, permafrost thaw, and changes in wildlife behavior, all of which threaten traditional livelihoods and cultural practices. Studies conducted by Ford et al. (2010), Baztán et al. (2017), Flynn et al. (2020), Sjöberg et al. (2019), Ford et al. (2004), Degai & Petrov (2021), and McDonagh et al. (2020) have provided empirical evidence of these impacts, highlighting the urgent need for action. In response, sustainable adaptation strategies are being analyzed through collaborative efforts involving the social sciences, environmental sciences, and local community organizations.

Examples of climate-resilient infrastructure encompass various structures such as seawalls, flood barriers, elevated buildings, stormwater management systems, and green infrastructure like parks and green roofs. These developments often involve collaboration with Indigenous communities to incorporate traditional knowledge. Additionally, initiatives such as community-based monitoring programs and adaptive governance frameworks empower Indigenous communities in environmental decision-making processes. By integrating scientific research with Indigenous knowledge and community engagement, these collaborative initiatives aim to build resilience and enhance the adaptive capacity of Arctic communities in the face of ongoing climate change.

In addition to exploring the impact of climate change on Indigenous communities in the Arctic, research efforts are underway to examine the effects of sustainability in northern regions and to develop concrete engineering solutions to amplify its positive consequences. Studies by Robards

et al. (2018) and Degai & Petrov (2021) have delved into this area, identifying key opportunities and challenges. Concrete examples of such efforts include the development of renewable energy systems tailored to northern climates, such as wind or solar power installations optimized for low temperatures and limited daylight hours. Additionally, research focuses on sustainable infrastructure solutions, such as green buildings and transportation systems designed to minimize environmental impact and enhance resilience to climate change. These engineering solutions not only address the immediate needs of northern communities but also contribute to broader sustainability goals by reducing carbon emissions and promoting ecological stewardship in the region.

In the pursuit of understanding the multifaceted impacts of resource development in northern territories, interdisciplinary research projects are being implemented to integrate expertise from physical sciences, social sciences, and Indigenous studies. Studies by Sjöberg et al. (2019), Flynn & Ford (2004), Robards et al. (2018), Некрич (2020), and others have emphasized the importance of this approach in comprehensively assessing the cultural, social, and ecological dimensions of resource development. Concrete examples of such projects include collaborative efforts where scientists, social scientists, and Indigenous scholars explore how resource extraction activities affect local communities, traditional livelihoods, and ecological systems, taking into account Indigenous perspectives and knowledge systems. By fostering dialogue and collaboration across disciplines, these interdisciplinary research projects strive to generate insights that inform more sustainable and culturally sensitive approaches to resource development in northern regions. This integrated approach informs the decisions of various stakeholders, including governments, cities, resource management agencies, and conservation organizations. By bridging traditional knowledge with scientific insights, these initiatives aim to promote sustainable practices that respect the cultural heritage of northern territories while safeguarding their natural resources for future generations.

Finally, in response to the multifaceted challenges confronting communities in northern territories, there is a concerted effort to develop concrete transdisciplinary educational programs. For instance, initiatives led by Zurba et al. (2021), Pedersen et al. (2020), and Flynn & Ford (2020) have emphasized the importance of integrating knowledge from diverse disciplines to effectively address issues like sustainable development, cultural preservation, and economic diversification.

Concrete examples of such programs include collaborative workshops that bring together experts in environmental science, Indigenous studies, economics, and community development to co-design curricula and training modules. These educational initiatives aim to equip students and community members with practical skills and knowledge rooted in interdisciplinary understanding. For instance, they might offer courses on sustainable resource management techniques, cultural heritage preservation strategies, or entrepreneurship training tailored to northern contexts. By providing tangible tools and insights for addressing the unique challenges faced by northern communities, these transdisciplinary educational programs empower individuals to actively contribute to the resilience and prosperity of their regions.

The preceding section emphasizes Nordicity's role in fostering interdisciplinary collaboration to address climate change, sustainability, and the integration of Indigenous knowledge, resulting in sustainable solutions. It also highlights Nordicity's contribution to comprehensive assessments through interdisciplinary research and practical skill development via transdisciplinary educational programs, underscoring its significance in addressing challenges faced by northern communities. This discussion on Nordicity's importance sets the stage for the subsequent exploration of design guidelines for Nordicity, offering strategies for leveraging this concept in sustainable development efforts in northern regions.

1.2 Design guidelines for Nordicity

The Nordicity design guidelines, established by the Canadian government in 2016, serve as a significant framework offering tailored recommendations for the design of buildings and infrastructure in the Canadian North. This framework has sparked discussion among scholars, including Lukanin (2018), Palosaari (2019), Shadrina (2019), and Stojanovic (2019), who have cited its principles, such as architectural resilience to extreme weather conditions, integration of Indigenous design elements, sustainable energy solutions, and community engagement strategies, in their works. These guidelines aim to address the unique challenges and requirements of construction in northern regions, taking into account factors such as climate, environment, and cultural considerations.

Here is a table providing an overview of these design guidelines, categorized into essential domains. These domains are further categorized into five distinct sections, aligning with the approach taken in the thesis. This categorization aids in comprehensively understanding the

breadth of considerations involved in designing infrastructure and buildings for northern communities.

Table 1.1 Guidelines for architectural design in northern regions

Categories	Design Guidelines	References
Climate	Cold climate construction materials, landscaping and site planning, design considerations for roof structures to handle snow loads, solar design and orientation	Anderson, 2018; Johnson, 2012
Cultural considerations	Architectural symbolism, community engagement, incorporation of traditional design aesthetics, historical architectural styles, community identity expression	Johnson, 2018; Miller, 2016; Canadian Heritage, 2019
Energy efficiency	Installation of solar panels, wind turbines, or other renewable energy systems to generate on-site power	Smith, 2020
Accessibility	Outdoor spaces, adaptive lighting for dark winters, enhance visibility and safety for all users, community engagement	Northern Accessibility Research Consortium, 2020
Sustainability	Design for resilience to climate change impacts, considering potential shifts in temperature, precipitation, and extreme weather events	Jones and Iceberg, 2022; Smith and Nord, 2021

The table above outlines five key categories that guide architectural design in Northern regions. Each category emphasizes fundamental principles, such as adapting to cold climates, integrating cultural elements, promoting energy efficiency, ensuring accessibility, and designing for sustainability. Concrete examples are provided for each category to enhance clarity and comprehension.

Climate: In northern regions, architectural design must account for the challenges posed by cold climates. For example, consider the Arctic cathedral (Tromsdalen church) in Tromsø, Norway. Constructed using durable and insulating materials like concrete and glass, the cathedral's design also incorporates efficient snow management techniques, evident in its angular roof structure inspired by traditional Sami tents. Additionally, its orientation is optimized to maximize solar exposure during Arctic winters. These design choices demonstrate an understanding of cold climate construction materials, landscaping, and site planning, as well as the necessity of effectively managing snow loads (Smith, 2024).

Figure 1.1 Illustration of the Arctic cathedral in Tromsø, Norway (The Viking Herald, 2023)

Cultural considerations: Cultural sensitivity is paramount in northern architecture, where structures often serve as symbols of community identity and heritage. The Sami parliament (Sámediggi) in Karasjok, Norway, exemplifies this approach. Its architecture, characterized by curved wooden forms reminiscent of traditional Sami tents, symbolizes the cultural heritage of the Indigenous Sami people. Moreover, the design process involved extensive community engagement to ensure the incorporation of traditional aesthetics and historical styles, fostering a sense of community identity and expression (Jasmin, 2004).

Figure 1.2 Illustration of the Sami parliament in Karasjok, Norway (Nordnorge, 2023)

Energy efficiency: With a growing emphasis on sustainability, energy efficiency plays a crucial role in northern architecture. For example, the Swedbank headquarters in Sundbyberg, Sweden, completed in 2014, exemplifies energy efficiency in architecture. Its design incorporates triple-glazed windows, external sunshades, and a heat recovery ventilation system, all contributing to reduced energy consumption. Furthermore, rooftop solar panels generate on-site electricity, while maximizing natural light minimizes reliance on artificial lighting. These sustainable practices not only cut carbon emissions but also result in significant cost savings (Swedbank headquarters, 2014).

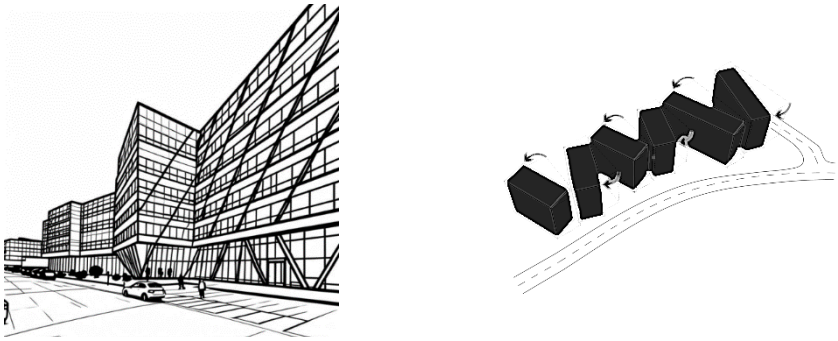

Figure 1.3 Illustration of the Swedbank headquarters in Sundbyberg, Sweden (ArchDaily, 2014)

Accessibility: Accessibility is a fundamental aspect of northern architecture, particularly in environments characterized by harsh winters and limited daylight. The Snowflake hotel in Kemi, Finland (also known as SnowCastle of Kemi), addresses this need through thoughtful design elements. By offering accessible outdoor spaces and adaptive lighting for dark winters, the hotel ensures enhanced visibility and safety for all users. Moreover, community engagement informs the design process, ensuring that accessibility features are tailored to meet the diverse needs of visitors (Nebasifu & Cuogo, 2017).

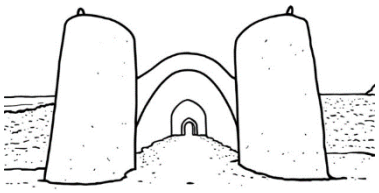

Figure 1.4 Illustration of the Snowflake hotel in Kemi, Finland (Finland.fi., 2023)

Sustainability: As climate change poses increasingly urgent challenges, sustainability has become a key consideration in northern architecture. Kiruna city hall in Sweden exemplifies sustainability in its architectural design, addressing the challenges posed by climate change in northern regions. The building incorporates various features to withstand extreme weather events and temperature fluctuations while promoting environmental responsibility. These features include insulation to minimize heat loss, energy-efficient systems for heating and lighting, and the use of renewable energy sources like solar panels and geothermal heating. Additionally, natural ventilation systems and sustainable materials contribute to reducing energy consumption and environmental impact. By considering potential climate change impacts, Kiruna city hall demonstrates a commitment to resilience and sustainability, emphasizing the importance of creating environmentally responsible buildings that are adaptable to changing environmental conditions (Klinger et al., 2023).

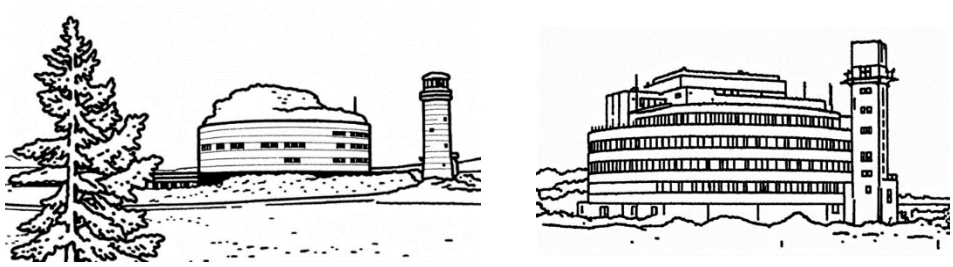

Figure 1.5 Illustration of the Kiruna city hall in Sweden (Scandinavian Architects, 2023)

Together, these guidelines emphasize the comprehensive approach necessary for addressing the unique challenges of Northern construction, blending cultural sensitivity with environmental sustainability. The next section will explore case studies demonstrating the practical application of these principles.

