How Deep is the Pit?

Long-Term Building Maintenance Debt of Multiple-Ownership Residential Buildings in Israel

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Abstract

Israel, one of the most densely populated countries in the OECD in terms of population per square kilometer, faces increasing pressure to accommodate housing needs through urban densification. However, the absence of a regulatory framework for financing long-term maintenance in multi-ownership residential buildings poses a significant threat to the longevity, structural integrity, and economic sustainability of the housing stock. This study seeks to quantify the current and future long-term maintenance debt borne by Jewish households in such buildings and to stimulate public and policy discourse on the necessity of sustainable funding mechanisms. The research employs the "Depth of the Pit" model, an analytical tool that integrates empirical data from the Central Bureau of Statistics’ Long-Term Household Survey, maintenance cost estimates from the National Authority for Urban Renewal, and CBS demographic projections, simulating debt trajectories through 2050 and 2075 across scenarios of population growth and urban development patterns. Results indicate a current maintenance debt of 57.6 billion NIS in 2023, predominantly tied to older low-to mid-rise buildings (2–10 floors), with projections showing an increase to 136–137 billion NIS by 2050 and 255–258 billion NIS by 2075, driven by a shift toward high-rise structures (21+ floors) that incur higher, more rigid costs due to complex engineering systems. These findings highlight a mounting financial burden equivalent to 20% of Israel’s 2022 household mortgage debt, underscoring the urgency for preemptive policy interventions.

Keywords: Long-term maintenance debt, multiple-ownership buildings, high-rise construction, urban densification, Depth of the Pit model.

Hebrew Abstract

ישראל, אחת המדינות הצפופות ביותר ב- OECD, מתמודדת עם לחץ הולך וגובר לענות על צורכי הדיור של אוכלוסייתה. על מנת להתמודד עם ביקושים אלו, נוקטת ישראל, וביתר שאת בעשור האחרון, במדיניות של בנייה לגובה במטרה למקסם את ניצול משאבי הקרקע במרחבים העירוניים. אחד האתגרים המרכזיים של בנייה גבוהה הוא עלות התחזוקה ארוכת הטווח הגבוהה האופיינית למבנים אלו. בשונה מעלויות תחזוקה שוטפות, המתבטאות בניקיון, בתיקונים ובתחזוקה קלה ומונעת של מבנים, עלויות תחזוקה ארוכות טווח מתמקדות בהיבטים מורכבים ומהותיים יותר של טיפול במבנים. אלה כוללים תיקון והחלפה של מערכות הנדסיות מורכבות ויקרות האופייניות לבניינים רבי-קומות. הספרות המדעית מראה כי היעדר מסגרת רגולטורית למימון תחזוקה ארוכת טווח של מבנים גבוהים ורבי-בעלויות מהווה איום משמעותי על שלמות ובטיחות המבנים, מובילה להזנחה ולירידה בערך הנכסים, ולהעמקת אי השוויון בין משקי הבית היכולים לשאת בעלויות התיקון לבין משקי בית שאין ביכולתם לעמוד בהוצאות אלו.

מטרת מחקר זה היא לכמת את "חוב" התחזוקה ארוך הטווח, הנוכחי והעתידי, של משקי הבית ביישובים יהודים בישראל, ולעורר שיח ציבורי בנושא ובדרכי ההתמודדות המיטביים עימו. אמידת חוב התחזוקה מתבצעת באמצעות מודל סימולציה ("מודל עומק הבור") המשלב נתונים אמפיריים מסקר משקי הבית ארוך הטווח של הלמ"ס, מנתוני הרשות הלאומית להתחדשות עירונית ומתחזיות דמוגרפיות של הלמ"ס. המחקר מציג תחזיות לעלות התחזוקה ארוכת-הטווח המשקית לשנים 2050 ו-2075, תחת תרחישים שונים של גידול אוכלוסייה ודפוסי פיתוח עירוני. ממצאי המודל מעריכים כי חוב התחזוקה הנוכחי של משקי הבית (2023) עומד על 57.6 מיליארד ש"ח, ונובע ברובו מבניינים ישנים בגובה 2-10 קומות. המודל חוזה כי בשנת 2050 יעמוד חוב התחזוקה ארוך הטווח על כ-137 מיליארד ש"ח ובשנת 2075 על כ-258 מיליארד שקל. חלק ניכר מהגידול בחוב התחזוקה ארוך-הטווח מושפע מהצפי לבנייה גבוהה מאוד (מגדלים מעל 21 קומות), המאופיינת על ידי עלויות תחזוקה גבוהות של מערכות הבניינים. ממצאים אלה מדגישים הנחיצות בהתערבויות מדיניות שיתמכו במודלי מימון בני קיימא לתחזוקה ארוכת-טווח של מבנים ובקידום דפוסי ציפוף אלטרנטיביים שאינם מושתתים בלעדית על בנייה גבוהה מאוד.

מילות מפתח: תחזוקה ארוכת טווח, בניינים רבי-בעלויות, בנייה רוויה, ציפוף עירוני, מודל עומק הבור.

1. Introduction

Israel ranks among the most densely populated nations within the OECD, and with its population projected to double by 2065 according to the Central Bureau of Statistics' medium-growth scenario, the imperative to optimize land use has become increasingly evident. The Integrated National Master Plan for Construction, Development, and Preservation (TAMA 35) advocates for greater urban density through high-rise construction, aiming to address housing demands while preserving open spaces. However, this transition introduces significant challenges, particularly concerning the long-term maintenance of multiple-ownership residential buildings. Although short-term maintenance is managed through mandatory Homeowner Association fees, the financing and regulation of long-term maintenance—essential for sustaining complex systems such as elevators, fire suppression equipment, and structural components—remain largely voluntary and unaddressed. This regulatory shortfall poses a substantial financial risk to homeowners and threatens the long-term viability of the housing stock.

The present study seeks to characterize the long-term maintenance debt of multiple-ownership residential buildings by developing a simple model for its estimation. The "Depth of the Pit" model quantifies the current and future debt burdens in multiple-ownership buildings, with the aim of fostering public dialogue on the importance of funding long-term upkeep, with particular attention to high-rise structures. By providing critical data and a practical framework, this research could support policymakers and urban planners in formulating strategies to manage long-term maintenance debt, while contributing meaningfully to the public discourse on the issue.

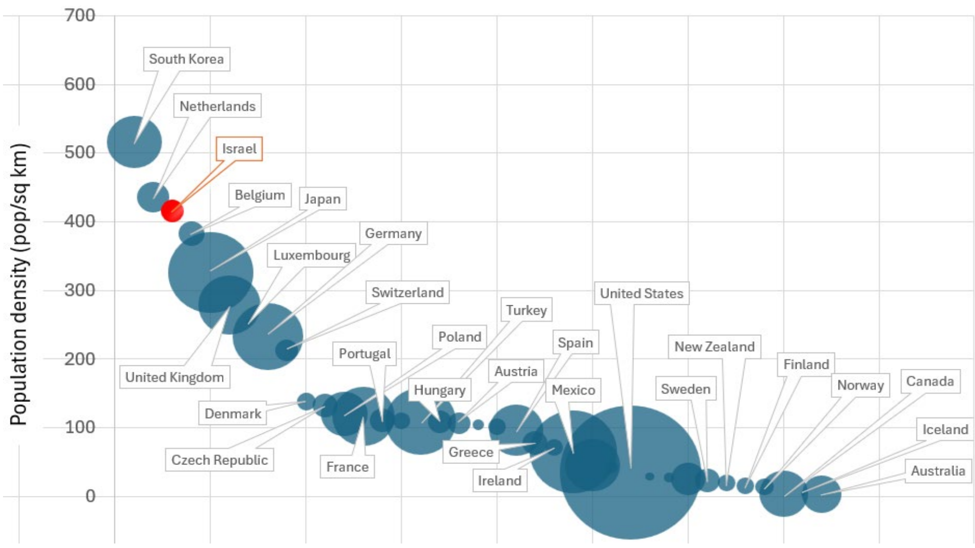
The methodology integrates empirical data from the Central Bureau of Statistics' Long-Term Household Survey, cost projections from the National Authority for Urban Renewal, and demographic forecasts, enabling debt estimates for two target years (2050 and 2075) under various population and urban development scenarios. The analysis is confined to housing units in multiple-ownership buildings in cities and localities with a Jewish majority, thus excluding housing units in (predominantly) Arab localities due to their predominant single-ownership patterns. Like any analysis relating to a future situation, the analysis relies on assumptions such as a standardized 25-year maintenance cycle, which may not fully reflect real-world variability. The methodological choices are further discussed in Chapter 3.

The report is structured as follows. Chapter 1 introduces the research context, problem, objectives, and approach. Chapter 2 reviews existing literature on building maintenance and urban development. Chapter 3 details the methodological framework and data sources. Chapter 4 presents the findings on maintenance debt. Chapter 5 discusses their implications for policy and stakeholders. Chapter 6 concludes with recommendations to address this pressing issue within Israel’s evolving urban and policy landscape.

2. Literature Review

Israel is among the most densely populated countries in the OECD (Figure 1) and has the highest population growth rate among OECD member states (CIA, 2025). Israel's demographic trajectory demonstrates robust growth, with a 2.1% population increase in 2022 compared to the OECD average of just 0.5%, suggesting that future population density in Israel will substantially exceed both its current levels and those of other OECD member nations (Fran & Klinger, 2018; FRED, n.d; Winreb & Shreberman, 2022). The CBS medium-growth demographic scenario projects that Israel's population will double—from 10 million to 20 million—by 2065 (Fran & Klinger, 2018).

Figure 1: Population density per square kilometer



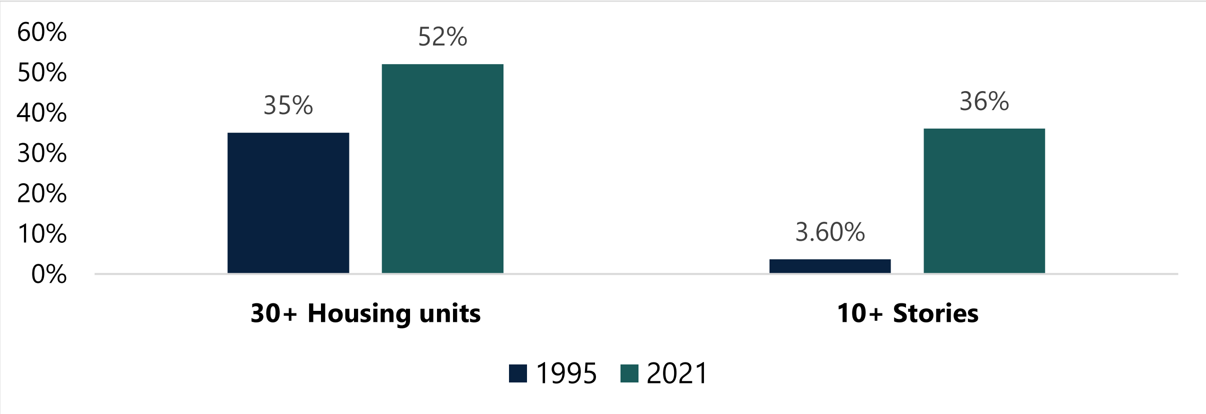
Source: World Bank Data, 2025

In response to this rapid demographic expansion, the Integrated National Master Plan for Construction, Development, and Preservation (TAMA 35) underscores the need for increased urban density and high-rise construction (Planning Administration, 2024). The plan advocates for concentrating development within existing urban areas to optimize land use efficiency while preserving open spaces for future generations. This strategy seeks to accommodate growing housing demands while balancing environmental sustainability through urban renewal. Recent amendments to TAMA 35 (amendment 4) raised the permissible residential density, particularly in major cities – with over 500,000 residents (Tel Aviv and Jerusalem) – permitting up to 30 housing units per dunam, and up to 20 housing units per dunam in cities of 200,000-500,000 residents (Planning Administration, 2024).

