8. Contingencies in rooftop extensions on multifamily buildings from the 1950s and 1960s in Hamburg

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Context and ecological relevance of rooftop extensions in post-war housing stock

Post-war housing stock in Hamburg, particularly from the 1950s and 1960s, represents one of the most widespread and structurally homogeneous settlement types in many German cities. These buildings are increasingly coming into focus as both a challenge and an opportunity for urban transformation, due to their ecological footprint, aging materials, and socio-spatial implications. Accordingly, a growing body of research has addressed their transformation potential, often emphasizing participatory, social, and design-based strategies for adaptive reuse (Simon-Philipp and Hopfner, 2013; Harnack et al., 2020; Brunner et al., 2021; Kaufmann, 2024). While these perspectives have provided valuable insights into how post-war settlements might be reimagined, they often assume that transformation is materially and structurally feasible.

The aim here is not to assess architectural or social relevance of these settlements but to explore how technical and informational contingencies shape the feasibility of one specific intervention, namely densification through rooftop extensions. In doing so, this chapter contributes to a broader understanding of urban transformation under conditions of uncertainty. It draws on the conceptual lens of urban future-making, which emphasizes that desirable futures emerge not through linear planning but through negotiation, friction, and material contingency. In this light, the question is not whether rooftop extensions are desirable but under what conditions they can realistically be implemented.

Climate change and the scarcity of natural resources demand a transformation of the building sector that both reduces greenhouse gas emissions and limits the consumption of new materials and land. In Germany, the goal of achieving climate neutrality in building stock by 2045[1] must be addressed alongside the challenge of providing additional housing. Over the past years, strategies for the densification of existing buildings have gained attention in both research and policy discourse (see, among others, BBSR, 2014; BSU, 2013; Nitschke, 2023). Among these strategies, rooftop extensions are increasingly viewed as a promising approach, as they enable the creation of additional floor space without further land take and are often combined with energy-efficiency measures (BBSR, 2016; Tichelmann et al., 2016).

From an ecological perspective, rooftop extensions offer several advantages. They allow for the use of existing structural components, significantly reduce the need for new construction materials, and help avoid demolition waste. When combined with retrofitting measures such as improved insulation, window replacement, and the installation of low-emission heating systems, rooftop extensions can contribute to a considerable reduction in the operational energy demand of a building. In comparison to demolition and new construction, they typically result in lower environmental impacts across the building life cycle (Hafner and Storck, 2023).

Multifamily buildings from the 1950s and 1960s are particularly relevant in this context due to their high prevalence. According to the 2018 German housing microcensus *Wohnen in Deutschland* conducted by the Federal and State Statistical Offices (Statistische Ämter des Bundes und der Länder, 2020), approximately 16.7 million apartments are located in buildings constructed between 1949 and 1978, of which around 10.5 million are in multifamily buildings. This represents around 42% of the total housing stock (or 26% of multifamily buildings). A significant number of these structures were built before the introduction of the first German Thermal Insulation Ordinance (Wärmeschutzverordnung [Wärmeschutz V]) in 1977 and have undergone relatively low levels of modernization (BSW, 2023). Multifamily buildings from the 1950s and 1960s therefore offer significant potential for densification as well as energy efficiency improvements, as their outdated construction methods and insufficient insulation result in high energy consumption and heat loss (BBSR, 2016). Tichelmann et al. (2016) assume that multifamily buildings constructed between 1950 and 1989 generally possess the structural

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[1] §3, Paragraph 2, Bundes-Klimaschutzgesetz.

conditions for rooftop extensions. Specifically, buildings from the 1950s and 1960s exhibit the greatest potential for future rooftop extensions due to their technical and structural characteristics (BBSR, 2016). Advantages include simple structural systems with short spans, sufficient load-bearing reserves in existing structures, adaptable construction methods, façades with uncomplicated geometries, and a general need for thermal insulation improvements (BBSR, 2016).

While such studies highlight the considerable theoretical potential of rooftop extensions, more recent practice-oriented publications identify substantial barriers to implementation. As noted by Fath et al. (2019), the frequent absence of reliable structural documentation significantly complicates the assessment of load-bearing capacity and introduces major planning uncertainties. These include difficulties in estimating costs, securing regulatory approval, and coordinating construction logistics. In many cases, the lack of trustworthy information about the structural condition of existing buildings leads to increased complexity in the early planning phases. This can result in time-consuming and costly clarification efforts, which may discourage stakeholders from considering rooftop extensions as a viable option. The contrast between strategic potential and implementation barriers highlights the need for a more differentiated understanding of the conditions under which rooftop extensions can be realistically pursued.