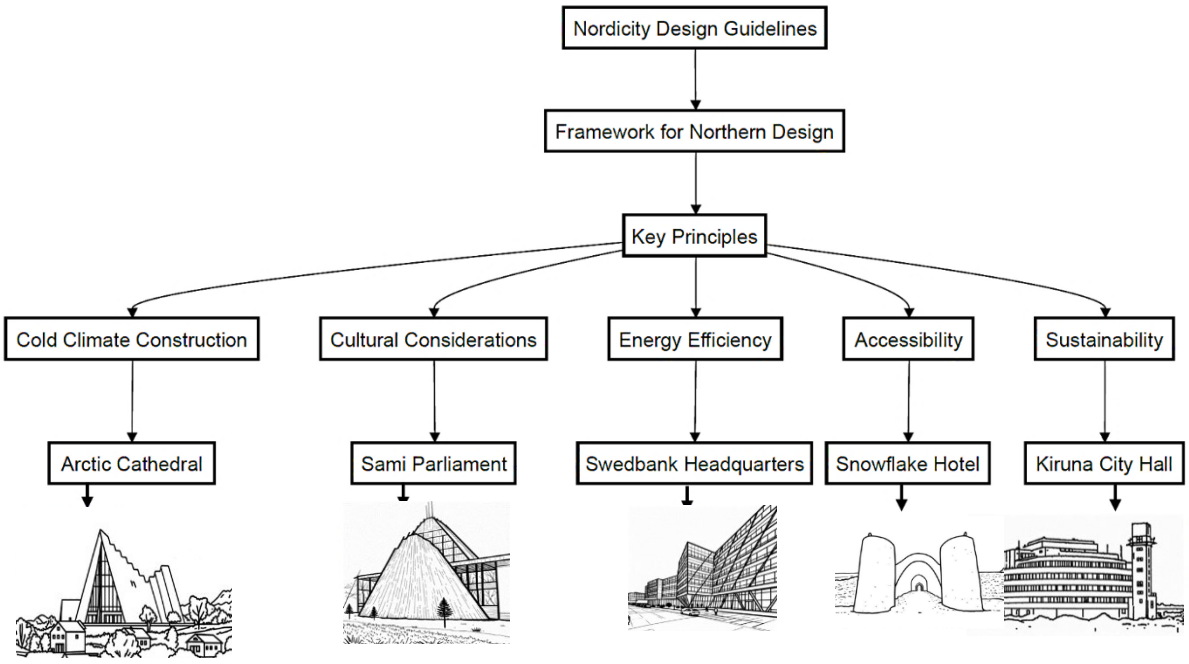

Figure 1.6 Design guidelines for Nordicity

1.3 Pavilion design

After exploring the concept of Nordicity and delving into design guidelines for Nordicities, the following section examines the definition of urban and Nordic pavilions and explores how these guidelines may be applied.

1.3.1 Urban pavilions

The word ‘pavilion’ finds its roots in the old French term ‘pavillon’, which originates from the Latin word ‘papilio’, meaning butterfly (Cantz, 2009). This etymology reflects the ephemeral nature of tent structures, often depicted as delicate and mobile, resembling butterflies. In architectural contexts, a pavilion typically denotes a lightweight and open structure serving a singular purpose, such as a shelter in a garden or an exhibition hall (Samson, 2016). As described by Lowenstein (2016), pavilions stand as freestanding units, exposed from all sides, embodying the concept of architectural shelter (Laugier, 2009) and often symbolizing a single-cell type of primitive hut, constructed with natural materials as fundamental architectural elements.

It's fascinating to consider how certain architectural interventions, initially planned as temporary, end up becoming permanent fixtures in our urban landscapes. Take the Eiffel tower, for example, designed by Gustave Eiffel for the 1889 world's fair. Originally intended to be dismantled after the fair, it has since become an enduring symbol of Paris. Similarly, structures like city park pavilions, such as the Lovejoy Fountain pavilion by Charles Moore in 1962, located in Portland, Oregon, United States, were designed with the intention of permanence from the outset.

A diverse array of pavilions, initially meant to be ephemeral, embody unique design concepts and purposes. The Biosphere pavilion in Montreal stands as a testament to the transformative power of architectural innovation and its lasting impact on environmental education. Designed by Buckminster Fuller, its innovative geodesic dome made of steel and acrylic cells not only showcases technological advancements but also fosters a visual connection between the interior and exterior through transparency. Initially built for Expo 67 to spotlight environmental and technological innovations, the pavilion later evolved into a permanent museum with a primary focus on environmental education and sustainability. Its transition underscores the enduring educational legacy of the Biosphere, continuing to educate the public on crucial environmental issues while also becoming an iconic cultural symbol of Montreal, representing innovation and ecological awareness. Similarly, the Butterfly Wings pavilion in Paris (2018), crafted as an interactive art installation, symbolizes transient beauty and the ephemeral nature of extraordinary structures. Meanwhile, the Garden Shelter pavilion in Kyoto (2015) harmoniously blends architecture with nature, providing a serene retreat for reflection and appreciation of seasonal adaptability. Lastly, the Timeless Ephemera pavilion in Rome (2020) celebrates the historical

significance of Roman architecture while exploring temporality, serving as a testament to the enduring impact of temporary structures and fostering historical appreciation among visitors. Together, these examples of urban pavilions highlight their multifaceted roles in shaping cultural landscapes and fostering awareness and appreciation for architectural innovation and historical heritage.

Urban pavilions serve as versatile structures within open public spaces, integrating various features to enhance user experience and enrich urban environments. These pavilions, exemplified by iconic structures worldwide, blend art, architecture, and landscape to create vibrant community spaces. The Serpentine pavilion in London (2000), known for its annual showcase of innovative designs, offers shade and hosts events to foster community engagement in Kensington gardens (Melvin, 2006). Similarly, the National Museum of African American History and Culture pavilion in Washington D.C., designed by David Adjaye in 2016, draws inspiration from Yoruba art and architecture, featuring integrated lighting for evening illumination (Towle, 2017). In Singapore, the Cloud Forest Conservatory at gardens by the Bay (2012) provides a cool respite while promoting environmental conservation efforts (Davey, 2011). The Lotus pavilion in Beijing (2019) serves as a futuristic cultural space with its translucent roof and LED lighting, while in Sydney, the Green Square library and plaza (2022) showcases sustainable design with its green roof and solar panels (Jing et al., 2024). Through thoughtful integration of materials, lighting, and cultural elements, these pavilions not only provide sanctuary and promote social interaction but also align with sustainability norms, enhancing the ecological resilience of urban landscapes.

Together, these attributes emphasize the dynamic nature of urban pavilions, showcasing their adaptability, cultural significance, and pivotal role in shaping inclusive and visually captivating urban environments. Serving as vibrant elements within urban landscapes, pavilions enhance user experiences, foster social connections, and contribute to the cultural and environmental fabric. They provide essential amenities such as shelter, shade, integrated lighting, and sustainability features, crucial for creating inclusive and visually stimulating urban spaces. Moving forward, the text will shift to exploring the unique considerations and design aspects of pavilions tailored specifically for winter settings.

1.3.2 Winter pavilions

Winter pavilions, commonly found in colder regions, serve both practical and recreational purposes, providing shelter from cold weather while enabling people to engage in outdoor activities or simply appreciate the winter landscape (Yang et al., 2013). These pavilions vary in size and form, ranging from small open-air shelters to larger enclosed buildings equipped with heating systems. Constructed from durable materials like wood, metal, or plastic, they are designed to withstand harsh winter conditions and offer insulation, heating, and lighting systems for comfort (Lonsdale, 2020; Studio North, 2019). Design considerations often focus on enhancing the winter experience, incorporating features such as large windows for natural light and panoramic views of snow-covered landscapes, as well as cozy seating arrangements and stylish aesthetics that complement the season (Jodidio, 2016; RBGE, 2018; Garden design magazine, 2017). For example, the Snowflake Retreat Pop-up Lounge in Banff National Park (Canada, 2020) and the Winter Wonderland Pop-up Cafe in Quebec City (Canada, 2018) demonstrate these principles, utilizing innovative technologies like outdoor heaters and snowmelt systems to ensure usability in cold weather conditions. These pavilions may be temporary installations set up during the winter season or permanent structures designed to withstand winter weather year-round, found globally in regions where winter is prominent, offering charm, warmth, and functionality to the winter experience (Koop, 2017; Hardy, 2015). The adaptability of temporary pavilions to specific locations and seasonal needs is illustrated by examples like the Snowflake Retreat (2019) and Winter Wonderland Pop-up café (2017), providing visitors with unique and memorable experiences. Additionally, the Frosty Meadows Glamping pavilion (2016) in Lapland showcases the diverse applications of temporary structures, offering a luxurious escape in the midst of Lapland's winter wonderland, combining shelter with a direct connection to the natural environment (Parsaee et al., 2020).

Collectively, these examples emphasize the innovative design approaches and the multifaceted roles that temporary winter pavilions can play. Moving forward, the next section will explore specific attributes tailored to meet the distinct requirements of pavilion design in northern regions.

1.4 Observations in Urban and Winter Contexts within Nordicity

The observations in this figure provide an understanding of pavilion design within the unique contexts of Nordicity. In urban pavilions, the design features are crafted to align seamlessly with

the concept's definition and evolution, emphasizing functionality and aesthetic harmony. This includes considerations for the integration of natural and built environments, among other factors. In contrast, winter contexts require a distinct approach, with design solutions that address extreme weather conditions and seasonal variations as central elements, purposes, and features. Features such as thermal efficiency, snow management, and winter-specific aesthetics become critical. The observations illustrate how pavilions can adapt to these diverse conditions, embodying the broader principles of Nordicity, which encompass both the cultural and environmental dimensions of high-latitude regions. These insights emphasize the importance of context-specific design strategies in creating functional and visually appealing pavilions and forms in both urban and winter settings.

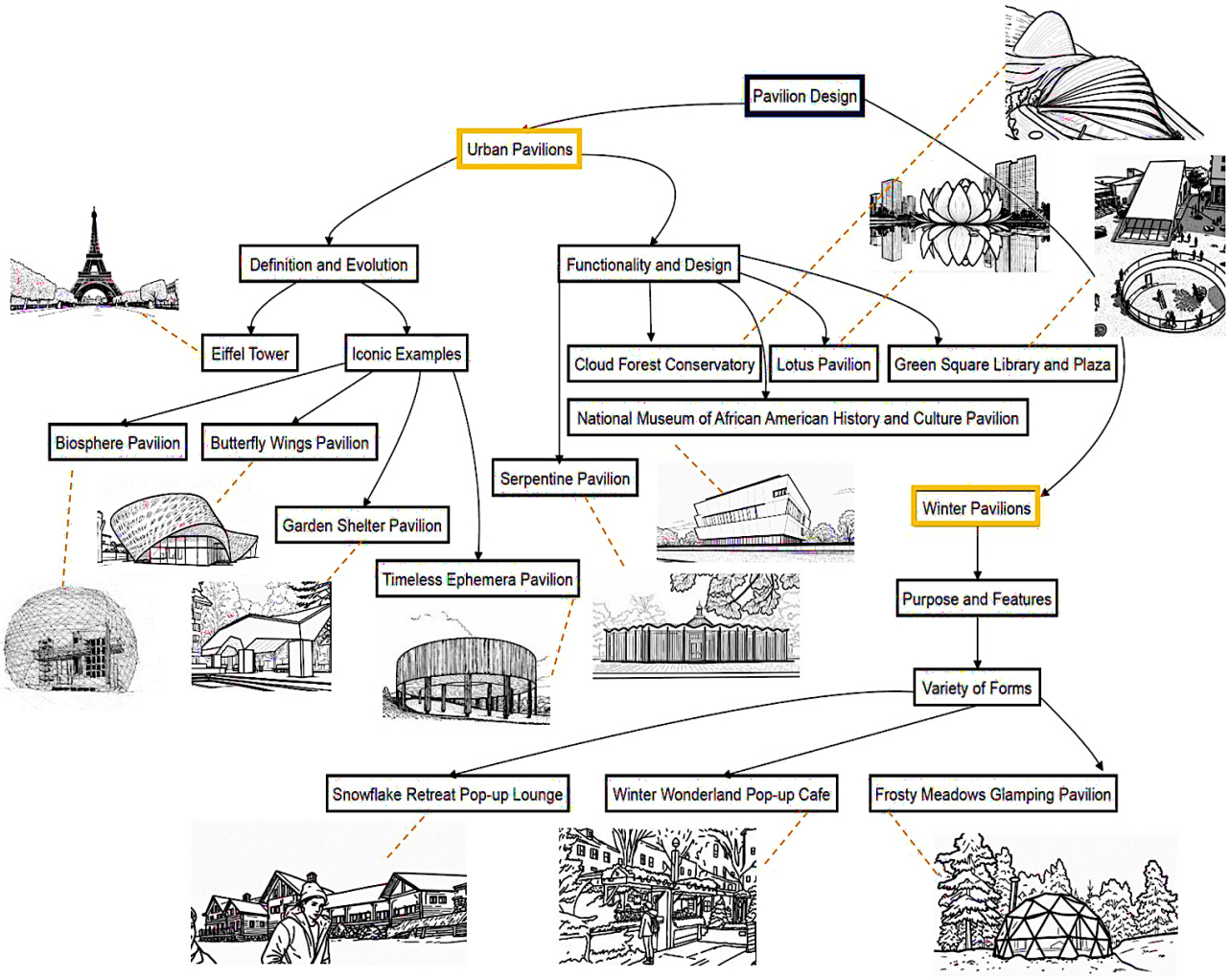

Figure 1.7 Observations in Urban and Winter Contexts within Nordicity

In the following sections, we will explore key design features for pavilions in Nordic contexts, including sloped roofs for effective snow management, high ceilings and large windows for

enhancing spaciousness and natural light, and the indoor/outdoor connection to integrate accessible outdoor spaces. We'll also examine the use of natural materials for sustainability, simple forms for elegant design, windbreaks for protection from harsh elements, and cultural references to connect with local heritage.