Consequently, Israel's urban landscape is undergoing a significant transformation, marked by a shift from low-rise and detached housing toward high-density residential buildings.

In 1995, 35% of newly constructed apartments were in buildings with 30 or more housing units. By 2021, this proportion had increased to 52% (CBS, 2022). Simultaneously, the share of newly built apartments in buildings with up to nine housing units declined from 41% in 1995 to 22% in 2021 (CBS, 2022). The prevalence of high-rise buildings (10+ stories) has also grown dramatically, from 3.6% of new housing units in 1995 to 36% in 2021 (Figure 2). Notably, the share of new housing units constructed in buildings of 21 or more stories increased from 0.4% in 1995 to 12% in 2021 (CBS, 2022). As of 2023, the number of housing units being built in high-rises of 21 or more stories, totaling 9,811 units, has surpassed those in mid-rise buildings of 11 to 20 stories, which account for 8,890 units (CBS, 2024).

Figure 2: Share of high-rise buildings under active construction (Buildings with 30+ housing units, buildings of 10+ stories), 1995 - 2021



Whereas in the past high-rise buildings were built in mostly affluent areas, the current vertical expansion is occurring across communities with diverse socio-economic backgrounds (Paz, 2017). This means that the long-term maintenance costs need to be paid by households with varying income and wealth. Given the increasing population and urban population density and the structure of Israel's housing market—characterized by a high rate of private homeownership and a minimal presence of institutional ownership—long-term building maintenance is emerging as a critical challenge.

2.1 Analytical classification of multiple-ownership residential buildings

Building maintenance of multiple-ownership residential buildings, particularly for high-rise structures, encompasses a comprehensive system of care that can be categorized into two primary maintenance levels - short term and long-term maintenance (Mualam, 2018). Short-term maintenance involves routine upkeep tasks such as minor repairs, cleaning operations, landscaping activities, and regular preventive maintenance of engineering systems aimed at averting potential future malfunctions. In contrast, long-term maintenance addresses more complex and substantial aspects of building care, specifically focusing on the repair and replacement of sophisticated engineering systems that are characteristic of high-rise buildings, including electrical systems, fire suppression equipment, elevators, ventilation systems, waste compaction units, water pumps and storage facilities, parking structures, and underground facilities. Long-term maintenance also encompasses critical structural maintenance aspects such as structural repairs, façade treatments, and waterproofing measures. These two maintenance categories work in tandem to ensure the ongoing functionality, safety, and longevity of building structures.

Table 1 provides an illustrative representation of the presence and relative intensity of various engineering systems across different building heights. The plus signs (+, ++, +++) serves as a visual indication of how frequently or extensively these systems are incorporated in buildings of varying heights. While ventilation systems are present at a consistent level (+) regardless of building height, other systems—such as elevators, underground parking, and fire extinguishing—become more prevalent and extensive as building height increases, reaching their highest intensity (+++) in structures with 21 or more floors. Furthermore, certain systems, including water reservoirs, waste management, and generators, are typically absent in buildings with 5–9 floors but become increasingly common in taller buildings, with their presence and intensity growing for those exceeding 20 floors. As can clearly be seen from this illustrative table, high-rise buildings require more complex engineering systems (Paz, 2017), and furthermore they necessitate substantial capital expenditures for cyclical repairs and comprehensive modernization projects, significantly elevating their ongoing upkeep and long-term maintenance expenses (Alterman, 2016).

Table 1: Intensity and presence of engineering systems in high-rise buildings parsed by building height

	5 – 9 floors	10 – 20 floors	21+ floors
Ventilation systems	+	+	+
Elevators	+	++	+++
Underground parking	+	++	+++
Water reservoirs		+	+
Waste management		+	++
Generators		+	++
Fire extinguishing systems	+	++	+++

Source: based on data from Paz (2017)

Multiple scholarly works present detailed classifications of residential building maintenance (see Lind & Muyingo, 2012). Alterman's (2016) typology distinguishes between four distinct types of maintenance based on their purpose and frequency: routine upkeep, preventive measures, scheduled replacements, and larger-scale renovations:

- **Level 1: Ongoing maintenance** – Routine activities such as cleaning, elevator servicing, gardening, and security. These tasks are performed on a daily or weekly basis and are considered short-term maintenance.
- **Level 2: Preventive upkeep** – Measures taken to prevent the deterioration of structures and mechanical systems, ensuring their continued functionality. This type of maintenance is typically conducted approximately every five years and is classified as mid to long-term maintenance.
- **Level 3: Periodic replacement** – The scheduled replacement or renovation of essential building components, including mechanical systems, elevators, external walls and facades. This occurs approximately every ten years and falls under long-term maintenance.
- **Level 4: Renovation and updating** – Maintenance aimed at improving housing quality, aligning with evolving housing standards, or counteracting the natural deterioration of buildings. This type of maintenance helps maintain the attractiveness of residential properties in terms of both quality and market value. It is typically undertaken approximately every 20 years and is categorized as long-term maintenance.

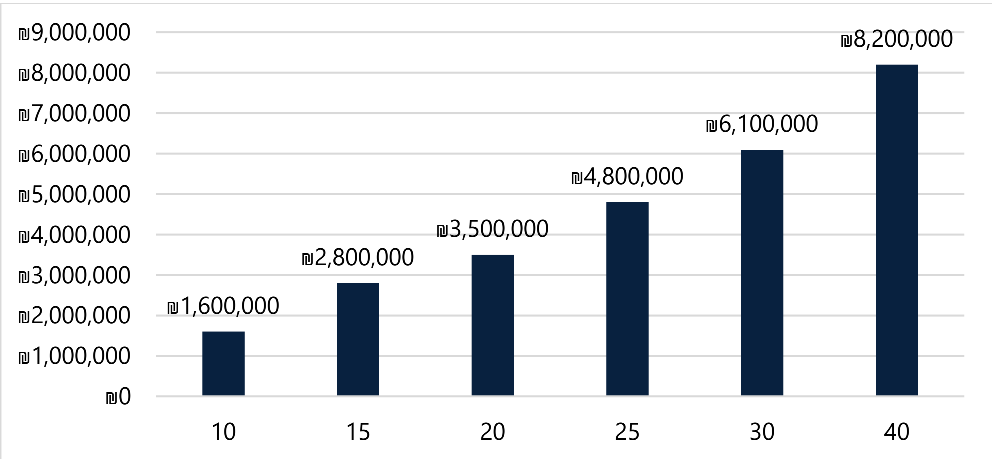
Alterman (2016) claims that maintenance visibility directly influences owner compliance, with routine upkeep (Level 1, can also be referred to as short-term) receiving greater support due to its immediate visibility and lower periodic costs, while preventative maintenance and replacements (Levels 2-3) face greater resistance due to their less apparent benefits. Long-term maintenance needs (Level 4), while clearly visible, remain chronically underfunded as they require substantial reserves beyond regular contributions and can create conflicts when ownership changes.

2.2 Challenges in long-term maintenance

The following section outlines the primary challenges identified in the literature which are associated with long-term residential building maintenance:

- **Substantial Long-Term Maintenance Costs**: Long-term maintenance entails considerable financial outlays, often reaching millions of NIS (Figure 3). For most households, who may not have substantial financial reserves, this necessitates the establishment of long-term savings plans, typically through regular contributions to a designated fund.

Figure 3: Long term maintenance cost of a single building (25 years) NIS, by the number of floors



Source: NBUR[1]

- **Inadequate Maintenance Resulting in Excessive Expenses**: Buildings that undergo suboptimal or insufficient maintenance are subject to higher repair costs (Kwon et al.,

[1] Cost calculation based on buildings with 4 housing units per floor.

2020). Homeowners are left to bear the financial burden of these elevated expenses when deferred maintenance issues ultimately require more costly interventions.

- **The Free Rider Dilemma**: As with other collective efforts, maintenance in multi-unit residential buildings is susceptible to the free rider problem, whereby certain residents try to benefit from the maintenance efforts without contributing to the associated costs or responsibilities. This free rider behavior may lead to a refusal of all apartment owners to contribute to maintenance efforts, leading to further deterioration of the building (Van Zandt & Rohe, 2011).
- **Principal-Agent Problem**: The principal-agent problem arises when an agent, acting on behalf of a principal, pursues self-serving interests that diverge from those of the principal. For instance, a maintenance company may focus on ensuring the building presents a visually appealing facade at a lower cost, in order to secure the contract, while the homeowners' (the 'principal') main concern is minimizing overall maintenance expenses. This approach can lead to superficial maintenance, leaving underlying issues unresolved, which ultimately results in higher costs in the long term (Garfunkel, 2022).
- **Reluctance to secure financing for structural renovations:** Recent research indicates that residents, particularly those with lower incomes, are hesitant to take out loans to cover the maintenance costs of shared homes (Streimikiene & Balezentis, 2020). One potential solution is governmental programs, such as the European LTRS scheme, through which most countries offer some form of financial assistance for renovations (European Commission, 2022; Kurvinen et al., 2024).

In addition to the financial and structural challenges posed by inadequate long-term maintenance regulations, the literature highlights a growing concern related to the increasing cost of housing and stagnant wages (Adkins et al., 2021; Vershevski, 2018). While in recent years real wages have increased somewhat in most OECD countries (OECD, 2025b), and real housing prices have decreased (on average) between 2022 and 2024, the overall trend (1996 – 2024) is still that of housing prices raising much faster than wages (OECD, 2025a). This necessitates households to take on larger mortgages with higher debt levels, increasing their loan-to-value ratios and extending their repayment periods. This trend suggests that if left unregulated, the financing of long-term maintenance as a lump sum –

via additional loans or otherwise may present an even greater challenges for most households in the future.

2.3 Regulatory state of long-term maintenance in Israel

In Israel, homeowners are responsible for the upkeep of their individual apartments and for maintaining and managing the common areas, infrastructure and facilities. Short-term maintenance costs are typically covered by monthly homeowners' association fees ('Vaad Bayit') or by allocating said fees (usually with a higher price-tag) to a management company. Long-term maintenance of multiple ownership residential buildings in Israel remains largely unregulated and voluntary, as opposed to the more binding state of short-term maintenance regulation (Alterman, 2009; Garfunkel, 2022; Mualam, 2018). Long-term maintenance costs are addressed on an ad hoc basis—or not at all (Paz, 2017). Although it is possible for homeowners to allocate funds for long-term maintenance purposes, there is no legal framework governing the management or utilization of these funds, and such practices are uncommon in Israel. These responsibilities may be delegated to a management company under Section 71(b) of the Israeli Land and Property Law, but the precise duties and rights between homeowners and the managing entity are not formally defined. The lack of long-term vision concerning the problem of rising short and long-term maintenance costs is also illustrated by the following statement of the CEO of NBUR:

"This issue has not been sufficiently addressed thus far. An individual from a less affluent background moving into a tower with a monthly management fee of 600 shekels often struggles to cope with the significant increase in expenses[2]. This matter requires stricter legislative oversight." – Elazar Bamburger, Ynet Real Estate, 21.1.2025)

A partial solution to long-term maintenance for newly constructed buildings in Israel is the **developer-endowed funds for excess maintenance costs**. This fund relies on an initial endowment from the developer, intended to cover approximately 25 years of long-term maintenance of a newly built building. In exchange for the endowment the developer receives additional building rights. As of 2025, this mechanism has been used in a limited number of

[2] Increase in expenses compared to the previous state of things – i.e. to costs in the 'old' building, usually low-rise, compared to costs of a new high-rise buildings.

projects in Jerusalem (NBUR, 2023). While it offers a partial solution to long-term building upkeep, it does not address the entire lifecycle of the building and may place additional strain on the built environment.

