

TRENDS IN THE USE OF TIMBER IN THE BUILT FABRIC OF COPENHAGEN

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Abstract. Innovative approach and existing natural values, proximity to water, green structure are key elements and aspects that combine sustainable activities with high quality of life in Copenhagen's architecture and urban development as a whole. Whether it is new housing developments, new cycle routes, city parks, Copenhagen is at the forefront of architecture and is constantly, continuously preparing for a more sustainable future, while meeting the needs and aspirations of the local population. The most advanced and innovative knowledge from around the world has helped to make Copenhagen a sustainable city of the future, working with quality solutions in architecture, transport infrastructure, energy. At the same time, thinking about meeting the needs of the citizens, culminating in appropriate urban solutions, creating a quality urban fabric. The aim of the study is therefore to look at the trends in the use of timber in the built fabric of Copenhagen from the point of view of visual and aesthetic quality. The study describes the sites surveyed by the authors, based on previous experience and practice, and evaluates a modern building structure developed and designed in the 21st century. **Keywords:** timber structure for buildings, trends of use, urban environment

Introduction

Urban gardens, greener streets, and pleasant, colorful courtyards all contribute to Copenhagen's cohesive landscape and building fabric, which is closely related to surface stormwater drainage channels or systems in the urban setting. High-quality methods that show, via tangible examples, how Copenhagen's urban planning integrates and combines not only climate solutions with recreational benefits for the local population, but does so as an essential, cohesive system within the urban environment rather than as a bonus or side effect. For instance, cycling has been emphasized as a clever, secure, and healthful method for Copenhagen residents to get from point A to point B since the 1960s. Currently, Nowadays, 49 % of Copenhagen residents ride their bikes instead of driving a private vehicle to work or school (Marco, 2024). The visual-spatial aspects of architecture are ever-evolving, and architects and urban planners recognize the importance of creating livable, affordable, and sensible urban living spaces by incorporating healthy, lively, and active public outdoor spaces (RUDI, 2009). High-quality urban environments are combined with green structures and a comprehensive approach to sustainable architecture and design. The active and ongoing synthesis of design and construction processes in urban environments is one of the promising directions in contemporary architecture for the development of visual-spatial environments and structural forms (Schröpfer, 2016). Recent technological advancements have introduced rationalistic and commercial tendencies into architecture, necessitating intentional collaboration between architects and urban planners in the development of development plans. In a condensed, visual-spatial structure, the collaborative format rationally balances and brings the various aspects of the urban environment closer together. One of the synthesis tasks in architecture is to create spatially meaningful architecture that enhances emotional potential by considering the psychological perception of the human being as a user of living space, in addition to creating a compact visual-spatial structure. A development complex's visual-spatial solutions and dimensions vary; some components arise from a well-defined plan with a clear architectural intention, while others develop over an extended period of time, progressively changing on the basis of cohesive compositional ideas based on sustainable and balanced socio-economic and urban contextual considerations. In order to create areas and objects that are functionally usable within the urban environment, architects and urban planners logically concentrated on the overall visual image of the

area to be designed and developed (Schröpfer, 2016; Īle, 2021). According to the study, political divisions, land use requirements, and inadequate infrastructure investment can all have an impact on the structure of residential development, which can result in issues. Therefore, it is crucial to encourage municipalities to be involved in the design of the architectural and spatial structure and to take specific actions in a balanced manner that do not conflict with the municipality's goals (Bertaud). Architecture is an art form that can endure because it creates an aesthetically pleasing, practical, and materially useful urban environment for people to live, work, and play in. Residential neighborhoods' exterior space is essential to the architectural-spatial structure's revitalization (Babalís, 2016). As a result, the human aspect of urban planning has received little attention, analysis, or study in recent years. Road transportation has received a lot of funding and resources, but other factors that are crucial for the urban environment—like people's ability to walk around cities or multipurpose outdoor areas that can be used as gathering spots—have been overlooked (Gehl, 2011; Stokmane, 2022). The idea that the urban environment is a living thing with a complex metabolism is the foundation of contemporary approaches to urban planning, which support various development concepts (Țîrlă, Manea, Vijulie). As a result, living space organization is determined by the visual-spatial dimensions of architecture, which reflect the logical arrangement and relationships between functional zones. The development of the urban form is also significantly influenced by the appropriate use of materials in all solutions. The use of wood in the built environment is highlighted in the study as a suitable strategy and solution for the urban fabric. A vast array of building materials has been produced in recent decades as a result of the development of new timber materials and the reevaluation of existing timber species. Today's construction uses timber of various sizes. Numerous varieties of Laminated Veneer Lumber (LVL), Cross Laminated Timber (CLT), and Glulam Solid Timber (GLT) panels, beams, and columns are among the most extensive selection of glulam components. According to current research, new timber construction systems are being developed through practical experimentation, which may involve combining timber with other materials or employing better fixing techniques. Additionally, systems or structural solutions that have not been utilized for a long time are becoming more important. Each project's selection of structural solutions and building materials is influenced by a variety of factors. Everybody