This discrepancy between the widely discussed strategic potential of rooftop extensions and their limited realization in practice forms the starting point of this chapter. Rather than asking whether such extensions are feasible in principle, the chapter investigates the structural and informational contingencies that influence the applicability of the extensions to the most prevalent type of post-war multifamily buildings. It does not evaluate rooftop extensions as a planning instrument; instead, it focuses on how the availability and reliability of building documentation affect whether rooftop extensions are considered a realistic option in early planning stages. The aim is to better understand why a densification strategy that is often discussed in research and policy as ecologically and spatially promising remains difficult to implement in practice. In this sense, the chapter contributes to a grounded understanding of how urban futures take shape through material conditions, shaped in turn by the enabling or constraining fabric of the past.

Methodology and data

Research background and analytical framework

This chapter builds on the findings of its author's ongoing doctoral research, the first phase of which analysed the quantitative potential of rooftop extensions on buildings owned by housing cooperatives in Hamburg. Based on a typological classification and the evaluation of available building documentation, supported by the interpretation of digital maps and aerial imagery, the study found that a large number of buildings in the city appear formally suitable for extension. The theoretical densification potential was substantial: Up to 14,588 additional apartments could be realized through two-storey extensions within the cooperative stock alone, corresponding to more than one year of Hamburg's annual housing demand (Meyer and Klotz, 2023).

However, a more detailed structural analysis revealed a considerably more limited technical feasibility. Most buildings showed very little structural reserve in their foundations; in many cases, the available strength calculations indicated utilization rates between 90 and 100%. Accordingly, extensions could only be realized with additional reinforcement measures such as underpinning the foundations (Meyer and Klotz, 2023). These results challenge the widespread assumption that post-war buildings generally provide favourable structural conditions for rooftop extensions (BBSR, 2016; Tichelmann et al., 2016).

Beyond structural capacity, the availability and quality of existing building documentation emerged as a key constraint. In practice, the early exclusion of extension options is often linked to the absence of reliable information about the load-bearing structure. These findings point towards a complex set of interrelated contingencies that influence the feasibility and planning of rooftop extensions.

The analytical framework developed in this chapter is based on a literature review, empirical document analysis, and planning practice insights. First, existing studies on post-war buildings, rooftop extensions, and structural planning formed the conceptual foundation. Second, original data was collected between 2020 and 2023 through archive research, consultations with public authorities, and engagement with housing cooperatives. Third, a comparison of these findings with current planning instruments and professional discourses informed the categorization of planning contingencies. This triangulated approach allowed for the identification of recurring challenges across different stages of the planning process and for the development of an analytical lens that connects structural-material conditions with actor-based decisions and systemic constraints.

Building on this methodological basis, a conceptual framework is introduced that differentiates between two interrelated analytical perspectives: the characteristics of the existing building stock, and the ways in which planning actors respond to them. These perspectives are further specified through four closely connected types of contingency. The first two concern the conditions of the building stock itself, namely (1) material and structural heterogeneity, and (2) insufficient, inaccurate, or incorrect building documentation. The latter two refer to how these conditions are addressed in practice, through (3) extensive case-by-case structural assessments and (4) the limited applicability of digital decision-support tools. These dimensions do not function independently but reinforce one another. For example, insufficient documentation may require costly and time-intensive structural investigations, which in turn reveal the limitations of typologically driven planning tools. Together, these interdependencies create a layered and cumulative complexity that shapes how rooftop extensions are planned and decided upon.

A particular emphasis is placed on the issue of building documentation. Not only did the research identify a lack of documentation as a practical barrier in many cases, but the status and accessibility of documents became a central lens for analysing planning feasibility more generally. In this sense, the investigation into building documentation was not merely a methodological precondition but part of the analytical approach itself. The research process made visible how the absence, ambiguity, or inaccessibility of information actively shapes planning decisions in early project phases.

Document retrieval and empirical basis

Between 2020 and 2023, documentation and information was collected from three main sources. First, a targeted search was conducted at the Hamburg Architectural Archive of the Hamburg Chamber of Architects (Hamburgisches Architekturarchiv der Hamburgischen Architektenkammer). This archive houses written records, architectural plans (including designs and construction drawings), photographs, and occasionally films. A database search conducted by archive staff under the criterion 'three- to four-story residential buildings' yielded multiple dataset lists corresponding to document collections from Hamburg-based architects such as Sprotte & Neve, Streb &

Tinneberg, and Matthaei, as well as records from former non-profit German construction and housing company Neue Heimat and municipal housing company SAGA GWG. However, the data provided insufficient information to determine whether the listed buildings met the study criteria. Where addresses were available, a preliminary selection was made using Google Maps and Google Street View. Subsequently, original construction drawings were reviewed in analogue format (Figure 1) and, if deemed relevant, photographed on a light table. The archive primarily contained design drawings from SAGA GWG construction projects. At the time of research, no digitized plans were available.