A similar solution, also based on funds endowed by the developer, is relevant to urban renewal projects. In urban renewal projects the developer provides a fund to cover the excess costs of short-term maintenance costs for specific populations (elderly and public housing tenants) and for a 5-year period (Kol Zchut, n.d.; NBUR, 2021). This fund does not relate to long-term maintenance costs and is only available to 'resuming' tenants – i.e. tenants that lived in the building before the urban renewal projects and answer specific criterions that make them eligible (age and/or income).

2.3.1 International regulations and policies for long-term maintenance of residential buildings

Long term maintenance of multi-owner residential buildings faces significant implementation challenges in many countries (Lujanen, 2010). In post-socialist countries, deficient legal frameworks have left privatized housing stock vulnerable to deterioration as ownership associations remain optional and often unestablished. In Russia, the voluntary nature of association membership fundamentally undermines collective action; while in France, excessive delegation of decision-making to professional managers (syndics) reduces owner involvement and transparency. These jurisdiction-specific issues are compounded by widespread enforcement difficulties, with countries like China lacking statutory mechanisms to mandate payment of maintenance fees, and even nations with formal enforcement provisions finding foreclosure procedures politically sensitive or administratively burdensome (Lujanen, 2010).

Despite these widespread challenges, countries around the world have developed diverse regulatory frameworks and institutional mechanisms aimed at addressing the long-term maintenance dilemma in multi-owner residential buildings (Alterman, 2016; Lujanen, 2010). We present regulations and policies dealing with long-term maintenance in Florida (US) and Finland. Afterwards we present highlights of the Italian, German and French - EU Long-term Renovation Strategy (LTRS) plans – which is a comprehensive European plan dealing with renovation of old buildings.

Florida's condominium law establishes a comprehensive framework for long-term maintenance of shared residential buildings (Alterman, 2016). The system requires condominium associations to operate as formal corporations with authority to conduct real estate transactions and enforce fee collection. Financial requirements include detailed maintenance projections, quarterly budget estimates, and mandatory reserve accounts for major repairs like roof replacement, building painting, and any maintenance item exceeding $10,000. Associations are granted substantial legal mechanisms for enforcement, including the ability to place liens on units, impose fines, and even sell properties to recover unpaid fees without requiring court approval (Alterman, 2016).

Despite these robust mechanisms, Alterman (2016) finds mixed compliance, with only about 40% of condominiums maintaining adequate reserves for long-term needs. Florida's system function effectively during economic stability, with associations typically initiating enforcement actions after a month of nonpayment. However, economic downturns reveal vulnerabilities, as demonstrated during the 2008 financial crisis when foreclosures led to widespread maintenance fee defaults and postponement of critical building upkeep. While generally more effective than simpler regulatory systems (as is in place in Israel), Florida's approach still struggles to completely address the challenge of sustainable maintenance funding for high-rise condominiums, particularly during economic stress periods.

The Finnish housing company model represents a distinctive approach to multi-unit property ownership through a limited liability company structure rather than traditional condominium arrangements (Lujanen, 2010). Under this system, residents purchase shares corresponding to specific units rather than directly owning physical space, with the housing company itself retaining ownership of the entire property. This corporate framework enables decisive governance through shareholders' meetings that operate by simple majority voting, while a professional board of directors and superintendent manager handle day-to-day operations and maintenance planning. The model's financial strength derives from its dual collateral mechanisms—individual share certificates can secure personal loans while the company can independently obtain mortgage-backed financing for common repairs—and its graduated enforcement system that permits temporary possession of defaulting units without permanent ownership transfer. Notably, the sanction of unit possession to collect rental income serves primarily as a deterrent, rarely requiring implementation because of its effectiveness in motivating payment compliance (Lujanen, 2010).

The EU, following the need to reduce carbon emissions, and to renovate the deteriorating multiple ownership residential housing stock in Europe (Matschoss et al., 2013), enacted the long-term renovations strategy (LTRS) (Kurvinen et al., 2024). Though not specifically dealing with long-term maintenance of multiple home-owner buildings, it is a comprehensive plan dealing with a deteriorating housing stock though the prism of carbon neutrality.

The LTRS requires each member state of the EU to develop a renovation plan for the residential built stock, in-order to achieve environmental objectives. The EU has set about €36 billion for member states for the renovation of private buildings (European Commission, 2022). Though, as evident by the breakdown of costs in each member's plan – the allocated €36 billion is not enough to cover the majority of costs of said renovation (European Commission, 2022, pp. 21–22).

All plans prioritize buildings based on energy performance certificates, with special focus on worst-performing buildings, but vary in their approach to compulsion. **Italy** leans heavily on tax deductions – with the Superbonus tax deduction which covers 110% of energy efficiency and seismic improvement costs, allowing property owners to either deduct expenses over five years or transfer the credit to third parties/suppliers. Buildings are prioritized based on energy performance, with specific focus on pre-1976 buildings. Financing is based on multiple streams (mostly public), and the strategy requires €9-12 billion annually for residential renovations through 2050, with the aim of renovating 66% of the residential building stock by 2050 (European Commission, 2022).

Germany relies on subsidized loans to achieve renovation targets, the financing combines direct subsidies (€182.2 million in grants in 2018), federal funding for energy-efficient construction, market incentives for renewable heating systems, and a new carbon pricing system. The German plan emphasizes serial refurbishment for apartment blocks in-order to achieve cost saving through standardization. **France** employs a combination of guarantees, tax incentives, and regulatory measures to improve building energy efficiency. In 2021, the government banned rent increases for poorly performing buildings and by 2023, it prohibited their rental altogether. Additionally, all worst-performing buildings must undergo renovation by 2028. To support these efforts, France offers tax incentives, including a reduced VAT rate of 5.5% (instead of 20%) for energy renovations. The French plan also allocates funds to help low-income household renovate their homes (European Commission, 2022).

In conclusion, there are diverse regulatory approaches with varying degrees of effectiveness around the globe. While Florida's framework provides robust enforcement mechanisms but struggles during economic downturns, Finland's corporate ownership model offers a more sustainable alternative through its innovative share-based structure and graduated sanctions. The EU's Long-term Renovation Strategy demonstrates a shift toward integrating maintenance concerns with broader sustainability goals, though with significant funding gaps. These international examples highlight that successful maintenance regimes require a balance of clear governance structures, adequate financing mechanisms and effective enforcement provisions.

3. Methodology

We present an analytical framework and model for estimating the long-term maintenance debt of multiple-ownership residential buildings in Israel. Our model quantifies both current and future maintenance debt by analyzing building characteristics, estimating per-household maintenance costs, and projecting demographic trends.

To further enhance the predictive capacity of the model, simulations are carried out under different assumptions and scenarios reflecting potential variations in demographic growth and building characteristics. These scenarios include an incremental shift toward high-rise construction and a more dramatic transition to ultra-dense vertical development. By modeling multiple trajectories, this study aims to capture the range of possible maintenance debt burdens that Israeli households may face in the coming decades. The methodological approach combines empirical analysis with practical assumptions, aiming to produce findings that are both theoretically grounded and useful for policymakers, urban planners, and housing authorities.

3.1 Research objectives

The main objectives of this study are:

- To characterize long-term housing maintenance debt.
- To develop a simple model for estimating maintenance debt in multiple-ownership residential buildings.
- To quantify the current and future long-term maintenance debt of Israeli households living in multiple-ownership residential buildings.
- To encourage public discussion on the challenges of long-term maintenance debt in multiple-ownership residential buildings.

3.2 Research Population

The research population in this study consists of housing units in multi-ownership residential buildings located in cities and localities with a Jewish majority population. Housing units in (predominantly) Arab cities and towns are excluded from the study due to the distinct ownership structures prevalent in their communities, which are primarily characterized by single (or family-based) ownership. While a small share of the Arab population lives in multi-ownership buildings in predominantly Jewish towns, they are also excluded from our estimates for pragmatic reasons, given the inability to parse single and multi-ownership buildings by ethnicity.

3.3 Research Data

The primary data inputs for the model are derived from three key sources. First, the Long-Term Household Survey (LTHS) conducted by the Central Bureau of Statistics (CBS, 2022) provides comprehensive data on 4,500 households surveyed annually over an extended period. The LTHS survey includes key housing characteristics, such as the number of floors and the year of construction of the building. Floor counts are reported in specific increments: 1–4, 5–10, 11–15, 16–20, 21–25, 26–30, and 30+. To focus on multiple-ownership residential buildings, single-family homes (including semi-detached cottages, row cottages, detached houses, and temporary structures) were excluded from the analysis. As a result, approximately 600,000 housing units were subtracted from the total housing stock, reducing the 2023 housing stock for the Jewish population from 2.357 million to 1.756 million units—establishing the baseline for our analysis. According to the LTHS survey, this housing stock is categorized into four building age groups: 25 years or older, 20–24 years, 14–19 years, and 13 years or newer.

The second data source is the National Authority for Urban Renewal (NBUR), which provides estimates of long-term maintenance costs for multiple-ownership residential buildings based on the number of floors in newly constructed buildings. These cost estimates reflect the monthly maintenance fees necessary to sustain the structural integrity and functionality of buildings over time.

Our model is based on NBUR's assumption that essential structural maintenance follows a 25-year cycle, ensuring buildings remain safe and in good condition. This period is defined as the 'debt accumulation' phase, during which maintenance costs gradually accrue. Ideally, maintenance fees would continue to be collected beyond this period to build an endowment fund for future large-scale renovations. However, for the purposes of our model, we calculate maintenance debt only for the initial 25-year cycle, assuming that the accumulated fund—augmented by interest in subsequent years—will be sufficient to cover future maintenance needs.

The third data source consists of demographic projections and household attributes provided by the Central Bureau of Statistics (CBS). These projections are utilized to estimate the addition of Jewish households (serving as a proxy for housing units) across four distinct time periods (2024–2031, 2032–2038, 2039–2044, and 2045–2050).

3.4 Depth of the Pit model

3.4.1 Current housing stock model

The “Depth of the Pit” model provides an analytical framework for estimating the long-term maintenance debt of multiple-ownership residential buildings in Israel. For this purpose, the relevant housing stock is divided into categories defined by number of floors and age brackets. The model subsequently computes the long-term maintenance costs for each housing category, before summation into the maintenance debt across the entire relevant housing stock. The model operates on two temporal dimensions: the current housing stock debt as of 2023, and the current housing debt at the completion of the building cycle. The building maintenance cycle refers to the 25-year period during which maintenance fees are supposed to be collected. As many of the existing stock buildings are younger than 25 years, they have not yet completed their initial maintenance cycle and thus continue to accumulate debt toward their maintenance fund requirements.

To account for the time value of money, the model incorporates the future value formula, which estimates the worth of the maintenance fees at a specific point in the future. This formula assumes that the fees collected today will both grow through investment returns and simultaneously be eroded by inflation over time. By applying this concept, the model can more accurately project the financial burden on households at the end of the maintenance cycle, factoring in the compounded effects of interest and inflation on long-term financial obligations.

3.4.2 Future Housing Stock Model

The future housing stock model extends the framework established for the current housing stock to project long-term maintenance debt of new housing. The model divides the projection period into four distinct time segments (2024-2031, 2032-2038, 2039-2044, and 2045-2050) to capture evolving demographic and urban development patterns. A key advantage of this model is its ability to simulate different future scenarios by adjusting several critical parameters, allowing sensitivity testing:

- Population projections: The model incorporates three different population forecast scenarios (minimum, medium, and maximum) from the Central Bureau of Statistics to account for uncertainty in demographic trends and the resulting scope of required housing.
- Urban development patterns: two distinct scenarios for the evolution of building heights are modelled:
    - **Incremental high-rise transition** - gradually shifting toward taller buildings.
    - **Skyline Surge** - accelerating dramatically toward high-rise urban development.
- Financial Factors: The model accounts for the time value of money through changing inflation/interest rate parameters.