working on the project has unique building material ideas, expertise, and experiences. Because the parties involved lack adequate wood experience, wood is frequently left off of the list of potential building materials during the material selection process or deemed inappropriate during the design phase. Even though wood has many benefits and drawbacks as a building material, it must overcome social perceptions and prejudices to compete with other materials. Wood's comeback as a building material in the twenty-first century is attributed to both the state's deliberate collaboration with the forest and timber industries as well as the availability of new, more sustainable wood products. In Scandinavia and some European countries, the situation is favorable. Businesses in the sector are organizing focused events to encourage the use of timber construction, educating professionals and the public through seminars, consultations, and awards for the best timber buildings. They are also working to change building codes to make wood a competitive building material in modern architectural projects (Viġuma, 2020). With experts working diligently on multipurpose urban planning projects, Copenhagen's architectural art of the twenty-first century suitably emphasizes and exemplifies the use of high-quality wood not only in the built environment but also throughout the entire urban environment.

Materials and Methods

Using a comparative approach, the study examines mixed-use neighborhoods that were constructed recently and are situated in particular areas of Copenhagen. These neighborhoods exhibit concentrated urban living while maintaining their unique form, close proximity to waterways, green character, and convenient infrastructure connections. As a result, the study looks at four multipurpose neighborhoods in Copenhagen (Fig. 1), highlighting the background of contemporary urban development while emphasizing various timber details and elements. The paradigm of timber architecture has evolved in the modern era, and reestablishing the standing of wood as a building material requires interdisciplinary collaboration on a national and international scale. While some nations prefer to let the free market determine changes in the volume of timber construction, many are developing systems to encourage the practice. Generally, forest and timber companies and organizations initiate or organize wood promotion strategies that are centered on a national level. Key goals that are being brought up in national and international contexts include sustainability, lowering CO₂ emissions, and lessening the negative environmental effects of construction (Viluma, 2020). Therefore, Copenhagen's mixed-use neighborhoods show a logical approach to the development and application of contemporary solutions. Digital maps, publicly accessible materials, and the use of wood through aesthetic qualities in Copenhagen's multipurpose neighborhoods are all analyzed during the research process. Ørestad is the first sizable mixed-use neighborhood to be assessed and examined during the research process. The Ørestad neighborhood is in southern Denmark, 30 minutes from Malmö and 7 minutes from Copenhagen by metro. The region is being developed in line with the currently popular idea of a "compact city" that is connected to the metro in Copenhagen (Ile, 2021; Stokmane, 2022). The second study area is Sluseholmen Kanalby (Danish: Sluseholmen Kanalby), a 135,000 m² residential development on the Sluseholmen peninsula in Copenhagen's southern harbor area. It was finished in 2008 and features a lot of wood in both the building materials and the public outdoor space, from which large terraces, floating saunas, and boardwalks have been constructed for the use



Fig. 1. Objects of the research area
 [created by author's, 2024]

of everyone in the neighborhood. The research process included an analysis of the third mixed-use development, Kaktus Towers, which also has an IKEA store, a low-cost hotel, and residential apartments connected by an elevated public park. Earlier this year, the two towers—the tallest standing at 80 meters—were finished. The fourth space is the Nordhavn Quarter, which combines volumes, vertical garden accents, and green façade structures to create a multipurpose space that offers recreational opportunities to locals on multiple levels.