Figure 1: Review of existing building plans at the Hamburg Architectural Archive, 2020/2021.

Source: Author.

The second approach involved accessing the respective building records at the responsible building authority. This process requires a preselection of relevant buildings and written consent from the property owners. Additionally, access to these records is subject to fees. A request to the District Office of Eimsbüttel (Bezirksamt Eimsbüttel) revealed that building documentation was significantly reduced in the early 1990s across all building types, with strength calculations in analogue format being removed from the archives. These were offered to property owners for retrieval; in cases of non-response, they were destroyed.

Third, building documentation was obtained from four housing cooperatives. Two cooperatives provided digital plans, while another allowed access to original plans for digitization. A fourth cooperative facilitated on-site research through multiple visits, allowing examination of both digital databases and analogue archives. The collected building documentation included submitted building applications, construction drawings, and building descriptions. Most documentation consisted of scanned copies of originals, while some was later recreated as 2D CAD representations.

For each selected building, the research aimed to retrieve construction drawings, structural calculations and descriptive building documents. Nearly all of the 83 building datasets included complete construction drawings at a scale of 1:100, including floor-plans, cross-sections, and elevations. However, only 20 of these datasets contained original strength calculations. All documentation was evaluated with regard to completeness, clarity, and internal consistency. This data formed the basis for analysing how gaps in documentation affect the feasibility of extension planning, and why this dimension must be considered a core factor in understanding planning contingencies.

Structural heterogeneity, materiality, and urban development in the 1950s and 1960s

The structural variability of multifamily buildings from the 1950s and 1960s represents a crucial factor in assessing the feasibility of rooftop extensions. Although these buildings often appear similar in their architectural form, their construction methods, material composition, and load-bearing structures differ significantly. This heterogeneity is derived from the diverse conditions under which they were built, influenced by both post-war reconstruction efforts and evolving urban planning strategies. As a result, structural assessments for rooftop extensions cannot rely on uniform assumptions but must consider the specific construction characteristics of each individual building.

In the course of the 1950s, building development in Hamburg took a new direction. In the first half of the decade, most construction took place on inner-city rubble sites. Many residential buildings were constructed on existing basement foundations, reusing established street layouts and utility connections, which provided an immutable framework for redevelopment (Stapelfeld, 1993: 173). The row scheme of the *Zeilenbau* became a defining feature of this period, as it aligned with contemporary urban planning goals that sought to move away from perimeter block structures in favour of more open and airy residential environments (Stapelfeld, 1993: 199). Since multi-storey apartment buildings were generally limited to three to four storeys, the four-storey *Zeilenbau* became the dominant residential building type of the 1950s (Stapelfeld, 1993: 199). This approach was primarily driven by economic considerations, as it enabled housing to be provided at the lowest possible cost to meet the pressing demand of the time (Kindt, 1969: 431). Beyond economic efficiency, this building typology also offered several functional advantages. With sufficient spacing between individual buildings and the arrangement of only two apartments per landing, the multi-storey *Zeilenbau* ensured a high level of sunlight exposure, natural illumination, and cross-ventilation for each unit, significantly improving living conditions (Kindt, 1969: 431). The low building density, reflected in a floor area ratio[2] ranging from 0.4 to a maximum of 1.0, further emphasized the planning approach of open, well-lit residential environments (BSU, 2013: 114). Additionally, the repetition of standardized house types facilitated greater efficiency in both planning and construction processes, allowing for a rationalized building execution (Kindt, 1969: 431). Alongside the introduction of the new *Zeilenbau*, ruins were reconstructed, damaged residential buildings were repaired, and new buildings were erected on the preserved foundations of pre-war perimeter block structures in their original layout. Furthermore, gaps within existing perimeter block structures were filled.

By the second half of the 1950s, urban development began to diversify. Settlement structures increasingly incorporated a mix of building typologies, including terraced houses, multi-storey apartment buildings, and taller point houses, resulting in a more varied cityscape (Stapelfeld, 1993: 173). Hans-Henning Buchholz and Ekko Flick (1969: 41) describe settlement groups composed of multifamily *Zeilenbau*, point houses, and single-family houses in recurring types. Large-scale residential estates emerged, with housing developments consisting of repeated building types arranged in clusters (Buchholz and Flick, 1969: 41). A significant shift in land utilization occurred during this

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[2] The floor area ratio is an urban planning metric that indicates building density by expressing the ratio of a building's total floor area to the size of its plot.

period: Whereas in 1955, 63.5% of new residential buildings were still being constructed on inner-city rubble sites, this share had dropped to only 17.4% by 1958. Conversely, the proportion of new housing developments on previously undeveloped land rose from 36.5% to 82.6% within the same period (FHH Baubehörde, 1959: 10).

