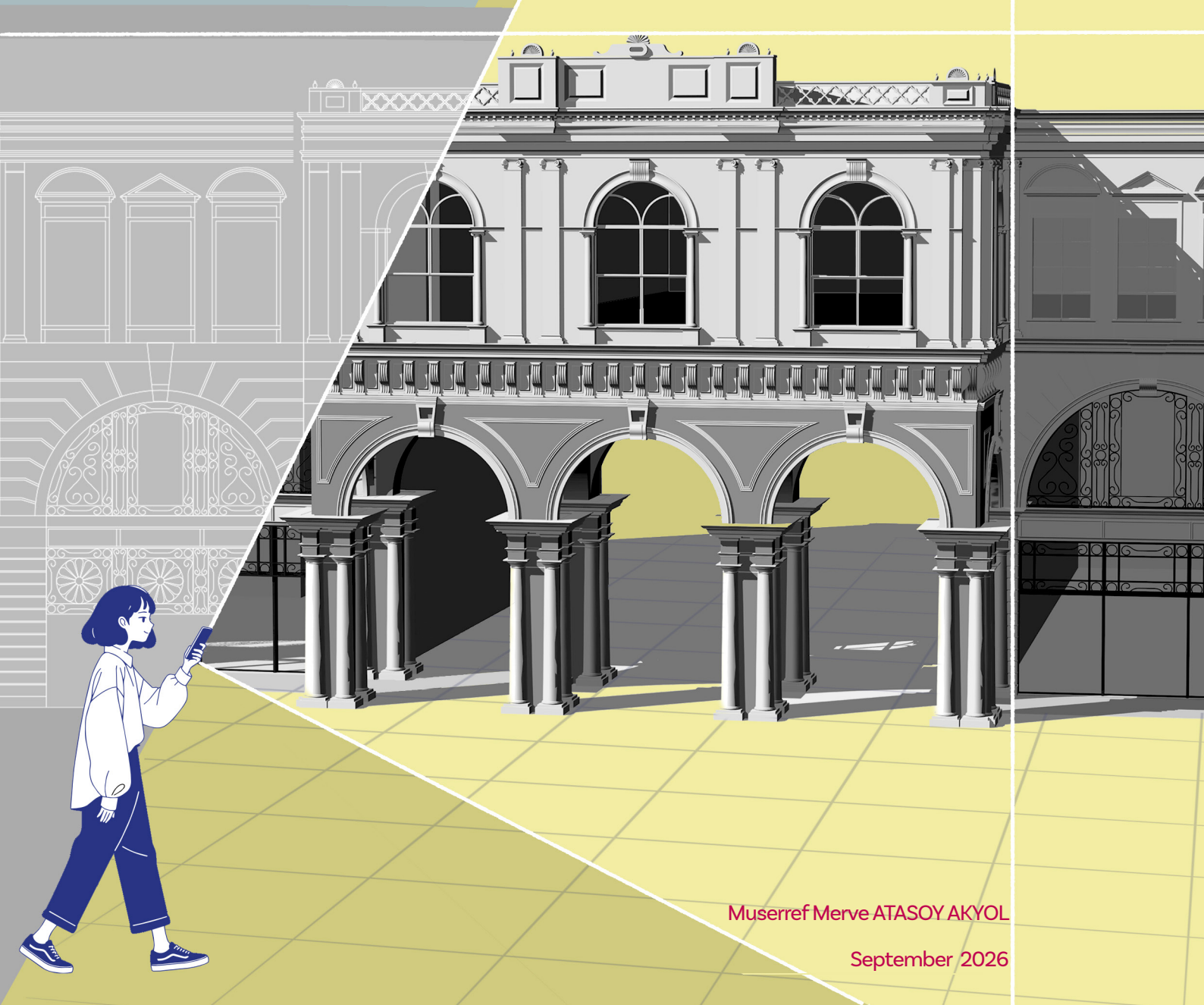
Politecnico di Torino
Architecture Construction City

Reconnecting Lost Architectural Layers with the Present City:

Source-Based Digital Modelling and Mobile AR in Tophane, Istanbul



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September 2026



Politecnico di Torino

Master of Science Program in Architecture Construction City

Reconnecting Lost Architectural Layers with the Present City: Source-Based Digital Modelling and Mobile AR in Tophane, Istanbul

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Politecnico Di Torino
Academic Year 2025/2026

Acknowledgement

This thesis looks for what is no longer visible. Following the traces of lost buildings has also meant questioning how we see what remains. Looking often follows the rhythm of habit: we pass over familiar places with the sense that we already know them. Seeing begins when we question that certainty. It takes a conscious effort to notice what we have learned to overlook, and patience to recognise how seemingly unrelated fragments might belong together.

My own way of seeing has also taken shape through relationships. The questions I ask and the things I notice carry something of the people who have shared their thoughts, time, and care with me. Their contributions are not always visible in the drawings or the words, but they belong to this work. Here, I want to thank those whose presence made it possible.

To my supervisor, thank you for your guidance, thoughtful questions, and careful reading of this work.

To my parents, my brothers, and my grandmother, thank you for your love and for always standing beside me. I have been able to make my own choices knowing that I would have your support. That certainty has meant a great deal to me.

To my husband, Fahri, thank you for your love and for being beside me through this process. Some days I needed encouragement; on others, simply your company. I am grateful for both.