Results and Discussion

The study process has shown that mixed-use development projects have been developed and implemented in the Nordic region in recent years, in line with one of the key principles - mixed-use in the urban environment. One of the most modern sites is in Copenhagen: Ørestad Syd, which was revisited in the autumn of 2024, based on the authors' research into development trends for the period 2017-2021. The area contains a variety of architectural and landscaping solutions that mark modern development trends, taking into account the use of wood in the urban fabric. One of the distinctive features of Ørestad Syd is Ørestad Syd Himmelbyen, a mixed-use development that aims to combine functions as densely as possible in one complex, including a supermarket area, a children's leisure centre and residential areas on the upper floors. The outdoor space of the residential area is defined as a "City of Heaven", which, similar to the Ørestad Syd area, has a functionally structured inner courtyard. The use of timber in the outdoor solutions creates a visual overall image and architecturally emphasises the timber structure in the built form, which is clearly read from all parts of the street. The presence of timber and the façade finishes visually divide the large building volume into smaller parts through contrasts and the smooth concrete volume, thus achieving human scale dimensions even in the multifunctional outdoor space (Fig. 2, 3). The large staircase along the facade creates a functional link with the semi-enclosed courtyard volume, which is accentuated in places by the timber cladding structure. Not far from the Ørestad Syd area is the Ørestad North area, where the round building Tietgen Dormitory stands out. The round shape of the building makes it possible to successfully



Fig. 2. Ørestad Syd Himmelbyen [photos by author's, 2024]



Fig. 3. Ørestad Syd Himmelbyen courtyard [created by author's, 2024]

organize the functional side of the building, thus there are rooms on the outside, and common rooms and corridors on the inside, which ensure mutual socialization of students. Common rooms are located on the 1st floor, and 360 rooms on the other floors. The Tietgen Dormitory is expressive with its facade structure, where the wooden structure is used in various techniques (Fig. 4, 5).

Sluseholmen, on the other hand, has a different development pattern to Ørestad Syd, as it is connected to water channels, bridges and quays, and the waterfront gives residents access to the water. The overall concept for the neighbourhood was developed by architect Sjoerd Soeters and Arkitema Architects, inspired by the artificial island in Amsterdam. Sluseholmen consists of eight inhabited islands with large and small buildings that architecturally form continuous building blocks, piers and waterfronts that give residents access to the water. For the Sluseholmen area, the authors developed specific architectural and spatial structures, general planning rules that define the use of specific proportions and dimensions, materials and colours. The site comprises 1,350 apartments spread over eight artificial islands and separated by excavated canals. Throughout the block, wood is used not

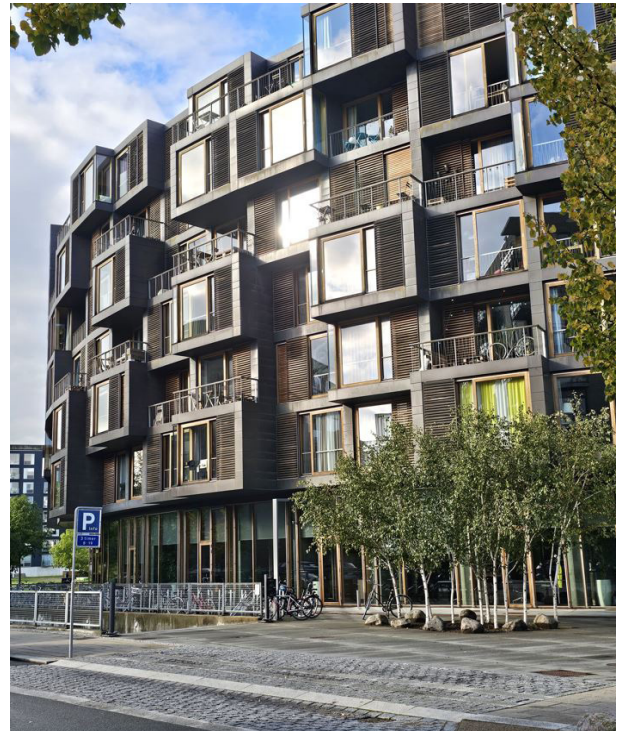


Fig. 4. Viewpoint from street to the Tietgen Residence Hall [created by author's, 2024]



Fig. 5. The Tietgen Residence Hall with green area [photos by author's, 2024]

only for the variety of the building structure on the façade, but also for the outdoor spaces along the canal system, using wooden beams in the waterfront areas (Fig. 6, 7, 8).