1.4.1 Sloped roofs

The incorporation of sloped roofs in architectural design, particularly in a Nordicity context, offers a practical solution to snow management while ensuring safety and aesthetic appeal. Sloped roofs allow snow to slide off naturally, preventing accumulation that could potentially cause damage to the structure. However, the degree of slope must be carefully considered to strike a balance between effective snow shedding and avoiding hazards. This principle is underscored by insights from 'arctic architecture: snow management guidelines' (Smith et al., 2018), which emphasize the importance of roof pitch in snowy environments. For instance, the Arctic Visitor Center in Tromsø (2016), Norway, exemplifies this principle with its modern interpretation of traditional Norwegian architecture, featuring steeply pitched roofs. This design not only facilitates efficient snow shedding but also creates a visually striking silhouette against the Arctic landscape, demonstrating how architectural considerations can seamlessly blend functionality with aesthetics in snow-prone regions.

1.4.2 High ceilings

The incorporation of high ceilings in pavilion design serves multiple purposes, contributing to both the aesthetic appeal and functionality of the structure. High ceilings create a sense of spaciousness and openness within the pavilion, enhancing the overall atmosphere for visitors. Moreover, they facilitate proper ventilation and air circulation, crucial for maintaining a comfortable indoor environment. This principle draws inspiration from studies in "Arctic interior design dynamics" (Jones, M., 2019, p. 18), which highlight the importance of high ceilings in architectural design, particularly in regions with extreme weather conditions. For example, the Northern Lights pavilion (2020) in Kiruna, Sweden, exemplifies this concept with its soaring ceilings and expansive glazing. This design not only floods the interior with natural light, creating an inviting ambiance, but also offers visitors unobstructed views of the mesmerizing aurora borealis during winter nights. By integrating high ceilings, pavilion designers can effectively enhance both the visual and functional aspects of the space, creating an immersive experience for visitors.

1.4.3 Large windows

The integration of large windows serves as a strategic means to enhance both the aesthetic and functional aspects of the structure. By providing ample natural light, large windows illuminate the interior space, creating a bright and inviting atmosphere. Additionally, these windows offer captivating views of the surrounding landscape, allowing occupants to immerse themselves in the beauty of their surroundings. This emphasis on large windows for abundant natural light and panoramic views is supported by insights from "Window scape in Nordic architecture" (Nordic Architectural Review, 2020, p. 21), which underscores their significance in architectural design. For instance, the Lapland Wilderness Retreat (2018) in Finland exemplifies this concept with its cabins featuring large, floor-to-ceiling windows. These windows frame breathtaking views of the snow-covered forests, establishing a seamless connection between the cozy interiors and the natural setting. Through the strategic incorporation of large windows, pavilion designers can effectively blur the boundaries between indoor and outdoor spaces.

1.4.4 Indoor/outdoor connection

The winter-centric approach to design underscores the vital role of the indoor-outdoor connection in creating engaging and immersive environments. This design philosophy emphasizes the importance of buildings offering views of the surrounding winter landscape while seamlessly integrating accessible and enjoyable outdoor spaces, even during the colder months. Aligned with principles from "Winter architecture: integrating outdoor spaces" (Arctic design journal, 2021, p. 14), this approach seeks to blur the boundaries between interior and exterior environments, enhancing the overall experience for occupants. A prime example of this concept is evident in the Winter Wellness Center (2019) in Reykjavik, Iceland. Here, an indoor hot spring and relaxation area connect to outdoor geothermal pools, providing visitors with a rejuvenating experience while offering uninterrupted views of the winter landscape. By prioritizing the indoor-outdoor connection in design, winter-centric structures like the Winter Wellness Center demonstrate how architectural innovation can foster a deeper appreciation for the surrounding environment while ensuring year-round enjoyment for visitors.

1.4.5 Natural materials

In architectural design, the incorporation of natural materials like wood, stone, and locally sourced materials plays a significant role in creating a sense of warmth and connection to the surrounding

natural environment. This emphasis on natural materials not only enhances the aesthetic appeal of the structure but also promotes sustainability by reducing transportation costs and supporting local economies. In Montreal, a concrete example of a natural material that supports the local economy is Eastern White Cedar. This wood species is native to the Eastern Canada region, including Quebec, making it readily available and sustainable for architectural use in the area. (Bachman, 2014) Guided by research in "Materiality in northern architecture: a sustainable approach" (Green building perspectives, 2017, p. 32), architects prioritize the use of natural materials to imbue structures with warmth and sustainability. A prime example of this approach is evident in the sustainable Sami cultural center (2021) in Inari, Finland. Here, locally sourced timber and stone are prominently featured in the construction, reflecting the sustainable ethos of the Sami community. By embracing natural materials, architects not only create visually appealing structures but also contribute to the preservation of the natural environment and support local communities.

1.4.6 Simple forms

In Nordic architecture, simplicity and clean lines are celebrated as defining features. Embracing minimalist design principles, architects often opt for simple forms to create pavilions that exude elegance and timelessness. Inspired by insights from "Nordic elegance: a study in architectural simplicity" (Architectural trends, 2016, p. 15), the adoption of simple forms emphasizes the beauty of understatement. A striking example of this approach is showcased in the Nordic design museum in Oslo, Norway. Here, a sleek and minimalist design with clean lines and geometric shapes defines the pavilion's aesthetic.

1.4.7 Windbreaks

In regions prone to harsh winds, the strategic placement of windbreaks emerges as a vital consideration. By integrating walls, fences, or trees around the pavilion, architects can provide protection from the elements while creating a sense of enclosure and privacy. This approach is informed by insights from "Wind-resilient architecture in northern climates" (Arctic engineering symposium, 2022, P. 11), which underscores the importance of wind-resistant design strategies. A prime illustration of this principle is observed in the Arctic retreat lodge in Svalbard (2019), Norway. Here, wooden windbreaks strategically encircle the outdoor terrace, shielding guests from the harsh Arctic winds. This thoughtful integration allows visitors to relish the breathtaking views

without exposure to extreme weather conditions, exemplifying how strategic windbreak placement can enhance both comfort and enjoyment in challenging climates.

1.4.8 Cultural references

The incorporation of cultural references also serves as a powerful means to establish a profound connection between the pavilion and the local community. By integrating elements such as traditional colors, patterns, or motifs into the design, architects can evoke a sense of heritage and belonging. This approach is guided by insights from "Cultural heritage in Nordic architecture" (Journal of Arctic studies, 2019, p. 51), which highlights the significance of cultural identity in architectural expression. A compelling example of this concept is exemplified in the Saami cultural pavilion (2017) in Jokkmokk, Sweden. Here, traditional Saami colors and patterns are intricately woven into the facade, paying homage to the Indigenous heritage of the region. These cultural references not only infuse the pavilion with a unique aesthetic but also foster a profound sense of identity and connection with the local community, illustrating the transformative power of cultural resonance in architectural design.

In summary, the principles and design features highlighted in this section underscore the importance of thoughtful consideration in creating winter-centric pavilions in Nordic environments. Sloped roofs facilitate snow shedding while maintaining safety, high ceilings and large windows optimize natural light and panoramic views, and an indoor-outdoor connection enhances the overall experience. Additionally, the use of natural materials, simple forms, windbreaks, and cultural references not only contribute to the aesthetic appeal but also promote sustainability and cultural resonance. By integrating these elements, Nordic pavilions can seamlessly blend functionality, aesthetics, and cultural sensitivity, offering immersive experiences for visitors while harmonizing with the surrounding environment. The next section will explore the connection between Nordicity design guidelines and sustainability to understand how adherence to these guidelines can promote environmentally conscious practices and contribute to well-being.

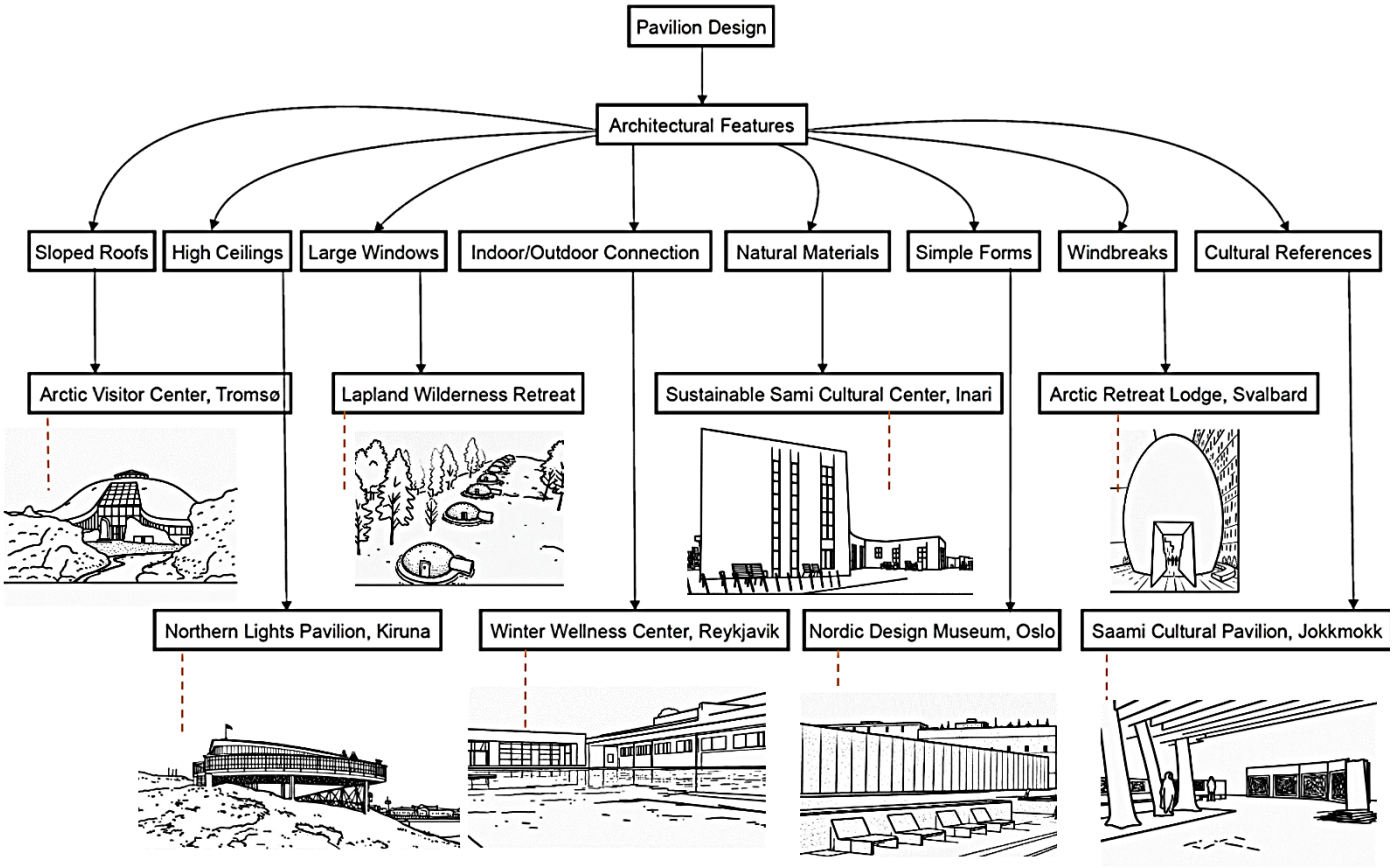

Figure 1.8 Design guidelines for winter pavilion

1.5 Connection between Nordicity design guidelines and sustainability

This research and design project, aligning with Nordicity design principles, investigates how pavilions can be conceptualized and built to minimize energy consumption while maximizing efficiency. Unlike traditional approaches, which may focus solely on functionality, the northern design paradigm views design as a powerful tool for promoting sustainability and well-being in northern regions, winter cities, and communities, employing sensitive and creative methodologies. Through its strategic design perspective, this concept sets itself apart from previous approaches in the realm of 'northern design' (Hasu, 2018).

Prioritizing aspects such as energy efficiency, sustainable infrastructure, walkability, integration with nature, and cultural sensitivity, Nordicity guidelines advocate for sustainable practices tailored to the distinctive needs of Nordic regions (Andersen, 2016). The upcoming sections delve

into these interactions and discuss the background, implementation, and outcomes of three case examples of winter pavilions.

1.5.1 Arctic exhibition in Stockholm's Nordicities pavilion

The Nordicities pavilion (2015) in Stockholm was conceived as an interactive exhibition to highlight the distinctive features and challenges of Arctic regions. Its implementation involved several key strategies. Firstly, the pavilion's design prioritized energy efficiency by incorporating sustainable building materials and innovative technologies to minimize environmental impact. Secondly, interactive exhibits were curated to engage visitors, focusing on sustainable practices within Arctic communities, thus reinforcing Nordicity's commitment to cultural sensitivity and environmental awareness. Finally, the pavilion featured showcases on renewable energy sources, offering practical demonstrations of sustainable energy applications in the Arctic context. The outcome of these efforts was the creation of an Arctic exhibition, which emerged as a symbol of sustainable design. Through educating visitors about Arctic sustainability and showcasing eco-friendly construction and operation practices, the exhibition effectively fulfilled its role as an educational and inspirational resource.