The 1960s marked another transition in housing development, characterized by an increase in large-scale residential estates with higher densities. These projects were dominated by multi-storey social housing and were largely carried out by housing cooperatives. These institutions acquired land on the city's outskirts, where they implemented urban planning concepts that emphasized modern architectural principles and social considerations (Mramor, 1969: 235; Harms et al., 1989: 44). The resulting developments consisted almost exclusively of multi-storey apartment buildings designed to provide affordable housing on a larger scale.

The structural variability of multifamily buildings from the 1950s and 1960s is not only a result of differing urban planning approaches and construction methods but is also closely linked to the materials used. The post-war years were marked by both material shortages and rapid technological advancements, which led to significant changes in building practices. With the introduction of new materials and the rapid advancements in construction technology since the 1950s, existing standards and current building practices had to be fundamentally reconsidered. One major consequence was the reduction in wall thicknesses, as improved materials allowed for more efficient strength utilization without compromising stability (Gloede, 1969: 68). However, the need for better thermal and sound insulation increased at the same time. Achieving adequate thermal insulation became a central issue, particularly in relation to energy efficiency, as coal remained the primary heating source in Germany (Böckl, 1951: 4). Additionally, growing traffic volumes and the increasing presence of indoor noise sources, such as household appliances and home audio equipment, heightened the demand for improved soundproofing. The challenge was further intensified by the trend towards smaller apartments. With the continuous advancement of construction methods and materials, many building components became lighter than in previous years, which in turn made them more sound-permeable. Additionally, the new concrete ceilings did not provide sufficient sound insulation (Sautter and Brand, 1956: 3).

The increasing demands on residential construction inevitably led to higher material consumption and greater construction efforts. Concerns arose that the high pace of housing production might decline despite continued demand. In response, rationalized and cost-effective construction methods were promoted to optimize efficiency (FHH Baubehörde, 1959: 9). In this context, rational and cost-saving construction methods developed alongside traditional masonry construction. These included the introduction of larger masonry units, such as brick and lightweight concrete blocks, as well as the so-called *Schuttbauweise*, a poured concrete method that incorporated rubble as aggregate. In addition to traditional bricks, alternative materials such as sand-lime bricks, slag aggregate concrete bricks, pumice stone bricks and brick concrete blocks, were increasingly used (Ahnert and Krause, 2009: 79).

Parallel to these developments, the prefabrication of reinforced concrete components became increasingly relevant. Although this method was consistently applied from the 1960s onwards, it did not entirely replace traditional masonry techniques but was instead used alongside them. In Hamburg, brick shell construction was regarded as the most weather-resistant solution for building exteriors. While plastered façades were introduced as an alternative, they were only considered feasible when significant cost savings outweighed the disadvantages associated with plaster construction (Hammonia Norddeutsche Verlagsgesellschaft mbH, 1953: 132).

Also, mandatory standards introduced for social housing set new benchmarks, such as floor-plans designed according to the dimensional coordination DIN 4172. This was intended to ensure that large-format hollow blocks or other building materials could later be installed without additional adjustments. Compliance with standardized storey heights according to DIN 4174 also facilitated the installation of stairs and utilities (Wandersleb, 1952: 73). The design of ceilings also underwent change. The previously common wooden beam ceilings with clay or slag infill were increasingly replaced by solid ceilings that met the new requirements.

The heterogeneity in material use and construction methods defines the first level of contingency in the assessment of rooftop extensions. The structural conditions of buildings from this period cannot be assumed to follow uniform standards but instead reflect the circumstances under which they were built – whether on pre-existing foundations in inner-city areas or as new developments on previously undeveloped land. The coexistence of different building techniques, material compositions, and load-bearing systems creates significant uncertainty when determining the feasibility of rooftop extensions. Despite often similar architectural appearances, these underlying structural differences necessitate careful evaluation in each case, as the suitability for additional floors is contingent on the specific construction characteristics of the existing building.

Insufficient, inaccurate, and incorrect building documentation

This section addresses the availability and quality of building documentation. Although such documents are a technical prerequisite in planning processes, retrieving and evaluating them proved to be a substantial practical challenge. The accuracy and completeness of construction records are critical for assessing the feasibility of rooftop extensions. However, research into existing documentation for three- to four-storey housing settlements from the 1950s and 1960s in Hamburg revealed significant gaps and inconsistencies.