By integrating population forecasts, housing distribution trends, and maintenance cost projections, the model provides an estimate of the maintenance debt that will accumulate in newly constructed housing between 2024 and 2050.

3.5 Model Specification

This section presents the mathematical formulations used to quantify long-term maintenance debt for both existing and future stock models.

3.5.1 Current housing stock model specification

Current Debt

The total household debt associated with the existing housing stock can be summarized using the following formulas:

$$D_{2023} = \sum_{i,j} C_i \times (H \times R_{i,j}) \times T_{m,j}$$

Current debt (end of building cycle)

$$D_{cycle} = \sum_{i,j} C_i \times (H \times R_{i,j}) \times T_{m,j} \times (1+r)^{T_{m,j}}$$

Where:

D_{2023}: Total long-term maintenance debt (in NIS) in 2023
D_{cycle}: Future value of long-term maintenance debt at the end of the building cycle (25 year period), adjusted for inflation
C_i: Monthly long-term maintenance fees per household in building type i (categorized by floor number)
$R_{i,j}$: Share of households in building type i (floor number) and building age j
H: Total number of Jewish households in multiple-ownership residential buildings
$T_{m,j}$: Time in months remaining to pay long-term maintenance fees for building age j
r: Monthly inflation/interest rate used to calculate future value

3.5.2 Future housing stock model

Urban renewal assumption

Based on data extrapolation based on the Authority for Urban Renewal report (2023), we estimate that approximately 220,000 housing units will be demolished over the next 25 years (8,810 annually) and will be replaced by new units by the year 2050 . It is important to note that the total number of housing units constructed in place of the demolished buildings will substantially exceed 220,000 (the housing unit multiplier or redevelopment ratio is larger than 4). However, to avoid double counting, only this figure is incorporated into the future stock model, as additional units (households) on top of excluded housing units, are already accounted for in the population growth projections. In our model, we assumed that the buildings targeted for demolition are those that are 25 years or older. According to the existing distribution of buildings by height, we assume that 67% of the buildings planned for demolition are 2-4 floors tall, and 33% are 5-10 floors tall. We removed these housing units (proxied in the model by households) from the current stock model and added them to the future stock model. These households will be retributed in buildings that are taller than 10 floors. Therefore, the total household debt of the future housing stock can be defined by the following mathematical expression:

$$D_{n,renewal} = \sum_{i} \sum_{p} \left[C_i \times \Delta HH_{p,i} \times (1+r)^{T_p}\right] + \sum_{k} \left[C_k \times URHH_k \times (1+r)^{T_k'}\right]$$

Where:

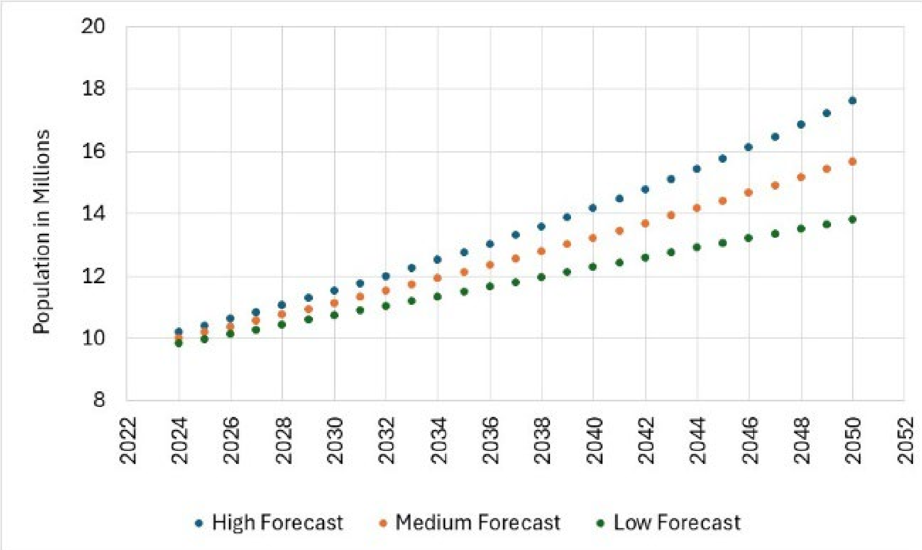
$D_{n,\ renewal}$: Total future value of long-term maintenance debt projected to target year n in the urban renewal scenario
Ci: Monthly long-term maintenance fees per household in building height type i (categorized by floor number)
$\Delta HH_{p,i}$: Incremental addition of households in period p and building type i
Tp: Average number of months left to pay maintenance fees for buildings constructed in period p.
r: Monthly interest/inflation rate
k: Index for building height in urban renewal
$URHH_k$: Number of renewed households of type k (replacing demolished units)
$T'_k{}'$: Months left in maintenance cycle for renewed buildings
i: Building height index (floor categories)
p: Time period index

3.5.3 Model Inputs and Parameters

This section outlines the inputs and parameters used in current and future debt models designed to evaluate long-term maintenance debt for multi-ownership residential buildings. These include demographic projections, housing distribution patterns, and maintenance cost estimations. The data provided here serve as critical inputs for two interconnected models: the current housing stock model, which evaluates existing maintenance debt, and the future housing stock model, which projects anticipated maintenance needs for new construction up to 2050.

Figure 4 presents the population forecast for Israel from 2024 to 2050, categorized according to three scenarios: low, medium, and high. As the CBS also provides the population distribution by ethnicity (Jewish and other, Arab) for each year, it is possible to calculate the incremental growth ("delta") of the "Jewish and other" population for each forecast scenario (as illustrated in Table 2). The projected addition of housing units for each time period and forecast scenario are then derived by dividing this population increment by the average household size.

Figure 4: Population forecast scenarios 2024-2050



Source: CBS

Table 2: Addition of Jewish population parsed by time period and population forecast scenario

Time Period	Minimum Forecast	Medium Forecast	Maximum Forecast
2024-2031	835,000	1,013,000	1,242,000
2032-2038	723,000	1,149,000	1,236,000
2039-2044	617,000	1,137,000	1,228,000
2045-2050	582,000	1,260,000	1,454,000
Total	**2,757,000**	**4,559,000**	**5,160,000**

Table 3 and Table 4 present data on the current and projected distribution of households. Table 3 provides the data used in the current housing stock model, which is based on the LTHS survey. The table includes the distribution of households categorized by building age and height, as well as the average time increment (in months) required to pay long-term maintenance fees, calculated based on building age, until the completion of the 25-year cycle. Similarly, Table 4 presents the inputs for the future housing stock model. Using assumptions, it outlines the distribution of households by building height and time period across two urban development scenarios: incremental high-rise transition, and skyline surge.

Table 3: Distribution of households by building height and age (current housing stock)

Number of floors	Building age	Households (n)	Households (%)	Total households in multiple-ownership	months for which maintenance fee was not paid in 2024
2-4	25 years or older	510914	76.7%	653,752	300
	20-24 years		8.0%	67,860	264
	14-19 years		8.9%	76,117	198
	13 years or newer		6.4%	54,674	78
5-10	25 years or older	411372	47.7%	327,664	300
	20-24 years		10.6%	72,491	264
	14-19 years		28.4%	195,229	198
	13 years or newer		13.3%	90,943	78
11-15	25 years or older	57388	26.8%	25,667	300
	20-24 years		12.8%	12,227	264
	14-19 years		38.1%	36,477	198
	13 years or newer		22.3%	21,375	78
16-20	25 years or older	45337	8.8%	6,649	300
	20-24 years		6.1%	4,649	264
	14-19 years		38.5%	29,137	198
	13 years or newer		46.5%	35,205	78
21-25	25 years or older	14314	4.5%	1,064	300
	20-24 years		0.0%	0	264
	14-19 years		58.6%	13,996	198
	13 years or newer		36.9%	8,822	78
26-30	25 years or older	7681	0.0%	0	300
	20-24 years		0.0%	0	264
	14-19 years		75.5%	9,681	198
	13 years or newer		24.5%	3,134	78
30+	25 years or older	5790	41.2%	3,976	300
	20-24 years		18.5%	1,785	264
	14-19 years		32.5%	3,137	198
	13 years or newer		7.9%	761	78

Source: Estimates based on CBS, LTHS survey

Table 4: Distribution scenarios of housing units in yet-to-be-build housing stock, by building height and time period

		Scenario	
Time period	Number of floors	Incremental high-rise transition	Skyline Surge
2024-2031*	Single (not in model)	17%	17%
	2-4	10%	10%
	5-10	41%	41%
	11-15	13%	13%
	16-20	10%	10%
	21-25	5%	5%
	26-30	2%	2%
	30+	2%	2%
2032-2038	Single (not in model)	15%	12%
	2-4	8%	6%
	5-10	36%	28%
	11-15	16%	18%
	16-20	13%	16%
	21-25	7%	10%
	26-30	3%	5%
	30+	2%	5%
2039-2044	Single (not in model)	11%	8%
	2-4	7%	6%
	5-10	31%	20%
	11-15	18%	22%
	16-20	16%	20%
	21-25	9%	12%
	26-30	4%	6%
	30+	4%	6%
2045-2050	Single (not in model)	8%	5%
	2-4	7%	4%
	5-10	26%	14%
	11-15	19%	23%
	16-20	18%	23%
	21-25	10%	14%
	26-30	7%	9%
	30+	5%	8%

* Seed distributions for the 2024-2031 time period are based on CBS LTHS distributions for the existing housing stock.

To calculate the monthly long-term maintenance cost per household, broken down by building height, we relied on data provided by the National Authority for Urban Renewal (NBUR). This estimation for the current housing stock model and the future housing stock model are presented in Table 5 and Table 6. In the case of lower-rise buildings (2-4 and 5-10 floors), as well as some medium-rise buildings (11-15 floors), we can see that the estimated maintenance costs for the current housing stock are lower than those for future buildings. This is due to the fact that older buildings generally lack the more complex engineering systems present in newer constructions, resulting in lower maintenance costs. For example, the maintenance cost for a 25-year cycle for a 2-4 floor building in the current stock is NIS 400,000, whereas the cost for a similar building in the future stock is NIS 600,000. Similarly, buildings in the 5-10 and 11-15 floor categories exhibit similar trends, with the maintenance costs for future buildings being higher. For higher-rise buildings (16+ floors), however, the maintenance costs in both the current and future stock are relatively similar due to the comparable complexity of their engineering systems. The monthly maintenance cost per household is calculated by dividing the total maintenance cost for the 25-year cycle by the number of apartments in the building, and then dividing that figure by 300 (25*12) to yield the monthly cost. In addition, the simulations assume a 1.7% annual inflation rate, based on the Consumer Price Index annual average over the past 15 years (2009-2024).

Table 5: Long-term maintenance cost of the current housing stock

Number of floors	Maintenance cost (NIS) for 25 year cycle	Average number of apartments in a building	Monthly long-term maintenance cost per household (NIS)	Long-term maintenance cost per household for 25 Years (NIS)
2-4	400,000	10	133	40,000
5-10	900,000	24	127	38,084
11-15	2,200,000	56	131	39,286
16-20	3,000,000	72	140	41,892
21-25	4,800,000	92	174	52,174
26-30	6,100,000	112	182	54,464
30+	8,200,000	130	210	63,077

Table 6: Long-term maintenance cost of future housing stock

Number of floors	Maintenance cost (NIS) for 25 year cycle	Average number of apartments in a building	Monthly long-term maintenance cost per household (NIS)	Long-term maintenance cost per household for 25 Years (NIS)
2-4	600,000	12	167	50,000
5-10	1,600,000	30	178	53,333
11-15	2,800,000	56	167	50,000
16-20	3,500,000	72	162	48,611
21-25	4,800,000	92	174	52,174
26-30	6,100,000	112	182	54,464
30+	8,200,000	130	210	63,077

3.6 Research Limitations

While the methodological framework presented in this study offers a robust approach to estimating the long-term maintenance debt of multiple-ownership residential buildings in Israel, several limitations must be acknowledged. These limitations stem from the scope of the research population, the assumptions underpinning the model, the availability and granularity of data, and the inherent uncertainties associated with long-term projections. A brief discussion of these constraints is essential to enable proper interpretation of the findings and for guidance of future research.