1.5.2 Winter Sustainability Expo in Reykjavik's Nordicities pavilion

Reykjavik's Nordicities pavilion (2019) was dedicated to promoting sustainable practices customized for winter climates. Its implementation strategies encompassed various initiatives. Firstly, the pavilion showcased designs for winter-friendly architecture, emphasizing energy-efficient buildings and infrastructure that are tailored to local climate conditions, thus reflecting Nordicity's commitment to climate-adaptive solutions. Secondly, exhibits featured renewable energy solutions suitable for cold environments, addressing the unique challenges posed by winter sustainability. Additionally, the pavilion highlighted sustainable practices in winter agriculture and food production, emphasizing the importance of local food sustainability and promoting self-sufficiency in Nordic regions. As a result, the winter sustainability expo held within this pavilion provided valuable insights into sustainable practices specifically adapted to winter environments, underscoring the significance of tailoring design guidelines to meet regional needs.

1.5.3 Green roof innovation in Helsinki's Nordicities pavilion

Helsinki's Nordicities p avilion was conceived with the ambitious goal of pushing the boundaries of sustainable architecture and design. Its implementation strategies included several key

initiatives. Firstly, the pavilion boasted a living green roof adorned with native vegetation, effectively enhancing insulation and reducing energy consumption. Secondly, advanced water recycling systems, encompassing rainwater harvesting and recycling, were put in place to minimize water usage and promote conservation efforts. Thirdly, the pavilion prioritized the use of locally sourced and renewable materials in its construction, thereby bolstering regional economies and mitigating transportation emissions. As a result, the green roof innovation showcased within Helsinki's Nordicities pavilion not only exemplified sustainable building practices but also served as a source of inspiration for future architectural designs focused on environmental conservation.

1.6 Conclusion

This chapter explored the multifaceted concept of Nordicity, a term that encapsulates not only geographical but also cultural and environmental dimensions inherent to northern regions. By analyzing the influential work by Hamelin and its ongoing impact, this study delved into the importance of Nordicity in shaping regional identities, guiding policy decisions, and sparking broader discussions on northern cultures and environments.

Moreover, Nordicity was approached as a potent lens through which to approach sustainable design, offering solutions and practices tailored to the unique challenges and opportunities presented by northern landscapes. Embracing Nordicity design guidelines, which intricately intertwine with sustainability principles, unveiled a framework advocating for energy efficiency, sustainable infrastructure, cultural sensitivity, and integration with nature.

Transitioning to the conceptual realm, I examined case studies of winter pavilions, each serving as a testament to the fusion of Nordicity design principles with sustainability objectives. From the Arctic exhibition in Stockholm's Nordicities pavilion to the winter sustainability expo in Reykjavik's Nordicities pavilion and the green roof innovation in Helsinki's Nordicities pavilion, these examples illustrated how these structures embodied sustainable practices while engaging visitors and promoting environmental awareness.

Furthermore, this chapter delved into the architectural features of winter pavilions erected in Nordicity settings, emphasizing the importance of sloped roofs for efficient snow shedding, high ceilings for spaciousness and ventilation, large windows for natural light and panoramic views, and the seamless integration of indoor-outdoor spaces to foster a connection with the surrounding

winter landscape. Through a comprehensive exploration of design features for pavilions in Nordicity's context, the significance of incorporating natural materials, simple forms, windbreaks, and cultural references to create resilient, culturally relevant, and aesthetically pleasing structures was explored.

Finally, by linking Nordicity design guidelines with sustainability outcomes through concrete examples, I showcased the transformative potential of strategic design in fostering sustainability and well-being in northern regions.

CHAPTER II

THEORETICAL FRAMEWORK FOR AN ECO-TECH PAVILLION

In this chapter, I delve into the theoretical framework for an eco-tech pavilion study. My exploration focuses on how an eco-tech pavilion can showcase innovative architectural solutions for addressing environmental challenges while promoting socio-environmental sustainability. I begin by examining the foundational design principles that guided the creation of the eco-tech pavilion, and that integrate technology and environmental stewardship. I then conduct an analysis of the sustainability approaches embedded within the pavilion's design and operation, including energy-efficient systems and the utilization of renewable resources. Lastly, I explore the critical aspect of contextual relevance in sustainable architecture, highlighting how the eco-tech pavilion can embrace local environmental, cultural, and social dynamics.

2.1 What can could be an eco-tech pavilion?

The eco-tech pavilion showcases sustainable technologies and innovations. It is envisioned to be an educational and interactive space that highlights the integration of eco-friendly practices into daily life (Golebieski, 2019; World expo, 2021; Terra, 2020; Expo Dubai, 2021; Tegola et al., 2019; Ohno, 2010).

The pavilion can feature various displays and exhibits that demonstrate how technology can be harnessed to protect the environment and promote sustainability. For example, there may be presentations on energy-efficient appliances, renewable energy sources such as solar panels and wind turbines, and smart home systems that optimize energy usage (Terra, 2021; Wang et al., 2011). The result of using natural forms in architectural design combines structural efficiency, performance needs, and aesthetics (Wollenhaupt, 2018; Pennell, 2019).

The definitions commonly provided for sustainable designs underscore the paramount importance of environmental sustainability within architectural practices. For instance, one such definition posits that “a sustainable structure is a structure which has the minimum incompatible effects on natural environment during its lifetime and in its regional and global implementation” (Lagdameo, 2021, p. 32). This definition emphasizes the importance of buildings minimizing their environmental impact throughout their lifecycle and across different geographical areas. However,

it's vital to recognize that sustainability encompasses not only environmental factors but also social and economic dimensions. Therefore, achieving a comprehensive understanding of sustainable design involves integrating these multifaceted aspects. In the following section, we will delve into how these principles shape sustainable architectural solutions.

2.2 Design principles for Nordicity in the context of an eco-tech pavilion

In my research, informed by my exploration of sustainable design, the design principles guiding an eco-tech pavilion emphasize the creation of a harmonious and sustainable space that seamlessly integrates with its natural surroundings, while also integrating cutting-edge technology and innovative design elements. For example, the pavilion could incorporate state-of-the-art solar panels to harness solar energy, significantly reducing its dependence on conventional energy sources. Moreover, intelligent building systems could manage lighting, heating, and ventilation to optimize energy efficiency according to occupancy levels and environmental factors. Additionally, the pavilion could feature inventive green roofs and vertical gardens, not only enhancing its visual appeal but also fostering biodiversity and enhancing air quality. Furthermore, the utilization of recycled and locally sourced materials in construction underscores the pavilion's commitment to minimizing its environmental footprint while promoting sustainable practices. These instances illustrate how a pavilion can capitalize on technological advancements and design ingenuity to establish itself as an environmentally conscious space.

These design principles are geared towards reducing the pavilion's ecological impact and amplifying its positive influence on the environment (Xu & Ji, 2020; Wang et al., 2011; Tegola et al., 2019). Prioritizing the use of sustainable and recyclable materials, such as eco-friendly building components or repurposed materials from existing structures, is a cornerstone of the pavilion's design approach. Additionally, a focus on natural lighting and ventilation aims to minimize reliance on artificial energy consumption (Tegola et al., 2019). Moreover, the incorporation of green roofs or living walls serves to bolster biodiversity and enhance air quality within the pavilion's premises.

In the context of Nordicity, an eco-tech pavilion underscores the integration of renewable energy sources, energy-efficient technologies, and sustainable building practices (Gültekin et al., 2018; Li & Sun, 2019; Salihbegović & Salihbegović, 2020). This approach aligns with the overarching

ethos of Nordicity design, emphasizing the adaptation of architectural solutions to local environmental conditions while prioritizing sustainability and environmental stewardship.

2.3 Approaches for socio-environmental sustainability

The conceptual design for an eco-tech pavilion includes research approaches identified from the literature review. Authors such as Al-Sallal (2018), Andelin and Häggström (2016), Bahadori and Novakovic (2016, 2017) emphasize the importance of energy efficiency, renewable energy, and sustainable materials. These aspects are crucial in nordic contexts, where extreme weather conditions necessitate innovative solutions for heating and insulation (Fan et al., 2016; Smith, 2021). Additionally, the integration of water conservation strategies (Cook, 2000) becomes vital to minimize environmental impact. Cultural sensitivity, as highlighted by Baldwin and Seymour (2017) and Canadian Heritage (2019), is an approach that must guide the design process. Understanding and respecting the local culture of Nordicities can contribute to the pavilion's acceptance and functionality within the community (Xu & Ji, 2020). Inclusive design research approach advocated by Baldwin and Lane (2021) further emphasize the importance of accommodating diverse user needs, promoting accessibility, and fostering a sense of belonging. Native greenspaces, as discussed by Boisvert and Brisson (2001) and Du Plessis (2012), play a significant role in the pavilion's integration into the natural environment. Incorporating green elements not only enhances the aesthetics but also supports biodiversity and ecosystem services. This aligns with principles of sustainable urban development (Mathew et al., 2018) and contributes to the overall well-being of the community. Community engagement, a central approach in the works of Baldwin and Seymour (2017) and Liao and Humphreys (2018), is pivotal in ensuring that the pavilion meets the needs and expectations of the local population. For these authors, involving the community in the design process fosters a sense of ownership, promotes social cohesion, and enhances the pavilion's relevance. The flexibility of design, aesthetics, and functionality, as discussed by Bevan (2015) and Tennenbaum (2019), ensures the pavilion's adaptability to changing needs and climates. Designing for well-being and quality of life, as proposed by Falk and Dijk (2018) and Hestad et al. (2020), reinforces the holistic approach required for sustainable architecture. The approaches outlined above provided the foundation for the conceptual design of the pavilion that not only responds to the unique challenges of Nordic climates but also integrates the cultural, social, and ecological contexts of the surrounding communities.

The next section emphasizes the significance of contextual relevance in designing a winter eco-tech pavilion, stressing the need to understand and incorporate local environmental, cultural, and social factors unique to Montreal. It highlights the importance of community engagement and cultural expression, ensuring the pavilion aligns with local values and fosters a sense of belonging. Additionally, resilience and innovation are underscored, advocating for adaptive design elements that can withstand and respond to changing climate conditions while pushing the boundaries of innovation.

2.4 Considering contextual relevance

As highlighted by Ramos (2020) and Gullberg (2019), contextual relevance serves as a foundational principle for a winter eco-tech pavilion. This principle underscores the importance of understanding the local context, including environmental, cultural, and social factors unique to Montreal. Unique characteristics for including environmental factors in Montreal could involve its specific climate, which features cold winters, as well as its location near the St. Lawrence River, which influences local ecosystems and biodiversity. Cultural factors might include Montreal's rich history, bilingualism, and diverse population, which includes Indigenous communities and immigrants from various backgrounds. Social factors could encompass Montreal's vibrant arts and cultural scene, strong sense of community, and progressive social policies, all of which shape the city's identity and values. Integrating these aspects into the design of a winter eco-tech pavilion would ensure its relevance and resonance with the city's unique environmental, cultural, and social context. (Cohen & Lapointe, 2020) Incorporating contextual relevance, influenced by the insights of Al-Sallal (2018) and Baldwin (2021), ensures that an eco-tech pavilion aligns with the specific needs and conditions of the city, fostering environmental sustainability while contributing to cultural identity and community pride.

Community engagement is another critical aspect prioritized in the design framework, as emphasized by Hestad (2020) and Liao (2018). Recognizing that an eco-tech pavilion aligned with local values can foster a sense of place, identity, and pride. The design framework integrates cultural references, local materials, and relevant technologies, inspired by the works of McMillan (2018) and Semaniková (2020), making an eco-tech pavilion a focal point for community involvement, garnering support and stewardship. In my research, this principle aims at establishing

a connection between an eco-tech pavilion and Montreal's residents, creating a shared space that resonates during the winter months.

Resilience also stands as a critical principle, acknowledging the necessity for a pavilion to endure and adapt to local environmental challenges. Considerations range from extreme weather events to changing climate conditions and local infrastructure. Drawing inspiration from Islam (2020) and Meerow (2016), the eco-tech pavilion can incorporate modular and flexible design elements. These features enable the pavilion to adjust to evolving winter weather patterns, optimizing energy efficiency for sustained operation and reduced environmental impact.

Focusing on the exploration of innovative ideas, techniques, and approaches specific to Montreal, representing the principle of innovation and creativity. This principle, inspired by the works of Haase (2016) and Chang (2019), pushes the boundaries of eco-tech design, contributing to sustainable practices. Embracing a culture of innovation and creativity, influenced by the insights of Eriksen (2019) and de Souza (2021), encourages experimentation with new materials and technologies, leading to pavilion designs that are not only environmentally sustainable but also aesthetically pleasing and culturally resonant.

