# Evaluation of Housing, Parking and Mobility Measures in Gothenburg

## Analysis of Building Permit Data

Master's thesis in Sustainable Energy Systems

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CHALMERS UNIVERSITY OF TECHNOLOGY
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## Abstract
Parking policy is increasingly used as a planning tool to reduce car dependency and support more sustainable mobility in cities. In Gothenburg, residential developments can reduce their parking requirements through a step-by-step parking investigation process, where location, accessibility, housing characteristics, and mobility agreements are considered. This thesis examines how this process is applied in residential building permits approved in Gothenburg between 2021 and 2025.

The results show that parking reductions are influenced by the combined effect of all reduction steps. Accessibility-related reductions and project adaptation measures contribute significantly to the final parking supply, while mobility agreements provide additional reductions (the highest between steps) through the implementation of mobility measures. The analysis further shows that the contribution of each reduction step varies across geographical zones, differences in accessibility, urban density, and housing conditions. The study also identifies clear geographical patterns in the implementation of parking reductions and mobility agreements. More central and accessible zones generally achieve larger parking reductions per flat, while outer zones tend to show lower reductions overall. In addition, mobility agreements are more common in larger housing projects and are most frequently combined with both base and star packages. Among the implemented mobility measures, some low and high effort measures appear more frequently than others.

Overall, the findings suggest that Gothenburg's parking investigation process functions as a flexible planning tool that combines accessibility conditions, housing characteristics, and mobility measures to adapt parking supply to different urban contexts. At the same time, the results highlight variations in how reductions and mobility agreements are implemented across projects and zones, emphasizing the importance of continued evaluation of how these planning tools contribute to sustainable urban mobility in practice.

Keywords: Parking policy, building permits, parking reductions, accessibility, mobility agreements, low and high effort measures.

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Mohyieldean Elsafi

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# Contents

# List of Figures

# List of Tables

# 1 Introduction

According to the European Environment Agency [1], private car transport is one of the main contributors to environmental impact in urban areas, particularly through greenhouse gas emissions and air pollution. In response, many cities use parking policy as a planning tool by reducing minimum parking requirements and encouraging shared mobility solutions in residential developments to reduce car dependency and environmental impacts [2].

Gothenburg is one of the cities that has introduced policies and planning tools to encourage more sustainable mobility. Instead of focusing on just building parking spaces, new housing developments are allowed to reduce parking requirements by including bicycle facilities, car sharing options, and other mobility services. These strategies aim to reduce car ownership and make alternative transport modes more attractive[3] .This approach reflects a broader shift in urban planning where parking regulations are used as an active sustainability instrument rather than a purely technical requirement: by linking reduced parking provision to mobility measures, the municipality encourages developers to integrate sustainable transport solutions directly into residential projects which could influence transport behaviors and contribute to long term reductions in car dependency. In recent years, this shift has received increasing attention in planning practice and research, as parking provision is no longer treated simply as a response to high levels of car ownership, but also as a policy instrument that can influence mobility behavior and support broader sustainability goals. However, questions remain about how such policies are implemented in practice, how consistent reductions are applied, and what role different mobility measures play in achieving intended outcomes. This makes evaluating practical implementation an important part of understanding the effectiveness of such planning tools.

By analyzing building permits data and mobility requirements in Gothenburg, this project aims to understand how parking numbers are determined, how reductions are applied, and what types of mobility measures are implemented in practice. In addition, the study examines trends over time to assess how parking policies have evolved and how consistently these measures are implemented; which allows for an evaluation of whether policy intentions are effectively translated into practical outcomes in residential developments. Gothenburg's parking reduction process and policy framework are described in more detail in the background chapter.

In addition, this study contributes to the ongoing discussion on sustainable urban planning by providing a systematic and data-driven analysis of how parking policies are implemented in practice. While previous research has focused primarily on the outcomes of mobility agreements [3,4] this thesis broadens the perspective by examining the entire reduction process, including accessibility factors and housing characteristics. By doing so, the study aims to offer a more comprehensive understanding of how these deferent elements work together and how they can help reduce car dependency in residential areas. A particular contribution of the study is therefore that it does not solely focus on mobility agreements as an isolated measure but evaluates how several reduction steps together shape the final parking supply in residential areas.

This broader perspective is relevant because much of the discussion around reduced parking provision has focused on specific mobility measures, while less attention has been paid to how earlier reduction steps, such as accessibility and housing characteristics, affect outcomes and interact with later measures. By analyzing this entire process through building permit data, the thesis aims to contribute both empirical insights and a stronger basis for evaluating how these planning instruments work in practice.

## 1.1 Purpose

The purpose of this project is to analyze how parking requirements and mobility measures are applied in housing projects in Gothenburg by examining building permit data. The aim is to understand the relationship between initial parking numbers, applied reductions, and the types of mobility solutions included in approved projects. Moreover, the project analyses trends over time in the use of mobility agreements and examines whether the application of parking reductions and mobility measures varies between different geographical areas of the city. This allows for an assessment of how consistent parking policies are implemented in Gothenburg.

Rather than focusing on a single area or a case study, the intention is to review many housing developments to identify patterns in how parking reductions are granted and which mobility measures are most frequently implemented. The study will mainly rely on data from official permit documents for the period 2021-2025 to conduct a comparative and data-driven analysis.

This project is being carried out within the framework of a collaboration between Chalmers University of Technology, the City of Gothenburg, Poseidon and Framtiden AB, with the intention to provide a clearer overview of how parking reduction strategies and mobility measures are currently used and how they are related in Gothenburg's housing developments and how consistently these tools are applied across projects.

## 1.2 Aim

Building on the previous studies that will be mentioned in the background section, this thesis aims to provide a more comprehensive analysis of Gothenburg's parking policies by studying how the different reduction steps affect the parking supply in multi-family buildings for permits approved between 2021 and 2025. This shall be achieved by analyzing building permits, which include the parking investigation reports and mobility agreements. The study aims to deepen the understanding of how parking reductions are implemented in practice and how mobility measures interact with accessibility conditions and housing characteristics within the planning process.

The GotPark project shows that buildings with mobility agreements generally offer about 25% fewer parking spaces than similar projects without such agreements. Residents of these buildings tend to own fewer cars, use them less frequently, and rely more on public transportation. At the same time, while many projects offered additional mobility services such as car and bike sharing and public transport passes, these services were not always widely used. This suggests that the availability of parking spaces may play a larger role in shaping mobility behavior than the individual mobility services themselves [3]. By looking at these two different approaches, this thesis explores whether we are actually making cities more sustainable through where we build things or through the extra advantages we provide, helping us understand which strategy really works in the long run.

## 1.3 Research questions

This thesis will aim to answer the following questions:

- How does the mobility and parking investigation process influence parking requirements and final parking supply in multi-family housing projects in Gothenburg?
- How are parking reductions distributed across different steps of the investigation process, and which steps contribute most to the total reduction?
- How do parking reductions and the implementation of mobility agreements vary across different geographical zones in Gothenburg?
- What patterns can be observed in the use of mobility agreements across projects and over time (2021–2025)?
- What are the most implemented measures across the permits studied?

## 1.4 Scope

This study is limited to the analysis of residential building permits in the City of Gothenburg and does not aim to be representative of all municipalities in Sweden. Due to time constraints, we have focused on covering the permits of the period 2021–2025. The results therefore reflect current planning practice rather than long-term historical trends.

The research focuses primarily on documented planning data such as parking requirements, applied reductions, mobility measures and apartment characteristics. The study does not include direct surveys or interviews with residents and therefore does not evaluate actual travel behavior, user satisfaction or the real use of mobility services. Instead, the emphasis is on how policies are formulated and implemented in official planning documents.

Another limitation is related to language and interpretation, as the permits documents are in Swedish. Although attention was taken to ensure correct translation and understanding, minor differences in interpretation may have arisen when extracting information into the excel dataset. To reduce the risk of misinterpretation, the permits were carefully reviewed, and key terms were translated consistently throughout the process.

Moreover, the availability and clarity of information within each permit varies, as housing projects are prepared by different developers and companies, and use different documentation styles and levels of detail. Some may include extensive mobility descriptions while others provide more limited information, which may affect the degree of comparability between projects.

Finally, the project also does not aim to perform financial or economic evaluations, such as construction costs, parking prices or profitability analyses. The focus remains on planning decisions rather than economic outcomes.

# 2 Background

## 2.1 Parking Policy and Urban Transport Planning

Parking policy has become a crucial tool in urban transport planning. Traditionally, parking requirements were designed primarily to ensure that each new building had enough parking spaces to accommodate all the vehicles it might attract. For decades, city officials and traffic engineers operated on the assumption that vehicle ownership and use will continue to grow indefinitely. Because of this, their main planning focus was to protect public roads from excessive parking, preventing residential streets from becoming congested with cars searching for parking. This perspective viewed parking spaces as a basic public infrastructure: a necessity that results from increasing demands, rather than an active tool that could change how people choose to travel [5].

However, current research and planning practices recognize that parking not only responds to car use but also actively shapes it [5]. This means that the decisions urban planners make regarding the size, location, and overall design of parking facilities have a considerable impact on households' decisions to buy a car, how they move around the city, and the sustainability of the entire transportation system. By choosing to expand or restrict the physical spaces allocated to cars, urban planners influence the dynamics of daily commutes [6]. When a city prioritizes convenient vehicle parking at both the beginning and end of every trip, it encourages the citizens to drive [7]. This approach quietly undermines public investments in rail networks, bus systems, and bicycle lanes.

Many cities today face serious problems resulting from their heavy reliance on cars. These problems include daily traffic congestion, poor air quality, increased greenhouse gas emissions, and inefficient land use [8]. The environmental costs of these trends are documented and known. For example, data collected by the European Environment Agency show that greenhouse gas emissions from the transport sector remain a major obstacle to achieving net-zero carbon emissions, highlighting the private cars to be the main driver of these urban emissions [9].

At the same time, urban density is increasing, leading to greater competition for space among parking, housing, public spaces, and green areas. Every square meter of land allocated to a parked car represents a direct loss of one square meter that could be used to build affordable housing, pedestrian walkways, or green infrastructure. As a result, parking policy is increasingly used as a strategic tool to support broader goals, such as reducing car use, improving accessibility, and promoting sustainable mobility [10].

Research indicates that parking availability plays a pivotal role in these processes [5]. Providing ample, convenient, and affordable parking facilities makes car ownership more attractive, while limiting parking may encourage residents to reconsider their mobility options and use alternative modes of transport such as public transportation, cycling, and walking [3]. When municipalities intentionally limit the supply of parking spaces or separate the cost of parking from the rent of the property, the true financial cost of owning and using a car becomes fully transparent to the citizens [11]. This transparency helps change personal habits, moving away from car dependency and toward shared and sustainable alternative transportation.

## 2.2 The Impact of Parking Availability on Car Ownership and Mobility Behavior

Empirical research demonstrates a clear relationship between parking availability and car ownership [5]. In a large-scale study from New York City, Guo found that households living in buildings with more off-street parking were more likely to own cars, even after adjusting for factors such as income, household size, and neighborhood characteristics [7]. By comparing similar (economically and socially) households located in dense urban neighborhoods with equivalent access to public transportation, the study demonstrated that the presence of residential parking spaces acts as a powerful motivator for car ownership. This shows that parking availability not only reflects existing demand but can also generate it [7].

Similar findings have been obtained in other densely populated urban contexts where good public transportation alternatives are available [6]. Reducing the number of residential parking spaces has been linked to decreased car ownership and increased use of sustainable transportation [12]. This suggests that parking standards can influence long-term mobility decisions, rather than simply accommodating current car use. When an individual or family chooses a new place to live, the physical layout of their residential building determines their daily commute behavior [6]. A home designed without an attached parking space affects the family's financial equation, making public transport passes and car-sharing subscriptions the practical and economical default options.

Parking availability also affects daily commute behavior [3]. When parking is plentiful and free or cheap, residents tend to use their cars for daily commutes. The mindset that comes from knowing a free, subsidized parking space awaits at the beginning and end of a journey reduces the natural thinking that would otherwise lead to considering alternative transportation options. On the other hand, when parking is limited, shared, or expensive, residents may adapt by reducing or foregoing their car use altogether. Residents shift their transportation habits toward active modes of travel or adjust their daily routines to accommodate public transportation schedules [10]. These effects are particularly clear in apartment complexes, where parking decisions influence long-term behavior [3].

The economic factors behind these decisions are directly linked to real estate development and local land use. The construction of off-street parking represents a considerable cost for residential development projects, especially when limited site dimensions force developers to build concrete parking buildings above ground or excavate deep underground parking garages. Strict municipal laws often restrict developers and force them to allocate a large portion of their budgets to vehicular infrastructure rather than living space [13].

These high construction costs are passed directly on to residents through increased rents or home purchase prices, regardless of whether they own a vehicle. This hidden cost negatively affects the local housing market. It forces carless households to financially support the parking spaces of their neighbors who own cars, reducing overall housing affordability and creating a structural dependence on cars throughout society [13].

## 2.3 From Minimum Parking Requirements to Flexible Parking Systems

For decades, urban planning has relied on minimum parking requirements, which stipulate a fixed number of spaces based on land use or building size. These standards were often based on assumptions of high car ownership and aim to prevent parking shortages. However, experience has shown that these standards often lead to an oversupply, especially in central, easily accessible urban areas [14].

An excess of parking spaces leads to increased construction costs, especially when parking is built in garages or underground. Since developers must recoup these large capital investments to maintain profitability, these high infrastructure costs are passed directly on to residents through higher monthly rents or higher home purchase prices [13]. Furthermore, this design actively reinforces car dependency by making vehicle parking a permanent and integrated part of residential housing. This integration makes the car an essential requirement even for low income or environmentally conscious households that might otherwise consider living without a car [7].

In response, many cities have moved toward more flexible parking systems, where requirements can be adjusted based on location, accessibility to public transport, and local conditions. Under these modern frameworks, parking space requirements can be dynamically adjusted based on the specific geographic location, the property's proximity to public transportation networks, and particular local conditions. Parking limits are sometimes applied in central areas, while alternative mobility measures are implemented to reduce reliance on private vehicles [11].

Integrating parking policies with mobility management strategies is a crucial element of this shift. These strategies include car-sharing programs, bicycle infrastructures and paths, public transport incentives, and mobility information services. Rather than focusing solely on providing parking spaces, these approaches aim to provide access to transportation without necessarily requiring private car ownership [4].

## 2.4 Types of Parking Reforms

In the past, cities required developers to build many parking spaces, or minimum number of parking spaces. Today, modern planning employs three main strategies to change this: eliminating parking minimums, reducing parking requirements for specific reasons, and establishing parking maximums [5].

### 2.4.1 Eliminating Parking Minimums

For a long time, municipal regulations required developers to build a certain number of parking spaces for every new building, without exception. This made car ownership easier and cheaper, but it took up valuable space. The most significant change a city can implement today is to eliminate these "parking minimums" [15].

When a city eliminates these regulations, it does not mean that parking is prohibited. Instead, it allows developers to decide how many parking spaces are truly necessary based on buyer needs and construction costs. Eliminating these strict regulations significantly reduces the cost of building new homes. Furthermore, it allows developers to build housing on small, historic, or densely populated urban plots where it would be physically impossible to accommodate a large parking garage [16].

### 2.4.2 Flexible Reduction of Parking Requirements

Another approach involves maintaining basic parking regulations but allowing developers to reduce the number of spaces if their project meets certain environmental conditions. Cities do not grant these discounts for every project; they are linked to the neighborhood and the building design. Gothenburg guidelines are a good example for this which will be discussed further in the coming paragraphs [11].

This strategy allows the cities to maintain control while rewarding the developers who provide sustainable mobility options [11].

### 2.4.3 Establishing maximum parking limits

While eliminating minimum limits removes the lower limit on parking, establishing maximum limits introduces a strict legal cap [5]. This means that a developer is legally prohibited from building more than a certain number of parking spaces, even if they have the capital and want to build them.

Cities use this tool in congested city centers and busy business districts to prevent too many cars from blocking the streets and causing traffic jams. Generally, the city is divided into different zones. In the city center, where the trains and buses are more, the maximum parking limit is very low. In the suburbs, the rules are much more relaxing. This overturns the old way of thinking: instead of viewing parking as something the city should provide, it views it as a source of traffic and pollution that must be strictly limited [9].

These three overall strategies demonstrate why Gothenburg's approach is so interesting. Rather than choosing just one of these ideas, Gothenburg combines elements of all three into a single, flexible system.

As explained in the city's official guidelines (Riktlinjer för mobilitet och parkering i Göteborgs Stad), Gothenburg divides the city into zones and sets strict parking limits which function as a minimum parking limit. At the same time, it allows property developers to obtain substantial discounts on the number of parking spaces they are required to build [11].

The most important aspect of Gothenburg's plan is that developers can only obtain these discounts if they actively invest in sustainable mobility options. By directly linking parking reductions to nearby public transport, local services, and shared mobility options, such as car-sharing and excellent cycling facilities, the city ensures that building fewer spaces is beneficial [11].

## 2.5 Gothenburg Parking Policy: Developments and Challenges

Gothenburg presents an interesting case study for examining how parking policies work in practice and how they influence community mobility. The city has experienced population growth, urban densification, and increasing pressure for public spaces, while simultaneously striving to reduce car dependency and improve environmental performance.

Gillmén and Gräsberg [17] describe how Gothenburg's parking standard, implemented in 2011, represented a shift from previous approaches that were primarily based on projections of increased car ownership. These 2011 regulations were directly aligned with the city's overall parking policy objectives, which aim to restrict the total number of parking spaces and manage existing ones through strategic planning and targeted regulations. Instead of continuing to build costly infrastructure for private cars, the 2011 framework represents parking as an active mechanism that could influence and encourage residents to use active and sustainable transport networks [17].

Their study also revealed a gap between policy intentions and actual outcomes. Case studies of residential buildings and kindergartens showed that the number of available parking spaces at development sites is often insufficient to meet demand, leading to congestion on adjacent streets. This finding partially contradicted the objectives of parking policy and highlighted the complexity of managing parking demand through planning alone, demonstrating the complexity of attempting to reduce vehicle demand solely through development regulations. Since the surrounding public streets often lacked coordinated parking fees or time restrictions, drivers simply avoid the limited parking available at the building itself by parking for free on nearby public streets. This spillover led to visible friction in the neighborhood, demonstrating that reducing parking at the building itself cannot be successful unless combined with strict enforcement of parking regulations throughout the surrounding areas [17].

The study further confirmed that parking demand varies depending on the type and location of the housing. For example, tenant-owned apartments tend to generate higher parking demand than rented housing, suggesting that standardized parking criteria may not adequately reflect local conditions [17].

## 2.6 Parking Zones and Accessibility in Gothenburg

Parking policy in Gothenburg is closely linked to accessibility. The city is divided into parking zones based on distance from the city center and ease of access to public transport. Zones with high accessibility are assigned with fewer parking requirements, based on the assumption that residents of these zones are less reliant on cars. This rule built on the logical planning assumption that residents living in these highly connected areas are usually less reliant on private cars for their daily travel needs. This zoning model connects real estate development requirements to municipal investments in public transportation networks [11].

Although this approach has a solid theoretical basis, previous research shows that simply reducing the number of parking spaces may not be enough to influence car ownership if alternative options remain available nearby. When residents can park on surrounding streets or in nearby facilities, car ownership may remain high despite a reduced number of available parking spaces on the site. When apartment residents can easily find alternative parking spots on surrounding public streets or in nearby commercial facilities, household car ownership remains high despite a restricted parking supply within their own residential building. This reality underscores how important it is for planners to evaluate how parking standards function in practice, paying close attention to how different policy tools interact with local neighborhood conditions. If a driving household can easily find a low-cost loophole to store their car nearby, the on-site residential reduction acts as a daily inconvenience rather than a meaningful tool to switch to public transit [17].

## 2.7 Implementation of Mobility and Parking Guidelines in Gothenburg (from 2018)

Since 2018, the City of Gothenburg has implemented a unified set of guidelines for mobility and parking planning, as outlined in Riktlinjer för mobilitet och parkering i Göteborgs Stad [11]. These guidelines represent a clear shift from traditional parking standards toward a system where the provision of parking spaces is directly linked to accessibility, urban context, and mobility measures. This system aims to support sustainable travel behaviors while ensuring easy access for residents, visitors, and services.

This system is designed to encourage sustainable travel habits while maintaining comfortable, reliable access for residents, visitors, and commercial delivery services. These guidelines are primarily used in planning new development projects and major reconstructions and are applied during the detailed development plan and building permit phases [11].

### 2.7.1 Parking Zones in Gothenburg

The division of Gothenburg into four parking zones, as shown in the zoning map below, is a key element of these guidelines. These zones are based on differences in urban structure, accessibility to public transport, and proximity to the city center [11].

- **Zone (A)** comprises the most central parts of Gothenburg, where public transport is readily available, but parking space is very limited.
- **Zone (B)** covers the inner areas surrounding the city center, characterized by abundant public transport and high population density.
- **Zone (C)** comprises the intermediate urban areas, which are relatively easily accessible but have diverse land uses.
- **Zone (D)** consists of the outer urban areas and suburbs, where distances are longer and reliance on cars is generally higher.

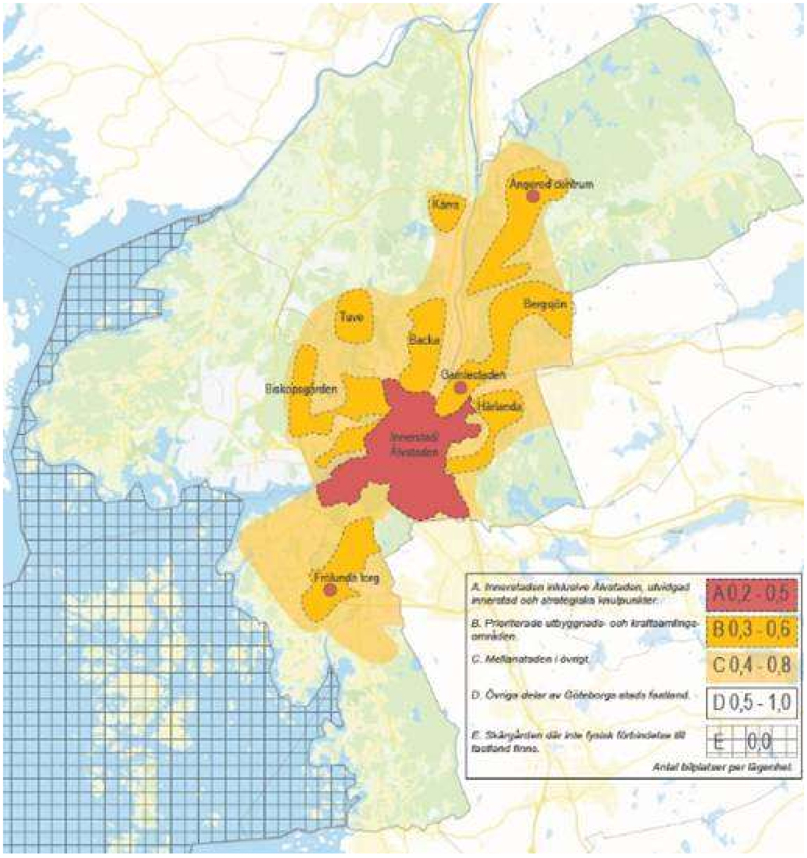


*Figure 1:Gothenburg Zoning map*

These guidelines assume that car ownership and parking demand decrease as accessibility and centralization increase. Therefore, lower parking requirements apply in zones (A) and (B), while higher requirements apply in zones (C) and (D) [11].

### 2.7.2 Step-by-Step Process for Determining Parking Requirements

These guidelines provide a detailed, step-by-step process for determining parking requirements. This process ensures a systematic assessment of parking availability and allows for structured and transparent reductions [11].