First, the study's future projections are restricted to Jewish households residing in multiple-ownership residential buildings, excluding Arab households due to their distinct ownership structures, which predominantly feature single-family homes. This delineation enhances the specificity of the analysis but limits its generalizability across the entire Israeli population. The exclusion of Arab households, who constitute a significant demographic segment, may overlook unique maintenance challenges in their communities, thereby reducing the applicability of the model to the broader national housing stock. Future research could expand the framework to incorporate these populations by adapting the model to account for differing ownership and maintenance dynamics.

Second, the model relies on several simplifying assumptions that may introduce bias or imprecision. For instance, the 25-year maintenance cycle—termed the 'debt accumulation' phase—assumes that buildings cease accruing additional maintenance debt after this period, as the endowment fund, augmented by interest, is deemed sufficient to cover ongoing costs. This assumption, while grounded in data from the National Authority for Urban Renewal (NBUR), may not fully reflect real-world variability in maintenance needs, such as unexpected structural repairs or the impact of environmental degradation, particularly in older buildings. Similarly, the model's reliance on fixed inflation and interest rates to calculate the future value of maintenance fees may oversimplify economic fluctuations over the 25-year horizon, potentially skewing projections of financial burdens on households.

Third, the data sources, while comprehensive, present certain limitations in scope and detail. The Long-Term Household Survey (LTHS) from the Central Bureau of Statistics (CBS) provides valuable insights into housing characteristics but categorizes floor counts in broad increments (e.g., 1–4, 5–10, 11–15), which may obscure finer variations in maintenance costs across buildings of differing heights within these ranges. The NBUR’s maintenance cost estimates, based on new constructions, may also underestimate costs for older buildings with legacy systems or overestimate them for newer, more efficient designs, introducing potential discrepancies in the calculated debt.

Fourth, the future housing stock model incorporates demographic and urban development scenarios that, while carefully constructed, are subject to significant uncertainty. The population forecasts (minimum, medium, and maximum) and urban development trajectories (incremental high-rise transition and skyline surge) rely on CBS projections and policy assumptions about household size and construction trends. These projections may be disrupted by unforeseen socio-economic shifts which could alter the scale and distribution of future housing stock and thus of future maintenance debt. The model’s sensitivity to these parameters is a strength, but its predictive accuracy inevitably diminishes as the time horizon extends to 2050, given the compounding effect of such uncertainties.

Fifth, the urban renewal assumption in this study, which estimates that 220,000 housing units will be demolished over 25 years at a rate of 8,810 units annually based on the 2023 Authority for Urban Renewal report, represents a limitation due to its reliance on a simplified assumption. This projection, assuming a consistent demolition rate and replacement with taller buildings, contributes to the calculation of future maintenance debt but may either underestimate or overestimate the actual scope of urban renewal. By relying on a single extrapolation, the model may not accurately reflect potential variations in policy, funding, or implementation challenges over the long term, potentially resulting in inaccuracies in the projected maintenance debt for new constructions, possibly requiring refinement in future studies to improve the estimates.

Finally, the study’s emphasis on quantitative modeling may overlook qualitative factors that influence maintenance debt, such as resident behavior, governance structures within multiple-ownership buildings, or regional disparities in urban planning and resource allocation. For example, the willingness or capacity of households to contribute to maintenance funds—a critical determinant of debt accumulation—is not explicitly modeled, potentially limiting the framework's ability to capture social and cultural dimensions of the issue. Moreover, for some buildings funds may have been set aside for some of the long-term maintenance costs. However, since no data are available on the existence of such funds, we have assumed that none exists, which reflects the situation in the vast majority of multi-ownership buildings.

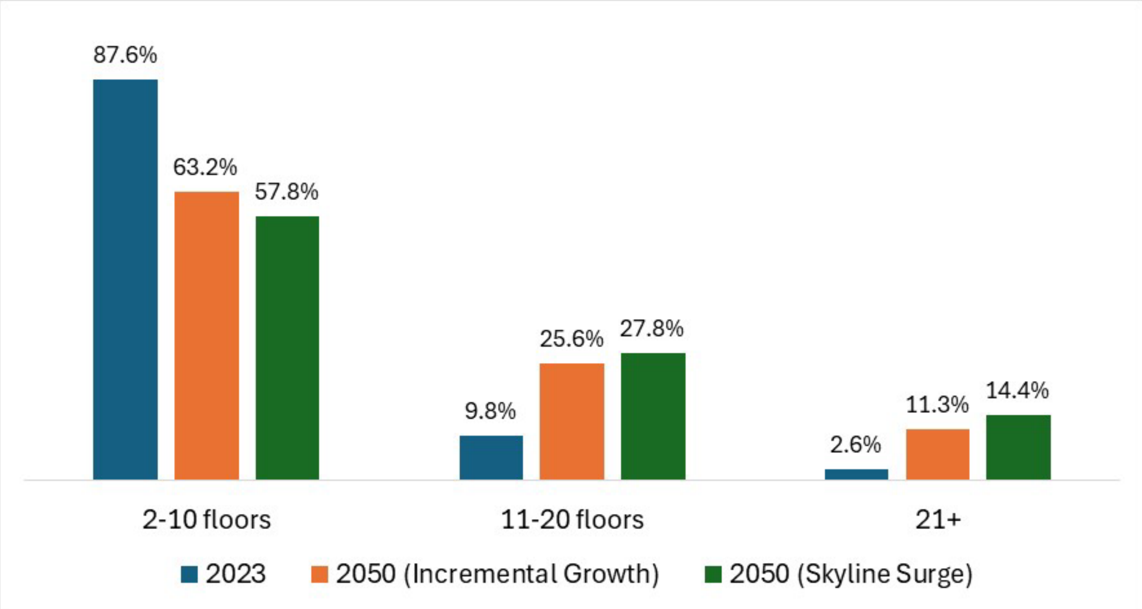
In conclusion, while this study provides a pioneering framework for quantifying long-term maintenance debt in Israel's multiple-ownership residential buildings, its findings should be interpreted with caution in light of these limitations. Future iterations of the model could address these gaps by integrating more granular data, relaxing key assumptions, and incorporating qualitative insights to enhance its robustness and relevance for policymakers and stakeholders.

4.Research Findings

This chapter presents the results of numerical simulations assessing the long-term maintenance debt of both existing and future housing stock. The simulation framework is based on the Depth of the Pit Model, which provides an analytical foundation for estimating the accumulated maintenance debt of multiple-ownership buildings of Jewish households. In the future housing stock model, projections for a given target year incorporate various scenarios related to population growth, shifts in vertical development, and urban renewal assumptions. By adjusting these parameters individually, the model facilitates a structured analysis of each factor's contribution to overall long-term maintenance debt.

Figure 5 illustrates both the current (2023) and projected (2050) distribution of Jewish households by building height. For these two simulations, the assumptions include (as constant parameters) an average household size of 3.1, the CBS medium population growth projection, and an inclusion of an urban renewal assumption as described in Section 3.2. As shown in the figure, as of 2023, the vast majority of Jewish households (87.6%) reside in buildings with 2–10 floors, while only 9.8% live in mid-rise buildings (11–20 floors), and only 2.6% occupy high-rise towers (21+ floors). By 2050, a significant shift in residential patterns is expected. Under the Incremental Growth scenario, the proportion of households in low- to mid-rise buildings (2–10 floors) is projected to decline to 63.2%, while those residing in mid-rise buildings (11–20 floors) will increase to approximately 26%. Additionally, the share of households in high-rise towers (21+ floors) is forecasted to quadruple, reaching about 11 %. In the Skyline Surge scenario, which assumes more intensive densification policies, predicts an even more pronounced transformation. The proportion of households in low-rise buildings (2–10 floors) is expected to decrease further to 58%, while mid-rise residences (11–20 floors) will rise slightly to about 28%. Notably, high-rise buildings (21+ floors) will accommodate approximately 14% of households.

Figure 5: Distribution of households by building height



Our approach estimates the total current debt in 2023 at 57.6 billion NIS. Figure 6 and Figure 7 illustrate the distribution of the current long-term maintenance debt accumulated up to the year 2023, parsed by building height and building age, respectively. As can be seen from these two figures, there is a clear concentration of maintenance debt in low-rise buildings (2-4 floors) at 31.1 billion NIS and mid-rise buildings (5-10 floors) at 20.7 billion NIS (Figure 6), while buildings older than 25 years account for the largest share at 40.2 billion NIS (Figure 7). The current debt burden decreases substantially as building height increases, with all high-rise categories (11+ floors) collectively accounting for only 5.8 billion NIS. Similarly, newer buildings show significantly lower maintenance debt, with buildings 13 years or newer representing just 2.2 billion NIS of the total, as they have not accumulated their total long-term, 25-year, maintenance debt. As we will later see in our numerical simulations, the debt of newer and taller buildings is projected to substantially rise as these buildings age and as we move deeper in the building maintenance cycle. This anticipated shift suggests that the current distribution, while heavily tilted toward older and lower buildings, represents only a snapshot of a dynamic system where maintenance debt will progressively accumulate across the entire housing stock as the building lifecycle advances.

Figure 6: Long-term current housing stock maintenance debt parsed building height (Billions of NIS)

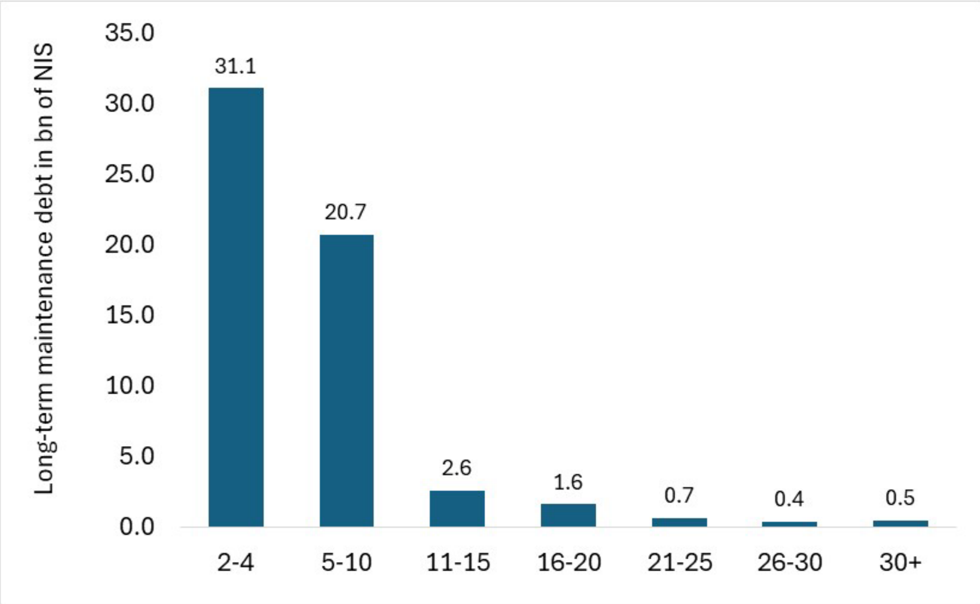


Figure 7: Long-term current housing stock maintenance debt parsed by building age (Billions of NIS)