Acknowledging Montreal's rich cultural heritage, the cultural expression principle emphasizes designing an eco-tech pavilion that reflects local culture and values (Dikmenli, 2017; Hawken, 2017). Integrating cultural elements and artistic expressions enhances the aesthetic and experiential qualities of the pavilion, ensuring it is not just environmentally sustainable but also culturally meaningful to the local community. This principle aligns with Montreal's tradition of celebrating its cultural diversity, as seen in events like the annual Fête des Neiges de Montréal (Montreal Snow Festival) (Jones, 2020). The festival, which showcases activities such as ice skating, snowshoeing, and ice sculpture competitions, exemplifies Montrealers' resilience and creativity in embracing the winter season. Moreover, beyond aesthetics, the incorporation of indeginous plant species in the landscaping, as discussed by Du Plessis (2012) and Wong (2018), contributes to sustainable practices while promoting biodiversity, cultural heritage, and environmental awareness.

Optimizing energy efficiency is also paramount, particularly in the context of Montreal's winter, according to the efficiency of energy consumption principle. The design, guided by principles outlined by Penner (2017) and Hoogstoel (2019), prioritizes heating solutions that minimize

environmental impact, ensuring a pavilion remains operational and energy-efficient during the colder months. Proper water and snow management strategies, as highlighted by Robitaille (2015) and Jiang (2021), are integrated to address Montreal's winter challenges under the water and snow management principle. These strategies not only contribute to energy production but also enhance the overall sustainability of the pavilion.

Finally, designing for adaptability, influenced by the insights of Boisvert (2001) and Brouillet (2010), ensures an eco-tech pavilion remains resilient in the face of changing climate conditions under the adaptability principle. Modular and flexible design elements, such as retractable roofs, adjustable insulation panels, and movable partitions, as discussed by Ernst (2017) and Fortin (2003), facilitate adjustments, allowing an eco-tech pavilion to respond effectively to evolving winter weather patterns.

2.5 Conclusion

Surveying the literature, this chapter employed a framework to guide the design of an eco-tech pavilion, particularly in the context of Nordicity and within the specific local context of Montreal, Canada. This entails considering the unique environmental, cultural, and social factors of Montreal, Canada, which influence the design decisions and requirements for the eco-tech pavilion. By synthesizing insights from various disciplines including sustainable architecture, environmental science, and community engagement, this framework aims to inform the creation of innovative structures that not only prioritize sustainability but also resonate with the cultural and environmental characteristics of their surroundings.

In this research, the conceptual development of an eco-tech pavilion emphasizes the integration of cutting-edge technology with sustainable design principles to create a space that minimizes its ecological footprint while maximizing its positive impact on the environment. From advanced solar panels and smart building systems to green roofs and locally sourced materials, the pavilion exemplifies how innovative solutions can be applied to promote environmental stewardship and community engagement.

Central to the litterature are principles such as contextual relevance, community engagement, resilience, innovation, cultural expression, and adaptability. These principles underscore locality, involving the local community in the design process, and ensuring the pavilion's ability to withstand and adapt to changing environmental conditions. Furthermore, the framework highlights

the significance of research approaches focused on socio-environmental sustainability, including energy efficiency, renewable energy sources, sustainable materials, water and snow management, cultural sensitivity, inclusive design, and native greenspaces. By incorporating these approaches into the design process, an eco-tech pavilion can not only address the specific challenges of Nordic climates but also contribute to the overall well-being and quality of life of the community it serves. Together, these principles encourage the creation of innovative structures that not only showcase cutting-edge technology, but also foster a deeper connection between humans and the natural world.

CHAPTER III

DECODING SUSTAINABLE AND ARCHITECTURAL DESIGN APPROACHES: FROM CONTENT ANALYSIS TO RESEARCH THROUGH DESIGN

Following the literature survey and theoretical framework, this chapter delves into the methodological process leading to preliminary design ideas of the eco-tech pavilion. Leveraging content analysis and Leximancer software as tools, I first discuss how I navigated through the aforementioned theoretical frameworks, distilling key insights and identifying prevalent research approaches pertinent to pavilion design principles. Secondly, I discuss how I proceeded to derive design principles essential for the conceptualization of the eco-tech pavilion, which, in turn, led to the identification of critical design criteria focusing on addressing locality-specific needs and climate resilience.

The relationship among research approaches, design principles, and design criteria is integral to the design process. Research approaches establish the foundation for gathering information and comprehending the context and requirements of a specific project. In contrast, design principles guide the overall conceptualization and aesthetic considerations of the design process. Design criteria, specific measurable objectives or requirements, ensure that the final design meets the desired goals and addresses identified needs. Ultimately, research approaches, design principles, and design criteria are interconnected and complementary elements of the design process, working together to inform and guide the creation (Luthe, 2017). It worth mentioning, design principles act as a link between the research approaches and the design criteria by providing guidelines and criteria for designing solutions that are informed by the research findings (fig. 3.1; Jagtap, 2019; Denyer et al., 2008)

Figure 3.1 Relationship between research approach, design principles, and design criteria (Jagtap, 2019)

The second part of the chapter delves into how content analysis informed the Research through Design (RtD) approach, facilitating a dynamic journey of iterative refinement. In the context of this thesis, RtD served as the backbone to harmonize research insights with conceptual design considerations. Through iterative cycles focused on each of the 12 research approaches (see table 3.1 below) and two design criteria (see table 3.3), I elaborate on how the design process generated sketches (fig. 3.3) and iterations aligned with specified criteria. This pivotal step delineates how the vision for the eco-tech pavilion begins to take shape, setting the stage for final design exploration and realization.

3.1 Content analysis

Content analysis has been defined as a systematic technique for condensing extensive text into fewer content categories based on explicit coding rules (Berelson, 1952; Krippendorff, 1980; Weber, 1990). I chose this research method due to its suitability for extracting meaningful insights from a diverse range of literature and theoretical frameworks such as those explored in the two previous chapters. In this case, it facilitated a structured examination of textual data to identify recurring themes or patterns related to the research topic, specifically pavilion design principles. A substantial volume of information could be efficiently processed, aiding in the identification and categorization of main research approaches. This methodological choice aligns with the need to understand the diverse perspectives and insights present in the literature, contributing to a more robust foundation for research-creation.

3.2 Research approaches in pavilion design: From literature to conceptual design

Utilizing insights derived from the literature review and theoretical framework, an automated content analysis was first conducted using Leximancer. Leaving out the reference lists, a compilation of "Research approaches" was generated, recognized by the algorithm as "Collections of words that generally travel together through the text" (Spina et al., 2021, p. 33). To refine the list, approaches that were excessively general, inconclusive, or commonplace in research paper writing (such as page, abstract, paragraph) were manually eliminated. The automated ranking of approaches was then carried out based on their frequency of occurrence in the analyzed material (Haynes et al., 2019). Table 3.1 illustrates this process:

Table 3.1 Illustration of the main research approaches identified in the study

Research Approach	Relevant Percentage
Energy efficiency	86%
Renewable energy	78%
Sustainable materials	75%
Water conservation	66%
Cultural sensitivity	59%
Inclusive design	84%
Native Greenspaces	72%
Community engagement	65%
Aesthetics	68%
Well-being and quality of life	61%
Functionality	67%
Flexibility	69%

Automated content analysis allowed identifying and ranking significant research approaches for pavilion design in Nordic settings. As the top 12 approaches offered crucial insights for sustainable pavilion design, the next section explores how this analysis fostered the identification of design principles for the eco-tech pavilion.

3.3 Deriving design principles for the eco-tech pavilion

The 12 research approaches laid the groundwork for a subsequent exploration, consistently utilizing Leximancer, with a focus on extracting nine sustainable design principles specifically tailored for approaching sustainability in the creation of the eco-tech pavilion for Nordicity. Through this iterative process, the objective was to distill the main principles of sustainable design, ensuring that they were firmly grounded in the pre-identified research approaches.

Table 3.2 Illustration the percentages of design principles identified in the study

Design Principles	Relevant Percentage
Contextual relevance	76%
Community engagement	81%
Resilience	89%
Innovation and creativity	72%
Cultural expression	68%
Planting local plants and vegetation	83%
Efficiency of energy consumption	87%
Water and snow management	65%
Adaptability	76%

3.4 Locality and climate resiliency as criteria

In a subsequent phase, the nine design principles prompted a more focused exploration to derive criteria for designing the eco-tech pavilion. Employing a systematic coding method, I organized literature findings based on the recognized design principles, streamlining data and revealing patterns across resources. The discerned patterns were condensed into a concise set of criteria aimed at enhancing socio-environmental sustainability. Through the content analysis methodology, two pivotal criteria — locality and climate resiliency — emerged as focal points encapsulating the core principles for the eco-tech pavilion design (table 3.3). This process ensured that the selected criteria not only align with the identified nine design principles but also withstand thorough scrutiny against established literature and frameworks.

Table 3.3 Illustration of the percentages of design criteria identified in the study

Design Criteria	Relevant Percentage
Design for locality	88%
Design for climate resiliency	85%

These two criteria fostered a transition toward RtD. This shift - including sketching as a hands-on method - allowed for the conceptual application and iterative refinement of the identified criteria, ensuring that the design effectively addresses the specific needs of Nordicity while prioritizing socio-environmental sustainability.

3.5 Integration of previous analysis into an RtD methodology

Research through design (RtD) enables the expression and materialization of knowledge and theoretical insights (Corteso & Lenzholzer, 2022). This approach facilitated the exploration of multiple iterations and aided in the selection of the most suitable design option for the pavilion. Figure 3.2 visually depicts this process, with subsequent sub-sections providing detailed explanations of each step.

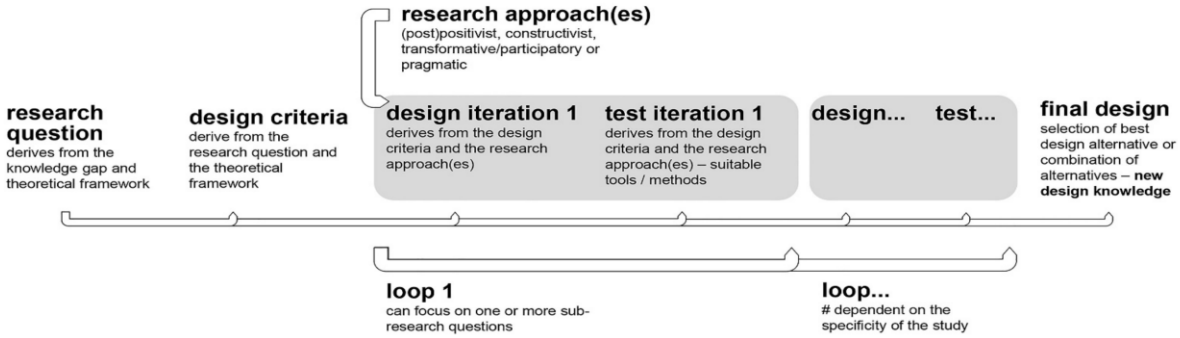

Figure 3.2 Indicative and simplified representation of the research (RtD) process (Corteso & Lenzholzer, 2022)

3.5.1 Revisiting the research question and design criteria

As described previously, design criteria derived from the content analysis were revisited. During this process, each criterion was carefully examined to determine its relevance, applicability, and alignment with the project's overarching research approaches, forming the foundational elements for the design exploration. In this context, the RtD process started with a reexamination of the research question. The original research question, centered on enhancing sustainability through the design of an eco-tech winter pavilion, "How can content analysis lead to defining sustainable and innovative principles for design in Nordic contexts?" evolved into two interlinked questions "How these principles can inform the conceptual design of an eco-tech pavilion that improves socio-environmental sustainability during winter? This complementary question signals a more nuanced focus and aligns with the design principles and criteria identified throughout the research process.

3.5.2 Harmonizing research and design iteratively: Inspiration from the Biosphere

The RtD methodology unfolded in iterative cycles, each focusing on one of the 12 research approaches. Within each cycle, design sketches were generated and aligned with specified criteria (fig. 3.4 to 3.10). It's important to note that design principles served as a link between research approaches and design criteria. They offered a framework for translating insights and data gathered into tangible experimentations (Jagtap, 2019; Denyer et al., 2008).

This approach facilitated a continuous refinement process, involving evaluation and feedback collection. For instance, in its early stages, the design of the eco-tech pavilion may have primarily emphasized the integration of cutting-edge technology to improve energy efficiency. However,

through successive iterations and feedback loops between research question, design criteria, and research approach, this evolution illustrates how the design process adapted in response to feedback. This enabled exploration of diverse design possibilities but also fostered creativity, allowing the design to effectively address the challenges presented by Nordicity features and the unique conditions of Montreal's winter.

I was inspired by the Biosphere (fig. 3.3), a structure seen as a symbol of Montreal's commitment to environmental stewardship and an iconic landmark in the city. Serving as a center for environmental education and interpretation, the Biosphere provides the public with exhibitions, interactive displays, and educational programs that aim to inspire visitors to take action towards a more sustainable future.