The next site to be assessed in the study process is Kaktus Towers, one of the newest sites to be realised in 2024. The visual solution of the towers has a rational approach to economic construction, where an efficient sloped plate structure creates an optimal ratio of proportions, but also a strikingly expressive overall architectural visual image (Fig. 9, 10). The Kaktus towers are built around a central core and have a complex and sculptural expression thanks to the façade, which has a different orientation on each floor. The exterior of the building consists of nearly 500 spiky balconies that wrap around the entire structure, clearly referencing the spiky desert vegetation. The jagged appearance is softened by the facade, which reflects the last rays of the sun in a golden hue – a stark contrast to the otherwise austere appearance of the building. The idea behind the towers was to create a mix of privacy and community, so the buildings include communal spaces such as a gym, kitchen, laundry room and outdoor barbecue area. The aim of the site is that these communal areas will foster



Fig. 6. Sluseholmen building facade structure [photos by author's, 2024]



Fig. 7. Wood elements with greenery [created by author's, 2024]

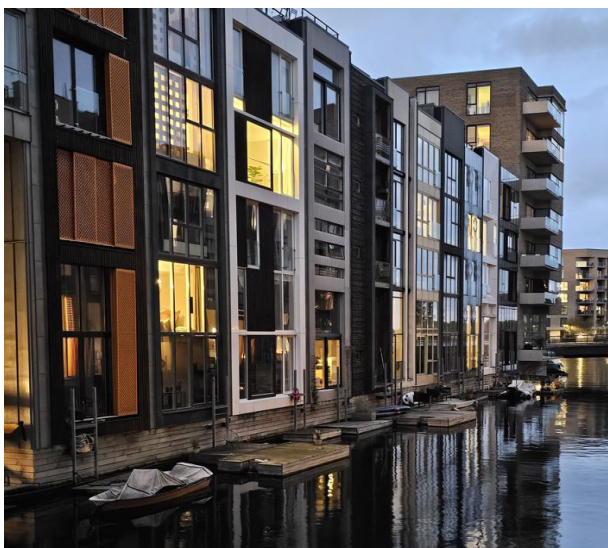


Fig. 8. Sluseholmen buildings with canal [created by author's, 2024]



Fig. 9. Kaktus Towers with park area [photos by author's, 2024]



Fig. 10. Kaktus Towers facade structure[created by author's, 2024]

a sense of community among residents and help to alleviate the loneliness that can be experienced by expatriates or city dwellers living alone.

In addition to concrete for the main frame and metal components, Kaktus Towers' finishing structure incorporates wood in a clean, contemporary design to produce an aesthetically beautiful building structure. The concrete volume of the façade and the timber panels of the façade visually interact with one another throughout the day to create an intriguing building volume structure that is easily readable in the urban setting from a variety of angles. The building's size, the roof gardens' volume, and the various levels of green spaces create an area that is both intriguing and well-balanced throughout the block (Fig. 12, 13). In contrast to the Kaktus Towers concept, Nordhavn is a new neighborhood. Many of the distinctive features of the area's former industrial areas have been preserved and transformed as part of the new quarter in Nordhavn (Fig. 14, 15), which also features new streets and buildings. They establish a cozy and private atmosphere in the streets