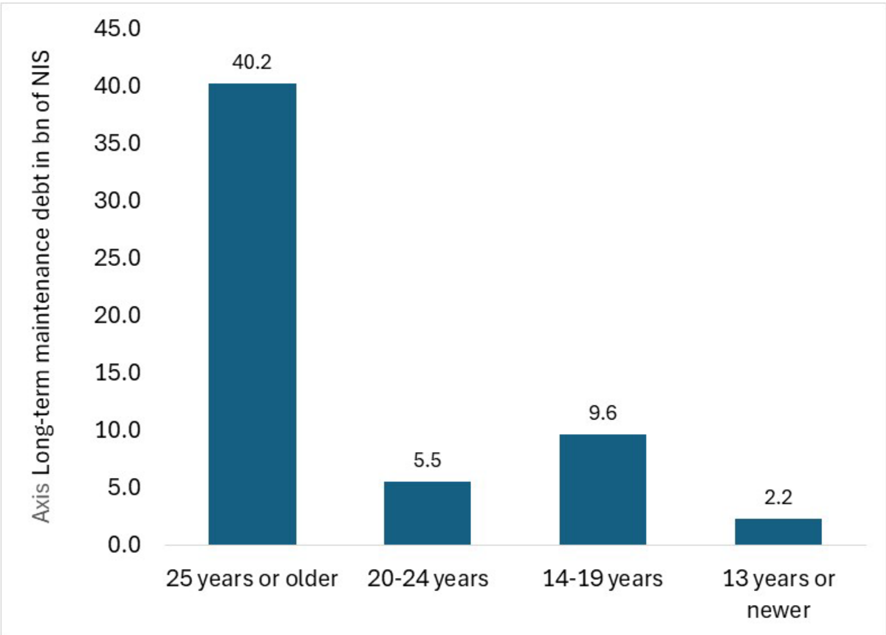


Figure 8 describes the distribution of current long-term maintenance debt (in billion NIS) across Israel's socio-economic clusters, as classified by the Israeli Central Bureau of Statistics (CBS). The data show that debt is heavily concentrated in mid-range clusters, particularly clusters 5, 7, and 8, which together account for the majority of the total debt. In contrast, clusters at the socio-economic extremes (clusters 1, 3, and 10) exhibit relatively low levels of debt. Cluster 2, with a total debt of 6.5 billion NIS, is of particular interest. This cluster predominantly comprises ultra-Orthodox municipalities as Jerusalem, Bnei Brak, Beitar Illit, Modi'in Illit, Elad, Beit Shemesh, Tzfat, Immanuel and Rechasim. Although the building stock in these cities is largely composed of low-rise structures—reducing the engineering risks associated with deferred maintenance—the limited economic resources and low income levels typical of these communities suggest a very low likelihood of sufficient long-term maintenance funding. As a result, progressive deterioration of the built environment is likely over time, even in the absence of high-rise structures.

Figure 8: Current Long-Term Maintenance Debt (Bn NIS) parsed by Socio-Economic Cluster of Municipalities

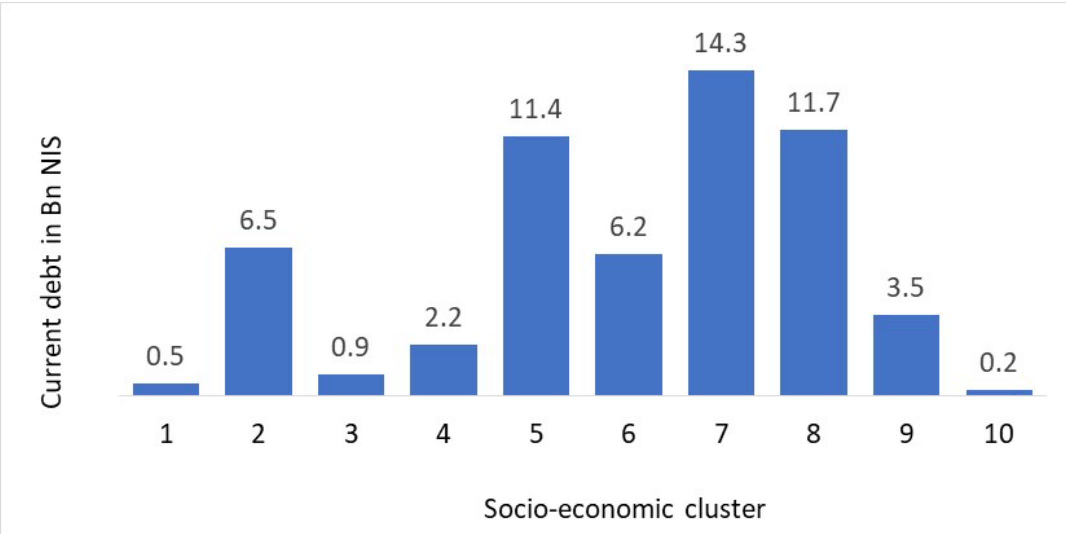


Figure 9 presents a projection of the total long-term maintenance debt for the years 2050 and 2075. The 2075 forecast excludes residential units constructed after 2050 while incorporating the interest accumulated over the period 2051-2075 for buildings constructed in the period 2026-2050. The inclusion of 2075 in the analysis is warranted, as it coincides with the completion of the 25-year maintenance cycle for structures built between 2026 and 2050, thereby fully capturing their upkeep costs. As illustrated in the figure, the maintenance debt in 2050 is projected to reach 125 billion NIS under the low population forecast, 136 billion NIS under the medium forecast, and 141 billion NIS under the high forecast. By 2075, these figures escalate to 219 billion NIS, 255 billion NIS, and 268 billion NIS, respectively. This increase is attributable to the time value of money (1.7% annual inflation assumption) and the incorporation of the complete maintenance cycle by this target year. Similarly, the incremental growth scenario estimates a debt of 136 billion NIS in 2050, rising to 255 billion NIS in 2075, while the Skyline Surge scenario projects 137 billion NIS in 2050, increasing to 258 billion NIS in 2075.

Figure 9: Total household long-term maintenance debt in 2050 and 2075 (Billions of NIS)

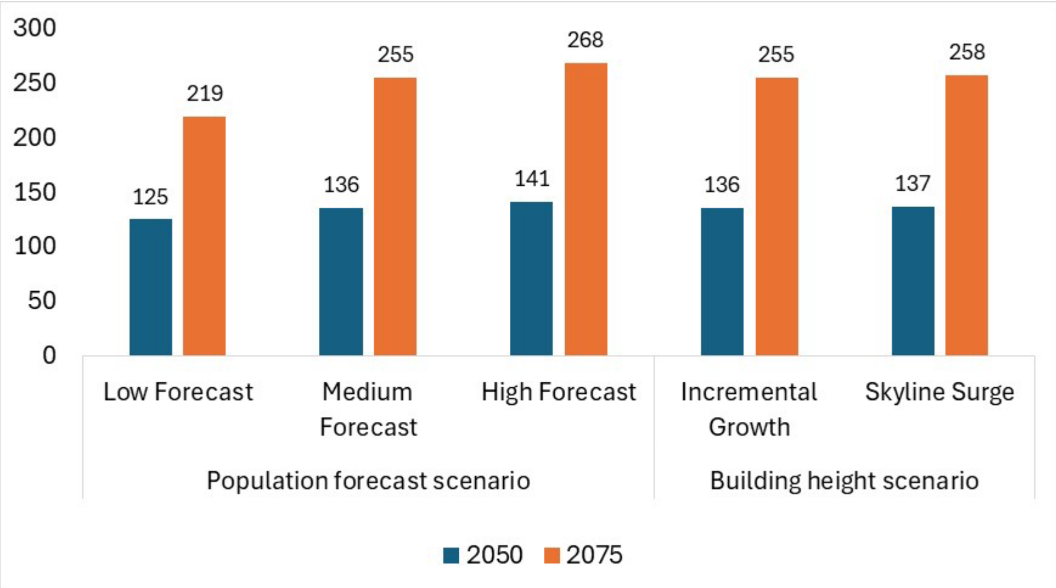


Figure 10 and Figure 11 present the total household long-term maintenance debt categorized by population scenarios. For the sake of clearer and more interpretable presentation, we grouped building heights into three categories—short to medium-rise (2–10 floors), medium to high-rise (11–20 floors), and 'skyscrapers' (21+ floors)—when displaying the results in these figures and those that follow. This grouping was applied solely for the presentation of results and not the underlying calculations, in order to reduce segmentation and minimize complexity in the analysis.

Figure 10 illustrates both the current debt and projections for 2050 and 2075, in billions of NIS across different population forecast scenarios. Currently, the debt totals 57.5 billion NIS, with projections for 2050 reaching 120.3 billion NIS, 130.3 billion NIS, and 135.5 billion NIS under the Low, Medium, and High Forecast scenarios, respectively. By 2075, these amounts increase to 208.6 billion NIS, 241.4 billion NIS, and 253.1 billion NIS, respectively.

Figure 10: Total household long-term maintenance debt parsed by population scenario (Billions of NIS)

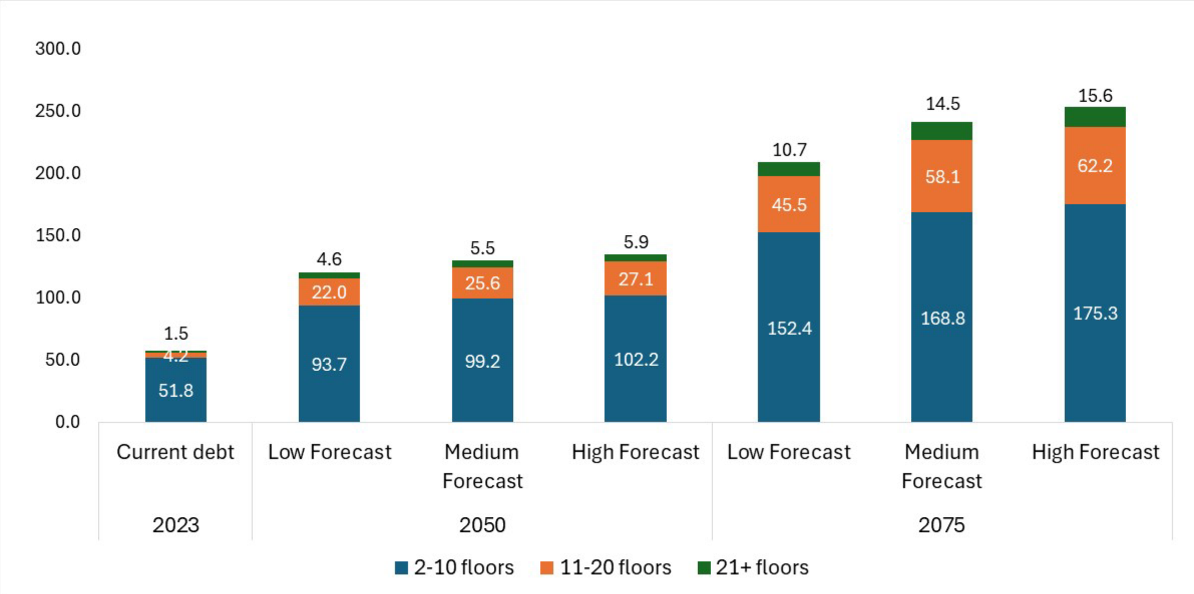


Figure 11 illustrates the evolving distribution of household maintenance debt across building height categories—2-10 floors, 11-20 floors, and 21+ floors—from 2023 to 2075, revealing a significant shift in debt allocation over time. In 2023, the debt is predominantly concentrated in lower-rise buildings, with 2-10 floor structures accounting for 90% of the total, while 11-20 floor and 21+ floor buildings contribute only 7% and 3%, respectively. However, under the medium population forecast scenario, by 2050, the share of debt attributed to 2-10 floor buildings decreases to 76%, while the proportions for 11-20 floor and 21+ floor buildings rise to 20% and 4%, respectively. This trend continues by 2075, with the debt share for 2-10 floor buildings declining further to 70%, and the shares for 11-20 floor and 21+ floor buildings increasing to 24% and 6%, respectively. This redistribution is driven by several key factors: urban development trends favoring taller buildings and slightly higher maintenance costs for taller structures.