**Step 1: Initial Value Based on Zone and Building Type**

The process begins with initial parking requirements based on:

- Parking Zone (A-D),
- Development Type (e.g., Residential),

This initial value represents a traditional standard for parking availability in the given context and serves as a basis for further evaluation. See the table below for the apartment building where the P-norms are given as the number of parking spots per flats [11]:

Table 1: Step-1 P-norms for apartment buildings.

| Zone | A | B | C | D | E |
|---|---|---|---|---|---|
| Initial Value (Analysis step 1) | 0.5 | 0.6 | 0.8 | 1.0 | 0.0 |

### Step 2: Adjustments Based on Accessibility

In the next step, parking requirements can be adjusted based on "Situation Assessment" and "large district center" assessment. Both assessments are addressing the accessibility in the area where the building is located [11].

The situation assessment reduction could be granted when all the conditions below are available in the location [11]:

- Direct proximity to good public transport within 500 meters.
- Direct proximity to good cycling infrastructure, such as cycle paths or a dedicated cycle network.
- Availability of shopping, groceries, kindergartens, primary schools, health centers, dental clinics, and pharmacies within 500 meters.

The classification of a large district center refers to areas that function as local urban hubs, characterized by high service density, a good public transport network, restaurants and cultural places, and mixed land uses [11]. These areas offer excellent accessibility and support car-free daily activities and hence further reductions in parking requirements could be possible.

See the table below for the reduction values for the apartment buildings in step-2 [11].

Table 2: Step-2 parking reduction values for building apartments.

| **Zone** | **Large district center** | **Situation assessment** |
|---|---|---|
| A | → | → ↘ 0.05 |
| B | → | → ↘ 0.05 |
| C | ↘ 0.05 | → ↘ 0.1 |
| D | ↘ 0.1 | → ↘ 0.1 |
| E | → | → |

From the above table we can see that the reductions are higher in the outer zones C and D and less in the inner zones A and B. In the results chapter will see how this affects the overall reductions and the reductions per flat in these zones.

**Step 3: Adjustments Based on Housing Characteristics**

Further adjustments can be made based on housing characteristics, such as:

- Distribution of apartment sizes,
- Targeting groups with specific mobility patterns.

This step reflects an understanding that different types of housing generate varying levels of demand for parking spaces, even within the same area. Based on the number of small and big apartments the parking requirements could be decreased or increased. See below for apartment buildings [11]:

Table 3: Step-3 parking adjustment values for building apartments.

| **Zone** | **Project adaptation** |
|---|---|
| A | ↗ → ↘ 0.05 |
| B | ↗ → ↘ 0.05 |
| C | ↗ → ↘ 0.05 |
| D | ↗ → ↘ 0.1 |
| E | → |

**Step 4: Mobility Measures and Required Packages**

If a real estate developer wishes to secure further parking discounts beyond the basic accessibility adjustments, they are legally required to implement mobility measures. The city guidelines divide these alternative services into two packages: the Basic Package and the Star Package [11] .

**Basic Package**

The Basic Package represents the mandatory baseline of mobility services that a developer must provide if they utilize any parking reductions. These measures ensure that residents have sustainable travel alternatives from the first day they move into the building. The standard measures within the Basic Package include [11]:

- **Welcome Package:** A comprehensive onboarding resource packet provided once to each incoming apartment household, containing detailed transit maps and mobility guides.
- **Transportation Information:** Dedicated physical or digital information boards explaining neighborhood walking paths, cycling routes, and shared transit options.
- **Public Transport Pass:** A free 30-day regional public transport ticket given to incoming residents to encourage sustainable travel habits early on.
- **Extra Good Bicycle Parking:** Safe, highly secure, and weather-protected bicycle storage facilities designed near main building entry.
- **Limiting Fixed Parking:** Restricting personally assigned permanent parking spaces to a maximum of 50% of the total parking spaces, leaving the remainder as shared spaces.
- **Separate Parking Rental:** Legally separating parking costs from apartment rents, ensuring that car-free tenants do not pay for empty vehicle parking spaces.
- **Car-Sharing Spaces:** Allocating dedicated, clearly marked parking spaces reserved for car-sharing vehicles.
- **Mobility Services Manager:** A dedicated property management role responsible for overseeing the agreed-upon mobility measures.

**Star Package**

The Star Package includes more comprehensive mobility measures and offers greater reductions in parking requirements. These measures go beyond basic infrastructure and aim to effectively influence mobility behavior [11].

The Package measures may include:

- **Annual Mobility Activities:** Regular community workshops and events designed to promote walking, cycling, and shared vehicle networks.
- **Real-Time Boards:** Digital screens placed in main building lobbies displaying live arrival and departure times for nearby buses, trams, and trains.
- **Bicycle Servicing Areas:** A dedicated maintenance room equipped with professional tools, repair stands, and automatic air pumps for resident use.
- **Cargo Bike Pools (*):** Providing a shared on-site fleet of electric cargo bicycles, making it easy for residents to transport groceries or heavy items without a car.
- **Car-Sharing Vehicles (*):** Maintaining a dedicated fleet of shared cars on-site, often paired with discount memberships for all residents.
- **Stricter Fixed Parking Limits:** Tightening space rules so that personally assigned parking spaces make up no more than 10% of the total parking spaces.

- **Car-Sharing Service Discounts:** Financial subsidies or waived fees paid or organized directly by the developer to reduce the daily cost of shared driving for residents.
- **Collective Parking Facilities (*):** Consolidating all neighborhood vehicle parking into a shared, centralized garage.
- **Shared Office Spaces:** Building dedicated working offices within the residential property to eliminate the need for daily commuting.
- **Open Mobility Solutions (*):** Integrating all neighborhood transport options into a single, unified digital smartphone application for residents.
- **Approved Custom Solutions (*):** Any alternative transport solution proposed by the developer. The proposal shall receive official municipal approval.

The developers do not have to implement all the above-mentioned controls to receive the parking reduction allocated for the star package, instead the developer shall select the measure that suits them best to implement. Some of these measures are with Stars and some are without and it works as per the triangle below showing the three steps toward the maximum Star reduction [11].

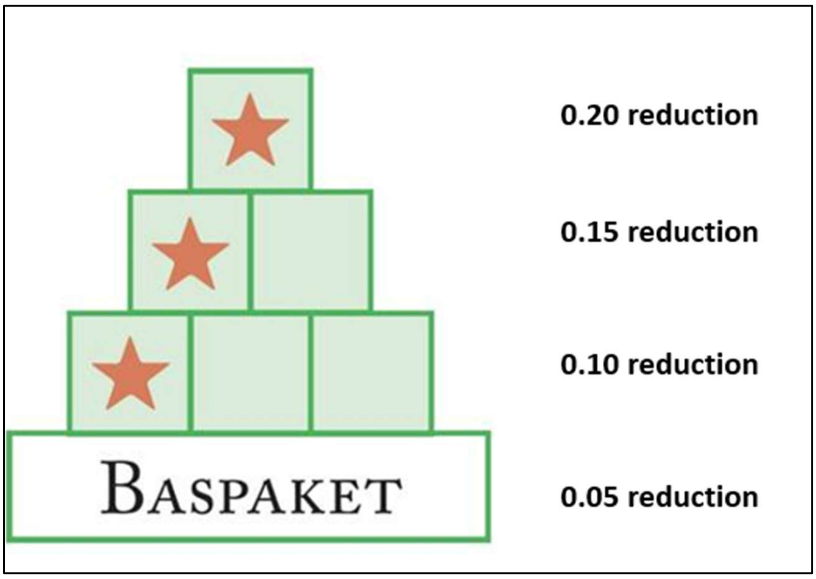


*Figure 2: Star package triangle [11]*

The precise components of the Star Package are determined based on the local context and project scale. The guidelines emphasize that measures must be appropriate, accessible, and sustainable over time to justify reducing the number of parking spaces.

### 2.7.3 The Role of Mobility Agreements

Commitments regarding the Base and Star package measures are established through mobility agreements between the developer and the Municipality of Gothenburg [11]. These agreements define:

- The mobility measures to be implemented,
- The duration of their provision,
- How implementation and maintenance responsibilities are distributed.

Mobility agreements are typically linked to the building permit process and serve as a binding instrument to ensure that parking space reductions are aligned with appropriate mobility support [11].

### 2.7.4 Evaluating Mobility Agreements and Remaining Research Gaps

In an initial assessment of these flexible parking regulations, Johansson and Rosendahl [4] demonstrated that mobility agreements can function as a highly practical framework for modern urban development. However, the true effectiveness of any mobility agreement depends heavily on the availability and accessibility of the existing public transport in the neighborhood and the long-term quality of the services provided. While property developers focus on the cost savings result from constructing fewer parking spaces, some physical mobility assets, such as shared cargo bikes or public transport access screens in lobbies, can easily deteriorate without proper management [4].

New data from the GotPark project, assessed by Holm et al. [3], provides further insights into how these policies operate in Gothenburg. The GotPark study revealed that residential projects built with mobility agreements offered approximately 25% fewer physical parking spaces compared to the ones without such agreements. The data confirmed that residents of these properties showed a significant decrease in private car ownership and a corresponding increase in daily use of public transport.

However, the GotPark data indicates that the reduction in parking spaces is a stronger motivator for behavioral change than some individual mobility measures. Services such as car and bike sharing were used less frequently than expected, suggesting that the availability of parking spaces plays a pivotal role in shaping mobility behavior [3].

# 3 Methodology

This chapter describes how the study was conducted and explains the methods used to answer the research questions. It details how the data were collected, processed, and analyzed, and clarifies the reasoning behind the methodological decisions. The overall objective of the method is to provide a clear, transparent, and reproducible approach to analyzing how parking requirements and mobility measures are applied in residential construction projects in Gothenburg.

The study is based primarily on a documentary analysis of building permits, supplemented by interviews with key professionals. The analysis follows a structured and step-by-step approach that reflects the official parking investigation process applied by the City of Gothenburg. This allows for tracking how parking requirements change throughout the planning process and evaluating the role of different mitigation measures, including mobility agreements.

## 3.1 Research Design and Approach

The study uses a quantitative and descriptive research design, combined with contextual qualitative perspectives. Instead of focusing on a small number of detailed case studies, the research examines a large number of housing projects to identify patterns, trends, and differences over time and between parking zones.

The main approach can be described as:

- Document analysis, using official planning and permit documentation.
- Comparative analysis, across years, zones, and project characteristics.
- Staged analysis, following the parking investigation process used in Gothenburg.

This approach was chosen because parking requirements and mobility agreements are formalized through planning documents. Therefore, building permits constitute a reliable source for understanding how policies are implemented in practice.

## 3.2 Data Sources

### 3.2.1 Building Permit Documents

The main data source is residential building permits approved by the City of Gothenburg between 2021 and 2025. These permits include detailed information on:

- Project location and parking zone.
- Number of dwellings.
- Initial parking requirements.

- Reductions applied in different stages.
- Mobility agreements and measures.

In total, 174 permits were initially reviewed. Of these:

- 56 permits were excluded because they did not correspond to standard apartment buildings (e.g., student or senior residences).
- 2 permits were excluded because they were approved in 2026, outside the study period.
- Following these exclusions, 116 permits were included in the final analysis.

### 3.2.2 Parking Research Reports and Mobility Agreements

In many projects, the building permit includes a parking investigation report. These reports describe how the parking requirement is calculated and reduced through different steps. Where applicable, permits also include mobility agreements that specify the required mobility measures.

Mobility agreements typically define:

- Whether a basic package or a basic package plus a star package applies.
- What specific mobility measures are required (e.g., car-sharing, cargo bikes, public transport incentives).
- Conditions for implementation and follow-up.

## 3.3 Parking Research Framework

The analysis follows the four-step parking research process used by the City of Gothenburg. This structure ensures that the research aligns with planning practice and that reductions can be systematically tracked.

**Step 1: Initial Parking Requirement**

The starting point is the initial parking requirement, which is calculated based on:

- Parking zone (A, B, C, or D)
- Applicable parking regulations
- Number of apartments

This step represents the parking requirement before applying any reductions.

**Step 2: Accessibility Assessment**

In Step 2, parking requirements can be reduced based on:

- Proximity to public transport

- Access to services
- Cycling infrastructure

**Step 3, Project Adaptation**

Step 3 adjusts parking requirements based on:

- Apartment size distribution
- Ratio of small to large apartments

This step may increase or decrease parking demand depending on the ratio of the small apartments to the big apartments.

**Step 4: Mobility Agreement**

Step 4 allows for further parking reductions if the developer enters into a mobility agreement. This involves the implementation of specific mobility measures and requires planning, financial commitment and ongoing management.

## 3.4 Data Extraction and Database Construction

All relevant permit information was systematically extracted and recorded in a structured Excel database. Each permit represents an observation, with variables grouped into several categories:

- Administrative information (year, permit ID)
- Location and parking zone
- Number of dwellings
- Initial parking requirement
- Reductions in stages 2, 3, and 4
- Existence of a mobility agreement
- Type of mobility package
- Specific mobility measures applied

This database allows for direct comparisons between projects and supports aggregation by year, zone, and type of reduction.

To improve consistency, common definitions and units were used throughout the dataset. When information was unclear or described differently in the various permits, careful interpretation was applied, and notes were taken to maintain transparency.

## 3.5 Classification of the measures used in the Star Package

For clearer analysis, the measures in the star package of the mobility agreement are grouped into low-effort and high-effort categories.

This grouping helps us understand how developers choose the measures they commit to. It can show whether they focus mainly on measures that require less effort, or if they are also willing to take on more demanding measures and consider other factors beyond effort alone.

## 3.6 Zonal Analysis

Each project was assigned to one of Gothenburg's parking zones (A-D). The zonal structure reflects differences in:

- Accessibility
- Urban density
- Public transport availability

The analysis compares:

- Number of permits per zone
- Adoption of mobility agreements per zone
- Parking reductions per zone and per flat
- Number of dwellings per zone

This allows us to understand why zones with fewer mobility agreements can achieve greater overall reductions due to the larger scale of the projects.

The older Gothenburg parking guidelines did not use lettered zones (A–D), but instead described areas based on their location in the city, typically distinguishing between inner city (Innerstaden), central areas (Centrala), and other outer areas (Övriga) [11].

For consistency, the permits related to the older guidelines were checked and adjusted according to the newer parking zones: 15 permits correspond to zone D,6 to zone C and 1 to zone A.

## 3.7 Temporal Analysis (2021-2025)

To identify trends, the data were analyzed by year of approval. This allows us to compare:

- Total parking requirements over time
- Adoption of mobility agreements
- Evolution of mobility measures

The year 2026 was excluded to avoid incomplete data and ensure consistency throughout the study period.

## 3.8 Interviews and Context

To complement the document analysis, exploratory interviews were conducted with:

- Representatives from Gothenburg City work with mobility agreements

- A representative from housing company Poseidon

The interviews were used to:

- Clarify how parking reductions are evaluated in practice
- Understand the challenges in implementing mobility agreements
- Identify which indicators practitioners consider most useful

The interview material is used solely to understand the context and not as the primary dataset.

## 3.9 Analytical Methods

The study is based on descriptive statistics and comparative analyses, including:

- Totals and percentages
- Comparisons between years and zones
- Normalization of parking reductions per flat by dividing the total number of parking spaces reduced by the total number of flats in the project. This approach ensures that the reduction in parking spaces is comparable across projects of different sizes.

No advanced statistical models were applied, as the objective is to understand planning practices, rather than causal behavior or predict outcomes.

## 3.10 Reliability and Transparency

To improve reliability:

- All calculations are traceable to the Excel database.
- Aggregations are clearly defined.
- Exclusions and assumptions are explicitly stated.

The stepwise structure ensures that the results can be directly linked to the planning decisions recorded in the permits.

## 3.11 Summary of the Methodological Approach

In summary, this study uses a structured, transparent, and policy-aligned method to analyze how parking requirements and mobility measures are applied in Gothenburg. By combining permit data, zonal comparisons, and a stepwise framework, the method allows for a detailed assessment of parking reductions per flat, zones, and years as well as clear understanding of the adoption of the mobility agreement through different zones and years.

# 4 Results

This chapter presents the results of the analysis of the residential building permits approved between 2021 and 2025. The findings focus on how parking requirements are applied, reduced, and adjusted during the investigation process, paying particular attention to the role of mobility agreements. The chapter describes trends over time, differences between parking zones, and the impact of various reduction measures. The results are based on aggregated permit data from the study period.

A total of 116 permits were included in the analysis. The results based on these permits are presented below.

## 4.1 Distribution of Permits and Flats with and without mobility agreements (2021–2025).

This section presents the distribution of building permits with and without mobility agreements for the period 2021–2025. It should be noted that the number of permits does not necessarily reflect the scale of projects, as permits vary in terms of flats number (116 permits include a total of 12289 flats unevenly distributed over the permits), therefore the analysis is presented both in terms of permits and flats.

### 4.1.1 Total distribution

Over the 116 permits that were analyzed:

- 60 permits include mobility agreements.
- 56 permits do not include mobility agreements.

This shows that permits with mobility agreements represent a slightly higher proportion of the total (51.7%) compared to those without. As shown in figure 3, permits with and without mobility agreements are relatively evenly distributed.

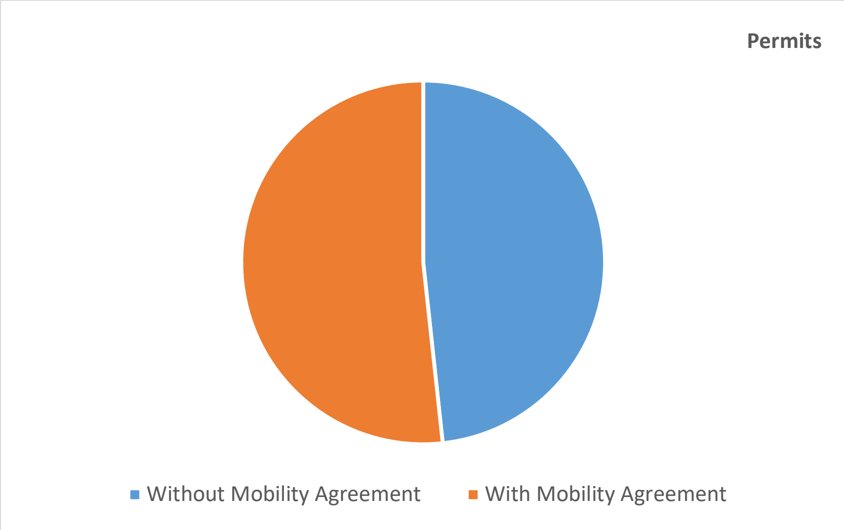


*Figure 3*: Distribution of permits with and without mobility agreements (2021-2025).

However, when considering the distribution in terms of the number of flats, a different pattern can be observed: of the total number of flats,68.7% have mobility agreements(8443 flats)while 31.3% do not include mobility agreements(4330 flats).This indicates a clear dominance of mobility agreements when measured by flats rather than permits, which can be explained by the fact that project including mobility agreements tend to involve a larger number of apartments.

These results show that the distribution based on apartments gives a more representative picture, showing that mobility agreements are applied in a larger proportion of housing, although this is less obvious when considering only permits.

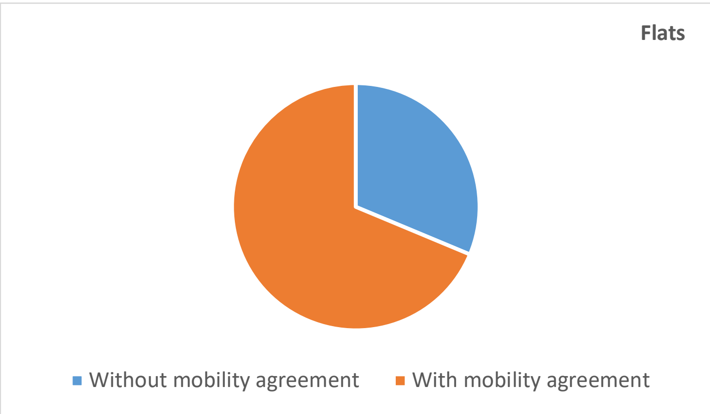


*Figure 4*: Distribution of flats with and without mobility agreements (2021-2025).

*Table 4*: Distribution of flats with and without mobility agreements (2021-2025).

| Approval year | Without mobility agreement | With mobility agreement |
|---|---|---|
| 2021 | 1472 | 3385 |
| 2022 | 863 | 2032 |
| 2023 | 625 | 1156 |
| 2024 | 502 | 963 |
| 2025 | 384 | 907 |
| **Total Flats** | **3846** | **8443** |

### 4.1.2 Annual distribution.

On a yearly basis, the number of permits with and without mobility agreements varies over time as seen in the figure below:

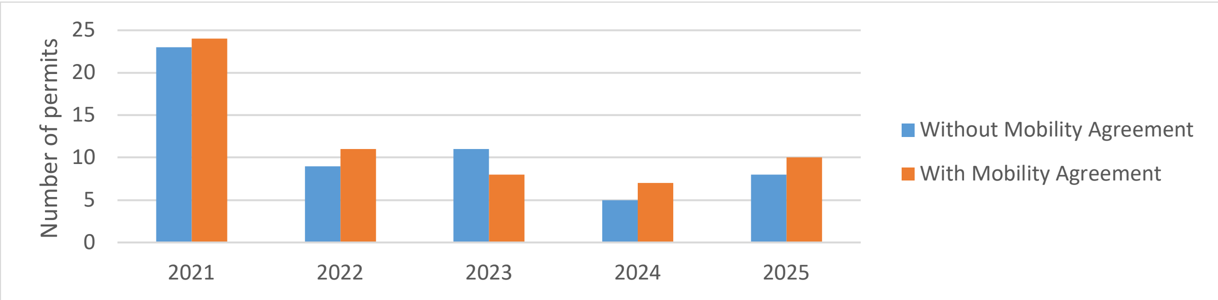


*Figure 5*:Annual Distribution of permits with and without mobility agreements (2021-2025).

- In 2021, the number of permits with and without mobility agreements was almost the same.
- In 2022, permits with mobility agreements were more than those without mobility agreements.
- In 2023, this trend reverses with permits without mobility agreements exceeding those with mobility agreements.
- In 2024 and 2025, permits with mobility agreements are once again slightly more common than those without.

  In terms of trends over time:

- Permits with mobility agreements show a general decrease from 2021 to 2024, followed by a small increase in 2025.
- Permits without mobility agreements show more variation, decreasing sharply after 2021, increasing slightly in 2023 then fluctuating in the following years.

However, this trend is further examined by considering the number of flats, which takes into consideration the scale of the projects: As a first step figure 6 shows that the total number of flats is highest in 2021 and gradually decreases in the following years, reaching its lowest level in 2025.This overall decline is consistent with the pattern observed in figure 7 indicating that the annual distribution of flats is influenced by the total number of flats each year.

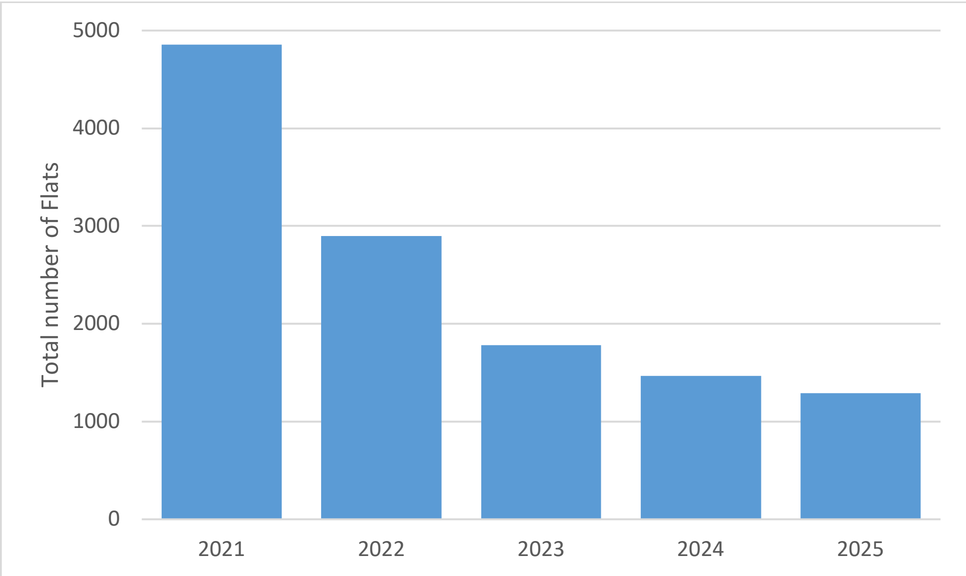


*Figure 6*:Total number of flats per year (2021-2025).