There have never been uniform national regulations regarding building permit applications and required building documentation in Germany. In Hamburg, the 8 June 1938 Building Inspection Ordinance (Baupolizeiverordnung [BPVO]) remained in effect long after World War II and was only replaced in 1969 with the Hamburg Building Code (Hamburgische Bauordnung [HBauO]) in 1969. In Schleswig-Holstein, the 1950 Legal and Regulatory Gazette specified which documents had to be submitted with a building application.[3] These included a construction description detailing building materials, a site plan, construction drawings at a scale of 1:100, and strength calculations to verify the load-bearing capacity of the construction. This final requirement was specific to structural elements made of steel and reinforced concrete, as well as to unusual or highly stressed timber joints and heavily loaded sections of masonry or foundations.[4] At that time, construction drawings were manually created as originals using drafting tools such as parallel rulers. Drawing instruments such as pencils, felt-tip pens, and ink pens were used for both drawing and annotating/dimensioning. If changes were made, the entire drawing had to be redone; minor alterations were, however, sometimes made by overlaying the affected area with transparent paper.

Researching the documentation of three- to four-storey housing developments from the 1950s and 1960s in Hamburg highlighted the fragmented avail-

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[3] Section 3, §15 Bauunterlagen, Gesetz- und Verordnungsblatt für Schleswig-Holstein 1950 Abschnitt 3 Bauantrag und Bauunterlagen.

[4] Ibid., 232.

ability of such documentation. Given the absence of a centralized repository for construction documentation, an empirical investigation was conducted to assess the availability and quality of records across different sources.

Plan-related contingencies

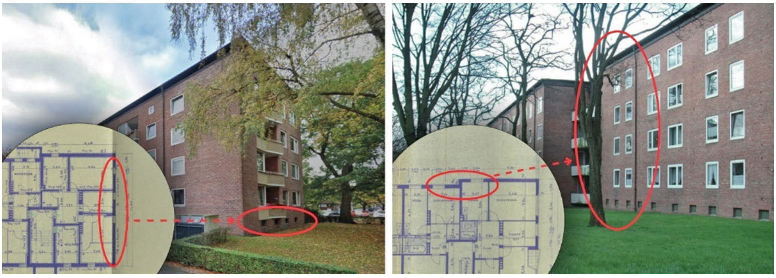
One contingency stemming from planning issues is *incomplete building documentation*. During the research process, datasets of varying completeness were obtained. The objective was to gather construction drawings, strength calculations, and building descriptions for existing buildings. However, archive research yielded inconsistent results. Many of the documents originated from estates of Hamburg-based architects, and, in most cases, only site plans and construction drawings were available. The search, review, and digitization process (in this case, photographing documents on a light table) proved to be time-consuming. In contrast, research conducted directly with property owners, particularly housing cooperatives, was more fruitful. For the buildings from the 1950s and 1960s under investigation, construction drawings at a scale of 1:100 were generally available. These typically included floor plans of all storeys, longitudinal and cross-section plans, and elevations. Only two out of four cooperatives were also able to provide building descriptions.

A major issue was the availability of strength calculations. Of the 83 datasets examined, only 20 contained strength calculations. Without these, it is impossible to make detailed statements about the load-bearing behavior of a building in the early planning phases in existing building projects. If property owners do not possess strength calculations and, as was the case in this research, such documents were removed from the archives of the responsible authorities decades ago, planners and decision-makers are left to make assumptions based on comparable projects and conduct costly on-site investigations. In the context of economic feasibility, contingencies regarding load-bearing capacity and material properties could lead to decisions in favour of demolition and new construction rather than retrofitting and rooftop extension.

A second contingency is based on *discrepancies in building documentation*. Research found that building plans in Hamburg often do not align with the actual constructed buildings. This applied not only to the original construction phase but also to subsequent modifications and renovations that are not recorded in the building documentation. Differences between original construction drawings and the final buildings frequently include design simplifications, material reductions, or on-site improvisations. Commonly identified discrepancies involve variations in dimensions and façade configurations. In some cases, balconies and loggias were constructed differently than originally planned, and windows were positioned or sized differently.

One example is a multifamily building on Diedenhofer Straße. According to the available floor plans, the building was designed with a setback at the rear. However, this setback does not exist in the actual structure. Additionally, several window openings were identified on-site that are not reflected in the planning documents, including basement windows and an additional row of windows on the north side of the building. This was verified by comparing recent photographs, Google Street View images, digital orthophotos from Hamburg's State Office for Geoinformation and Surveying (Landesbetrieb Geoinformation und Vermessung), and an on-site visit (Figure 2). In this case, the simpler building geometry (without a setback) in the existing structure is advantageous for planning a rooftop extension and retrofitting. Discrepancies are particularly relevant for rooftop extension projects when they involve structural elements. However, such discrepancies should become evident early in the planning process through detailed on-site analysis and be taken into account accordingly.