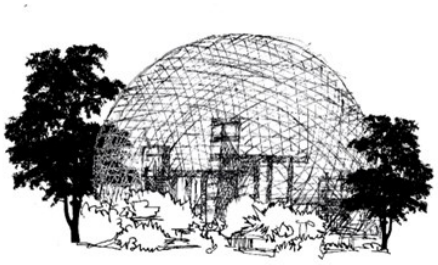

Figure 3.3 Illustration of the Montreal Biosphere (The Canadian Encyclopedia, 2023)

The design process commenced with the development of various design concepts. This phase involved the creation of sketches and brainstorming sessions to explore the feasibility and functionality of each concept (fig. 3.4 to 3.10) through geometric shapes based on design patterns. After careful consideration, the spherical shape emerged as the most suitable design for the eco-tech pavilion. The advantages of this shape, including better heat retention, structural strength, increased natural light, and improved heat insulation, were identified through the project's testing. Furthermore, the spherical shape offered not only functional benefits but also contributed to the pavilion's aesthetic appeal.

The following delineates the development and alignment of the design for my research within each cycle, adhering to research criteria. Informed by the methodology of RtD (fig. 3.2), it becomes evident through iterative cycles that each one emphasizes different research approaches and design criteria. Below, you'll find the initial sketches representing my iterative feedback, adjusted to

incorporate evaluations and adjustments, with a particular focus on proposing the initial step for the final design of my research in the next chapter.

Figure 3.4 Optimizing structural stability and energy efficiency

Architectural forms may adopt aerodynamic shapes, such as curved or tapered profiles, to minimize wind resistance and reduce the force of wind pressure on building surfaces. These streamlined shapes help improve structural stability and energy efficiency.

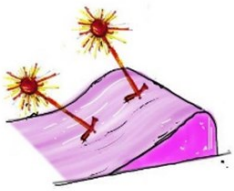

Figure 3.5 Curved roof design

A curved roof form (fig. 3.5) creates an aesthetically distinctive profile while offering ample surface area for solar panel installation. This design enhances architectural interest while maximizing solar energy capture. The curved shape can also promote natural ventilation and daylight penetration, contributing to overall energy efficiency and occupant comfort.

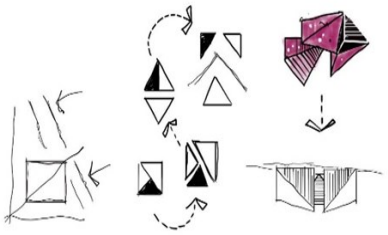

Figure 3.6 Optimizing solar gain

As shown in figure 3.6, the orientation and design of the pavilion prioritize capturing sunlight, particularly during the colder months when daylight hours are shorter. Generally, south-facing orientations are recommended for optimal solar gain, as they receive the most sunlight throughout the day. It's also essential to consider the local climate, prevailing wind patterns, and site-specific conditions when determining the best architectural form for a Nordic pavilion to ensure comfort, energy efficiency, and sustainability.

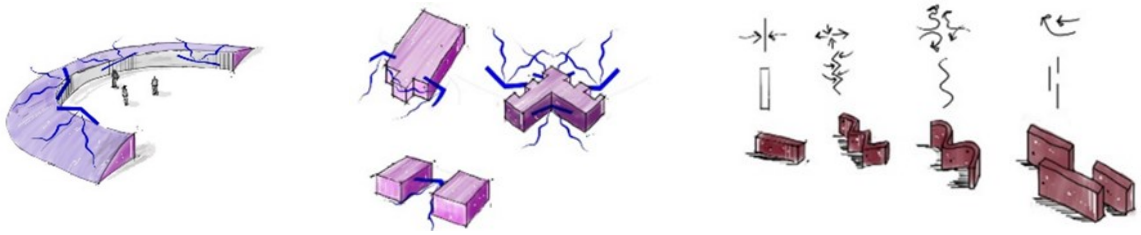

Figure 3.7 Enhancing aerodynamics

Considerations should also include a streamlined and low-profile structure that minimizes wind resistance and turbulence (fig.3.7). Additionally, incorporating features such as tapered or curved surfaces can help reduce drag and optimize airflow around the pavilion. Moreover, strategically placed openings or vents can allow for controlled ventilation while minimizing wind-induced pressure differences inside the pavilion.

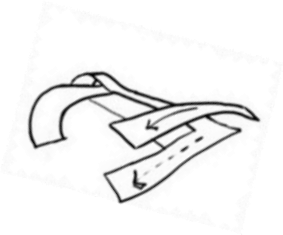

Figure 3.8 Importance of compact layers

Placing the layers of the walls in a compact manner, as illustrated in figure 3.8, are vital for winter pavilions due to their insulation properties, structural stability, and energy efficiency. These layers effectively retain heat, provide structural support against snow loads, and reduce the need for

heating, resulting in lower energy consumption. In essence, compact layers play a critical role in ensuring thermal comfort, structural integrity, and sustainable operation of winter pavilions.

Figure 3.9 Maximizing natural light and connection to nature

Further sketches strategically incorporated large openings to align with Nordicity design principles (fig. 3.9). These windows allow ample natural light, reducing reliance on artificial lighting and enhancing indoor ambiance. Additionally, panoramic views promote occupant well-being, fostering a deeper connection to nature and environmental awareness. This approach reflects a commitment to sustainable design in harmony with the surrounding environment.

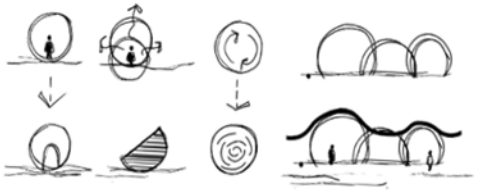

Figure 3.10 The sphere

Finally, the sphere emerged as an optimal form for a winter pavilion due to its practical advantages. Its efficient use of space, structural strength, and better insulation make it ideal for compact and durable designs. Additionally, the spherical shape promotes efficient heat circulation, offers aesthetic appeal, reduces material usage, and enhances natural lighting, all contributing to sustainable and comfortable pavilion architecture.

The research through design (RtD) methodology guided the selection of the final design proposal that will be discussed in the next chapter. By intertwining research insights from the 12 approaches

with conceptual considerations, sketches served as the initial conceptualization of the pavilion's form, facilitating further development and refinement.

Indeed, these cycles ensured the design evolved and adapted to feedback, evaluations, and adjustments I made myself based on research through design methodology and sketching. The iterative nature of RtD, combined with the conceptual testing and exploration of design concepts, ensured that the final design was not only functional but also informed by an understanding of socio-environmental sustainability and the specific requirements of the chosen Nordic context. This includes considerations such as extreme winter weather conditions, the importance of energy efficiency and insulation, and environmental sustainability, all of which influence the design of the eco-tech pavilion to ensure its suitability for the Nordic environment while also aligning with principles of sustainability and cultural relevance.

3.6 Conclusion

In this chapter I discussed how content analysis toward 12 research approaches, nine design principles, and two design criteria aimed at enhancing socio-environmental sustainability toward the conceptualization of an eco-tech pavilion tailored to the unique features of Nordicity. Content analysis helped navigate through the extensive literature and theoretical frameworks discussed in chapters I and II, distilling key insights and identifying prevalent research approaches and recurring themes and patterns relevant to pavilion design principles. Through iterative refinement and alignment with identified research approaches, the nine principles served as guides, shaping the trajectory of eco-conscious design endeavors. Additionally, the two design criteria were crucial for fostering socio-environmental sustainability in pavilion design, particularly addressing locality-specific needs and climate resilience. By harmonizing research insights with conceptual design considerations using RtD, the process underwent iterative sketching, marking the initial steps towards designing the pavilion. These sketches, informed by integrated research insights and conceptual design considerations, represented a synthesis of innovative ideas and sustainable principles, laying the groundwork for further development of the pavilion. The research method employed in this study is depicted in the following diagram. It begins with content analysis using Leximancer to refine and rank approaches, leading to the extraction of themes like energy efficiency and cultural sensitivity. These themes inform design principles, which are then translated into specific design criteria, such as locality and resiliency.

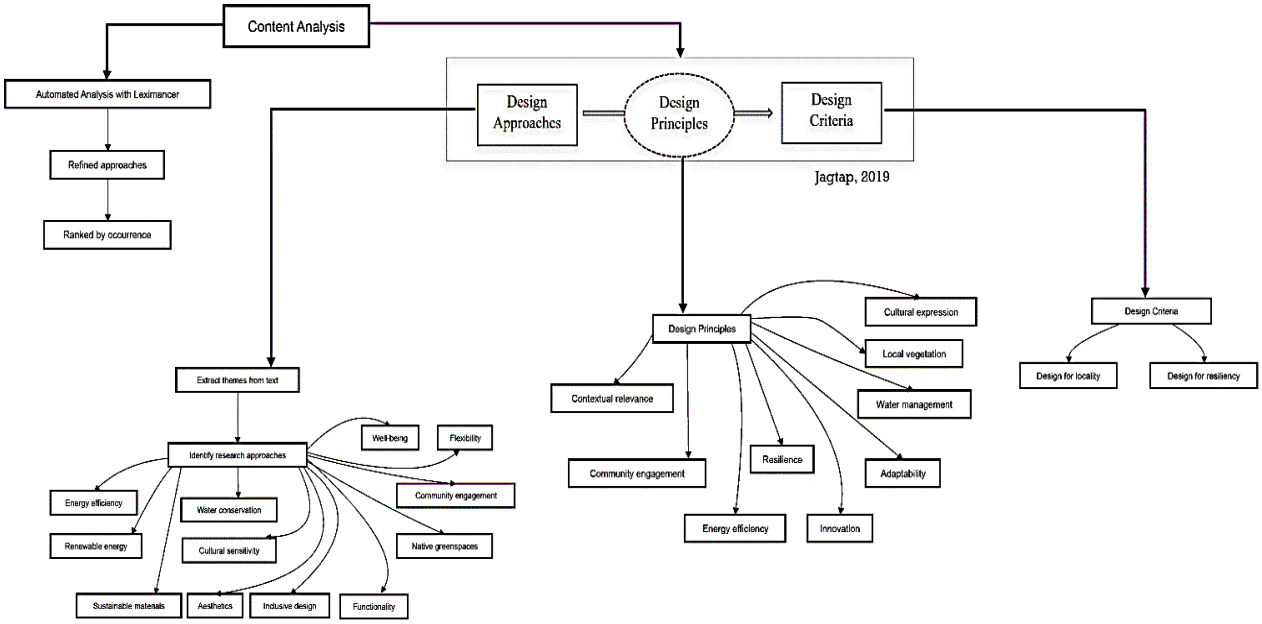

Figure 3.11 Decoding sustainable and architectural design approaches: From content analysis to research through design

CHAPTER IV

THE ECO-TECH PAVILLION: A DESIGN JOURNEY

Following preliminary sketches, this chapter delves into the speculative and conceptual process of designing the eco-tech pavilion. Three pivotal steps guided the exploration: 1) crafting sustainability through form, roof, wall, and interior environment; 2) decoding design patterns; and 3) exploring implementation and limitations of the eco-tech pavilion in Montreal.

The initial step involved an examination of the eco-tech pavilion's design elements, encapsulating form, roof, wall, and interior environment. Drawing insights from the literature review, design frameworks, and specific criteria, the goal was to create a structure that not only harmonizes with its surroundings but also embodies sustainability at its core. The eco-tech pavilion's design was thus crafted to enhance both energy efficiency and visual allure, making it an inviting space for the public to engage with moving forward, the evaluation of initial sketches involves analyzing design patterns within established frameworks and criteria. This systematic approach categorizes these patterns based on overarching principles, offering valuable insights into potential design solutions. Through detailed imagery and animations[2], the speculative pavilion model was brought to life to showcase innovative design features and sustainable elements, illustrating its potential to effectively address environmental challenges. Conceptual considerations inspired by Nordicity features then inform the refinement of the eco-tech pavilion's design, ensuring its effectiveness, sustainability, and seamless integration into its surrounding environment. During the design process, 3D design software, including Rhino (fig 4.1), was employed to create a comprehensive model of the structure. The conceptual design was rendered using Lumion (fig. 4.3 to fig. 4.6), providing detailed visualizations.