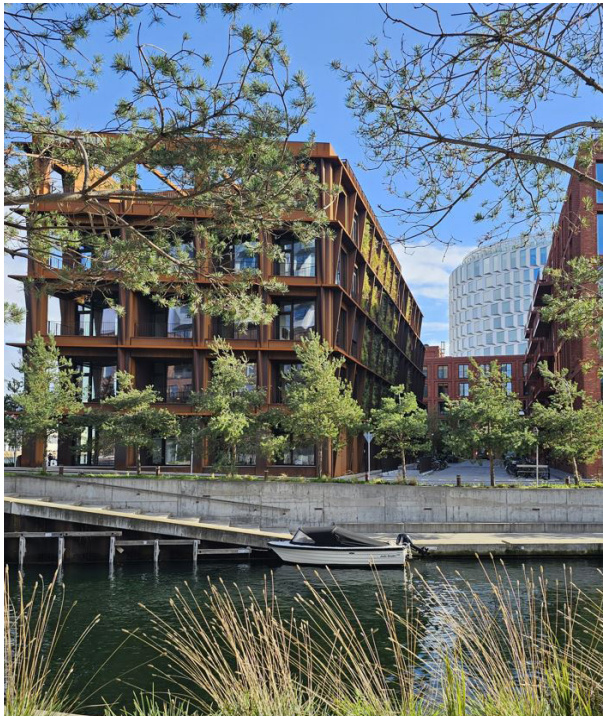


Fig. 11. Nordhavn area [photos by author's, 2024]

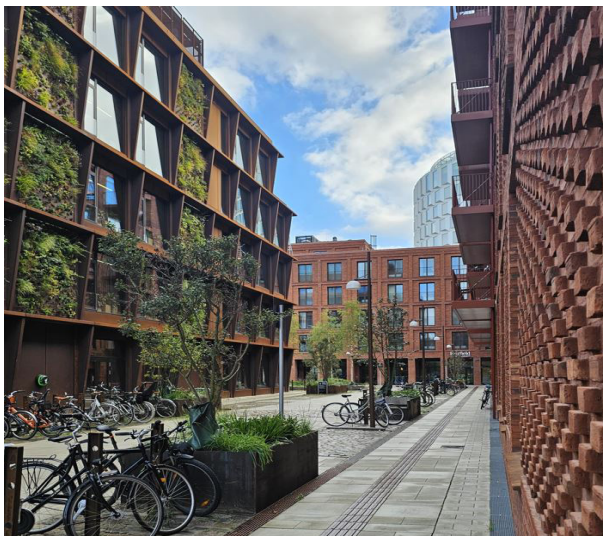


Fig. 12. Nordhavn Porten building [created by author's, 2024]

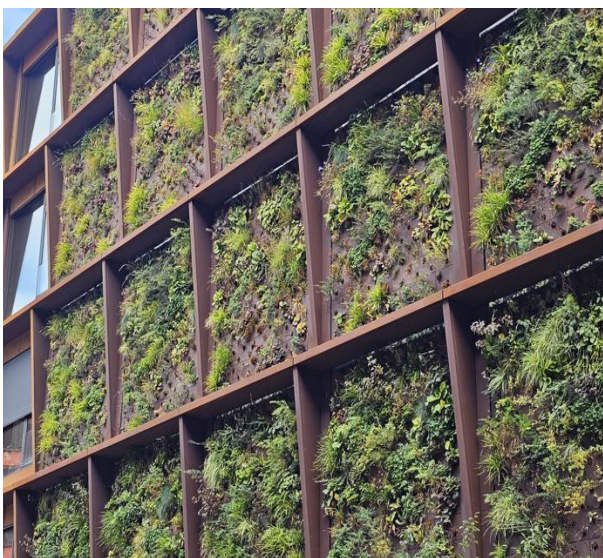


Fig. 13. Green facade structure of Porten building [created by author's, 2024]

and courtyards of Nordhavn by connecting the area with green areas. With views of Sweden and Copenhagen in the distance, the area is encircled by water on all sides. One of the area's highlights is Porten, a versatile office complex that was designed with a nod to the region's industrial past. The four-story building under analysis features a roof terrace, public outdoor gardens, and a metallic maroon façade structure. The Danish Ministry of the Environment supported the development of the Porten building, Copenhagen's first green façade solution, in partnership with BG Byggros and Komproment. The harsh winds, frigid temperatures, and close proximity to sea salt have all been taken into consideration when designing the building concept. The designers selected plants with two distinct qualities: some are aesthetically pleasing, while others are positioned to support biodiversity and are home to as many as 132 native insects. A controlled hydraulic buffer capacity built into the façade also collects rainwater from the roof, guaranteeing a steady supply of water for the plants and preserving plant life all year long. Numerous sensors integrated into the façade track the biodiversity of the façade and its effects on different urban conditions, including the urban heat island effect and noise pollution. A Singaporean building will always appear more opulent than one in Denmark. Therefore, the designers have created a façade that adjusts to the dynamics of Scandinavia's changing seasons rather than attempting to accomplish the impossible. It is anticipated that the façade will serve as a 15% living building element, cooling the streets and lowering noise levels, which will lessen the heat island effect. Future increases in insects and birds can be recorded by recording the variety of animal species present on the site. The Nordhavn block under review has a particularly high wood content, according to the study, with solid wood benches, landscaping platforms, and a variety of wood components (Fig. 16, 17).