Figure 2: Example of Diedenhofer Straße; discrepancies between planning documents and actual building.

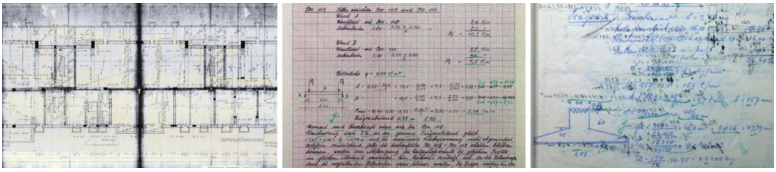


Source: Author. Illustration based on Google Street View imagery and documents from HANSA Baugenossenschaft eG.

Document-quality-related contingencies

The *reduced readability* of documents is a significant issue. Building drawings and strength calculations from the 1950s and 1960s were handwritten. Even when carefully stored in dry conditions, these documents show significant aging. This is evident in faded annotations and external damage that impairs readability. Strength calculations were often written on thin transparent paper, which becomes brittle with frequent handling. While building drawings were typically drawn and written in a readable handwriting style, sometimes using stencils for annotations, strength calculations were written in the individual handwriting of the structural engineer and supplemented with review notes (Figure 3). In contrast, building descriptions remain more easily readable today, as they were typed using typewriters.

Figure 3: Differences in the quality of building documentation; sample excerpts from a building drawing and strength calculations.



Source: HANSA Baugenossenschaft eG.

Also, many documents contain *ambiguous wording*. Strength calculations from the 1950s and 1960s contain outdated calculation methods and material designations. To compare existing calculations with current calculation standards, the units used at the time must be converted. For example, the units kg and kg/m^2 used in historical calculation are converted into kN and kN/m^2. Specifically, 100 kg corresponds to approximately 1 kN. Regarding a typical example of permissible soil pressure, 2.5 kg/cm^2 is equivalent to 250 kN/m^2.

Finally, the *degree of digitalization* must be considered. During the research on building documentation, documents with varying degrees of digitalization were found. Some plans existed in their original form, as large-format folded sheets that had suffered damage due to frequent use. A first step towards digitalization involved scanned versions of the original plans. However, working with these scans proved time-consuming, as the high resolution resulted in large file sizes. Significant differences in quality were observed. Some plans had been graphically processed to maximize contrast, ensuring a white background and black annotations. A further step was the creation of 2D CAD drawings of the existing buildings. However, material specifications from the original plans were not included. No digital 3D models were available.

Extensive case-by-case assessments for rooftop extensions

The feasibility of rooftop extensions is fundamentally dependent on the structural condition of the existing building. However, due to the lack of comprehensive and reliable building documentation, assessing this condition often requires extensive case-by-case analyses. A complete set of documents forms an essential foundation for assessing whether the building's structure and materials fundamentally allow for an extension. However, it cannot replace thorough on-site analysis, which is essential to detect potential damage or structural deficiencies that documentation alone cannot reveal. In contrast to new construction, where a clearly defined planning framework exists, building in an existing context demands these intensive preliminary investigations to verify the residual capacity and structural stability of the building. These necessary individual assessments represent a significant contingency, as they introduce additional costs, time delays, and planning uncertainties that can impact decision-making processes regarding rooftop extensions versus demolition and new construction.

In addition to regulatory aspects such as setback distances, parking spaces, and escape routes, structural stability is a key factor in determining the feasibility of a rooftop extension. Based on the construction drawings and strength calculations, load-bearing elements can be identified and preliminary conclusions can be drawn regarding their remaining load-bearing capacity, for example, through past over-dimensioning or low utilization rates of individual components. It must also be ensured that the additional loads specified by current technical building regulations – such as dead loads, snow loads, and wind loads – can be safely absorbed and transferred by both the unmodified parts of the building and any additions.

The structural heterogeneity of multifamily buildings from the 1950s and 1960s further complicates these assessments. As established above, these buildings were constructed using a variety of materials and techniques, ranging from traditional masonry to prefabricated concrete elements. Given this variability, a standardized evaluation process for rooftop extensions is hardly feasible, making the assessment process more demanding compared to new construction projects, where material properties and load-bearing capacities are clearly defined. The economic implications of these uncertainties play a crucial role in decision-making. In the past, an unfavourable cost-benefit ratio of full modernization compared to new construction has been a primary justification for demolition and new construction (Walberg and Gniechwitz, 2016: 50). The costs associated with extensive preliminary assessments often make rooftop extensions less attractive compared to demolition and new construction. In cases where load reserves are minimal or where significant structural reinforcements are required, the financial feasibility of an extension is often questioned.