Figure 11: Distribution of household long-term maintenance debt parsed by population scenario

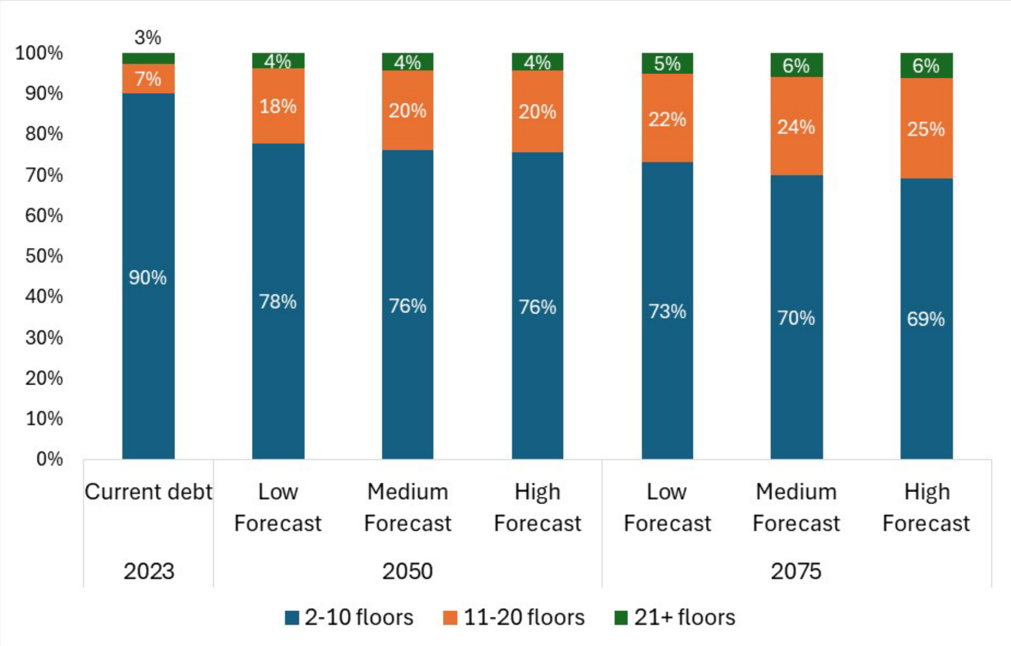


Figure 12 and Figure 13 present the long-term maintenance debt, categorized by building height scenarios. As shown in Figure 11, the total maintenance debt increases from 57.5 billion NIS in 2023 to approximately 136–137 billion NIS in 2050 and 255–258 billion NIS in 2075, with only a slight variation between the incremental growth and skyline surge scenarios. This outcome is primarily driven by the relatively small differences in long-term maintenance costs per household across most building heights, with a significant increase observed only in very tall structures (see Table 6). However, when analyzing the proportional growth in total maintenance debt by building height, it becomes evident that in the skyline surge scenario, the total debt for buildings 21+ floors tall is projected to increase by 786% in 2050 and by 2,287% in 2075 as compared to the current debt (rising from 1.5 billion NIS in 2023 to 13.3 billion NIS in 2050 and 35.8 billion NIS in 2075). The significance of the findings with respect to taller buildings is that their debt cannot be further “recycled” by urban renewal schemes, as tall buildings are nearly impossible to demolish; developers cannot profitably reconstruct them without building considerably taller structures. Furthermore, due to the presence of costly engineering systems in these buildings, the “debt” is not only higher in absolute terms but also more rigid, as essential infrastructure requires continuous, specialized upkeep that cannot be deferred without compromising the building’s functionality and safety. The increasing burden of long-term maintenance debt in taller buildings is further highlighted in Figure 13. While buildings of 2–10 floors currently account for 90% of total maintenance debt, their share declines to 71%–73% in 2050 and 62%–66% in 2075. In contrast, the debt share of buildings 21+ floors rises from just 3% in 2023 to 8%–10% in 2050 and 11%–14% in 2075.

Figure 12: Total household long-term maintenance debt parsed by building height scenario (Billions of NIS)

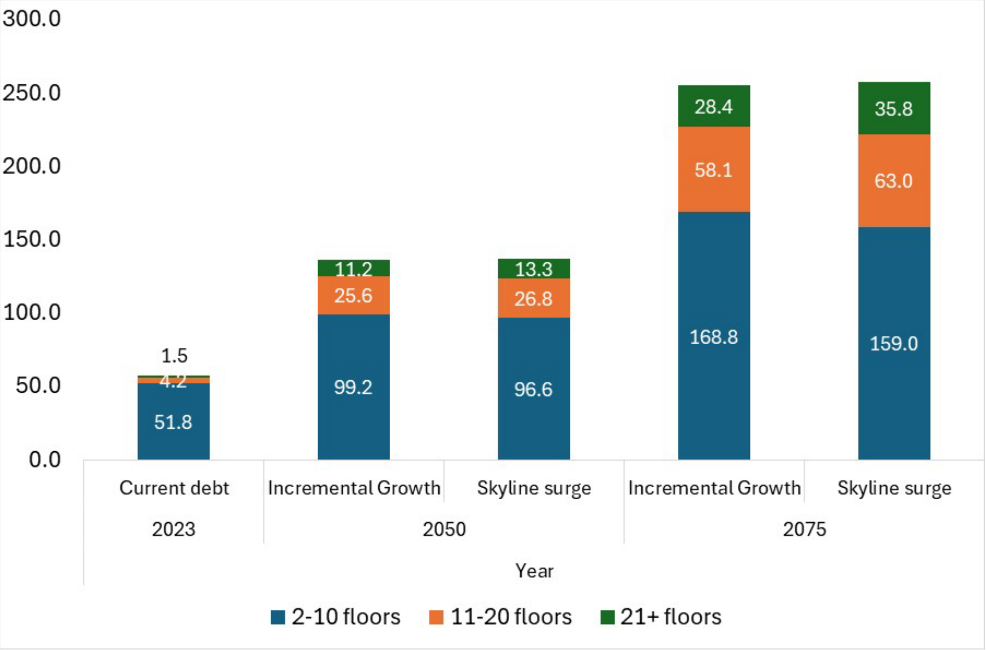
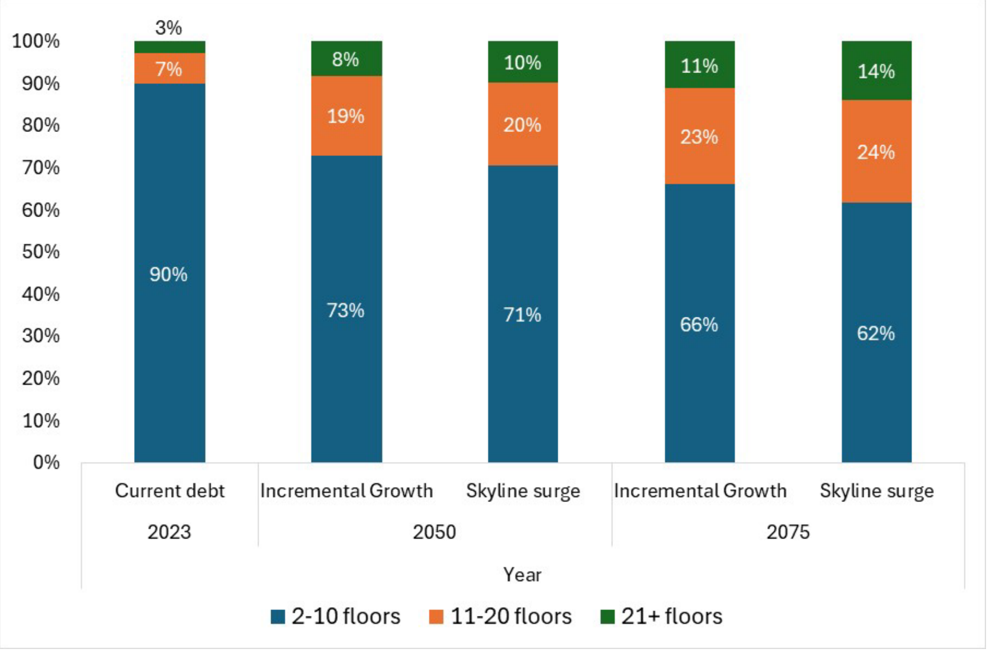


Figure 13: Distribution of household long-term maintenance debt parsed by building height scenario



To further contextualize the long-term maintenance challenge and explore potential solutions, we conducted an additional simulation comparing accumulated maintenance debt against hypothetical fund accumulation scenarios. These simulations address a possible policy of establishing investment funds dedicated to long-term maintenance of residential buildings. While such funds are relatively rare globally, and their implementation raises complex questions about accumulation, investment strategies, and distribution mechanisms, our analysis provides an illustrative projection of their potential effectiveness if implemented in Israel.

For this analysis, we maintained the 1.7% annual inflation rate used in previous simulations, while introducing two investment scenarios with different risk profiles[3]:

- **Low-risk investment strategy**: Based on the geometric average return of U.S. Treasury 10-year bonds from 2004-2024, yielding a nominal interest rate of 2.54% annually (approximately 0.8% real interest after accounting for inflation).
- **Medium-risk investment strategy**: Based on the geometric average return of BAA corporate bonds from 2004-2024, yielding a nominal interest rate of 5.25% annually (approximately 3.55% real interest after inflation).

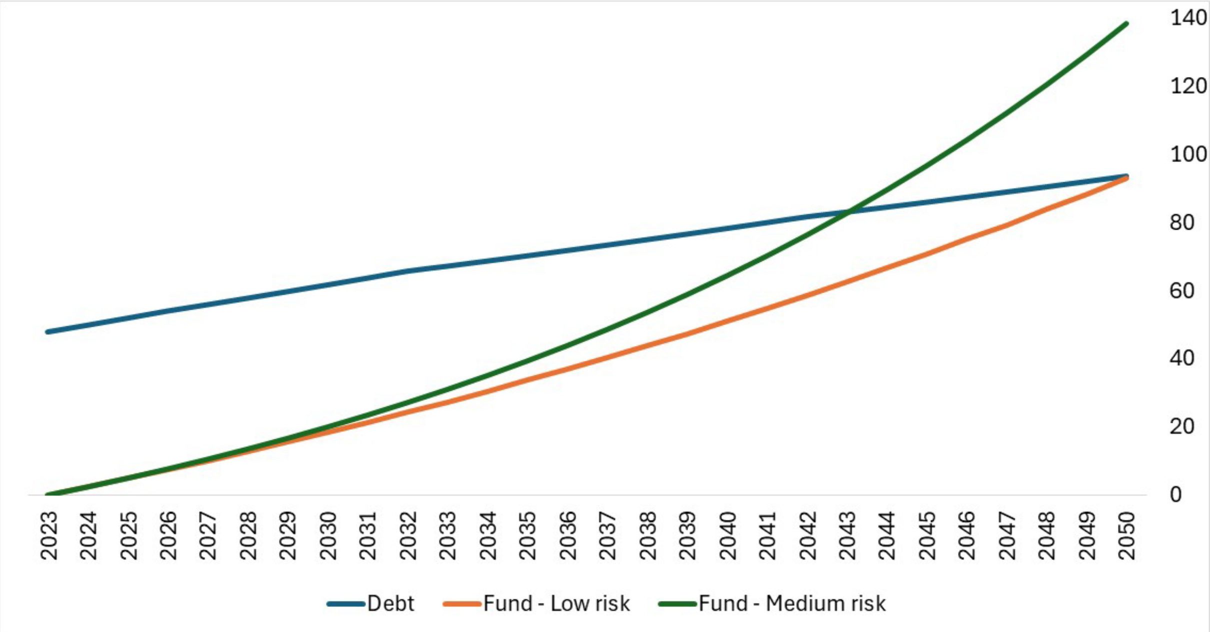
We present two simulations: the first for the built stock and the second for the future stock. In regards to the built stock, we assume that all maintenance debt accumulated by 2023 remains as "pure debt," as it would be unrealistic to expect households to invest large sums to address existing deterioration retroactively. Next, we assume that buildings begin accumulating funds starting from 2023 for 25 years. For future housing stock, the simulation calculates potential fund accumulation from their construction date onward.