Secondly, figure 7 shows that the number of apartments linked to permits including mobility agreements consistently exceeds the number without them, during all years. This confirms that the permits with mobility agreements tend to involve a larger number of flats.

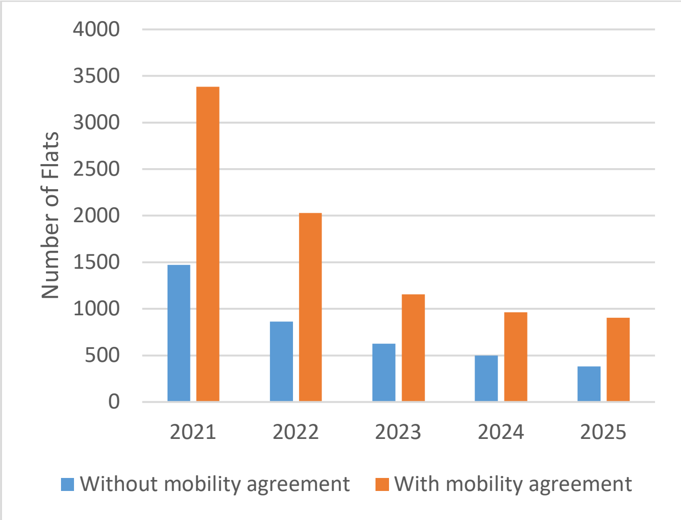


*Figure 7*: Annual distribution of flats with and without mobility agreements (2021-2025).

Overall, the analysis based on the number of flats provides a more representative understanding of the application of mobility agreements, as it better reflects the scale of the project (the different sizes of development projects in term of number of flats).

### 4.1.3 Percentage distribution over time

The percentage distribution shows the relative share of permits with and without mobility agreements and allows for comparison independent of the total number of permits each year:

In 2023, permits without mobility agreements are more common than those with mobility agreements while in the other years permits with mobility agreements are more frequent.

Overall, the permit-based analysis shows that the dominance between the two categories alternates over time, with no clear long-term increasing or decreasing trend as can be seen in the figure below:

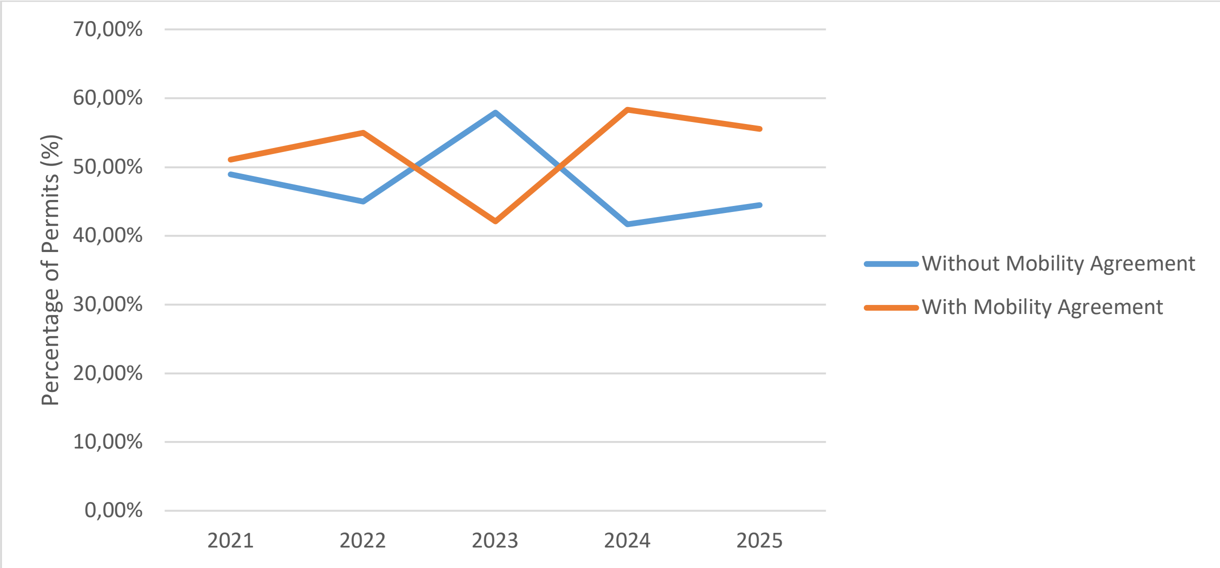


*Figure 8*: Percentage distribution of permits with and without mobility agreements (2021-2025)

However, when doing the analysis based on the number of flats, a different and more consistent pattern emerges. As can be seen from figure 9 below, apartments linked to permits including mobility agreements constitute the majority in all years. Overall, around 69% of apartments are linked to permits with mobility agreements, compared to around 31% without.

Looking in detail at the annual distribution in terms of flats:

- In 2021 and 2022 around 70% of flats include mobility agreements, compared to 30% without.
- In 2023, flats with mobility agreements represent around 65%, compared to 35% without.
- In 2024, the numbers remain almost the same as 2023.
- In 2025, flats with mobility agreements increase again to around 70%, while those without represent 30%.

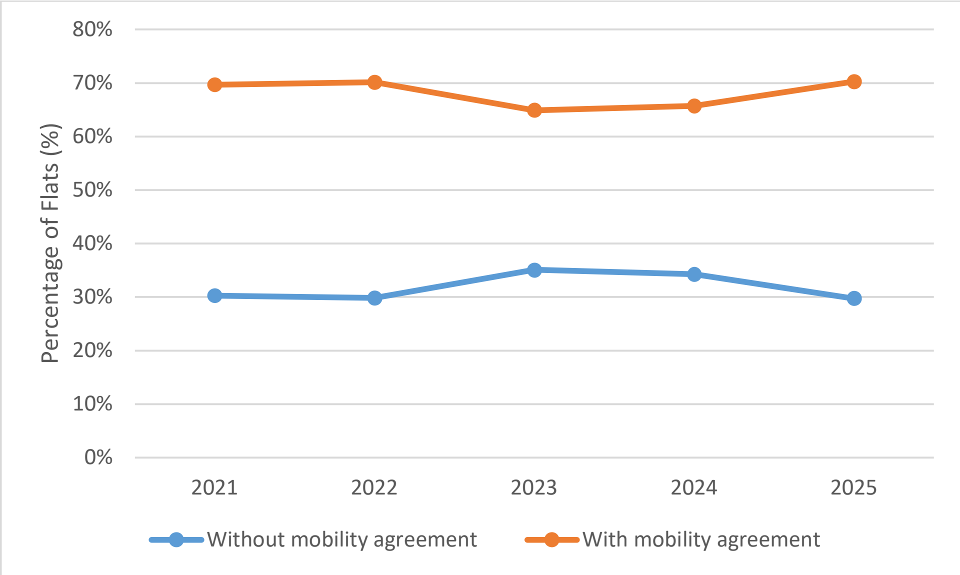


*Figure 9:* Percentage distribution of flats with and without mobility agreements (2021-2025).

Unlike the permit-based analysis, this distribution shows no intersection between the two categories, indicating a clear and stable dominance of flats including mobility agreements across all years.

*Table 5:*Percentage distribution of flats with and without mobility agreements (2021-2025).

| **Sum of No. of Flats** | | |
|---|---|---|
| **Approval year** | **Without mobility agreement** | **With mobility agreement** |
| 2021 | 30,31% | 69,69% |
| 2022 | 29,81% | 70,19% |
| 2023 | 35,09% | 64,91% |
| 2024 | 34,27% | 65,73% |
| 2025 | 29,74% | 70,26% |
| **Grand Total** | **31,30%** | **68,70%** |

## 4.2 Total Reductions

The total reduction refers to here is the sum of the parking reductions in step-2,3,4 altogether. The segregation of the reduction per step is discussed in 4.4.

Below table shows the total parking reductions per flat per zone per year

*Table 6:Total reduced parking spaces per flat per year.*

| Year | No. of flats | | | | Reduced parking | | | | Total flats | Total reduced parking | Reduced parking per flat |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | | | |
| 2021 | 1867 | 969 | 1290 | 731 | 344 | 134 | 157 | 133 | 4857 | 768 | 0.16 |
| 2022 | 1266 | 219 | 749 | 661 | 250 | 1 | 121 | 52 | 2895 | 424 | 0.15 |
| 2023 | 561 | 296 | 545 | 379 | 129 | 54 | 139 | 10 | 1781 | 332 | 0.19 |
| 2024 | 306 | 273 | 719 | 167 | 53 | 56 | 93 | 7 | 1465 | 209 | 0.14 |
| 2025 | 232 | 521 | 371 | 167 | 9 | 102 | 73 | 18 | 1291 | 202 | 0.16 |
| Total | 4232 | 2278 | 3674 | 2105 | 785 | 347 | 583 | 220 | 12289 | 1935 | 0.16 |

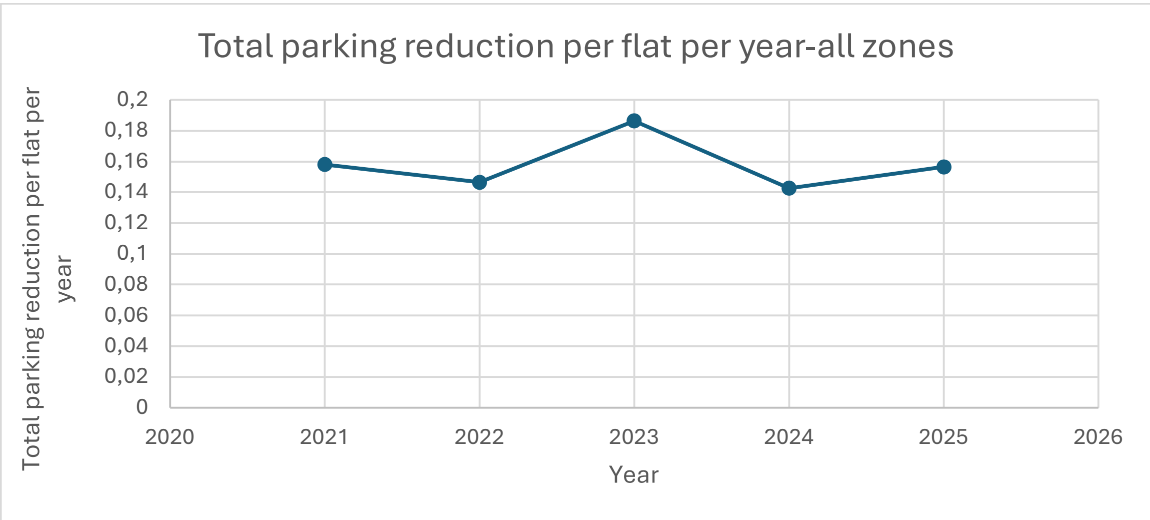


*Figure 10*:Total parking reduction per flat per year.

From Figure 10, the total parking reduction per flat ranges between 0.146 in 2022 as the minimum value to 0.186 in 2023 at the maximum value. 2025 shows similar level to 2021 while the total value is around 2021 and 2025 level with 0.157 parking reduced per flat.

Looking at the distribution of the total reduced parking per flat per zone per year gives the following trend:

*Table 7:Total reduced parking spaces per flat per zone per year.*

| Year | Total reduced parking per flat | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 2021 | 0.18 | 0.14 | 0.12 | 0.18 |
| 2022 | 0.20 | 0.005 | 0.16 | 0.08 |
| 2023 | 0.23 | 0.18 | 0.26 | 0.03 |
| 2024 | 0.18 | 0.21 | 0.13 | 0.04 |
| 2025 | 0.04 | 0.20 | 0.20 | 0.11 |
| Total | 0.19 | 0.15 | 0.16 | 0.10 |

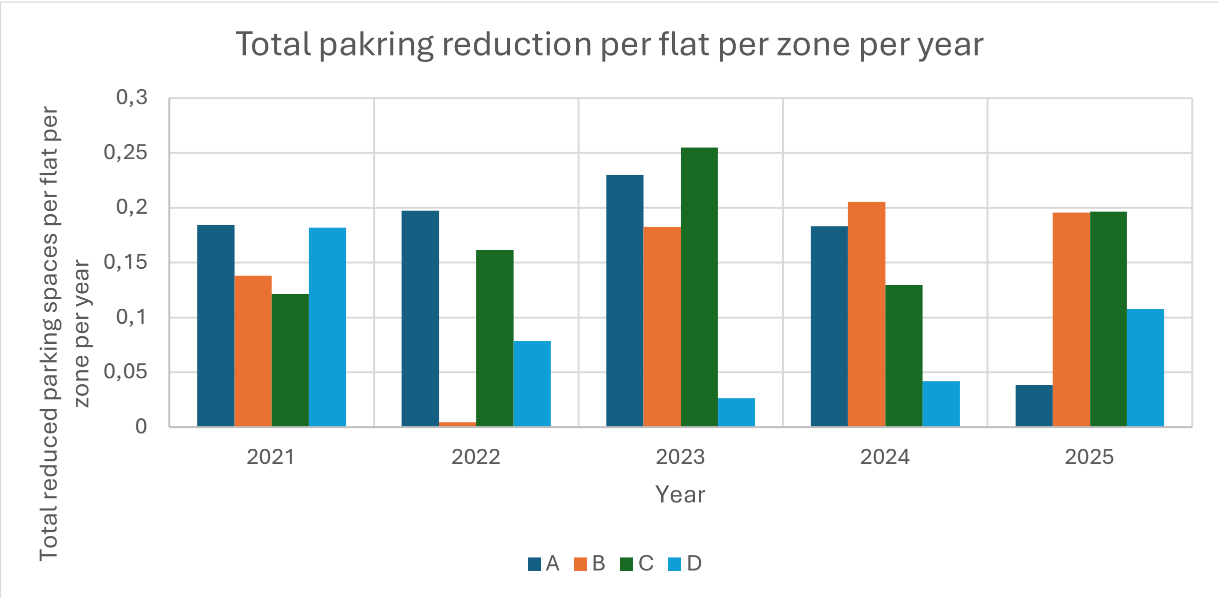


*Figure 11:*Total parking reduction per flat per zone per year.

From Figure 11, the total reduction per flat in zone A is reducing in general with slight increase in 2022 and 2023 but relatively sharp decline from 2023 and onward. Oppositely zones B and D show increase percentage of the reduced parking per flat after 2023 while the distribution in zone C is going up and down with a reducing value in 2025 that is higher than 2021 value.

If we consider the total reduction per zone, we get the below trend:

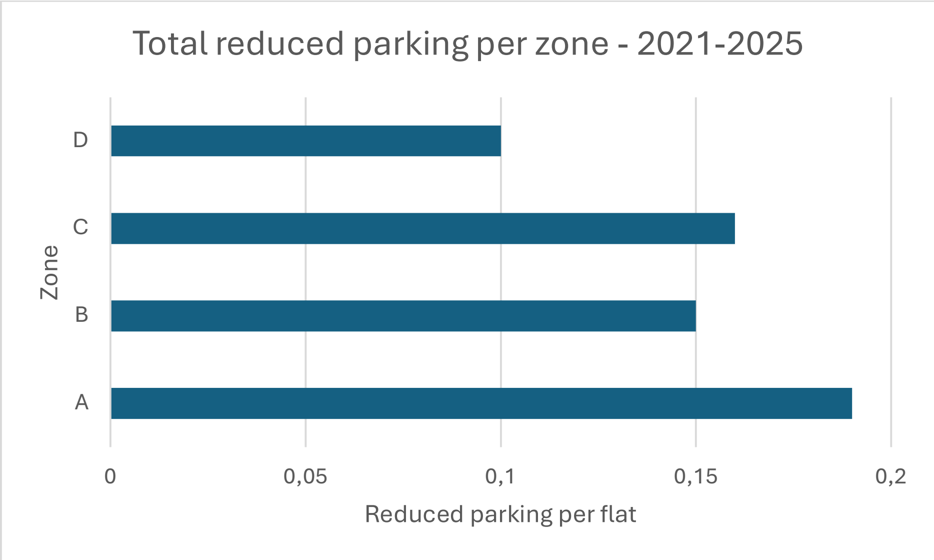


*Figure 12*:Total parking reduction per flat per zone.

Zone-A is the highest with normalized reduction equals to 0.185, followed by zone-C with 0.159 and zone-B with 0.152 and at last zone-D with 0.104. These results are combining the reductions in step-2 and 3 in addition to the adoption of the mobility agreements (the highest reduction as explained in 4.4.3) with the size of projects and hence do not necessarily reflect the adoption of the mobility agreement or any other reduction step individually. This is interesting to see that the total reduction in C is higher than B given that zone B is more centrally located and it would be expected to has higher total reduction than C. The reason will actually be seen in 4.5.

## 4.3 Reduction per Step

This section discusses the parking reductions per steps of the investigation process, i.e. step-2, step-3, and step-4 (mobility agreement). For each step the reduction values are normalized per flat and will be discussed per zone and per year.

### 4.3.1 Parking reductions in Step 2 (Project's accessibility assessment)

Step 2 is the first step where the initial parking requirement can be reduced. At this stage, adjustments are made based on basic conditions, such as location and accessibility.

The results show the following:

*Table 8:Step-2 parking reduction per flat per year.*

| Year | No. of flats | | | | step-2 reduced parking | | | | Total No. of flats | Step-2 total reduced parking | Step-2 reduced parking per flat |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | | | |
| 2021 | 1867 | 969 | 1290 | 731 | 81 | 38 | 78 | 55 | 4857 | 252 | 0.05 |
| 2022 | 1266 | 219 | 749 | 661 | 63 | 2 | 15 | 26 | 2895 | 106 | 0.04 |
| 2023 | 561 | 296 | 545 | 379 | 28 | 14 | 60 | 4 | 1781 | 106 | 0.06 |
| 2024 | 306 | 273 | 719 | 167 | 15 | 14 | 60 | 7 | 1465 | 96 | 0.07 |
| 2025 | 232 | 521 | 371 | 167 | 2 | 19 | 13 | 14 | 1291 | 48 | 0.04 |
| Total | 4232 | 2278 | 3674 | 2105 | 189 | 87 | 226 | 106 | 12289 | 608 | 0.05 |

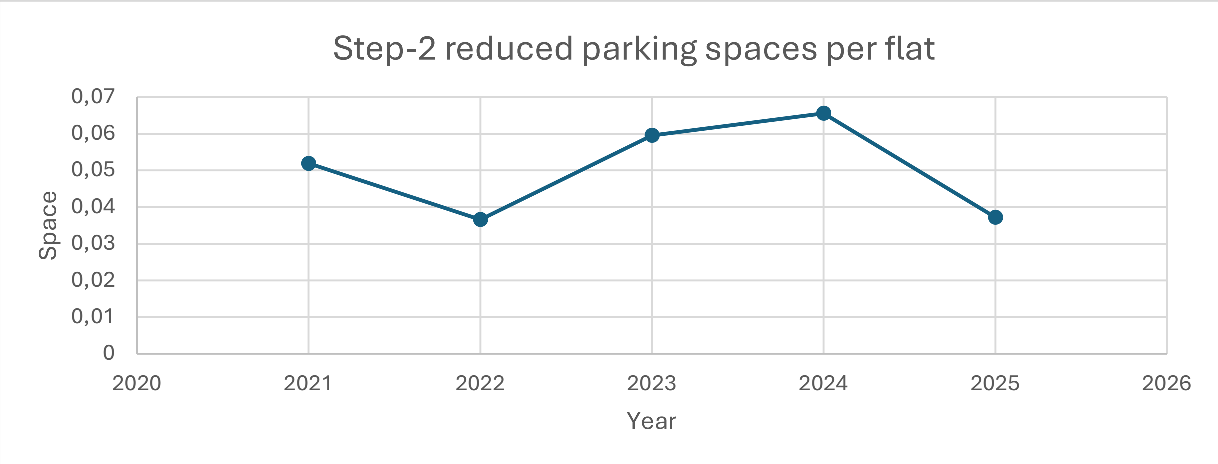


*Figure 13:Step-2 parking reduction per flat per year.*

Step-2 reduction shows fluctuation through 2021 to 2025 with the highest reduced parking in 2024 and the lowest in 2022.

Checking the reduced parking per flat per zone per year shows the following trend:

*Table 9:Step-2 parking reduction per flat per year.*

| Year | Step-2 reduced parking spaces per flat | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 2021 | 0.04 | 0.04 | 0.06 | 0.08 |
| 2022 | 0.05 | 0.01 | 0.02 | 0.04 |
| 2023 | 0.05 | 0.05 | 0.11 | 0.01 |
| 2024 | 0.05 | 0.05 | 0.08 | 0.04 |
| 2025 | 0.01 | 0.04 | 0.04 | 0.08 |
| Total | 0.04 | 0.04 | 0.06 | 0.05 |

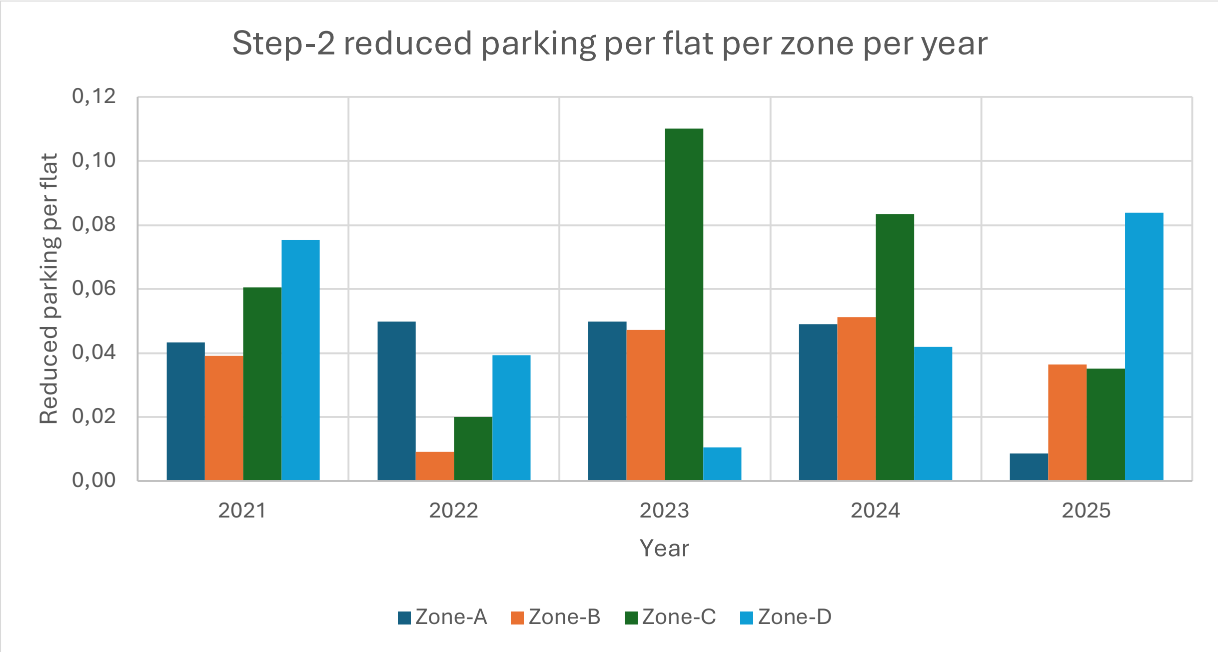


*Figure 14:Step-2 parking reduction per flat per zone per year.*

Zone-A shows steady values from 2021 to 2024 with sharp declining in 2025. Zone-B shows less reductions than zone-A in 2021 to 2023 but higher reductions in 2024 and 2025. Zone-C experienced large fluctuation between 2022 and 2023 and ending in 2025 with level that is less than 2021 levels. Zone-D started in 2021 with 0.08 reduction per flat, then 0.04 in 2022 and back to 0.08 in 2025.