[2] https://vimeo.com/942787892?share=copy

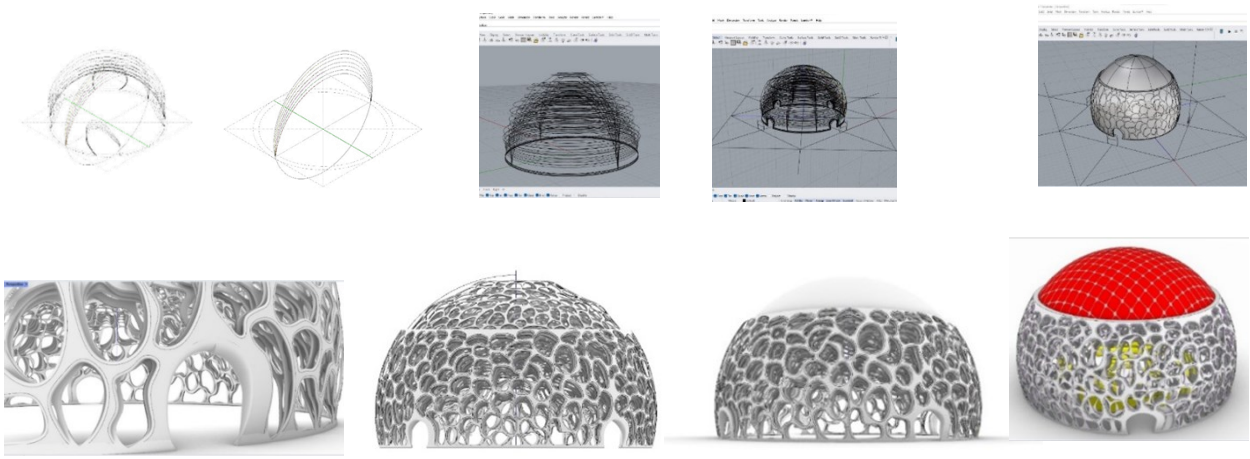

Figure 4.1 3D Modeling design process in Rhino software

The next section delves into the intricate process of crafting sustainability through various aspects of design, including form, roof, wall, and interior environment. It explores how these elements can be intentionally shaped and integrated to enhance the eco-tech pavilion's sustainability performance, addressing key considerations such as energy efficiency, material selection, and occupant comfort. Through an in-depth examination of each component, this section aims to elucidate the pivotal role of design in fostering sustainable practices and principles within the built environment.

4.1 Crafting Sustainability through form, roof, wall, and interior environment

In designing the eco-tech pavilion for sustainability and functionality, it was essential to analyze various structural elements using literature review, design frameworks, and specific criteria. These elements, comprising form, roof, wall, and interior environment, were key considerations. The form, encompassing overall shape and structure, holds significant potential to impact both energy efficiency and aesthetic appeal and can be optimized by improving airflow, natural lighting, and heat regulation, while simultaneously enhancing the pavilion's visual allure. This dual focus ensures that the pavilion not only serves its purpose sustainably but also captivates the audience with its inviting ambiance. The roof is an ideal component for the collection of snow and solar energy, as well as for providing shade and ventilation. The design of the wall layers thus had prioritized insulation and air barriers to reduce heat loss and increase energy efficiency.

Furthermore, the interior of the pavilion should incorporate sustainable materials and biophilic design principles to enhance visitors' well-being and create a healthy, entertaining, and

comfortable environment. By taking into account these four categories of design, the eco-tech pavilion can be constructed in an environmentally conscious and sustainable manner, as shown in figure 4.2. the final design represents a profound integration of biophilic principles, sustainability, and functional aesthetics. Inspired by the biosphere, the spherical shape was chosen to emulate the natural curves and harmony of the environment. This form not only serves as an aesthetically pleasing structure but also enhances functionality. The spherical design minimizes wind resistance, improves structural stability, and maximizes energy efficiency. Additionally, the strategic use of wood in the pavilion's construction further enhances its biophilic qualities. This biophilic principle is showcased by integrating a green space even during winter, featuring a diverse array of local vegetation, including cold-resistant grasses, flowers, and small shrubs. Visitors to the pavilion can revel in the beauty of the verdant surroundings and experience a profound connection with nature as they stroll through or relax amidst the greenery. This harmonious integration with nature enriches the pavilion experience, fostering relaxation, reducing stress, and nurturing a heightened appreciation for the environment even in the colder months. Wood, a renewable and biodegradable material, fosters a deep connection with nature while reducing the carbon footprint of the structure. Moreover, the incorporation of large windows aligns with Nordicity design principles, allowing ample natural light to flood the interior and offering panoramic views that promote occupant well-being and environmental awareness. In essence, the final eco-tech pavilion design encapsulates a holistic approach to sustainable architecture, seamlessly blending form, function, and environmental consciousness.

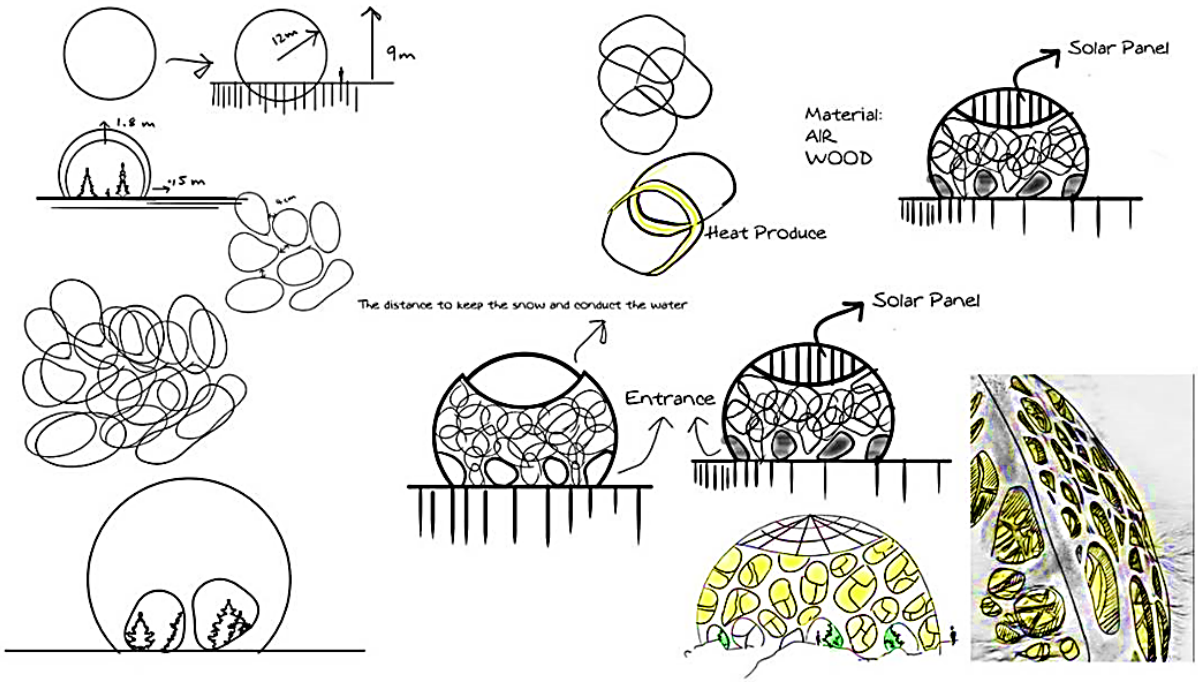

Figure 4.2 Initial sketches for the eco-tech pavilion

4.2 Decoding design Patterns: Form, roof, walls, and interior of the eco-tech pavilion

In this section, I embark on a detailed analysis of the eco-tech pavilion's design, focusing on its form, roof, walls, and interior layout. Each element is examined through functional, sustainable, and aesthetic lenses. As I delve into each aspect, I will explore how they contribute to the pavilion's overall objectives of energy efficiency, and environmental sustainability. I will begin by examining the pavilion's form and how it shapes its performance and visual identity.

4.2.1 Form

The proposed spherical form (fig. 4.3) for the eco-tech pavilion brings four key advantages. First, due to its spherical shape, this form proposes a high volume-to-surface area ratio that can be advantageous for energy efficiency. With a smaller surface area compared to its volume, the pavilion minimizes heat loss through its walls. This property is particularly beneficial in colder climates, such as during winter, as it enhances insulation. Second, the pavilion proposes active solar heating. If properly oriented towards the sun, the curved shape of the pavilion allows for efficient capture and retention of sunlight throughout the day. This active solar heating capability reduces the reliance on additional heating systems, lowering overall energy consumption during

winter and promoting sustainable energy practices. Third, the curved shape of the pavilion fosters natural light distribution in multiple directions. This feature can reduce the dependence on artificial lighting during daylight hours, creating a well-lit and comfortable interior space. This can not only enhance the overall occupant experience but also minimize energy use for lighting, aligning with eco-friendly design principles. Finally, the spherical form provides inherent structural stability by evenly distributing loads and stresses across its surface. This structural integrity ensures the pavilion's robustness, enabling it to withstand heavy snow loads and harsh winter weather conditions. The result is a durable and safe structure that aligns with the pavilion's long-term sustainability goals.

Beyond its functional benefits, the spherical shape offers a distinctive and visually appealing design for the eco-tech pavilion. This unique architectural form can serve as an iconic structure, attracting attention and inspiring visitors. Its smooth curves and symmetrical silhouette evoke a sense of harmony and balance, creating a visually pleasing structure. Moreover, the design flexibility inherent in the spherical shape allows for creative and innovative interior layouts, spatial arrangements, and circulation patterns, optimizing the functionality and user experience of the pavilion. This blend of aesthetics and functionality contributes to a holistic and sustainable design approach.

Figure 4.3 Proposed form features

After analyzing and itereating sketches, the design principles for the form prioritize efficient space usage, structural strength, enhanced insulation, effective heat distribution, aesthetic appeal, symbolic meaning, minimized material usage, and improved natural lighting.

4.2.2 Roof

The proposed installation of solar panels on the roof (fig. 4.4) leverages three key advantages for the eco-tech pavilion, contributing to the benefits of its shape and presenting innovative opportunities, particularly with the integration of Snow-Teng[3] technology. Snow-Teng technology represents an innovative approach to energy generation and snow management in wintry climates. This technology utilizes the accumulated snow on solar panels to produce electricity as a medium for enhancing energy efficiency (Chen et al., 2018).

Firstly, the spherical form facilitates enhanced snow accumulation, providing advantages such as insulation and an additional layer conducive to Snow-Teng technology operation. Secondly, positioning solar panels atop the spherical structure ensures optimal energy generation. The curvature of the roof allows for precise panel angling, maximizing exposure to sunlight, crucial for effective solar energy harnessing, especially during shorter winter daylight hours. Thirdly, the seamless integration of solar panels with Snow-Teng technology offers a sustainable energy generation approach. Accumulated snow on the panels acts as both an insulator and reflector, enhancing solar panel efficiency. By leveraging energy from both snow accumulation and solar panels, the pavilion significantly enhances its overall energy efficiency during winter months, reducing dependence on external energy sources and advancing eco-conscious initiatives.

Figure 4.4 Proposed roof features

The solar panels on the Eco-tech winter pavilion's roof are a crucial element of an active energy generation system, designed to maximize efficiency through a combination of innovative features. The spherical roof shape ensures optimal panel angling for maximum sunlight exposure, essential

[3] A snow-triboelectric nanogenerator (snow-TENG), designed to harvest energy from snow contact and friction, is installed on solar panels. Operating in single electrode mode, this device harnesses both contact electrification and electrostatic induction during snowfall. It capitalizes on various relative motions, including falling snow and sliding snow particles, to generate energy (Ahmed, et al., 2019)

for effective solar energy capture, especially during winter's shorter daylight hours. Integrated with Snow-Teng technology, which harnesses accumulated snow to generate electricity, the system demonstrates its active nature. Snow serves as both an insulator and reflector, enhancing panel efficiency and contributing to energy production from both solar and snow-based sources. Additionally, the roof design is crafted to enhance energy efficiency, manage snow accumulation, shed snow effectively, withstand wind forces, maintain structural integrity, and provide aesthetic appeal while seamlessly integrating with the natural surroundings and offering design flexibility.

4.2.3 Walls

The proposed wall design (fig. 4.5) for the eco-tech pavilion, featuring large openings and five intersecting layers, introduces three key advantages.

Firstly, within the conceptual framework of this project, the integration of large windows aligns with the foundational principles of Nordicity design, as outlined in chapter I. This choice to incorporate sizable openings serves a pivotal role in fostering a seamless connection between the interior spaces and the natural environment. They were envisioned to facilitate abundant natural light, thus diminishing reliance on artificial lighting and enhancing the overall indoor ambiance. Moreover, the expansive winter views offered by these windows are anticipated to enhance occupants' well-being, nurturing a profound sense of connection to nature and fostering a deeper appreciation for the environment. Such design decisions underscore the project's overarching commitment to sustainable architecture, emphasizing the importance of harmonizing with the surrounding ecosystem.

Secondly, the meticulous attention to optimizing insulation and heat loss prevention is an integral aspect of this conceptual undertaking. Within the envisioned design, a strategic arrangement of openings within five layers of the wall system is envisaged to create an effective barrier against harsh external elements, particularly in the challenging winter climate of Montreal. Through the synergistic interaction of these layers, a robust insulation system is conceptualized to maintain a comfortable interior temperature. This emphasis on insulation not only seeks to enhance the energy efficiency of the pavilion but also reflects a conscientious approach toward sustainable building practices, aligning with the project's broader vision of environmental sustainability.