Regarding the lifespan of buildings, a distinction is often made between technical and economic service life. The technical service life refers to the period in which a building component or layer fulfils its intended function, ending when its functionality is no longer guaranteed. These functions may include weather protection, structural stability, or fire safety. Construction materials used for foundations, walls, and ceilings generally have a long lifespan exceeding the reference period. Values for the expected service life of individual building components can be found in tables prepared by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR, 2017). The economic service life describes the period during which a building component remains cost-effective within the designated financial framework, whether with or without maintenance and repair measures. There is no universally binding lifespan, as different sources provide varying assumptions. According to the Real Estate Valuation Ordinance (Immobilienwertermittlungsverordnung) in its version dated 14 July 2021, the standard total useful life for multifamily buildings is 80 years.[5] Beyond these general model assumptions, the individual history of a building has a significant impact on the lifespan of its components and the overall structure, as well as on the possibility of extending the service life by at least 50 years through a rooftop extension project. While technical service life can extend beyond this period, the economic feasibility of extending a building's lifespan through an extension depends on cost-benefit considerations. If the required reinforcements and modifications exceed a certain threshold, the decision may favour demolition and reconstruction rather than an extension.

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[5] §12, Paragraph 5, Sentence 1, Annex 1.

From a structural perspective, precise knowledge of material properties is essential, as both structural and building physics aspects must be considered at the connection point between the existing structure and the rooftop extension (Fath et al., 2022). This requires ensuring compatibility between new and existing structures while maintaining essential building physics properties. To evaluate these aspects, planners must conduct detailed site investigations, structural assessments, and recalculations of existing load-bearing elements, even when original construction drawings and strength calculations are available, due to the potential for undocumented changes and material degradation over time. The decision between either retrofitting with a rooftop extension or demolishing is highly dependent on the quality of existing documentation and the condition of the building. Consequently, rooftop extension projects are often highly subject to planning risks.

New tools, persistent constraints: Assessing planning instruments for rooftop extensions

Several digital decision-support tools have entered the market, offering automated assessments of (re)development potential. In the context of building within existing structures, these tools primarily focus on energy efficiency measures and densification opportunities, including rooftop extensions. By automating building data analysis and incorporating regulatory constraints, they provide initial feasibility insights, reducing the need for time-intensive preliminary investigations. However, these tools also introduce new challenges and limitations, particularly regarding the accuracy of structural assessments when working with existing buildings.

For instance, CAALA GmbH produces software that systematically evaluates the retrofitting potential of existing buildings through automatically generated 3D models based on OpenStreetMap data and assumptions derived from the TABULA building typology[6] (for an overview, see Loga et al., 2011). Individual inputs regarding building envelopes, technical systems, and hot water demand allow for energy performance simulations, offering insights into possible efficiency improvements. While this tool provides valuable data on energy-related upgrades, it does not include detailed structural analy-

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[6] Typology Approach for Building Stock Energy Assessment.

sis or load-bearing assessments, which are critical for evaluating rooftop extensions.

Similarly, Syte GmbH employs AI-driven forecasts to assess potential forms of urban development, including rooftop extensions, repurposing, and densification. Its tool, an AI platform, relies on lidar data to evaluate possible development opportunities, integrating regulatory constraints such as Section 34 of the German Building Code (Baugesetzbuch),[7] which governs the permissibility of projects within existing urban areas. However, Syte does not assess structural reserves or load-bearing capacities, instead focusing on plot-level constraints and neighbouring developments.

While these tools offer valuable initial assessments, they highlight a fundamental trade-off between standardization and individualized structural analysis. Automated systems rely on generalized building typologies and assumptions, making them unsuitable for addressing the unique structural conditions of individual post-war buildings. As demonstrated in research on the material and structural variability of Hamburg's post-war housing stock, even buildings that appear visually similar can differ significantly in load-bearing systems, material composition, and prior modifications. Without knowledge of structural stability and load-bearing capacity, definitive statements about rooftop extension potential cannot be made.