Studying step-2 reduction per flat per zone gives the following results:

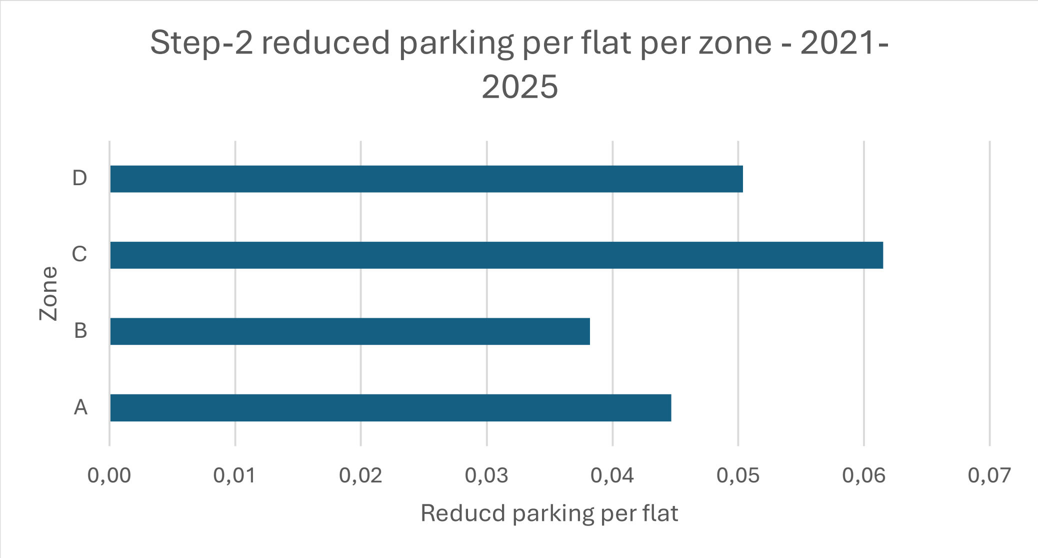


*Figure 15:Step-2 parking reduction per flat per zone.*

From the above figure, zone-C is the highest reduction per flat from step-2, then zone-D and at last zone-A and zone-B respectively.

### 4.3.2 Parking reductions in Step 3

Step 3 allows for further assessment based on combination of the apartments of the building. This step goes either ways to increase or decrease the parking requirements based on the share of the small and big apartments in the building under the permit.

The results show that:

*Table 10: Step-3 parking reduction per flat per year.*

| Year | No. of flats | | | | Step-3 reduced parking | | | | Total No. of flats | Step-3 total reduced parking | Step-3 reduced parking per flat |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | | | |
| 2021 | 1867 | 969 | 1290 | 731 | 20 | 21 | 0 | 9 | 4857 | 50 | 0.010 |
| 2022 | 1266 | 219 | 749 | 661 | 5 | 0 | 63 | 0 | 2895 | 68 | 0.023 |
| 2023 | 561 | 296 | 545 | 379 | 28 | 5 | 0 | 0 | 1781 | 33 | 0.019 |
| 2024 | 306 | 273 | 719 | 167 | 6 | 0 | 0 | 0 | 1465 | 6 | 0.004 |
| 2025 | 232 | 521 | 371 | 167 | 0 | 5 | 0 | 5 | 1291 | 10 | 0.008 |
| Total | 4232 | 2278 | 3674 | 2105 | 59 | 31 | 63 | 14 | 12289 | 167 | 0.014 |

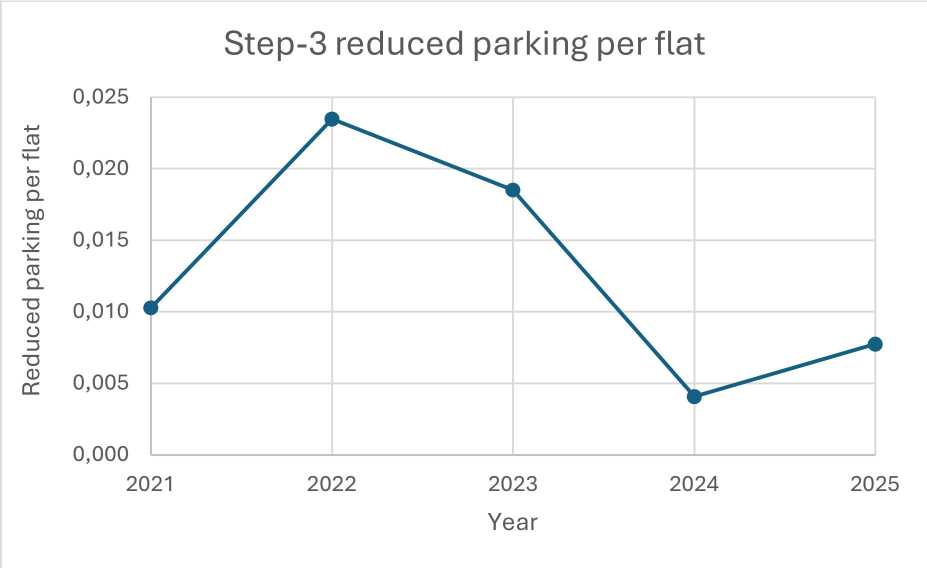

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*Figure 16: Step-3 parking reduction per flat per year.*

The distribution of the reduced parking in step-3 shows low value in 2021, higher value in 2022, sharp decline in 2024 and moving up again in 2025 but not up to 2021 level. In total 2022 was the highest year with normalized reduction of 0.023. The total normalized reduction for step-3 is 0.014 which is higher than 2024 and 2025 levels.

When examining the results per zone per year, we can see the distribution below:

*Table 11: Step-3 parking reduction per flat per zone per year.*

| Year | Step-3 reduced parking spaces per flat | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 2021 | 0.01 | 0.02 | 0.00 | 0.01 |
| 2022 | 0.00 | 0.00 | 0.08 | 0.00 |
| 2023 | 0.05 | 0.02 | 0.00 | 0.00 |
| 2024 | 0.02 | 0.00 | 0.00 | 0.00 |
| 2025 | 0.00 | 0.01 | 0.00 | 0.03 |
| Total | 0.01 | 0.01 | 0.02 | 0.01 |

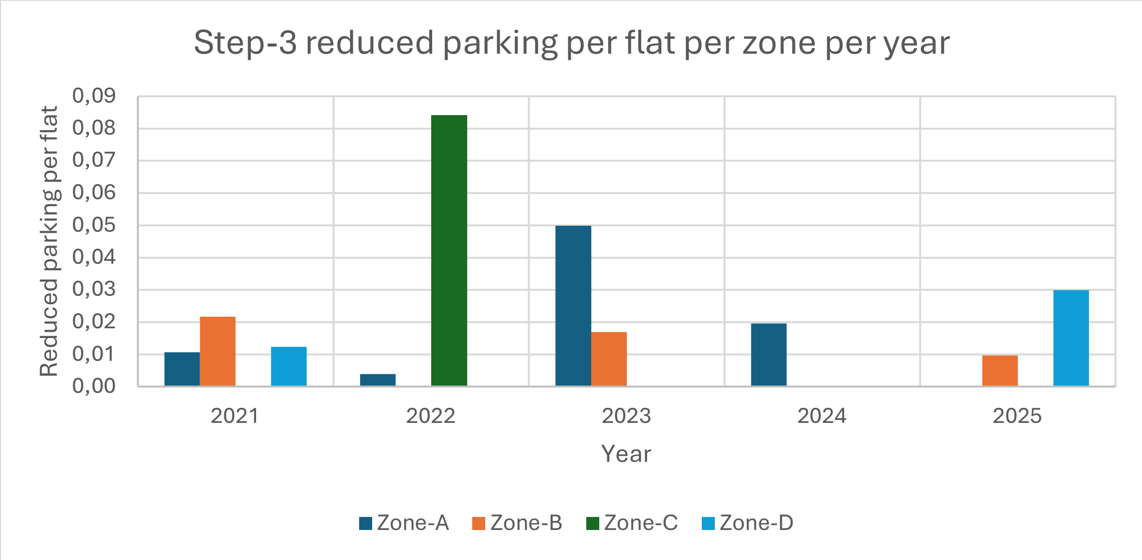


*Figure 17: Step-3 parking reduction per flat per zone per year.*

From the above figure we can see that the maximum reduction happened in zone-C in 2022 while the minimum reduction happened in zone-C and D in the following year (2023) with zero values. Zone-A achieved the highest reductions in 2023, and 2024 but in 2025 zone-D achieved the highest reductions. On many occasions, we can see the reduction per year is zero which shows that step-3 is not commonly used as step-2 and step-4 (discussed in the following section).

In some cases step-3 adds to the number of parking spaces but we do not see negative value in the above results because the reduction cases are more than the increase cases.

Looking to step-3 reduction per flat per zone gives the following:

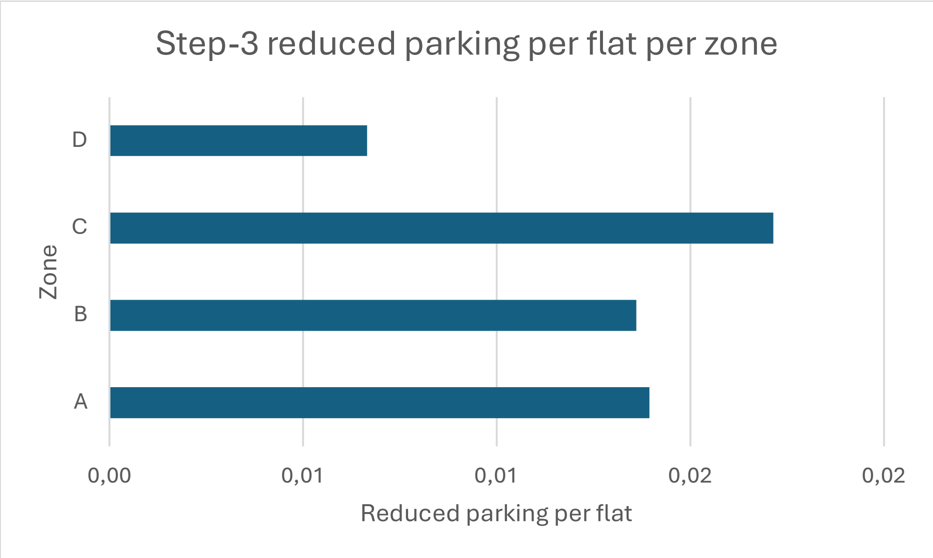


*Figure 18: Step-3 parking reduction per flat per zone per year.*

Zone-C shows the highest reduction from step-3 followed by zone-A, B, and D. This could be justified by that the projects in zone-C included a percentage of smaller apartments to the bigger apartments more than zone-A and B. Still, the comparison here is based on the percentage not the absolute numbers.

### 4.3.3 Parking reductions in Step 4

Step 4 is the final step of the parking investigation and is where mobility measures and mobility agreements are typically applied. The results show the following:

*Table 12: Step-4 parking reduction per flat per year.*

| Year | Step-4 reduced parking | | | | No. of flats | | | | Step-4 total reduced parking | Total flats | Step-4 parking reduced per flat |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | | | |
| 2021 | 243 | 76 | 152 | 71 | 1867 | 969 | 1290 | 731 | 542 | 4857 | 0.11 |
| 2022 | 183 | 0 | 50 | 29 | 1266 | 219 | 749 | 661 | 262 | 2895 | 0.09 |
| 2023 | 76 | 33 | 79 | 7 | 561 | 296 | 545 | 379 | 195 | 1781 | 0.11 |
| 2024 | 31 | 43 | 21 | 0 | 306 | 273 | 719 | 167 | 95 | 1465 | 0.06 |
| 2025 | 8 | 77 | 59 | 0 | 232 | 521 | 371 | 167 | 144 | 1291 | 0.11 |
| Total | 541 | 229 | 361 | 107 | 4232 | 2278 | 3674 | 2105 | 1238 | 12289 | 0.10 |

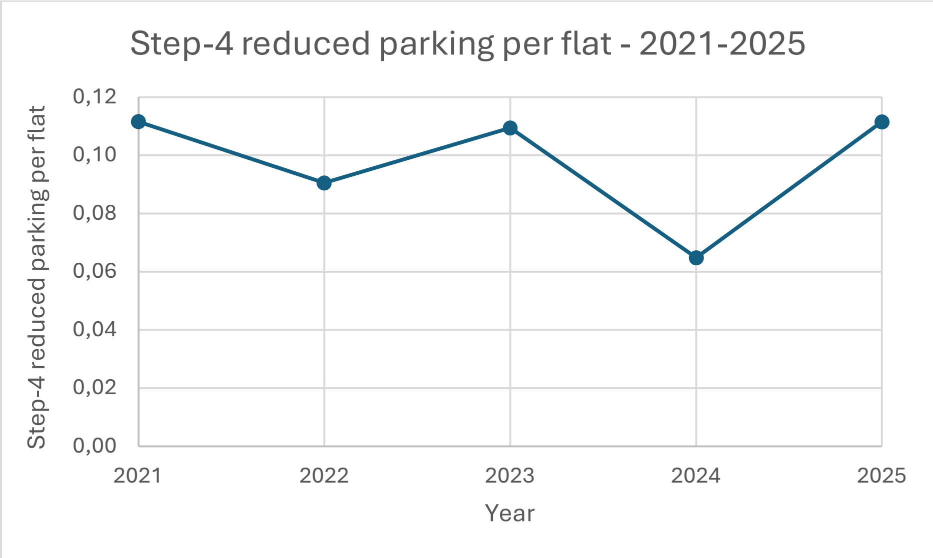


*Figure 19: Step-4 parking reduction per flat per year.*

From the above table and graph, the reduction through the mobility agreement or step-4 went through ups and downs starting with high level in 2021 to lower level in 2022 and even lower in 2024 while the number again pick up to 2021's level in 2025. The trend here is not stable, rather its up in a year following by down in the next year and so on. The lowest reduction can be seen in 2024 while the highest is equally in 2021 and 2025.

If we look at the reduction distribution per flat per zone per year, we can see the below pattern:

*Table 13: Step-4 parking reduction per flat per zone per year.*

| Year | Step-4 reduced parking spaces per flat | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 2021 | 0.13 | 0.08 | 0.12 | 0.10 |
| 2022 | 0.14 | 0.00 | 0.07 | 0.04 |
| 2023 | 0.14 | 0.11 | 0.14 | 0.02 |
| 2024 | 0.10 | 0.16 | 0.03 | 0.00 |
| 2025 | 0.02 | 0.15 | 0.21 | 0.00 |
| Total | 0.13 | 0.10 | 0.10 | 0.05 |

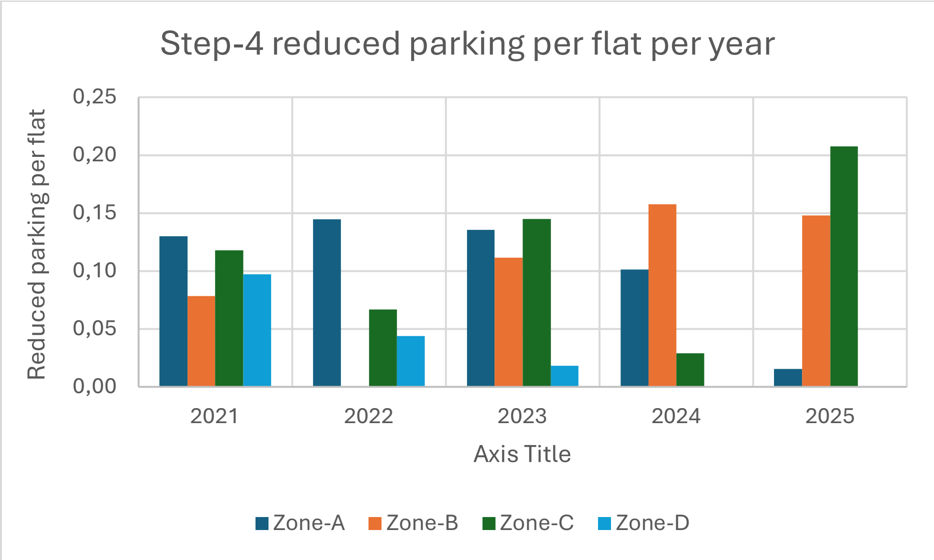


*Figure 20: Step-4 parking reduction per flat per zone per year.*

Figure 20 shows different trends for the normalized reduction per zone per year. Starting with zone-A, in 2021 zone-A achieved the highest reduction through step-4 and that increased slightly in 2022 and that was the highest reduction achieved in zone-A in the period 2021-2025. After 2022 zone-A showed slight decline in 2023 followed by sharper decline in 2024 to the minimum value in 2025 where zone-A was the second last zone with a slight value over zone-D.

Zone-B, opposite to zone-A started with the lowest value in 2021 and 2022 followed by considerable increases in 2023 and 2024. 2025 is slightly lower than 2024 and brought zone-B to the second highest zone that reduces the parking through step-4. It is worth mentioning that the reduction in 2022 was zero in zone-B through step-4.

Zone-C which was the second highest zone in 2021, experienced ups and downs through 2022 to 2024 but achieved considerable increase in 2025 that put it in the first place for step-4 reduction the year.

Zone-D started with third place and continued declining through the years. The results show zero values in 2024 and 2025 in zone-D.

Examining the step-4 reductions per zone gives us the following:

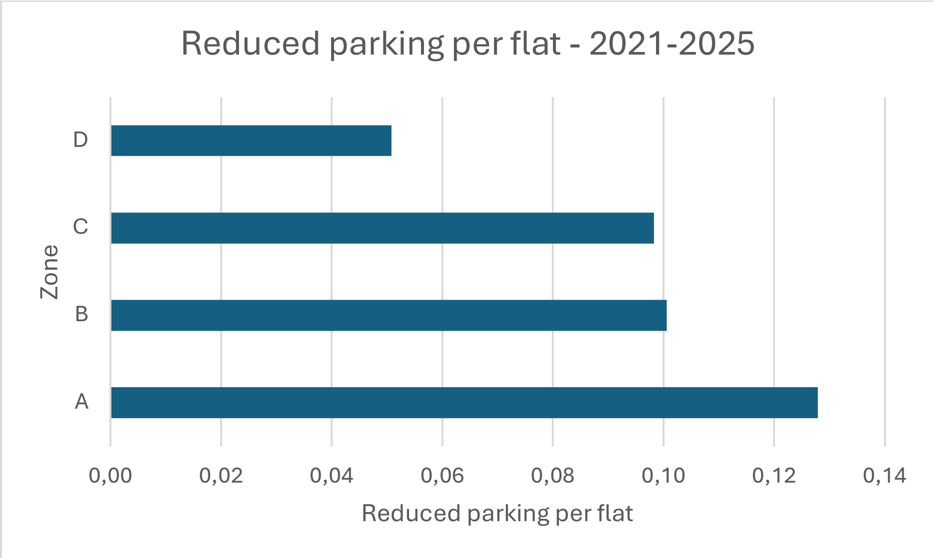


*Figure 21 : Step-4 parking reduction per flat per zone.*

Zone-A has the highest reductions from step-4 followed by zone-B then C and D respectively.

The above results show a good example of the importance of normalizing the results per flat i.e. dividing the number of reduced parking spaces over the total number of flats. Zone-C shows higher number of parking spaces reduced in total through step-4 however when normalizing that by flat, the normalized value for zone-C is less than zone-B.

### 4.3.4 Parking reductions in Step 4 Basic and Star packages

This section will discuss the normalized reductions per flat for the basic package and star package, which both are the components of step-4 the mobility agreement. The developer must satisfy all the requirements of the basic package before being able to unlock the star package reductions. More information on this is mentioned in Chapter 2.

The results show the following:

*Table 14:Basic and star packages reductions per flat per year.*

| Year | No. of flats | | | | | No. of parking reduced via basic package | | | | | No. of parking reduced via star package | | | | | Reduced parking per flat | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | Total | A | B | C | D | Total | A | B | C | D | Total | Basic Package | Star Package |
| 2021 | 1867 | 969 | 1290 | 731 | 4857 | 103 | 32 | 64 | 28 | 227 | 140 | 44 | 88 | 43 | 315 | 0.047 | 0.065 |
| 2022 | 1266 | 219 | 749 | 661 | 2895 | 52 | 0 | 12 | 13 | 77 | 131 | 0 | 38 | 16 | 185 | 0.027 | 0.064 |
| 2023 | 561 | 296 | 545 | 379 | 1781 | 23 | 14 | 19 | 2 | 58 | 53 | 19 | 60 | 5 | 137 | 0.033 | 0.077 |
| 2024 | 306 | 273 | 719 | 167 | 1465 | 16 | 13 | 11 | 0 | 40 | 15 | 30 | 10 | 0 | 55 | 0.027 | 0.038 |
| 2025 | 232 | 521 | 371 | 167 | 1291 | 4 | 25 | 18 | 0 | 47 | 4 | 52 | 41 | 0 | 97 | 0.036 | 0.075 |
| Total | 4232 | 2278 | 3674 | 2105 | 12289 | 198 | 84 | 124 | 43 | 449 | 343 | 145 | 237 | 64 | 789 | 0.037 | 0.064 |


*Figure 22:Basic and star packages reductions per flat per year.*

The table and the figure above show that the contribution of the star package in step-4 is always greater than the basic package through 2021 to 2025, however it differs between the years how much the star package contributes each year. In 2021the star package was 0.065 while the basic package is 0.047. In 2022 the gap increased and doubled where the star package accounts for 0.064 of the reduction in step-4 while less than half of that value achieved by the basic package. The gap increased more than double in 2023, 0.077 for star packages against 0.033 for basic packages. In 2024 the values went back to 0.038 against 0.027 for star and basic package respectively. 2025 recorded considerably higher reduction than 2024 with 0.075 and 0.036 from star and basic package respectively. The total reduction through step-4 is a combination between the two packages, and we can see from fig-21 that the highest total reduction for step-4 was in 2021 and 2025 which was achieved through different combinations of the basic and star packages as we can see in fig-22 above.