Figure 14 provides a temporal perspective on fund accumulation versus debt accumulation specifically for the existing built housing stock from 2023 to 2050. As illustrated in the graph, the maintenance debt (blue line) grows steadily but at a decreasing rate, reflecting the

[3] The data for average returns was calculated using financial market information compiled by Professor Damodaran of New York University ("Historical Returns on Stocks, Bonds and Bills: 1928-2024").

assumption that no new debt is accumulated for previously 'paid' maintenance, while additional months of maintenance become due as time progresses. By 2050, the maintenance debt reaches approximately 95 billion NIS for the existing housing stock.

Figure 14: Projected Fund Accumulation vs. Maintenance Debt for Built Housing Stock (2023–2050), in future nominal value (Bn NIS)



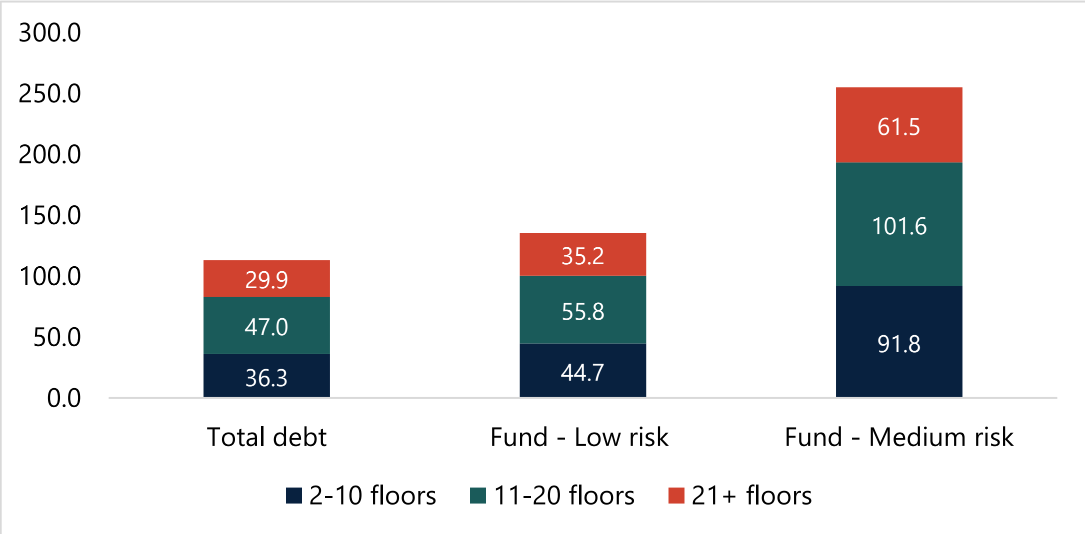
In contrast, the fund accumulation scenarios show markedly different patterns. The low-risk investment strategy using U.S. Treasury bonds (orange line) initially grows more slowly than the debt, creating a widening gap until approximately 2031. After this point, the fund's growth begins to accelerate due to compounding returns, narrowing the gap with the debt line and ultimately reaching about 90 billion NIS by 2050—nearly matching the accumulated debt despite the initial disadvantage.

The medium-risk investment strategy using corporate bonds (green line) initially follows a similar trajectory to the low-risk fund, until about 2028. At this point it experiences significantly accelerated growth due to the higher compounding rate (5.25% annually). Around 2043, this fund surpasses the accumulated debt amount and continues to widen the positive gap, reaching approximately 140 billion NIS by 2050—exceeding the maintenance debt by nearly 50%.

This temporal analysis highlights that even for the existing housing stock, establishing properly managed maintenance funds now could substantially address future maintenance funding gaps, particularly when employing moderate-risk investment strategies that capitalize on the power of compounding returns over time.

Figure 15 focuses exclusively on future housing stock (buildings constructed after 2023), providing a clear comparative snapshot of accumulated debt versus potential fund accumulation by 2075 under both investment scenarios.

Figure 15: Debt and Fund accumulation simulations, 2075, skyline surge, medium population growth



By 2075, the total maintenance debt for the future housing stock is projected to reach approximately 113.3 billion NIS. However, the low-risk investment strategy would accumulate approximately 133.2 billion NIS—exceeding the projected maintenance needs by about 18%. This indicates that even conservative investment approaches can fully address maintenance requirements when implemented from the outset of a building's lifecycle.

The medium-risk investment strategy demonstrates dramatically stronger results, with total fund accumulation reaching 254.5 billion NIS—more than doubling (225%) the projected maintenance debt. This substantial surplus could serve multiple beneficial purposes, including addressing unexpected building issues, funding additional improvements beyond basic maintenance, reducing monthly fees for residents, or providing a buffer against market volatility.

5.Discussion, conclusions and policy recommendations

The analysis of long-term maintenance debt for multiple-ownership residential buildings in Israel, utilizing the "Depth of the Pit" model, unveils an escalating financial challenge that necessitates immediate consideration. As of 2023, the current debt is calculated at 57.6 billion NIS, with projections indicating a rise to 136–137 billion NIS by 2050 and 255–258 billion NIS by 2075, contingent upon population growth and urban development trajectories. The debt for the existing housing stock is heavily concentrated in older, low to mid-rise buildings (2–10 floors). However, simulations of the future stock, spanning a 25-year horizon, reveal a substantial shift toward debt accumulated by high-rise structures (21+ floors), a shift as a result of the current policy of urban densification. While the differences in monthly per-household maintenance costs are relatively limited across buildings of different heights, the implications of deferring long-term maintenance for higher structures are likely to be much more severe. These findings both corroborate and extend prior scholarship. Alterman's (2010) identification of long-term maintenance as a persistent yet neglected issue in multi-owned buildings finds empirical support here, as does Paz's (2017) emphasis on the intensified upkeep requirements of high-rise structures. The potential for deferred maintenance to inflate costs exponentially, as noted by Kwon et al. (2020), parallels this study's projections.

The size of the current long-term maintenance debt roughly equals to 20% of Israel's household mortgage debt (516 billion NIS), underscoring the scope of the challenge. Unlike mortgages, which are subject to lender scrutiny and are backed by the (often increasing) value of real estate—maintenance debt often emerges unforeseen, amplifying economic strain on households already contending with escalating mortgage obligations. The projected increase in high-rise debt, particularly under the Skyline Surge scenario, underscores a critical challenge, as tall buildings are virtually impossible to replace through a demolish-and-rebuilt strategy.

Policy Recommendations

Israel faces an increasingly rigid and underfunded long-term maintenance burden in its residential sector. Without targeted interventions, the accumulated maintenance debt—already substantial—will continue to grow, threatening both housing quality and urban resilience. The empirical analysis conducted in this study, comparing projected debt with fund accumulation under different investment approaches highlights the potential effectiveness of structured, forward-looking policies. Accordingly, we propose the following multi-pronged policy measures:

1. Mandate Long-Term Maintenance Funds (LTMFs) for New Residential Developments

Introduce a legal requirement to establish dedicated Long-Term Maintenance Funds for all new high-rise buildings. These funds should be:

- Seeded at the time of construction.
- Professionally managed with regulated investment strategies.

Well-managed funds following even conservative investment strategies can accumulate sufficient reserves to cover long-term maintenance needs. More ambitious investment approaches can generate substantial surpluses, supporting affordability and resilience.

2. Introduce Tiered Incentives for Voluntary Early Adoption

Provide financial or regulatory incentives (e.g., tax credits, increased floor-area ratio, or expedited permitting) to developers or homeowner associations that voluntarily adopt LTMFs or professional maintenance management systems before legal mandates are fully enacted.

3. Establish a Public Maintenance Fund for At-Risk Populations

Create a government-backed emergency reserve to support long-term maintenance in vulnerable communities—particularly low-income populations—who may be unable to meet high maintenance costs. This fund would offer conditional grants or no-interest loans for critical repairs and system replacements.

4. Integrate Long-Term Maintenance Fund (LTMF) Contributions into Mortgage Financing or Municipal Taxation

Allow long-term maintenance fund contributions to be embedded within the mortgage structure or collected through the municipal property tax (Arnona). This integration would transition the burden from irregular, uncertain homeowner fees to a stable and pre-funded financial mechanism. While this approach may increase the upfront cost of homeownership, it enhances long-term affordability by ensuring predictable funding and the availability of resources when major repairs or replacements are needed.

5. Launch Public Awareness Campaigns on Maintenance Responsibility

Educate homeowners, tenants, and associations about the importance of long-term maintenance and the financial mechanisms that support it. Many delays in maintenance arise from underestimation of risks or confusion over legal responsibilities. A national communication effort could improve compliance and reduce resistance to necessary fees or reserve fund contributions.

5. Promote High-Density, Mid-Rise Urban Development

Encourage more maintainable urban forms by promoting horizontal, mid-rise (4–8 story) developments. These layouts, common in several European countries, simplify engineering and maintenance while preserving land efficiency. Such forms can reduce future maintenance liabilities while supporting livable, dense neighborhoods.

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Appendices

building height distributions

year	Time period	No. floors	Uniform	incremental	Skyline surge
1	2024-2031	1-2 (Single)	17%	17%	17%
2	2024-2031	2-4	10%	10%	10%
3	2024-2031	5-10	41%	41%	41%
4	2024-2031	11-15	13%	13%	13%
5	2024-2031	16-20	10%	10%	10%
6	2024-2031	21-25	5%	5%	5%
7	2024-2031	26-30	2%	2%	2%
8	2024-2031	30+	2%	2%	2%
9	2032-2038	1-2 (Single)	17%	15%	12%
10	2032-2038	2-4	10%	8%	6%
11	2032-2038	5-10	41%	36%	28%
12	2032-2038	11-15	13%	16%	18%
13	2032-2038	16-20	10%	13%	16%
14	2032-2038	21-25	5%	7%	10%
15	2032-2038	26-30	2%	3%	5%
16	2032-2038	30+	2%	2%	5%
17	2039-2044	1-2 (Single)	17%	11%	8%
18	2039-2044	2-4	10%	7%	6%
19	2039-2044	5-10	41%	31%	24%
20	2039-2044	11-15	13%	18%	20%
21	2039-2044	16-20	10%	16%	19%
22	2039-2044	21-25	5%	9%	11%
23	2039-2044	26-30	2%	4%	6%
24	2039-2044	30+	2%	4%	6%
25	2045-2050	1-2 (Single)	17%	8%	5%
26	2045-2050	2-4	10%	7%	4%
27	2045-2050	5-10	41%	26%	20%
28	2045-2050	11-15	13%	19%	21%
29	2045-2050	16-20	10%	18%	22%
30	2045-2050	21-25	5%	10%	13%
31	2045-2050	26-30	2%	7%	8%
32	2045-2050	30+	2%	5%	7%

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