Lastly, from a prospective standpoint, the proposed heating strategy for multi-purpose functionality represents a forward-thinking approach to enhancing energy efficiency and

operational versatility. Within the conceptual framework, the incorporation of heaters within the wall layers is envisioned to serve as both sources of illumination during nighttime hours and active participants in snow removal processes. This proactive strategy is anticipated to uphold the structural integrity of the pavilion while mitigating excessive weight accumulation caused by snow buildup. Furthermore, these heaters are expected to create a warm and inviting interior environment, thereby enriching the overall visitor experience, particularly during colder months. The seamless integration of this heating strategy into the insulating layers exemplifies the project's innovative spirit and underscores its adaptability to diverse weather conditions within a conceptual realm.

Figure 4.5 Proposed wall features

Finally, the wall design of the Eco-tech pavilion, featuring large windows and a multi-layered structure, presents several key aspects. The walls indeed include large windows without any glass, aligning with Nordic design principles to foster a strong connection between indoor spaces and the natural environment. They are composed of five intersecting layers, each contributing to the overall insulation and heat retention of the pavillion. This multi-layered design can create an effective barrier against harsh external conditions and optimize insulation to prevent heat loss, ensuring a comfortable interior temperature and promoting energy efficiency. Because the air outside the pavilion can be cold and dense, while the air inside can be warm and light due to the heaters installed in the wall layers, the trapped air between the five layers of the wall acts as insulation, preventing the extremely cold air from entering the pavilion.

Regarding the heating system, the walls incorporate heaters within these layers. This innovative approach not only provides illumination during nighttime but also assists in snow removal, preventing excessive snow buildup and maintaining structural integrity. The combination of large windows, multi-layered walls, and embedded heaters reflects a thoughtful and sustainable

approach to design, adaptable to cold weather conditions. However, there are practical limitations to the construction and installation of these walls. Issues such as construction costs, material sourcing, and feasibility have not been fully addressed.

4.2.4 Interior design

The proposed interior design (fig. 4.6) for the eco-tech pavilion introduces three key advantages, reflecting a thoughtful and multi-faceted approach to sustainability and user experience.

First, it emphasizes biophilic principles to strengthen the connection between visitors and nature, enhancing overall well-being. By incorporating wintergreen vegetation suitable for Montreal's climate, such as Holly, Wintergreen boxwood, and Blue spruce, the design can not only improve air quality but also create a distinctive, immersive experience. Additionally, the inclusion of curved wooden benches serves both functional and social sustainability goals. The use of natural materials adds an eco-friendly aspect, while the benches provide comfortable gathering spaces and act as a wind barrier, fostering a warm and inviting atmosphere during winter. This arrangement also encourages social interaction and community building. Furthermore, the interior layout, including some seats with their backs to the stage, is designed to offer flexible viewing options, accommodating visitors who prefer not to sit directly in front of the stage but still wish to enjoy the space from other perspectives.

Finally, the inclusion of a center stage for music and singing interaction enhances the pavilion's functionality and user engagement. This feature transforms the pavilion into a dynamic space for cultural and social activities, providing a platform for performances and interactive sessions. The pavilion aims to become a hub for community engagement, fostering inclusivity and shared experiences. This aligns with principles of sustainable community building, making the pavilion a vibrant and socially relevant space.

Figure 4.6 Proposed interior features

Informed by studies and sketch analysis, the conceptual considerations for interior design encompass biophilic design elements, aesthetic appeal, cultural significance, functional necessities, educational potential, provision of comfortable and livable spaces for social gatherings, utilization of recycled materials, fostering social impact, and enhancing mental well-being. The following section delves into an in-depth exploration of the implementation process and inherent limitations associated with the eco-tech pavilion within the context of Montreal.

4.3 Exploring implementation and limitations of the eco-tech pavilion in Montreal

Implementing the eco-tech pavilion in Montreal presents both opportunities and challenges. Identifying suitable locations within the city involves considerations of accessibility, visibility, and community engagement. Urban parks and cultural centers present promising locations for the eco-tech pavilion; however, challenges arise from zoning laws, land availability, and infrastructure compatibility. Given the conceptual nature of my research, proposing a conceptual design for the eco-tech pavilion necessitates meticulous planning to ensure its seamless integration into Montreal's urban landscape, harmonizing with existing architectural styles in each area. Hence, specific parks or cultural centers are not explicitly mentioned, as each case requires careful consideration, and I focus on the conceptual design of the eco-tech pavilion based on Nordicity features in the Montreal context.

However, several limitations must be addressed before the eco-tech pavilion can become a reality. Firstly, the conceptual nature of the project overlooks practical considerations such as construction costs, long-term maintenance expenses, and funding sources. Without a comprehensive budget analysis and funding strategy, realizing the pavilion on a large scale remains uncertain.

Additionally, ensuring accessibility and inclusivity for all individuals, including those with disabilities and from diverse cultural backgrounds, requires meticulous planning and design modifications. Finally, while sustainability is a core focus, assessing the pavilion's environmental impact and resilience to climate change is crucial. Comprehensive environmental assessments and climate change resilience strategies are needed to minimize ecological footprint and ensure the pavilion's long-term viability within Montreal's changing climate landscape.

4.4 Conclusion

Navigating design and environmental contexts, this design process illuminated the practical and formal aspects guiding the development of a sustainable and technologically advanced pavilion. By delving into design approaches and criteria inspired by the distinctive features of Nordicity, this process seeked to contribute valuable insights into the development of environmentally conscious and innovative architectural solutions.

By leveraging insights from literature review, design frameworks, and specific criteria, the conceptual aspects of the pavilion underscored the importance of crafting sustainability through attention to form, roof, wall, and interior environment. The spherical form of the pavilion emerged as a cornerstone of its functionality, offering advantages such as enhanced energy efficiency, active solar heating, natural light distribution, and structural stability. This distinctive architectural feature not only contributes to the pavilion's functionality but also creates a visually striking and inviting space for visitors.

Moreover, the integration of technologies like Snow-Teng and strategic design elements such as large windows and wooden benches further enhances the pavilion's sustainability and user experience. From efficient snow accumulation and optimal solar panel positioning to optimized insulation and biophilic interior design, every aspect of the pavilion's design was crafted to maximize energy efficiency, promote well-being, and foster community engagement. Through the use of advanced 3D modeling and visualization software, the final renders provide a comprehensive depiction of the pavilion's potential, inspiring further exploration of sustainable design principles in architectural practice.

CONCLUSION, REFLECTIONS, AND WAYS FORWARD

Throughout this thesis, titled *Content Analysis as a Generative Method Toward the Conceptual Design of an Eco-Tech Winter Pavilion*, my objective has been to explore the potential of sustainable design principles in conceptualizing a temporary winter pavilion, referred to as the eco-tech pavilion, using the content analysis method. Inspired by Nordicity's emphasis on sustainability, particularly in creating livable and vibrant urban environments during the winter months, my research-creation aimed to address the following questions: *How can content analysis lead to defining sustainable and innovative principles for design in Nordic contexts? and how these principles can inform the conceptual design of an eco-tech pavilion that improves socio-environmental sustainability during winter?*

The first chapter established Nordicity as a potent lens for sustainable design, particularly in northern regions. Through observations and tailored architectural features, this chapter layed the groundwork for addressing the thesis question, providing insights for sustainable design interventions. Subsequently, the second chapter provided a theoretical framework for studying and designing an eco-tech pavilion within the context of Nordicity, emphasizing sustainability and cultural relevance. By examining how advanced technology can align with sustainable design principles, the chapter aimed to explore how the pavilion could exemplify innovative solutions for environmental stewardship and community engagement. The third chapter details a systematic approach to advancing socio-environmental sustainability in the eco-tech pavilion design within Nordicity. Using content analysis and the Research-through-Design methodology (RtD), it distills essential research insights and design principles for eco-conscious design. Through iterative refinement, it emphasizes synthesizing innovative ideas and sustainable principles, setting the stage for the pavilion's development and realization. This chapter provided a framework for enhancing socio-environmental sustainability in winter context. Finally, the fourth chapter focused on the conceptual aspects guiding the development of the pavilion, and how it can blend seamlessly with the unique characteristics of Nordic environments. Through attention to form, roof, wall, and interior environment, the process demonstrated how the pavilion harmonizes with its surroundings while embodying sustainability principles.

The scope of this thesis encompasses the exploration of design features for an eco-tech pavilion within the context of Nordic urban environments, particularly focusing on the prolonged winter climate and its unique challenges. Through a comprehensive literature review and content analysis using Leximancer software, the research seeks to identify design patterns and guidelines that enhance socio-environmental sustainability. Employing a research-through-design (RtD) approach, the study integrates advanced 3D modeling and rendering techniques to propose conceptual designs tailored to Nordicity. Key elements such as spherical structures, active solar heating, natural light distribution, and innovative technologies like Snow-Teng are examined for their potential to improve energy efficiency and well-being. The research aims to contribute to sustainable urban development by advocating for designs that address locality and climate resilience, ultimately enhancing community engagement and environmental resilience in Nordic regions.

Exploring how the integration of Nordicity features into the design of the eco-tech pavilion could enhance socio-environmental sustainability during winter revealed additional promising avenues. For instance, key design elements, such as a spherical, active solar heating and natural light distribution, alongside innovative technologies like Snow-Teng can enhance energy efficiency. Moreover, strategic design features such as large windows and biophilic interior design can collectively promote well-being, and foster community engagement. This holistic approach has the potential to inspire designers and municipal overall sustainability efforts.

Undertaking this thesis journey has been profoundly transformative, both academically and personally. As a designer, this research has significantly expanded my understanding of architectural design, particularly within the distinctive environmental and cultural landscapes of Nordic regions. Through extensive theoretical research, iterative design processes, and deep reflection, I have gained a profound appreciation for the principles of Nordicity and their implications for sustainable design practices. This has not only enriched my knowledge but has also sparked a newfound curiosity and passion for delving into the intricate intersection of architecture, environment, and culture in cold climate regions. I have come to recognize the intricate relationship between environmental sustainability and design aesthetics, a realization that has not only influenced the development of the pavilion itself but has also reshaped my broader

understanding of the transformative power of sustainable design. This experience sparked a deep commitment to the ongoing exploration of — and advocacy for — sustainable design.

The principles, guidelines, and processes outlined in this thesis offer several benefits to the design community. By integrating pavilion design with sustainability, the thesis provides conceptual insights into creating environmentally conscious structures for cold climates. Additionally, these principles can guide pedagogical approaches in urban design and Nordic contexts, offering a framework for aspiring designers to develop sustainable and culturally responsive architectural solutions. Content analysis, employed in this research, is particularly advantageous as it allows for a comprehensive examination of existing design practices and principles, leading to well-informed, evidence-based design strategies. Furthermore, the use of 3D design software as a visualization tool has proven invaluable, aiding in informed decision-making and supporting sustainability goals while enhancing the visitor experience. Embracing visualization within the design process highlights the importance of iterative cycles in design research, offering both a visual and theoretical approach to inspire future designers committed to environmentally conscious architecture.

In critically examining the project's weaknesses, several key areas for improvement emerge. Firstly, the project's narrow focus on the link between pavilion design and sustainability in Nordic contexts may limit its scope, overlooking important economic, cultural, and policy factors that influence sustainable design practices. Additionally, the lack of long-term assessment of sustainability outcomes and the overemphasis on technological solutions without adequate consideration of social and cultural dynamics pose significant limitations. Addressing these weaknesses through a more comprehensive, inclusive, and context-sensitive approach could enhance the project's impact and contribute more meaningfully to the advancement of eco-tech pavilion design in Nordic regions. It should be noted that based on the studies conducted during the thesis, the walls could potentially be made from Eastern White Cedar, a lightweight wood native to Canada. However, since this research focuses on conceptual design, the use of this material remains theoretical. Future research and practical construction may explore these concepts further, providing more concrete and practical templates regarding the construction methods of the wall panels.

The discussion explored sustainable design principles in the context of Nordicity, leading to the conceptualization of the eco-tech pavilion. The goal is to enhance socio-environmental sustainability during the winter season, with Content Analysis employed as a generative method to inform the design. Content Analysis provides the advantage of systematically evaluating existing design practices and extracting valuable insights, leading to well-founded and innovative solutions. In this thesis, this method means a more rigorous and observation-based approach to integrating sustainability into pavilion design, ensuring that the final design is both conceptual and adaptable to cold climates. This approach not only advances sustainable architecture but also sets a benchmark for future designs in similar environments. By integrating insights from Nordicity, advanced technology, and sustainable design principles, the thesis presents avenues for architects and urban planners to create innovative solutions for environmental stewardship and community engagement. Moving forward, the next steps for this research will involve validation of the proposed design principles through prototype development and real-world applications as a design professional. This could include collaborations with local stakeholders, participation in design competitions focusing on sustainability, presentations at academic conferences, and seeking opportunities for freelance consultancy in eco-conscious architecture projects. In deepening my understanding of the relationship between design, climate considerations, and community well-being, this thesis has profoundly influenced my professional practice, and shaped my future approach to prioritizing sustainability in architectural education and practice.

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