Looking at the results from zone perspective, give the following output:

*Table 15:Basic and star packages reductions per flat per zone per year.*

| Year | Basic package – parking reduction per flat | | | | Star package – parking reduction per flat | | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D |
| 2021 | 0.06 | 0.03 | 0.05 | 0.04 | 0.07 | 0.05 | 0.07 | 0.06 |
| 2022 | 0.04 | 0.00 | 0.02 | 0.02 | 0.10 | 0.00 | 0.05 | 0.02 |
| 2023 | 0.04 | 0.05 | 0.03 | 0.01 | 0.09 | 0.06 | 0.11 | 0.01 |
| 2024 | 0.05 | 0.05 | 0.02 | 0.00 | 0.05 | 0.11 | 0.01 | 0.00 |
| 2025 | 0.02 | 0.05 | 0.05 | 0.00 | 0.02 | 0.10 | 0.11 | 0.00 |
| Total | 0.05 | 0.04 | 0.03 | 0.02 | 0.08 | 0.06 | 0.06 | 0.03 |

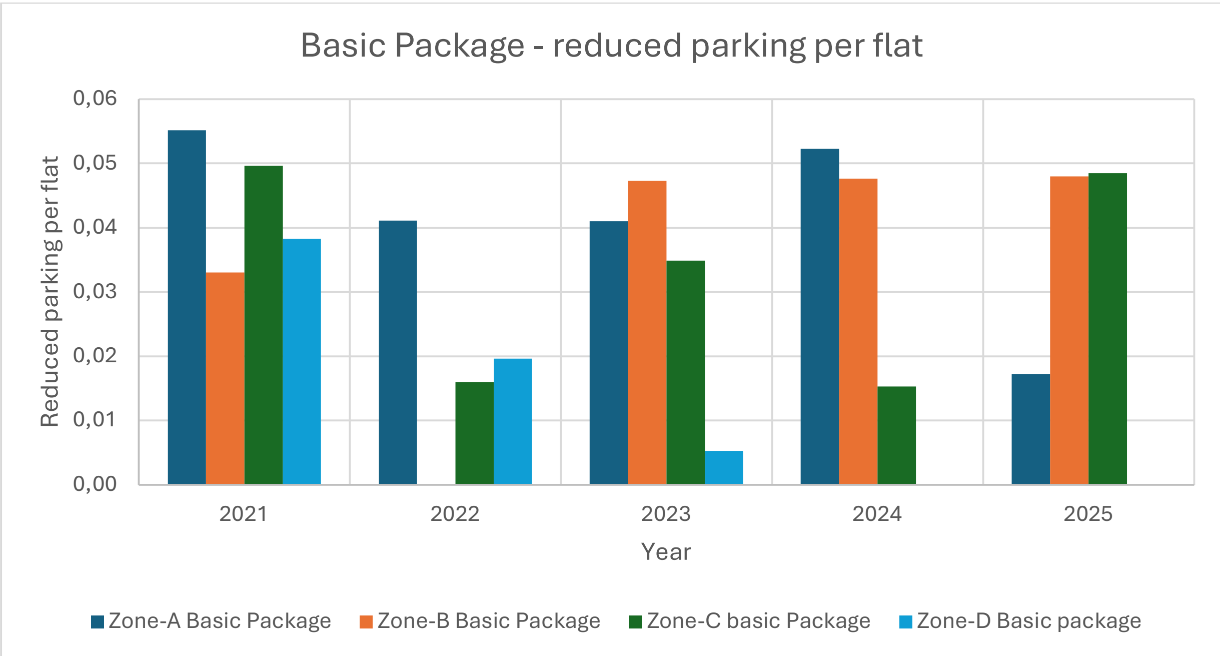


*Figure 23 :Basic and star packages reductions per flat per zone per year.*

Figure 23 shows that the reduction per flat in 2021 was the highest in zone-A, then zone-C, then zone-D, and zone-B. While in 2025, zone-B and C both achieved similar results as the highest reduction per flat while zone A shows considerable decline from 2021 level and zone D showed zero value. The reduction through the basic package is a reflection of the implementation of the mobility agreement (step-4) which will be discussed in the following sections.

Looking at the reductions through the star package per flat, zone and year, the output is as follows:

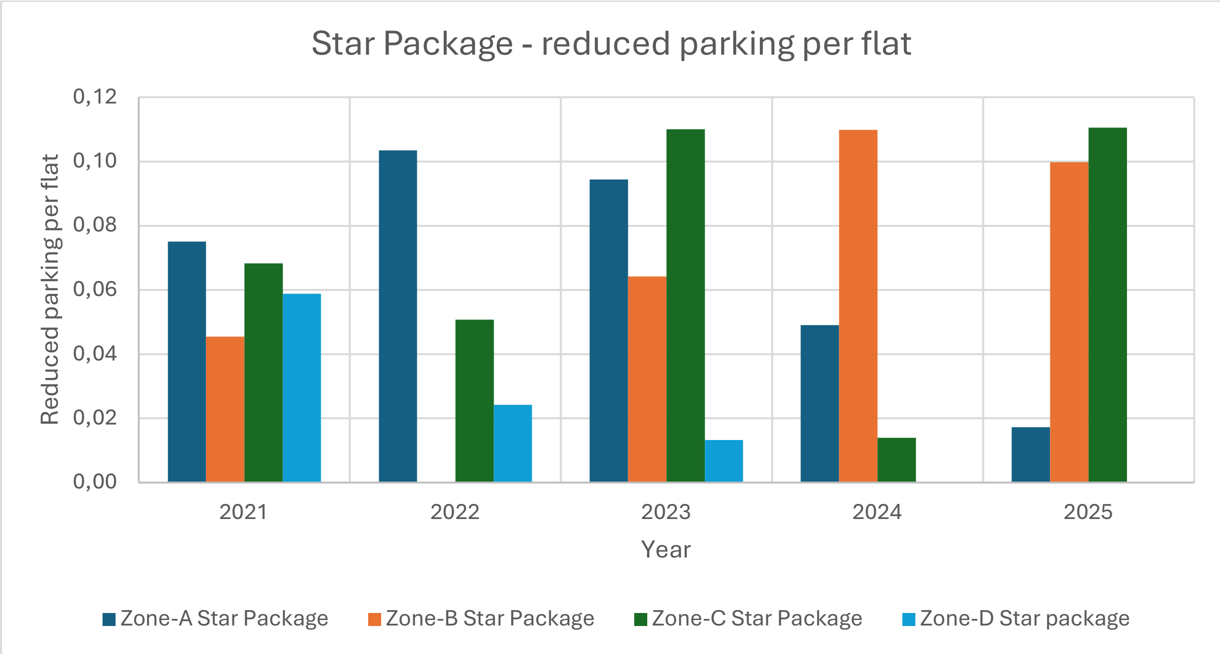


*Figure 24:Basic and star packages reductions per flat per year.*

Looking at both figures 23 and 24, with different normalized reductions per flat, we can see relatively similar trend per zone, except zone-A with slight difference. This is telling that the developers prefer to use the basic package and star package together rather than going with star package only. The same will be confirmed in section 4.7 when we outline the adoption of basic package against the basic package & the star package together where the results show that more than 95% of the permits  adopting mobility agreements choose to go for basic package & star package (accounts for more than 97% of the flats adopting a mobility agreement).

## 4.4 Comparison between Parking Steps

### 4.4.1 Total reduction per step per year

Below table and figure show the total reduction per each step normalized per flat.

*Table 16: Total p5arking spaces reduction per flat per step per year.*

| Year | Reduced parking spaces per flat | | | | |
|---|---|---|---|---|---|
| | Initial Requirement | Step-2 | Step-3 | Step-4 | Final Requirement |
| 2021 | 0.61 | 0.05 | 0.01 | 0.11 | 0.43 |
| 2022 | 0.53 | 0.04 | 0.02 | 0.09 | 0.38 |
| 2023 | 0.65 | 0.06 | 0.02 | 0.11 | 0.46 |
| 2024 | 0.64 | 0.07 | 0.00 | 0.06 | 0.51 |
| 2025 | 0.65 | 0.04 | 0.01 | 0.11 | 0.50 |
| Total | 0.61 | 0.05 | 0.01 | 0.10 | 0.44 |

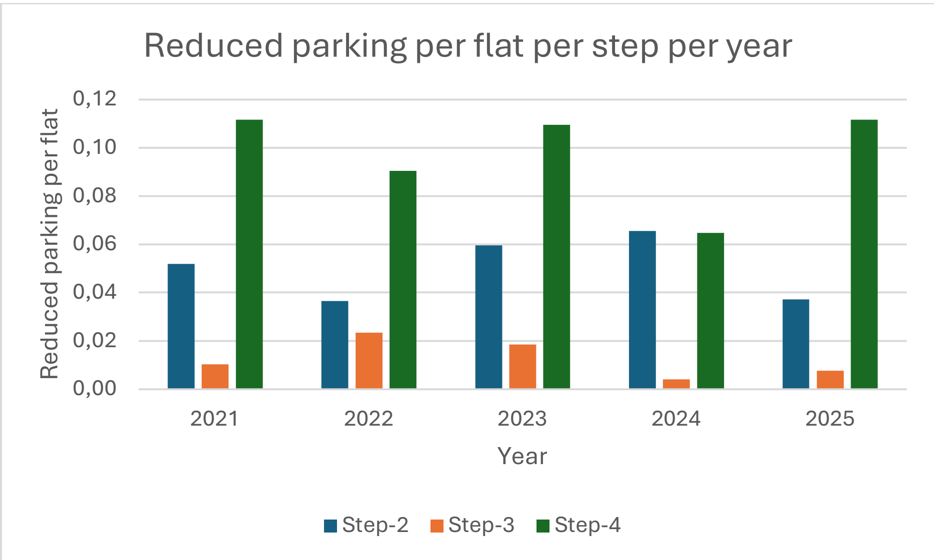


*Figure 25: Total parking spaces reduction per flat per step per year.*

From the table and figure above, we can see that step-4 is the dominant step for parking reduction throughout the period followed by step-2 and at last step-3.

To understand the contribution of each step, we compared the reductions per step to the total reduction of the three steps. See the figure below:

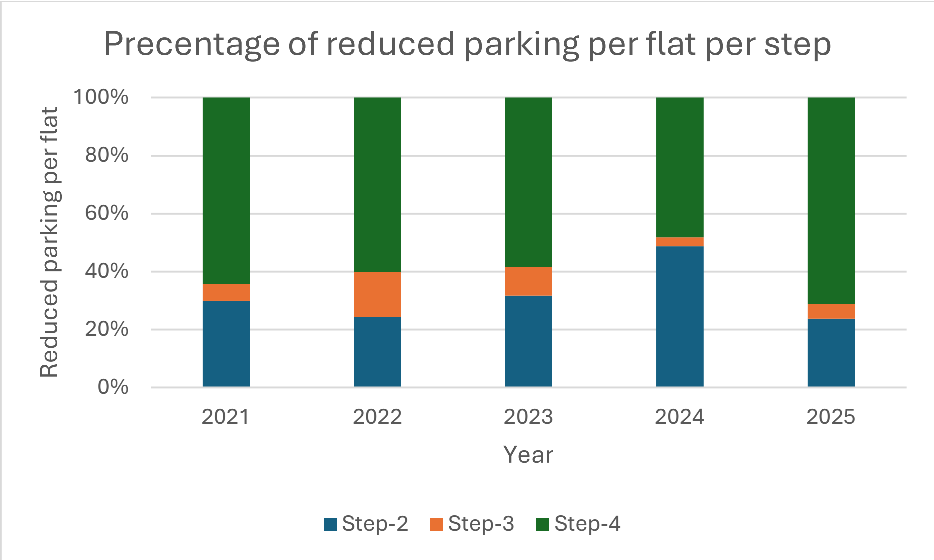


*Figure 26: Percentage of reduced parking per flat per step per year.*

From the above figure we can see in 2025 the contribution of step-4 was the maximum with more that 70% share of the total reduction followed by 2021 and the least contribution was in 2024 with less than 50%. For step-2 the maximum contribution was in 2024 where the step contributed in almost 50% of the total reduction at that year, and the least contribution was in 2022 with around 22%. Step-3 contributed the least all through the period, with maximum contribution of around 15% in 2022 and minimum of less than 3% in 2024.

### 4.4.2 Total reduction per step per zone

*Table 17: Reduced parking per flat per step per zone.*

| Step | Zone | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Step-2 | 0.045 | 0.038 | 0.062 | 0.050 |
| Step-3 | 0.014 | 0.014 | 0.017 | 0.007 |
| Step-4 | 0.128 | 0.101 | 0.098 | 0.051 |

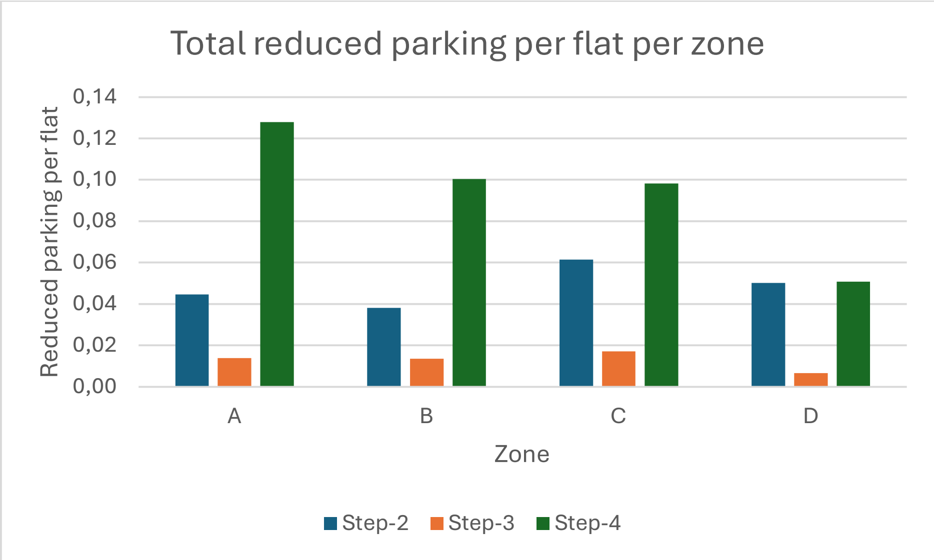


*Figure 27: Reduced parking per flat per step per zone.*

The above table and figure show the dominance of step-4 in all the zones . Following step-4, The highest zone is zone-A with normalized reduction of 0.128 parking per flat. Zone-C and B show relatively similar reductions and at last zone-D with around 0.05 parking reduced per flat.

After step-4, step-2 comes with highest reduction in zone-C, then zone-D, and zone-A and the last is zone-B. As mentioned in 4.4.1, these results show that the outer zones (C and D) received total reductions from accessibility assessment more than the inner zones (A and B).

Step-3 is the least used step in the mobility process compared to step-2 and step-4. Zone-A and B show relatively similar values in the middle range while Zone-C shows the highest value and zone-D shows the lowest value.

## 4.5 Mobility agreements adopted per zone.

### 4.5.1 Permits adopting mobility agreements

Figure 28 shows the number of permits adopting mobility agreements in the different parking zones in Gothenburg during the period 2021–2025, while figure 29 presents the corresponding percentage distribution between the zones.

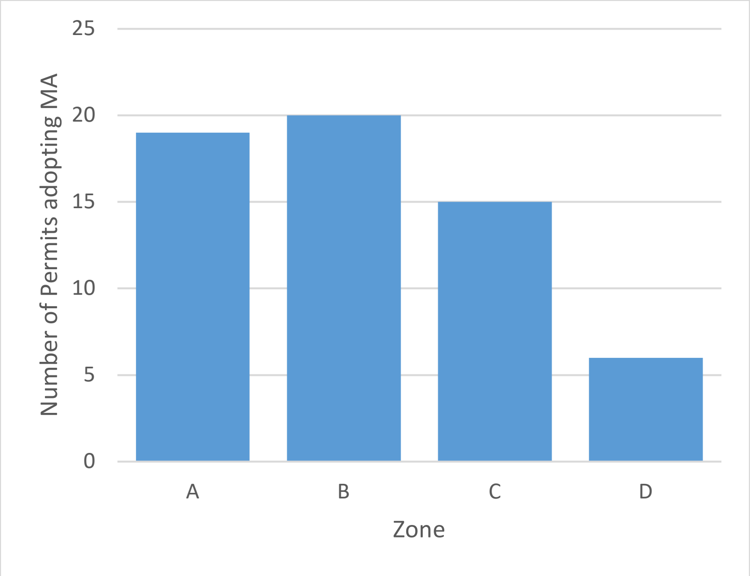


*Figure 28*:Number of permits adopting mobility agreements per zone.

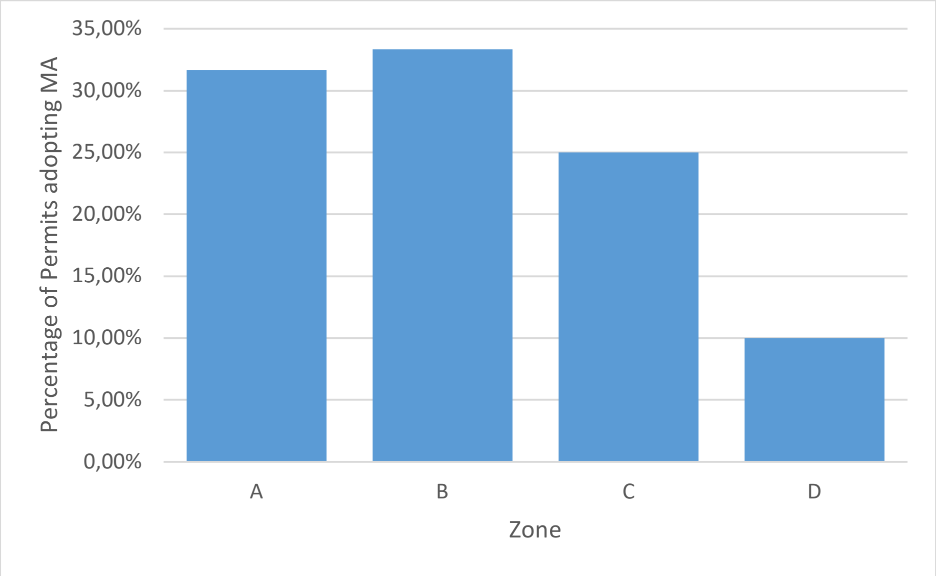


*Figure 29*:Percentage distribution of permits adopting mobility agreements across zones.

The results show the following distribution:

- 31.67% of the permits adopting mobility agreements are in zone A (19 permits).
- 33.33% of the permits adopting mobility agreements are in zone B (20 permits).
- 25% of the permits adopting mobility agreements are in zone C (15 permits).
- 10% of the permits adopting mobility agreements are implemented in zone D (6 permits).

Overall, the results indicate that the implementation of permits adopting mobility agreements is higher in zones A and B, while zone D contributes the least. Zone C represents an intermediate level between these two extremes.

It should be noted that the total number of permits is relatively similar in all zones (around 28–30 permits per zone) as shown below in figures 30 and 31(percentage distribution of permits per zone). Therefore, the observed differences reflect actual variations in the adoption of mobility agreements rather than differences in project volume.

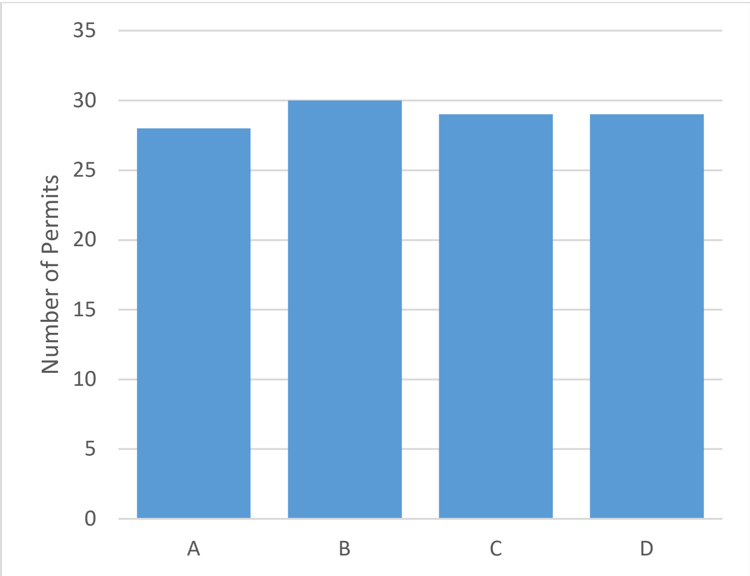


*Figure 30*:Number of permits per zone.

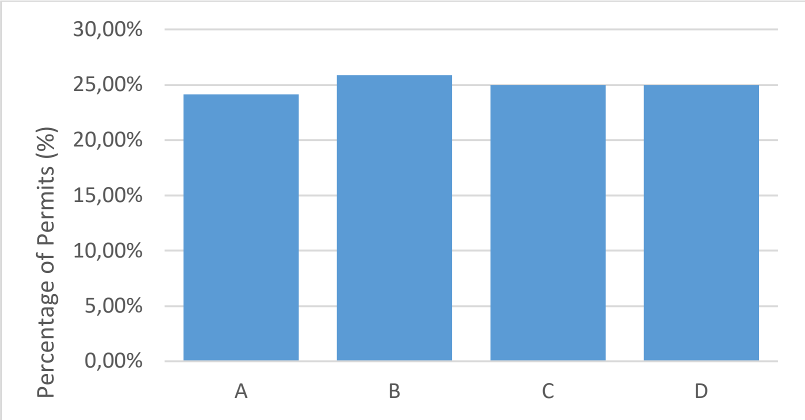


*Figure 31:Percentage distribution of permits across zone.*

### 4.5.2 Individual mobility agreements.

In addition to the permit-based analysis, the number of individual mobility agreements was also examined. Although 60 permits adopted mobility agreements, several permits were associated with the same mobility agreement. Therefore, the total number of individual mobility agreements was identified as 49. Figure 32 shows the number of individual mobility agreements per zone, while figure 33 presents the corresponding percentage distribution.

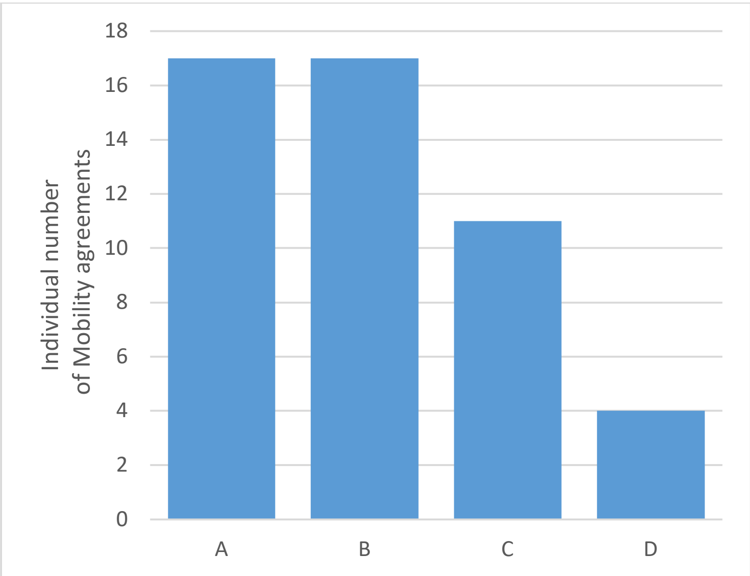


*Figure 32*:Number of individual mobility agreements per zone.

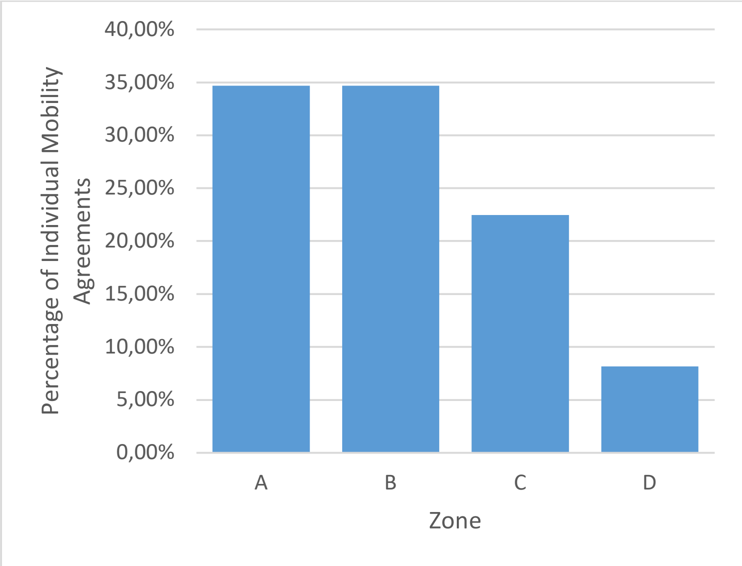


*Figure 33:Percentage distribution of individual mobility agreements across zone.*

The results show the following distribution:

- 34.69% of individual mobility agreements are implemented in zone A (17 mobility agreements).
- Zone B has the same number of individual agreements as in zone A.
- 22.45% of individuals mobility agreements are implemented in zone C (11)
- 8.16% of individuals mobility agreements are implemented in zone D (4).

### 4.5.3 Flats adopting mobility agreements.

Figures 34 and 35 show the number of flats adopting mobility agreements and the corresponding percentage distribution between the zones respectively.