Beyond technological limitations, another major challenge arises from the lack of economic incentives for working with existing buildings. Architectural and engineering services in Germany are typically regulated by the Fee Structure for Architects and Engineers (Honorarordnung für Architekten und Ingenieure, HOAI), which establishes compensation rates for planning tasks. However, the HOAI does not explicitly address the additional planning complexities associated with existing structures, nor does it define special services related to their assessment and retrofitting (Herke, 2019). This discrepancy leads to insufficient financial incentives for architects and engineers to prioritize work on existing buildings over new construction. The argument put forward by ARGE (Arbeitsgemeinschaft für zeitgemäßes Bauen), a working group for sustainable construction (Walberg and Gniechwitz, 2016: 50) further reinforces this point, stating that cost-benefit analyses have repeatedly favoured demolition due to the high costs of full modernization compared to new construction.

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[7] §34 Zulässigkeit von Vorhaben innerhalb der im Zusammenhang bebauten Ortsteile, Baugesetzbuch.

If modernization and extension are to be promoted as viable alternatives, financial incentives and compensation structures must both be reconsidered to reflect the additional effort required for working with the existing stock.

Unlike new construction projects, which follow a structured planning process from the macro to micro scale, working with existing buildings requires an adaptive approach (Herke, 2019). Early-stage planning must include detailed analysis of existing building components, which is facilitated by comprehensive building documentation. However, as demonstrated in the preceding sections, such documentation is often missing, incomplete, or outdated, requiring additional investigative efforts.

Given these challenges, architects thus play a crucial advisory role for property owners in determining the feasibility of rooftop extensions. From a climate policy perspective, all possible measures for reusing and upgrading existing structures should be considered before opting for demolition and new construction. The existing disincentives in regulation and compensation structures illustrate the need for frameworks that make sustainable building practices both financially and institutionally feasible.

Conclusion and outlook

This chapter has analysed why rooftop extensions on post-war multifamily buildings, despite their considerable ecological and spatial potential, often remain difficult to implement. Based on empirical research conducted in Hamburg, it has identified a set of interdependent conditions that affect the feasibility of such projects. These conditions can be grouped into two types: first, challenges that stem from the physical characteristics and documentation status of the building stock itself; and second, factors that relate to how planning actors deal with these contingencies in practice.

Among the first type are the structural and material heterogeneity of buildings from the 1950s and 1960s, and the fragmented and inconsistent nature of their documentation. These features are not simply technical details but form the material and informational starting point for any transformation strategy. The second type of conditions includes the necessity of conducting time- and resource-intensive structural assessments for each building and the limitations of current digital tools and regulatory frameworks. These aspects reflect how planners and decision-makers attempt to navigate the contingencies embedded in the existing building stock. Together, these interlocking conditions highlight the complex realities of planning rooftop extensions. They show that transformation is not automatically enabled by ecological or strategic imperatives. Rather, it is conditioned by the specificities of the built past and by the systems through which planning knowledge is generated, interpreted, and acted upon.

While previous research has illuminated the participatory, social, and design-oriented dimensions of transforming post-war housing (Simon-Philipp and Hopfner, 2013; Harnack et al., 2020; Brunner et al., 2021; Kaufmann, 2024), this chapter adds a complementary perspective. It shifts the focus towards the technical and procedural conditions under which such transformations become feasible in practice, highlighting the role of documentation quality, structural constraints, and early-stage planning knowledge in shaping decision-making processes. The chapter thus provides a grounded contribution to ongoing debates about urban future-making. It illustrates that the reworking of the post-war building stock – one of the most widespread and typologically homogeneous forms of housing in Germany – offers substantial potential for climate-conscious densification. At the same time, it is accompanied by considerable contingencies that must be actively negotiated in each case.

Beyond this chapter, additional qualitative research currently underway is further exploring these dynamics by investigating how architects, structural engineers, and property holders deal with missing information, distribute responsibility, and make decisions between demolition, retrofitting, and rooftop extension. Preliminary findings confirm that the presence or absence of reliable documentation plays a decisive role in whether rooftop extensions are even considered. When documentation is available and comprehensive, planning processes are perceived as more manageable. When it is not, actors tend to defer such projects or reject them altogether.

Furthermore, the regulatory and financial framework has emerged as a central issue. As several interviewees have pointed out, the HOAI does not reflect the additional workload and uncertainty that comes with planning in existing structures. Compensation and remuneration for early-stage assessments, coordination between disciplines, and context-sensitive design work are insufficient. This structural imbalance discourages adaptive reuse and perpetuates a preference for demolition and new construction.

In sum, this chapter has argued that rooftop extensions, although widely discussed as a spatially efficient and ecologically promising intervention, are subject to a range of conditions that cannot be standardized or resolved in advance. Planning in the existing fabric is always situated, uncertain, and dependent on institutional frameworks and professional practices. The contribution of this chapter lies in revealing these contingencies and showing how they shape the implementation of a transformation strategy that, in theory, could make a significant contribution to sustainable urban development.

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