Conclusions

The development of an architectural-spatial structure requires an interdisciplinary approach and cooperation between architects, urban planners, landscape architects, environmentalists, engineers and other professionals capable of understanding the values of the existing situation and ensuring the principles of sustainable development in the urban environment. The development of multifunctional open spaces is now the main form of residential development, both in the planning of new residential areas and in the renovation of existing residential areas (Ile, 2021; Stokmane 2022). The architectural-spatial structure defines and emphasises important functions that form links with areas of different character, highlighting certain features in urban planning. A rational and considered planning approach in modern residential areas is based on functionality, which needs to be appreciated and understood when designing new multifunctional blocks, areas. The form and layout of multifunctional open space is influenced by vertical or horizontal building types, which ultimately determine the character and organisation of the urban living space.

The visual-spatial dimensions of architecture in the urban fabric are constantly evolving and changing, resulting in certain principles and conceptual approaches. A livable, healthy and active living space, balanced with architectural-spatial approaches, provides a high quality, visually aesthetic and versatile multifunctional outdoor space.

The areas analysed in this study in Copenhagen focus on spatially structured and high quality living spaces, providing comprehensive approaches to sustainable architecture and

the development of multifunctional outdoor spaces. A holistic approach to the development of multifunctional outdoor spaces involves revitalisation processes or the planning of new buildings and areas, balancing human scale proportions, emotional potential and the psychological perception of the user of the living space.

The conceptual approaches and contemporary solutions of architects, landscape architects and urban planners need to be sound, research-based and provide a quality approach to living space that is imbued with the political and economic aspects of sustainable urban environments.

The study found that wood as a material of the future highlights key trends in both architectural solutions and the development of multi-functional outdoor spaces. As a result, it contributes to an efficient design approach, a creative and viable environment for every citizen, and reduces CO₂ emissions in construction. The expectations of users and consumers of mixed-use neighbourhoods are changing and the demand for diverse, short distance, yet comfortable and safe walkable urban living spaces is evolving at the level of contemporary research, resulting in a desire to return, socialise, seek a sense of community for users of areas and develop a sense of place identity. The use of wood in the public urban fabric is one of the high quality approaches to a long term sustainable and environmentally sound solution, and Copenhagen is one of the cities that can and does show significant developments in the built fabric, which is an example of good practice for other potentially developable cities in creating a modern, aesthetically and functionally pleasing urban environment for the public.

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Kopsavilkums

Inovatīva pieeja un esošās dabas vērtības, ūdens tuvums, zaļā struktūra ir galvenie elementi un aspekti, kas Kopenhāģenas arhitektūras un pilsētvides attīstībā apvieno ilgtspējīgas darbības ar augstu dzīves kvalitāti kopumā. Neatkarīgi vai tā ir jauna apbūve dzīvojamās kvartālos, jauni velo maršruti, pilsētas parki, Kopenhāģena ir arhitektūras priekšplānā un pastāvīgi, nepārtraukti gatavojas ilgtspējīgākai nākotnei, vienlaikus apmierinot vietējo iedzīvotāju vajadzības un vēlmes. Vismodernākās un inovatīvākās zināšanas no visas pasaules ir palīdzējušas padarīt Kopenhāģenu par ilgtspējīgu nākotnes pilsētu, strādājot ar kvalitatīviem arhitektūras, transporta infrastruktūras, enerģētikas risinājumiem. Līdz ar to pētījuma mērķis ir aplūkot kokmateriāla izmantošanas tendences Kopenhāģenas apbūves struktūrā no vizuāli estētiskās kvalitātes aspektu puses. Pētījumā aprakstīti autoru apsekoti objekti, balstoties uz līdzšinējo pieredzi un praksi, izvērtēti mūsdienīga apbūves struktūra, kas attīstīta un veidota 21. gadsimtā.