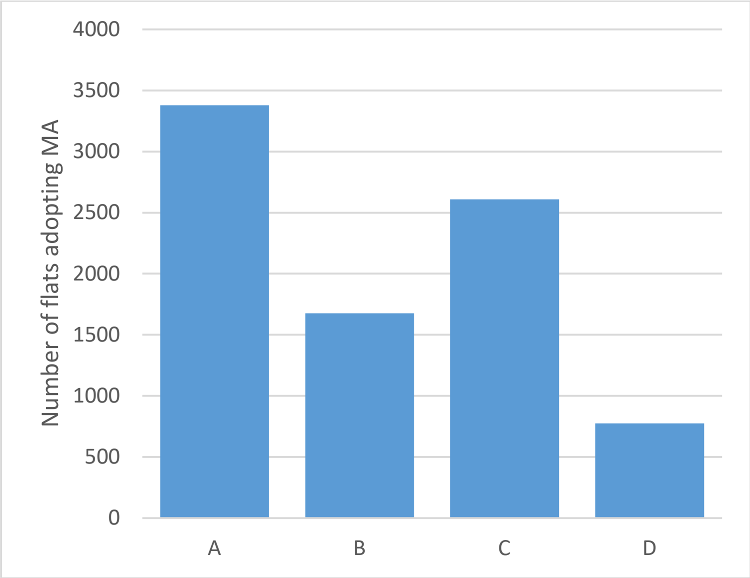


*Figure 34:Number of flats adopting mobility agreements per zone.*

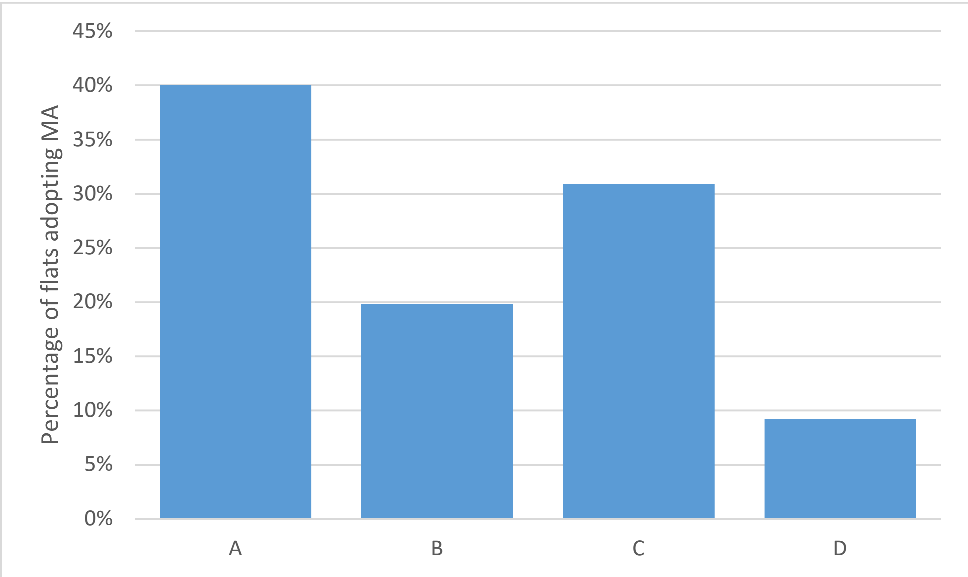


*Figure 35*:Percentage distribution of flats adopting mobility agreements across zone.

The results show the following distribution:

- 40% of the flats adopting mobility agreements are in zone A (3380 flats).
- 20% of the flats adopting mobility agreements are in zone B (1167 flats).
- 31% of the flats adopting mobility agreements are in zone C (2609 flats).
- 9% of the flats adopting mobility agreements are in zone D (777 flats).

## 4.6 Distribution of projects by mobility package type.

### 4.6.1 Distribution by package type

Figure 36 shows the distribution of permits that adopted a mobility agreement based on the mobility package type. Note that this analysis is based on the number of permits and does not account for the number of individual mobility agreements (presented in section 4.6.2) since the objective is to examine permits adopting mobility agreements regardless of the corresponding individual mobility agreements.


*Figure 36*:Distribution of permits that have mobility agreements by mobility package type.

The results show that out of the 60 permits that have a mobility agreement:

- 57 permits adopted both the base and star packages.
- 3 permits adopted the base package only.

This indicates that most of the permits with mobility agreements include both the star and base packages (95%), while permits that adopted the base package only are limited (5%).

Another step was taken to see where the projects including base package only are located as seen in figure 40 below:

- Zone B contains 2 projects with basic packages only.
- Zone D contains 1 project.
- Zones A and C contain no projects with basic package only.

This shows that projects with only the basic package are not only rare but also unevenly distributed and occur only in specific zones rather than across the entire city. However, due to the very small number of these cases, the distribution across zones should not be considered representative.

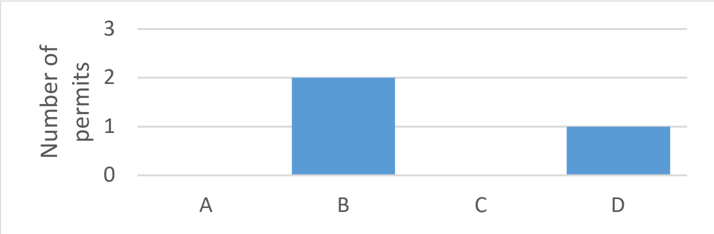


*Figure 37*: Distribution of projects with only the basic package across the different zones.

To further analyze, the same study was done but per flat and similar results were obtained as shown in figure 38:

- 261 flats (3%) adopt only base backage while 8182 flats (97%) adopt the basic and star package.


*Figure 38:*Distribution of flats adopting packages.

Note that the analysis of the star package type will be presented in the following section.

### 4.6.2 Distribution by Star Package level.

As presented in the methodology section, the star package level has 3 different levels so a distribution of these levels was made according to both permits and flats, where the analyses show actually a similar pattern in both categories across the different star package levels, with 3-star being the most common followed by 2-star and then 1-star packages as can be seen in the two figures below:

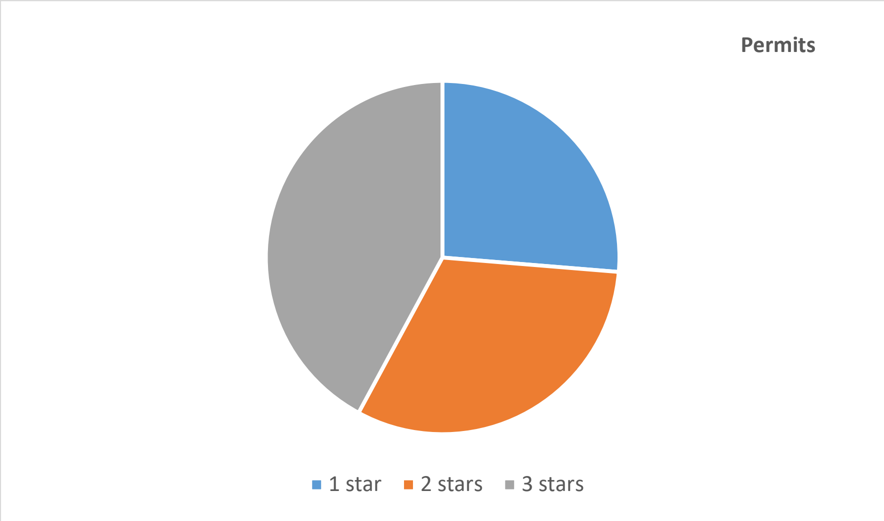


*Figure 39:*Distribution of permits by star package level.

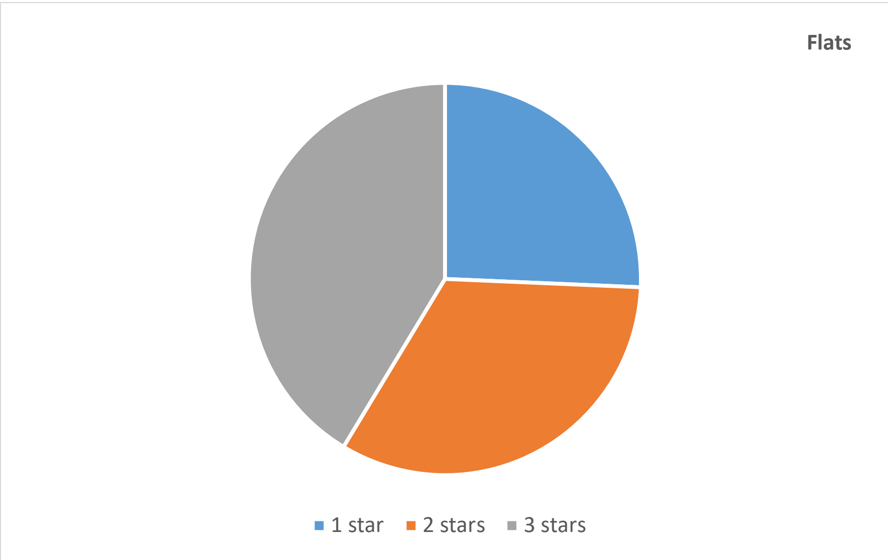


*Figure 40 :*Distribution of flats by star package level.

Detailed distribution

- Out of the permits that adopted base and star packages,42% adopted 3-star packages (24 permits),32% adopted 2-star packages (18 permits) and 26% adopted 1-star package (15 permits).

- Out of the flats that adopted based and star packages,41% adopted 3-star packages (3384 flats),33% adopted 2-star packages (2698 flats), and 26% adopted 1-star package (2100 flats).

#### *4.6.2.1 Star Package Measures classification.*

As presented in the methodology, the star package contains a set of mobility measures that aim to reduce parking demand. For the purpose of this study, these measures were further divided based on the level of effort they require from the developers: These star-measures were grouped into low-effort and high-effort categories.

It should be noted that this classification was developed by us and is not part of the original star package framework. The details of this classification are presented below:

*Table 18:*Star package measures classification.

| Measure | Annual mobility activity | Real Time Public Transport Board | Cargo Bikes Pool ★ | Limit on fixed parking | Collective Parking facilities ★ | Open mobility solutions ★ | Others | Property owner's own proposal ★ | Free 90 days ticket for Public Transport ★ | Area for Bicycle Servicing | Car sharing vehicles ★ | Discount on car sharing | Delivery Service | Digital services for mobility ★ | Shared offices Spaces |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of Measure | Low | Low | Low | Low | Low | Low | Low | Low | High | High | High | High | High | High | High |

The star package includes 15 measures which are almost evenly distributed between the two categories, with 53% classified as low-effort (8 measures) and 47% are high -effort (7 measures). Among the 7 measures that are classified as “star”, low-effort measures represent 57% (4 measures) while the remaining 43% are high-effort (3 measures).

#### 4.6.2.2 Distribution of Star Packages Measures by permits and flats.

This section presents the frequency of these measures across the studied permits and flats. The frequency represents the number of permits and flats that use each measure respectively, which also corresponds to the total number of times each measure is implemented across the studied permits and flats.

Figure 41 shows the frequency of the star package measures applied for all permits:

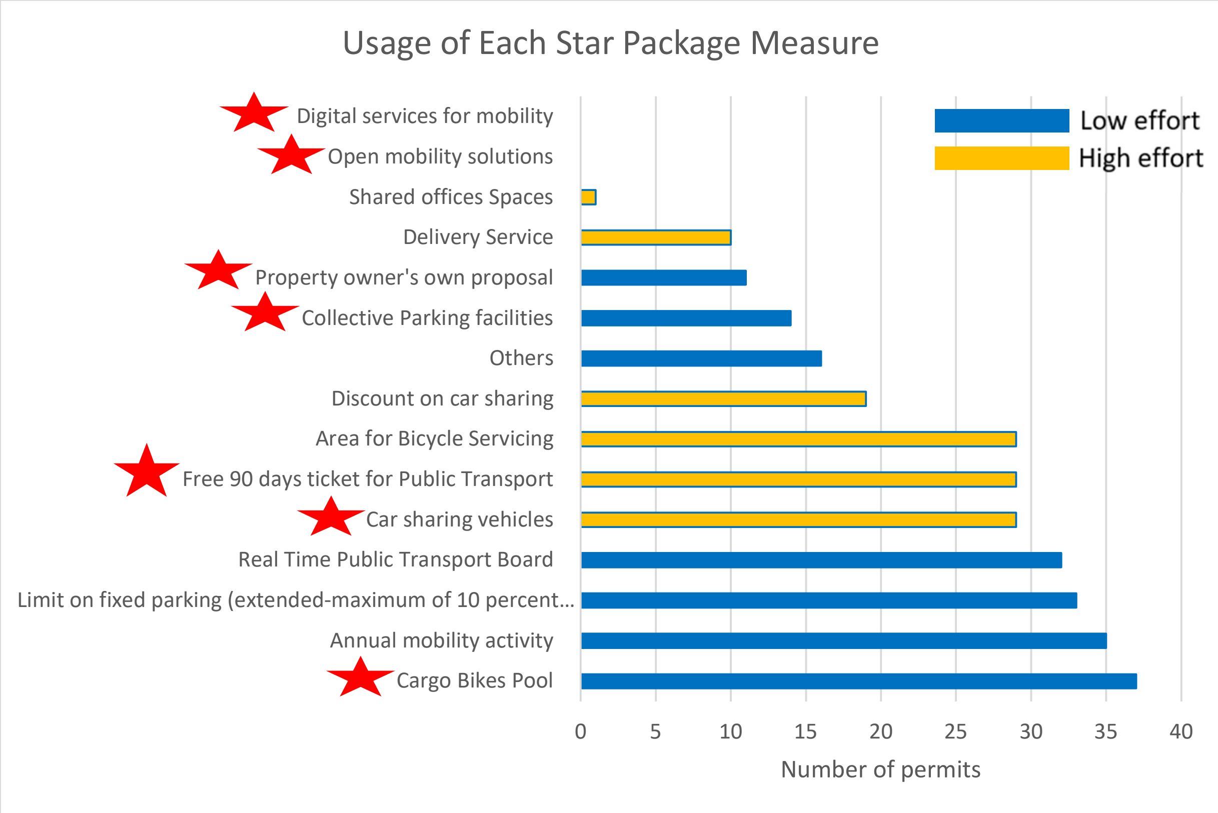


*Figure 41:*Usage frequency of star package measures according to permits analysis.

The results show that the most frequently applied measures among the 57 permits that adopt star packages are:

- Cargo bikes pool (37 permits-65% of the permits that adopt star package implement the cargo bikes pool) - low effort measure.
- Annual mobility activity (35 permits-61%) -low effort measure.
- Limit on fixed parking (33 permits-58%) -low effort measure.
- Real time public transport board (32 permits-56%) - low effort measure.
- Car sharing vehicles (29 permits-51%) -high effort measure.
- Free 90-day ticket for public transport (29 permits-51%) - high effort measure.
- Area for bicycle servicing (29 permits-51%) - high effort measure.

The detailed results for all measures including both permit and flat based analysis will be presented later in table 19.

While the permit-based analysis mainly reflects the measures most frequently selected and implemented by developers across projects, the flat-based analysis provides further insight into the number of flats affected by each measure as shown in figure 42 below:

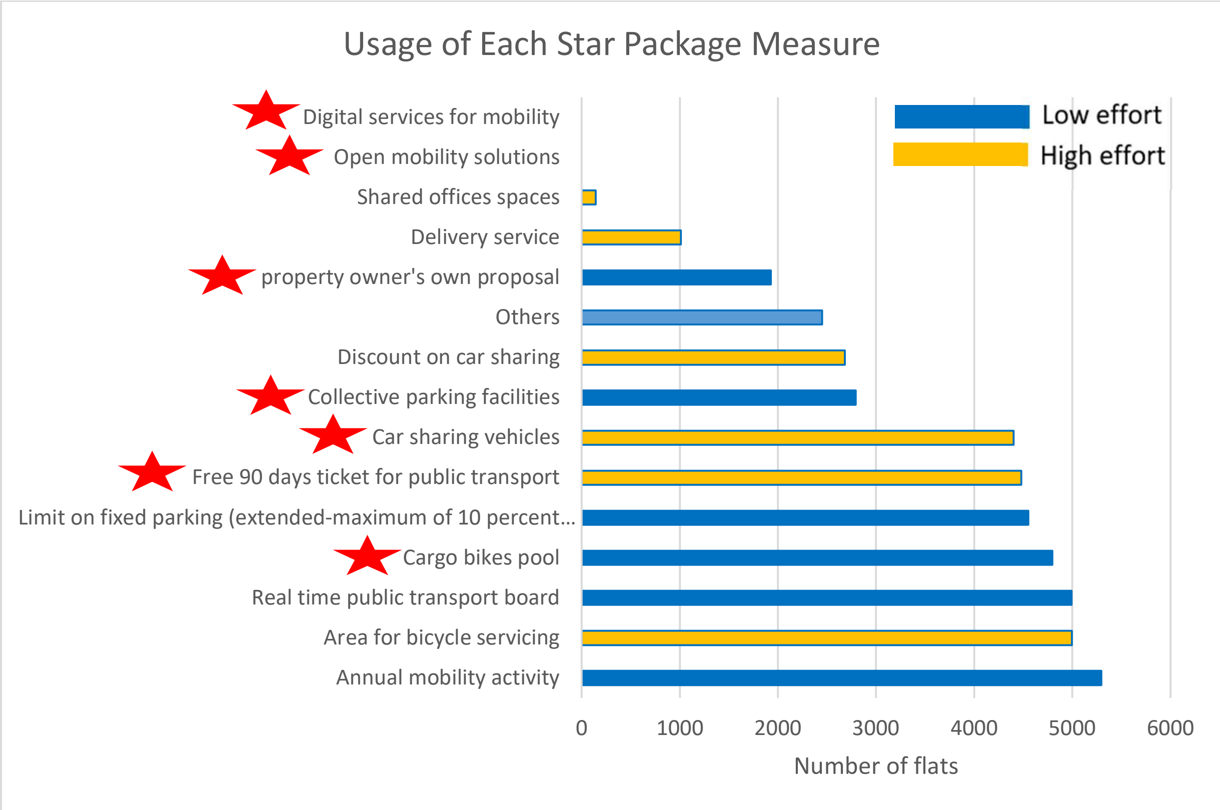


*Figure 42:* Usage frequency of star package measures according to flats analysis.

It can be noticed that flat-based distribution shows a slightly different pattern compared to the permit-based analysis. Annual mobility activity represents the highest value (5297 from the 8182 flats -65%-profiting from star package measures), followed by bicycle service area (4995 flats-61%), which is instead the seventh highest in permit-base analysis, and real-time public transport board (4993 flats-61%). In contrast, the cargo bike pool, which was the most common measure in the permit-based analysis, ranks fourth when evaluated by number of flats (4795 flats-59%). This indicates that some measures are implemented in permits containing a larger number of flats and hence affect more flats despite appearing in fewer permits and vice versa.

The remaining measures show lower levels of application, with several measures only appearing in a limited number of projects such as shared offices spaces (1 permit-142 flats corresponding to 2%) while digital services for mobility and open mobility solutions do not appear at all. It should be noted that the category “others “includes specific measures, that do not fall under the predefined measures and are proposed by the project’s developers such as annual events and small amounts of money provided annually as compensation for car rentals.

*Table 19:Frequency and distribution of implemented star package measures across permits and flats*

| Measure | Cargo Bikes Pool | Annual mobility activity | Limit on fixed parking | Real Time Public Transport Board | Car sharing vehicles | Free 90 days ticket for Public Transport | Area for Bicycle Servicing | Discount on car sharing | Others | Collective parking facilities | property owner's own proposal | Delivery service | Shared offices spaces | Open mobility solutions | Digital services for mobility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of Measure | Low | Low | Low | High | High | High | High | High | Low | Low | Low | Low | High | Low | High |
| Permits | 37 | 35 | 33 | 32 | 29 | 29 | 29 | 19 | 16 | 14 | 11 | 10 | 1 | 0 | 0 |
| Permits(%) | 64,9% | 61,4% | 57,9% | 56,1% | 50,9% | 50,9% | 50,9% | 33,3% | 28,1% | 24,6% | 19,3% | 17,5% | 1,8% | 0,0% | 0,0% |
| Flats | 5297 | 4995 | 4993 | 4795 | 4551 | 4480 | 4402 | 2793 | 2682 | 2449 | 1929 | 1012 | 142 | 0 | 0 |
| Flats(%) | 64,7% | 61,0% | 61,0% | 58,6% | 55,6% | 54,8% | 53,8% | 34,1% | 32,8% | 29,9% | 23,6% | 12,4% | 1,7% | 0,0% | 0,0% |

The initial analysis of the five most frequently implemented measures suggested a dominance of low effort measures, with low effort measures accounting for 83% of the total implementation frequency. However, extending the analysis beyond the top five provided a more balanced overview which became evident when including the sixth and seventh most frequently implemented measures (both classified as high effort) and had implementation frequencies almost equal to the fifth most implemented measure.

When considering all implemented measures across all projects, the overall distribution became more balanced: low efforts account for 60% of the total implementation frequency and high effort measures 40%. These results suggest that although low effort measures remain slightly more common overall, developers are also implementing high effort measures to a significant extent.

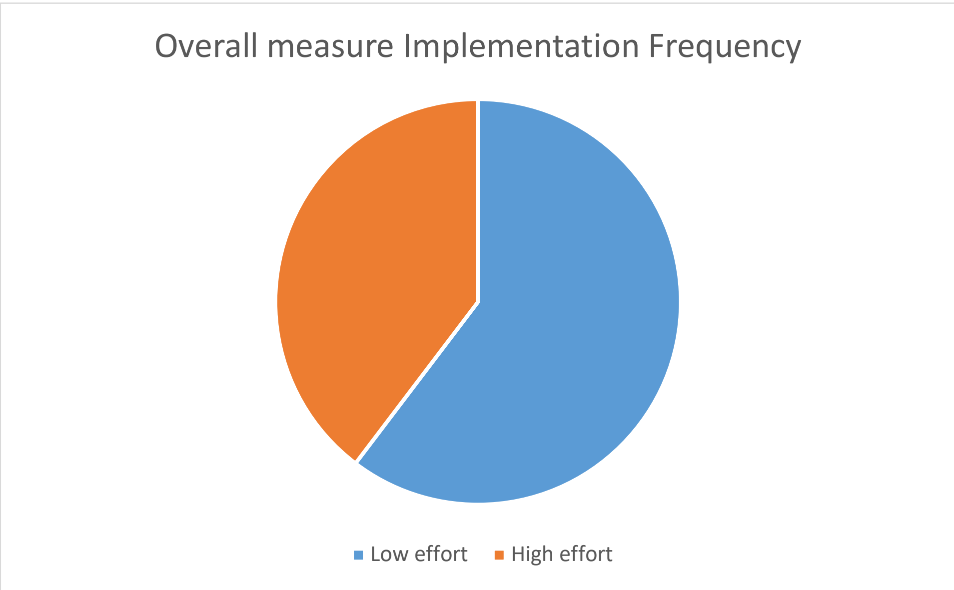


*Figure 43:Overall distribution of low and high effort measures based on total implementation frequency across all permits.*

Another interesting aspect is to see the distribution of low and high effort measures across the three different star package types as seen in the figure below:

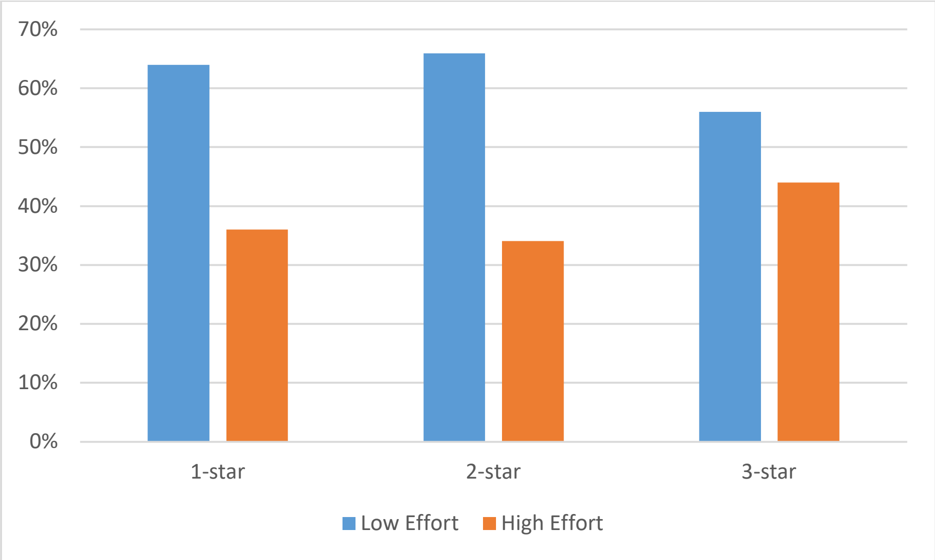


Figure 44:Distribution of low and high effort measures across different star package types.

The results show that:

- 64% of the total implemented measures in 1-star package are classified as low effort measures while 36% are high effort measures.
- 66% of the total implemented measures in 2-star package are classified as low effort measures while 34% are high effort measures.
- 56% of the total implemented measures in 3-star package are classified as low effort measures while 44% are high effort measures.

Moreover, it can be seen from figure 45 below:

- 18% of the total low effort measures are implemented in 1-star package,35% in 2-star package and 47% in 3-star package.
- 16% of the total high effort measures are implemented in 1-star package,28% in 2-star package and 57% in 3-star package.

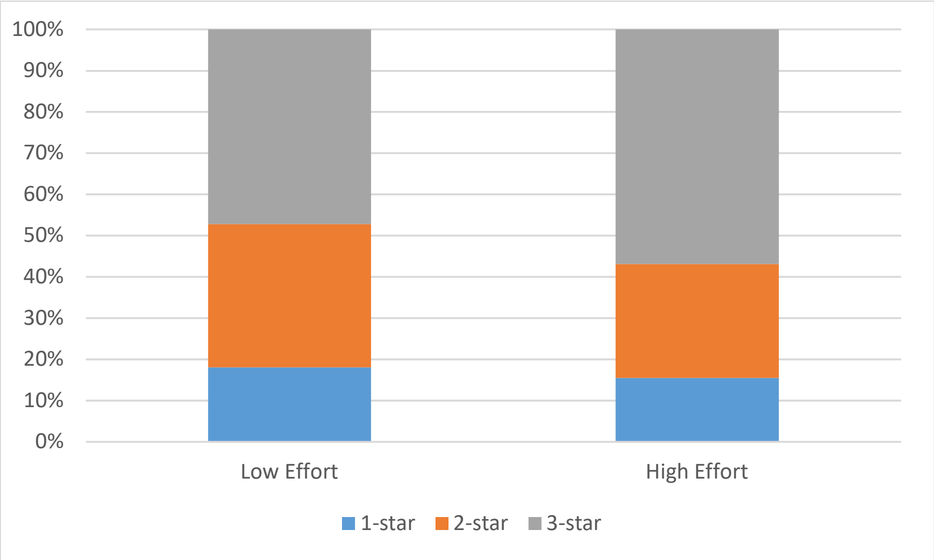


Figure 45:Distribution of star package types between low and high effort measures.

#### *4.6.2.3 Distribution of the most frequently implemented star package measures by zone.*

The overall distribution of the most selected measures (across the 57 permits that adopt star packages) across zones shows that central zones A and B have the largest shares (58% combined), followed by zone C while zone D represents only 8% of the total implementation as shown in the figure below:

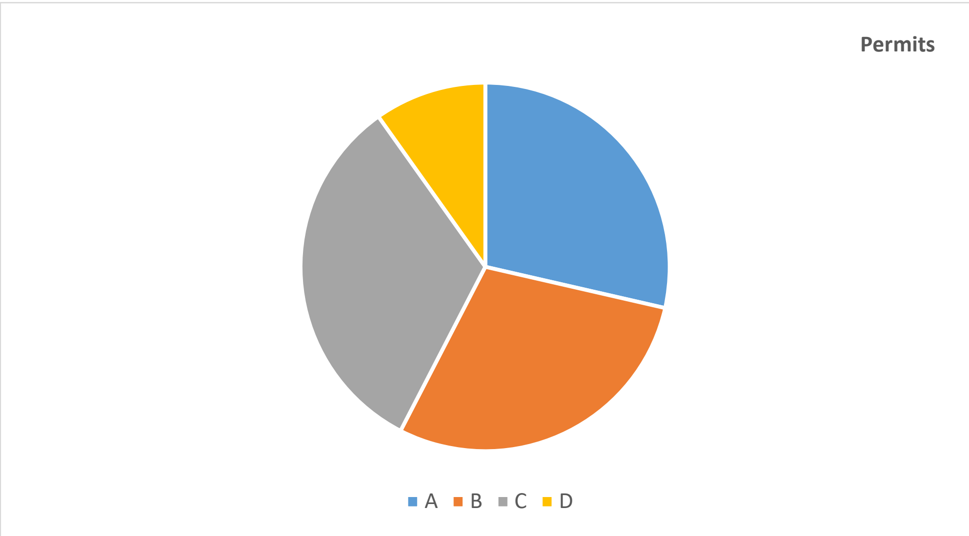


Figure 46: Overall distribution of the most selected measures-permit analysis.

Figure 47 below shows how each measure is distributed between different zones:

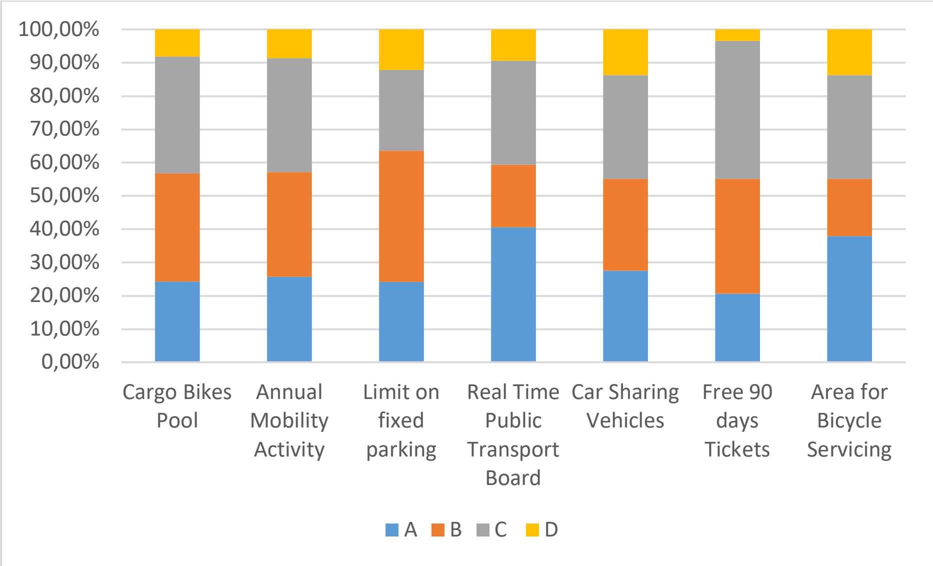


Figure 47:Percentage distribution of each selected measure across different zones according to permit analysis.

Some key observations include:

- All selected measures have a stronger presence in the more central zones (zone A and zone B combined) compared to the outer zones, with the combined share ranging between 55% and 64%.
- When considering individual zones separately, zone C shows the highest share for many measures, particularly free 90 day tickets.
- Real time public transport board and area for bicycle servicing show the highest individual share in zone A, while limit on fixed parking has the highest share on zone B.
- Zone D has the lowest share of all measures among all the zones, which can be explained by the characteristics of this zone where reliance on cars is generally higher.

While the previous figures illustrate the overall distribution and composition of the selected measures across zones to provide an overview of how the measures are represented across the studied permits, the following normalized analysis accounts for the unequal number of permits in each zone by examining the implementation rate of each measure within permits to get an additional insight into the implementation behavior of the permits across different zones:

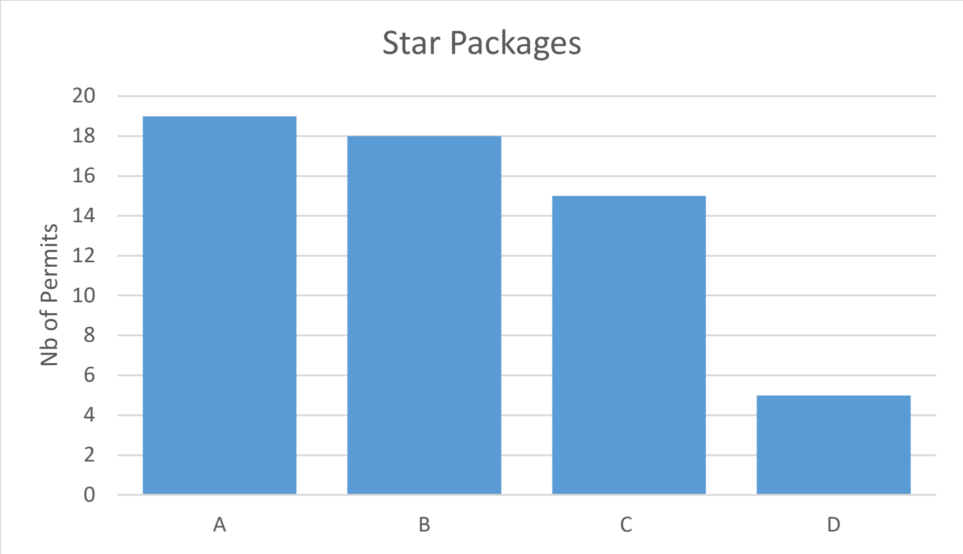


Figure 48:Distribution of permits adopting star packages across different zones according to permit analysis.

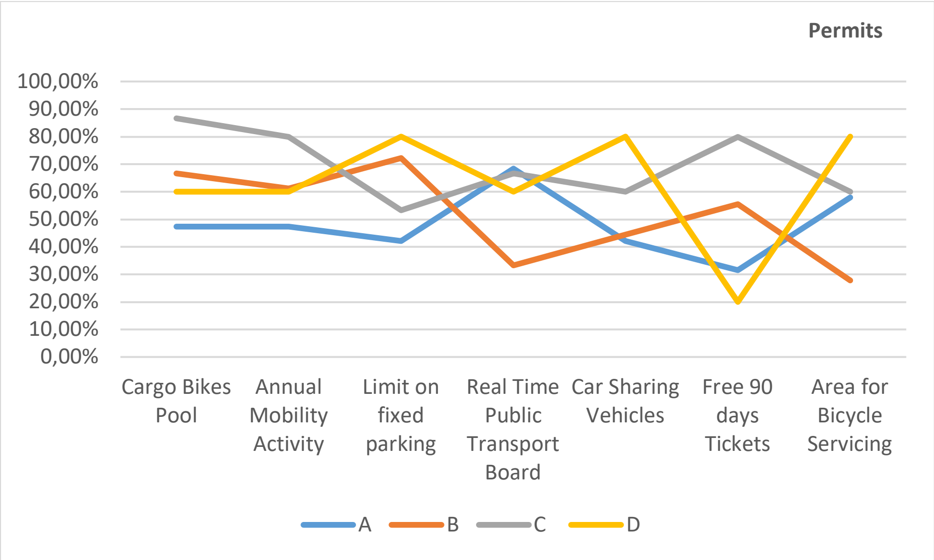


*Figure 49:Normalized implementation rate of the selected measures across zones, showing the percentage of permits within each zone that adopt each measure.*

The results show that:

- Permits in zone C and D tend to adopt several measures at higher rates which can be explained by their lower number of permits (especially zone D).
- In zone A,68% of permits include real-time public transport boards and 58% include area for bicycle servicing, while only 32% of permits include free 90 days tickets.
- In zone B, 72% of permits include limit on fixed parking and 67% include cargo bikes, while only 28% include area for bicycle servicing.

- In zone C, 87% of permits include cargo bikes pool and 80% include free 90 days tickets, while limit on fixed parking shows the lowest implementation rate within permits (53%).
- In zone D, 80% of permits include area for bicycle servicing, car sharing vehicles and limit on fixed parking, while only 20% include free 90 days tickets.

On the other hand, flat-based distribution (across the 8182 flats that are benefiting from star packages) shows a pattern broadly like the permit-based analysis. Zone A and zone B together still account for a slightly larger share (53%) compared to the outer zones, although the difference is smaller than in the permit analysis. At the same time, zone C shows a relatively strong representation across several measures while zone D remains the least represented zone overall. The detailed flat bases results are illustrated in the following three figures.

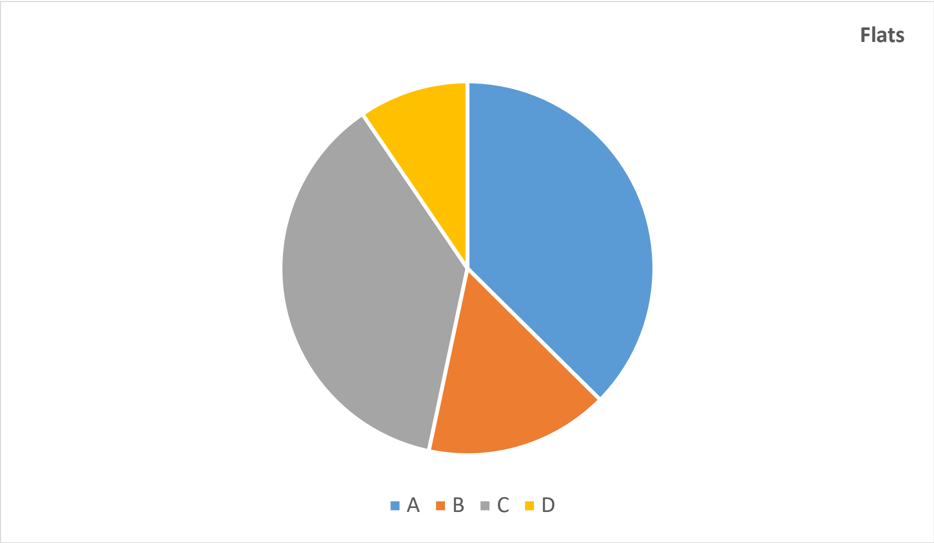


*Figure 50*: Overall distribution of the most selected measures-flat analysis.

Figure 51 below shows how each measure is distributed between different zones:

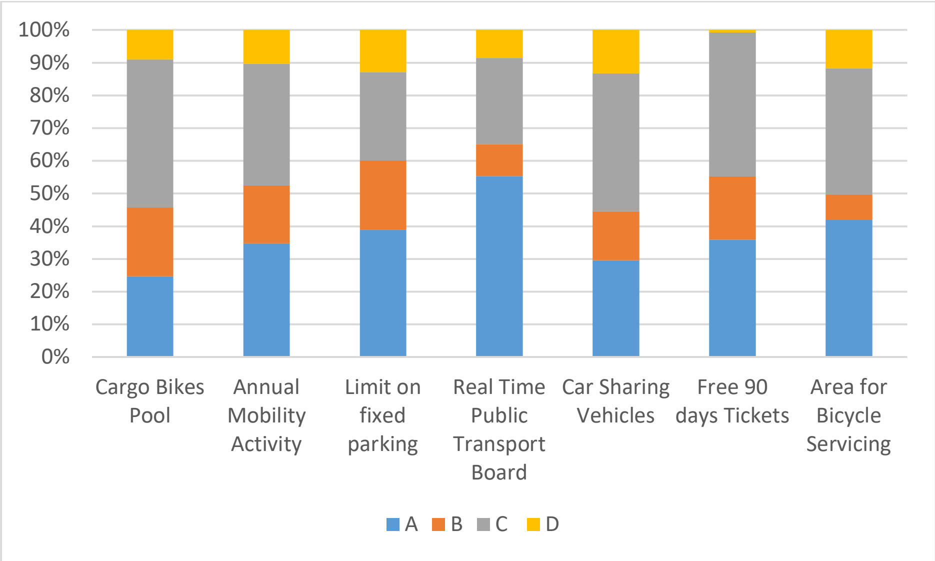


*Figure 51:Percentage distribution of each selected measure across different zones according to flat analysis.*

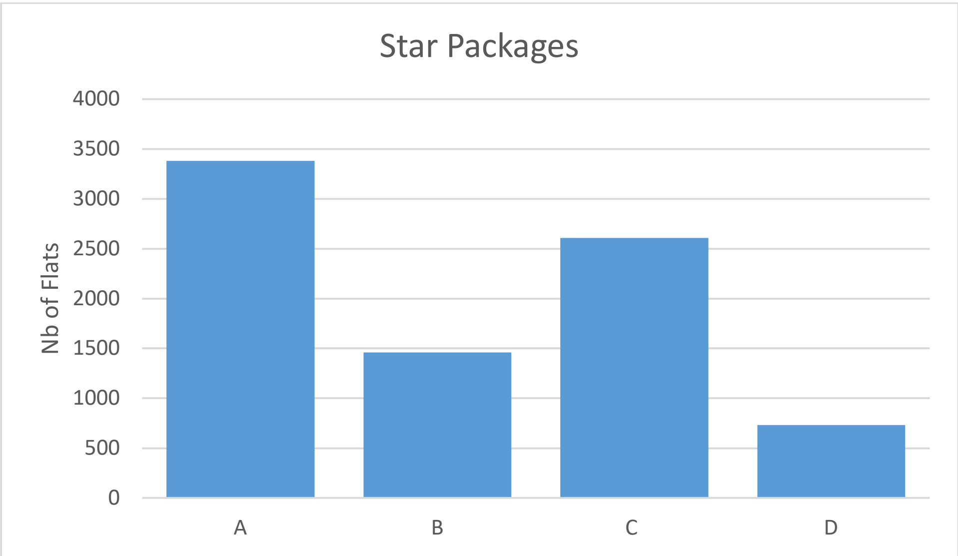


*Figure 52:*Distribution of permits adopting star packages across different zones according to flat analysis.

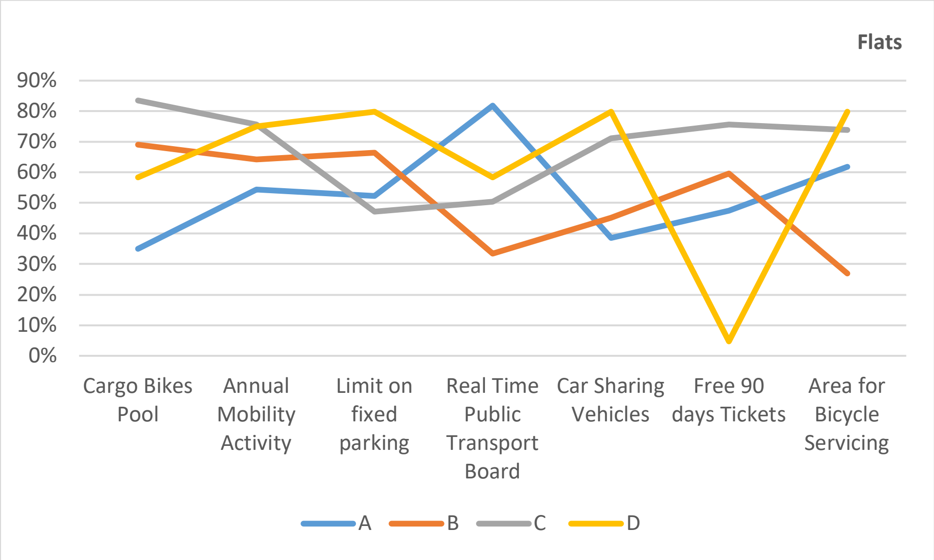


Figure 53 :Normalized implementation rate of the selected measures across zones, showing the percentage of flats within each zone that adopt each measure.

#### *4.6.2.4 Distribution of the most frequently implemented star package measures by year.*

The overall distribution of the most selected measures across the five years period shows that implementation was highest in 2021(40%),followed by a noticeable decline in the following years.However,2025 still represents a relatively significant share of the total implementation compared to 2023 and 2024,as shown in the figure below:

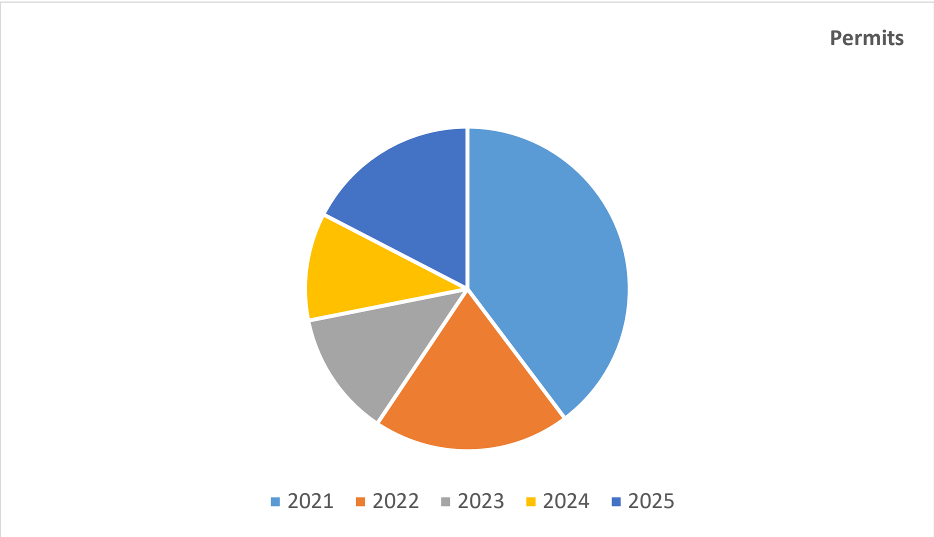


*Figure 54:Percentage distribution of each selected measure across different years according to permit analysis.*

Figure 57 below shows how each measure is distributed between different zones:

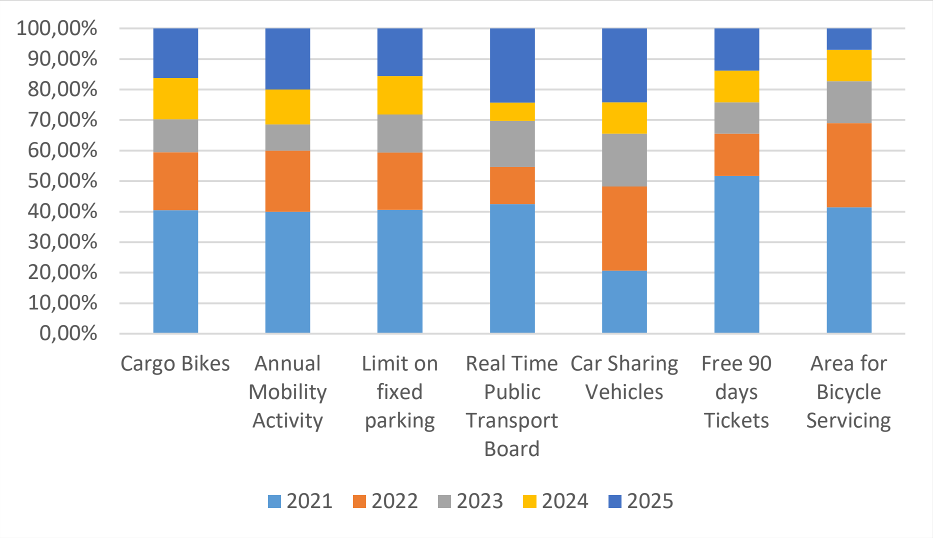


Figure 55:Percentage distribution of each selected measure across different zones according to permit analysis.

Some key observations include:

- Most of the measures show their highest implementation shares in 2021except for car sharing.
- More than half of the free 90-day tickets were implemented in 2021.

The following two figures examine the normalized distribution of the selected measures across years:

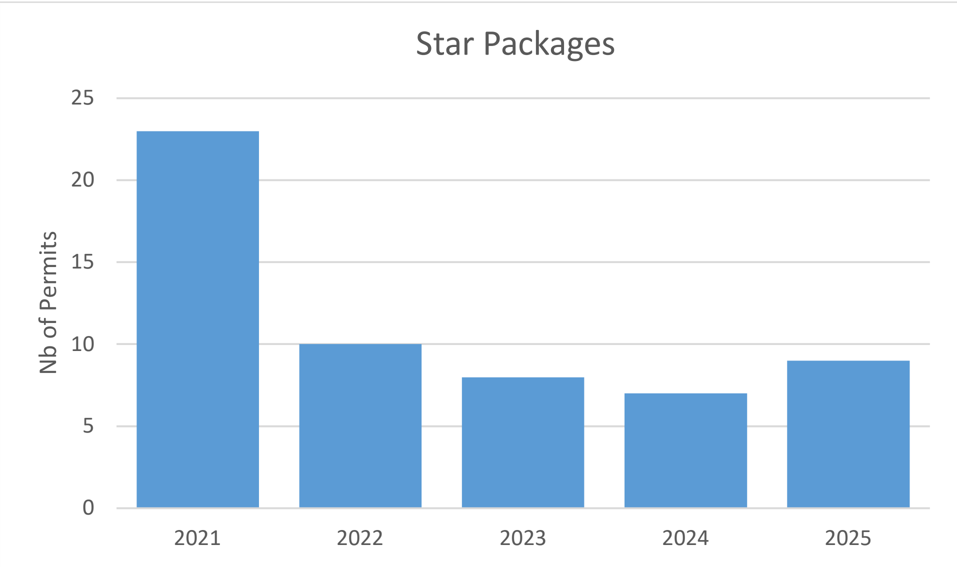


*Figure 56*:Distribution of permits adopting star packages across different zones according to permit analysis.

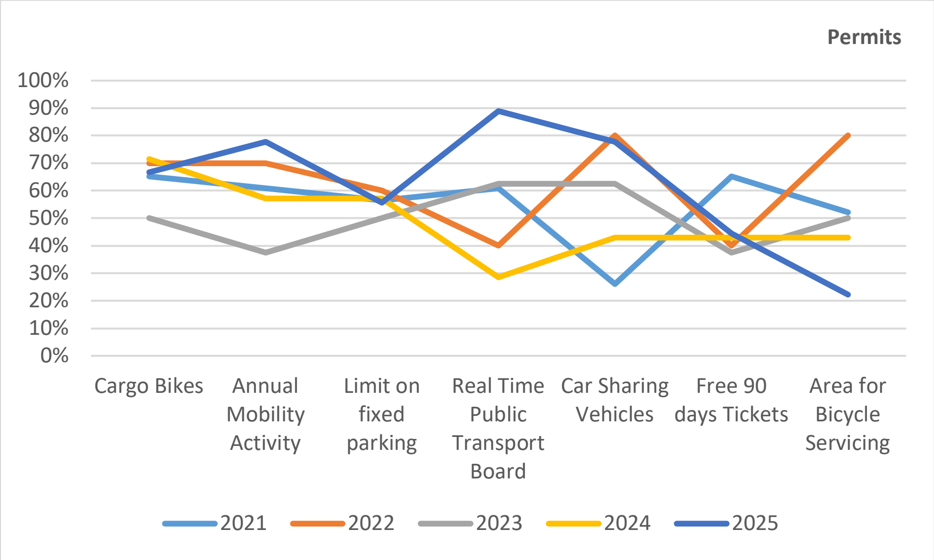


*Figure 57*:Normalized implementation rate of the selected measures across years, showing the percentage of permits within each zone that adopt each measure.

The results show that:

- No single approval year dominates across all measures. Instead, the highest implementation rates shift between years depending on the specific measure considered.
- In 2021,65% of permits include cargo bikes pool and free 90 days tickets, while only 26% include car sharing vehicles.
- In 2022,80% of permits include car sharing vehicles, while real time public transport board and free 90 days tickets show the lowest share (40%).
- In 2023,63% of permits include real time public transport boards and car sharing vehicles, while annual mobility activity and free 90 days tickets show the lowest implementation rates (38%).
- In 2024,71% of permits include cargo bikes pool and only 29% include real time public transport board.
- In 2025,89% include real time public transport board while only 22% include area for bicycle servicing.

For the flat based analysis, the same sequences were done, as illustrated in the following pictures:

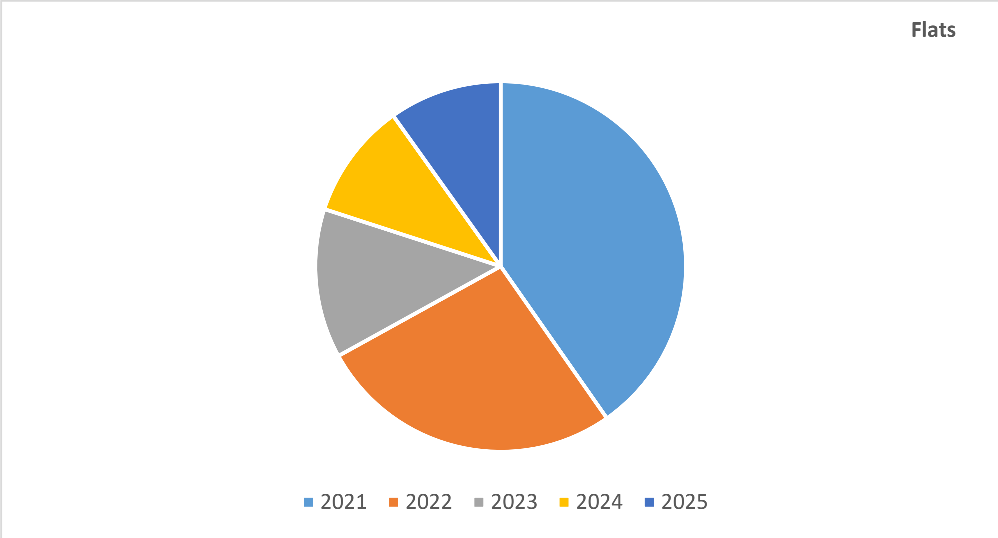


*Figure 58:Percentage distribution of each selected measure across different years according to flat analysis.*

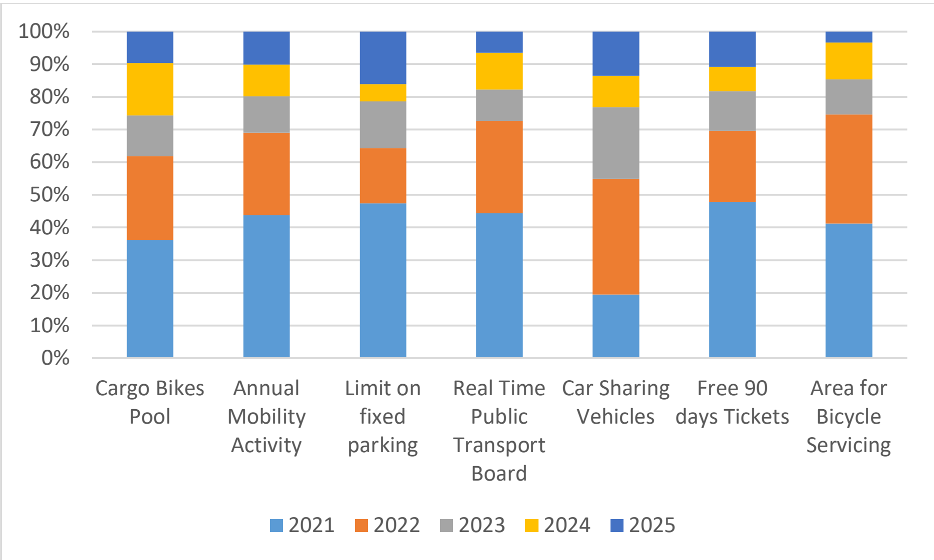


*Figure 59::Percentage distribution of each selected measure across different years according to flat analysis.*

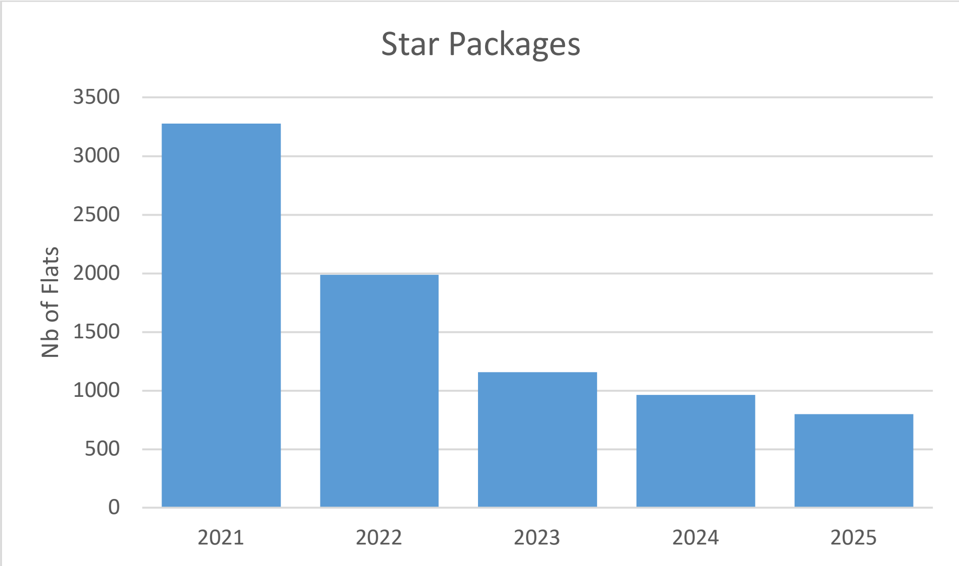


*Figure 60*:Distribution of permits adopting star packages across different zones according to flat analysis.

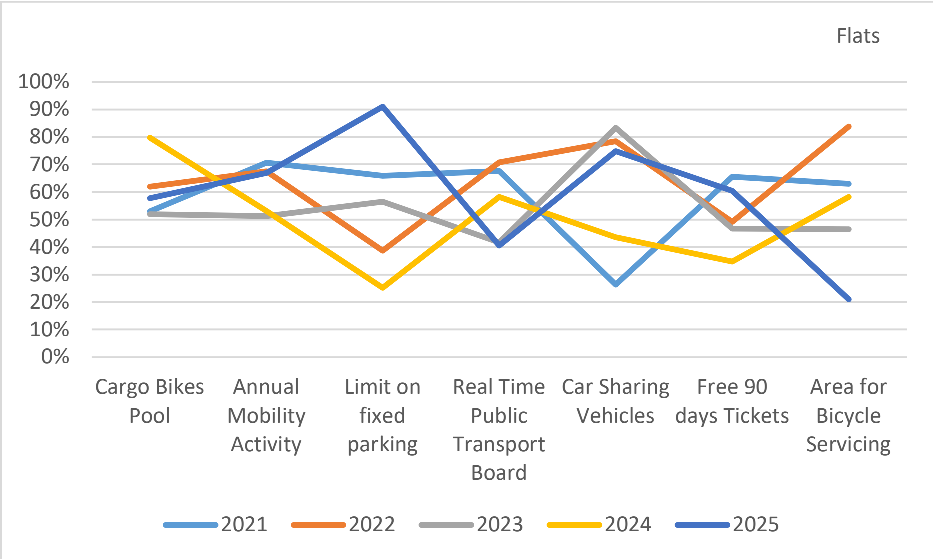


*Figure 61*:Normalized implementation rate of the selected measures across zones, showing the percentage of permits within each zone that adopt each measure.

Overall, the permit-based analysis reflects the measures selected and implemented by developers within the projects, while the flat based analysis provides an additional perspective on how these measures are distributed in relation to the benefiting flats. However, the permit-based analysis remains the primary focus of the “measures adopted” analysis as it more directly reflects the choices adopted within the projects.

# 5 Discussion

## 5.1 The parking investigation process and parking reductions.

The results of this study suggest that the Gothenburg parking assessment framework reflects a broader shift in urban planning where parking is increasingly being treated as a mobility and sustainability issue rather than simply a technical requirement linked to housing construction. Instead of relying on fixed parking standards, the projects demonstrate a system where parking reductions are achieved through multiple assessment steps linked to accessibility conditions, project characteristics, and mobility measures. This differs from more traditional parking planning approaches, particularly those historically applied in car-oriented countries such as the United States, where standardized minimum parking requirements focused primarily on accommodating private car use [18].

The reductions achieved through the different steps indicate that the framework does not simply aim to reduce the number of parking spaces in a uniform manner but rather to attempt to adapt parking provision to urban context and mobility conditions. Previous parking research has similarly argued that flexible parking systems can provide municipalities with opportunities to better adapt parking provision to broader sustainability and transport policy goals, such as encouraging public transport and reducing car dependency [19,20].This also means that the framework is partly based on the assumption that residents may adapt their travel behavior when parking availability is reduced and mobility alternatives are improved. For example, if parking becomes less available or less convenient, some residents may instead choose public transport, cycling, or shared mobility options. In this way, the parking investigation is not only used to calculate parking needs, but also to encourage more sustainable travel behavior over time. Previous research has similarly argued that parking availability itself can influence travel behavior, since easy access to parking generally encourages car use, while reduced parking supply may discourage dependence on private vehicles [18,7].

However, the results also suggest that the effects of reduced parking provision on travel patterns may depend strongly on the surrounding urban context and accessibility conditions. Previous studies have shown that reduced parking provision can contribute to lower car ownership and reduced car use, especially in dense urban areas with good access to public transport [21,22]. Previous studies from Gothenburg have shown that central and more accessible areas tend to have lower car dependency, while other areas generally show higher dependency on private vehicles [17]. This seems to be consistent with the results of this study, where central areas (zone A and parts of B) generally achieved larger parking reductions, while other areas showed lower reduction potential. At the same time, previous research has emphasized that parking reductions alone may not significantly reduce car dependency if realistic transport alternatives remain insufficiently developed [23]. This suggests that the effectiveness of parking reductions is closely linked to accessibility, urban structure, and the availability of sustainable mobility options.

Another important observation from the results is that the parking investigation framework allows parking reductions to vary depending on the conditions of each project. Factors such as accessibility, location, and mobility measures appear to influence how large reductions can be achieved in different developments. This creates flexibility within the framework and allows parking requirements to be adapted to different urban contexts rather than applying the same reduction approach to all projects. At the same time, the variation in reduction outcomes between projects indicates that project-specific assessments remain an important part of the implementation process. Similar challenges between standardized parking requirements and more flexible project-based approaches have also been discussed in previous international parking policy research [20,24].

## 5.2 Mobility agreements and mobility measures.

### 5.2.1 Mobility agreements.

Although all the reduction steps contribute to the final parking demand, the results indicate that step 4(mobility agreements) often represent one of the most influential reduction steps within the projects analyzed. This highlights the importance of this step within the Gothenburg framework and suggests that the municipality sees such measures as the best option to reduce parking provision. At the same time, a possible interpretation of these results is not necessarily that mobility agreements are exceptionally effective and earlier step reductions are not, but rather that the initial parking norms (starting value) have relatively high values : during an interview with Torunn Vikengren(at Gothenburg city)it was argued that mobility agreements are often used to reduce the final parking norm to a more realistic level and that a more effective approach could instead involve lowering the p-norm initial value itself and combine this reduced starting value with accessibility conditions, public transport availability and mobility agreements would be the best optimization.

At the same time, the results also indicate that mobility agreements should not be understood as isolated solutions. The reduction outcomes related to mobility agreements appear strongly connected to the previous investigation steps, particularly accessibility conditions and urban structure (step 2). For example, the results showed that projects located in more central and accessible zones generally achieve larger reductions in step 4 compared to projects in outer areas.This confirms that mobility agreements may function most effectively when combined with favorable accessibility conditions and urban environments. In fact, in these areas residents have already stronger opportunities to rely on sustainable transport modes which increase the practical effectiveness of mobility agreements and allow larger parking reductions to be achieved. However, mobility agreements require long-term implementation and management for measures to remain active and effective over time. This means that the success of larger parking reductions may depend not only on planning conditions and accessibility, but also on continued operational commitments from developers and property owners.

### 5.2.2 Mobility measures.

The results suggest that the implementation of mobility measures within the Gothenburg framework reflects a balance between practical feasibility, economic considerations, and ambitions for sustainable mobility. Although low-effort measures represented the larger share of measures implemented, high-effort measures still accounted for a significant share of the total allocation. This indicates that developers do not only rely on simpler simpler measures but are also willing to implement more demanding mobility measures to achieve greater parking space reductions.

An interesting observation is that the large proportion of the high-performing measures were adopted in 2- and 3-star agreements rather than 1-star agreements. Measures such as carpools, area for bicycle servicing and other more operationally demanding mobility solutions were more frequently included in agreements that provide larger parking reductions. This may indicate that developers are more willing to invest in measures that require higher financial costs, long-term management, or operational responsibility when larger parking reductions can be achieved in return: since the construction of parking spaces, especially structured or underground parking is often associated with significant financial costs, the implementation of more advanced mobility measures may in some cases still represent an economically advantageous option for developers. Previous research related to Gothenburg has similarly highlighted that mobility agreements and reduced parking can contribute to lower construction costs while supporting more sustainable transport options [25]. From this perspective, the implementation of high-effort measures can reflect not only sustainability ambitions, but also strategic economic considerations within the planning process.

The results also indicate that some mobility measures were frequently used across projects and zones regardless of geographical differences. Measures related to improved bicycle parking, bicycle repairs, annual mobility activities, public transport incentives, and car sharing were relatively consistent across many of the projects analyzed. This may indicate that some measures have gradually become standardized within the mobility agreements as a ‘one standard set’’ and are considered easier to implement administratively, easier to standardize across projects and more economically manageable compared to other measures.

On the other hand, several measures were rarely or not implemented at all in the analyzed permits between 2021 and 2025 such as digital services for mobility, open mobility solutions (who were both implemented in the framework in 2021)and shared office spaces. This may indicate that these measures are still difficult to integrate into housing projects due to uncertainty about their effectiveness, implementation complexity, management requirements, or lack of established application within the planning process. It may also indicate that developers and municipalities tend to rely more on measures that are already familiar and more predictable in practice. Consequently, the results raise questions about whether the current framework sufficiently encourages experimentation and innovation within mobility agreements, or whether it favors a relatively standardized set of recurring measures.

Another important aspect is if different mobility measures correspond to the needs and mobility behavior of residents. Although the framework uses similar categories of measures across projects, the effectiveness of these measures may vary depending on household composition, age groups, mobility habits and everyday travel needs. For example,measures such as bike sharing or public transport incentives may work differently depending on residents’ accessibility conditions, travel distances or reliance on private vehicles in everyday life. Previous research related to Gothenburg emphasized that travel behavior and the use of mobility services can vary significantly between different resident groups and everyday mobility needs, which may influence how effective each mobility service becomes in practice [26]. This raises an important discussion about whether mobility agreements should rely on relatively standardized mobility packages or whether greater adaptation to specific resident groups and local mobility conditions may be necessary in the future.

## 5.3 Geographical variation in parking reduction.

The geographical variation between zones suggests that parking reductions in Gothenburg are influenced not only by accessibility conditions, but also by how the whole parking investigation process is applied in different urban contexts. Although the more central zones generally achieved greater reductions, the comparison between zones B and C indicates that better accessibility alone does not automatically result in the highest total reduction levels. This suggests that the final reduction results are also strongly linked to how different assessment steps and reduction opportunities are structured within the Gothenburg framework itself. Previous Gothenburg-related studies have similarly emphasized that parking reductions and mobility agreements are shaped by a combination of accessibility conditions, planning priorities and the municipality's zoning structure rather than by location alone [17,25].

For step 4, the geographical implementation of mobility agreements followed a specific pattern. Mobility agreements and star packages were most often implemented in zones A and B, while lower implementation levels were observed in zones C and D. One explanation is that the more central and accessible parts of the city generally provide better conditions for mobility measures such as public transport, cycling and shared mobility services, making these measures more feasible to implement in practice. Previous studies have also highlighted that central city developments are facing pressure to optimize land use [27]. In such circumstances, reducing parking supply through mobility agreements (since reductions in step 2 is limited to the guideline norms and step 3 is related to apartments size) may become more attractive, as parking spaces compete with other land uses in dense urban areas.

Furthermore, building parking spaces can be expensive, especially underground garages [28]. This means that mobility agreements in central areas may offer developers a way to reduce costly parking construction. In addition, a study on land values in Gothenburg has shown that central locations generally imply higher land values compared to outer areas [29], especially Zone D which implies that building parking is cheaper in these districts which reduce the need for further parking reductions through mobility agreements.

## 5.4 Suggestions for future research

Several aspects identified during this research deserve further investigation:

- the relatively short timeframe of 2021–2025 makes it difficult to draw strong conclusions regarding long-term development trends so future studies covering longer time periods may become important for evaluating whether the trends identified in this study (results chapter) represent temporary implementation patterns or more permanent shifts in Gothenburg's parking policy approach.

- Regarding the mobility agreements, the implementation rate of mobility agreements remained relatively stable at approximately 65–70% throughout the studied period. However, the results do not clarify whether mobility agreements were consistently implemented by the same developers over time, or whether some developers systematically preferred mobility agreements while others rarely adopted them. Further investigation could therefore help determine whether these implementation rates are similar across all developers, or whether the differences are mainly due to certain developers adopting mobility agreements more frequently than others rather than geographical or economic conditions especially that a previous study show that the developer's own approach and strategies are one of the causes that affect the implementation of mobility measures and agreements[4].

- Further qualitative research based on interviews with developers and municipalities could also provide their suggestions on how to increase the attractiveness and practical implementation of mobility agreements as well as identify possible alternatives for the mobility measures that they rarely or never used.

- Future research could further investigate the relationship between parking reductions and actual car ownership patterns within the city. Previous Gothenburg studies already analyzed car ownership differences between parking zones using older datasets (2004-2012) [17]. However, more recent car ownership statistics available through Göteborgs Stad Statistikdatabas [30] are generally organized by individual geographical areas rather than by the parking investigation zones used in this study. Conducting a detailed comparison between updated car ownership patterns and parking reduction levels would therefore require additional geographical classification and data processing beyond the scope of the present study. Such analysis could nevertheless provide valuable insights into how well parking reductions and mobility measures align with actual car dependency across different urban contexts in Gothenburg.

- Further research could additionally combine parking reduction analysis with economic cost estimations for parking construction and mobility measures which could help determine whether in some areas it is cheaper to implement mobility measures or build parking instead.

# 6 Conclusion

This thesis examined how Gothenburg's parking investigation process is implemented in practice through building permits for housing between 2021 and 2025. By analyzing parking assessments, reduction steps and mobility agreements across different zones and years, the study aimed to better understand how parking requirements are adapted in relation to accessibility, housing characteristics and sustainable mobility measures.

The results show that Gothenburg's parking policy has evolved into a relatively flexible system where parking supply is no longer solely determined by fixed parking standards. Instead, the final parking quantity is influenced by a combination of accessibility conditions, project-specific characteristics and mobility agreements. The results show that the different reduction steps interact with each other rather than operate independently of each other, which means that the final parking supply reflects both the project's location and the measures included in it.

One of the clearest findings is the importance of geographical context in the investigation process. More central and accessible zones generally achieve larger parking reductions, while outer zones tend to maintain higher parking levels. This suggests that Gothenburg's parking policy is strongly linked to broader urban planning goals, where accessibility to public transport and urban density plays an important role in shaping parking demand and mobility strategies.

The study also shows that mobility agreements have become an established part of the planning process in Gothenburg. Most projects that adopted mobility agreements included both basic and star packages, which suggests that developers are increasingly integrating mobility measures into housing developments. However, the analysis also shows that some mobility measures are much more common than others, especially measures that require less effort or investment. This raises important questions about the difference between fulfilling the requirements of mobility agreements and creating measures that can contribute to long-term behavioral change and reduced car dependence.

Based on the results, future development of parking policies and mobility agreements could place more emphasis on the long-term effectiveness and follow-up of implemented mobility measures rather than mainly on the adoption of specific packages. In addition, further evaluation should be made of how different reduction steps affect actual mobility.

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