Finishing this thesis is a moment I am happy to share with all of you.

Abstract

This thesis examines how the demolished architectural layers of Tophane, Istanbul, can be interpreted through incomplete historical evidence and related to the present city through mobile augmented reality (AR). Tophane developed around Tophane-i Âmire as a military-industrial district. Demolition, road construction, and later redevelopment gradually weakened the spatial relationships between its buildings, square, monuments, and waterfront. The study focuses on four demolished building volumes that once formed part of this wider setting. Historical maps, photographs, written sources, and surviving structures were examined together. The Pervititch insurance map was georeferenced in QGIS to establish the approximate footprints and positions of the selected buildings. Historical photographs and surviving monuments were then used to interpret their massing, façade rhythms, proportions, and architectural details. The resulting source-based digital models were developed in Revit using parametric families and modular components, which allowed the interpreted elements to remain editable. The models were subsequently transferred to a Unity-based mobile AR prototype and positioned on site through local reference points, direction, and scale adjustments. The field tests showed that mobile AR supported a direct spatial comparison between the interpreted historical volumes and the contemporary environment. The models clarified the former scale of the demolished buildings, the boundaries they created, and their relationships with the surviving monuments. Their overlap with present roads, pedestrian routes, and open spaces also made the effects of later urban transformations more legible. Considered through the concepts of the urban Wunderkammer, the performing museum, and the tourist gaze, the prototype suggests how mobile AR could direct attention from isolated monuments towards the wider spatial history of the site. The study does not present the models as exact reconstructions or the AR placement as verified geospatial positioning. Both remain limited by the available historical evidence and the manual calibration method. Since no visitor study was conducted, the effects of the prototype on perception and engagement cannot be confirmed. Within these limits, the project establishes a source-based and site-responsive approach to making demolished architectural layers perceptible within the present city and provides a basis for further interdisciplinary development.

Keywords: Mobile augmented reality; source-based digital modelling; digital heritage;
urban memory; urban Wunderkammer; tourist gaze; Tophane, Istanbul.

Riassunto

Questa tesi esamina come le stratificazioni architettoniche perdute a seguito delle demolizioni a Tophane, Istanbul, possano essere interpretate attraverso testimonianze storiche incomplete e messe in relazione con la città attuale mediante la realtà aumentata (AR) su dispositivi mobili. Il quartiere di Tophane si è sviluppato intorno a Tophane-i Âmire come distretto militare e industriale. Le demolizioni, la costruzione di strade e i successivi interventi di trasformazione urbana hanno progressivamente indebolito le relazioni spaziali tra gli edifici, la piazza, i monumenti e il lungomare. Lo studio si concentra su quattro volumi edilizi demoliti che un tempo facevano parte di questo contesto più ampio. Mappe storiche, fotografie, fonti scritte e strutture superstiti sono state esaminate insieme. La mappa assicurativa di Pervititch è stata georeferenziata in QGIS per individuare in modo approssimativo le impronte a terra e le posizioni degli edifici selezionati. Le fotografie storiche e i monumenti superstiti sono stati poi utilizzati per interpretare le volumetrie, i ritmi delle facciate, le proporzioni e i dettagli architettonici di questi edifici. I modelli digitali basati sulle fonti sono stati sviluppati in Revit utilizzando famiglie parametriche e componenti modulari, che hanno permesso di mantenere modificabili gli elementi interpretati. I modelli sono stati successivamente trasferiti in un prototipo di AR mobile sviluppato in Unity e posizionati sul posto mediante punti di riferimento locali e regolazioni dell'orientamento e della scala. Le prove sul campo hanno mostrato che l'AR mobile ha consentito un confronto spaziale diretto tra i volumi storici interpretati e l'ambiente contemporaneo. I modelli hanno chiarito la scala degli edifici demoliti, i limiti spaziali che definivano e le loro relazioni con i monumenti superstiti. La loro sovrapposizione alle strade, ai percorsi pedonali e agli spazi aperti attuali ha inoltre reso più leggibili gli effetti delle successive trasformazioni urbane. Letto attraverso i concetti di Wunderkammer urbana, museo performativo e sguardo del turista, il prototipo suggerisce come l'AR mobile possa spostare l'attenzione dai singoli monumenti verso la più ampia storia spaziale del sito. Lo studio non presenta i modelli come ricostruzioni esatte, né la loro collocazione in AR come un posizionamento geospaziale verificato. Sia i modelli sia il loro posizionamento restano limitati dalle testimonianze storiche disponibili e dal metodo di calibrazione manuale. Poiché non è stato condotto alcuno studio sui visitatori, non è possibile confermare gli effetti del prototipo sulla percezione e sul coinvolgimento. Entro questi limiti, il progetto definisce un approccio basato sulle fonti e adattato alle condizioni del sito per rendere percepibili le stratificazioni architettoniche perdute nella città attuale e fornisce una base per ulteriori sviluppi interdisciplinari.

Parole chiave: Realtà aumentata mobile; modellazione digitale basata sulle fonti; patrimonio digitale; memoria urbana; Wunderkammer urbana; sguardo del turista; Tophane, Istanbul.

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1. Introduction

1.1 Background of the Study

Some parts of a city's past remain visible through individual buildings, while others survive only in maps, photographs, and written records. This becomes particularly important when demolition removes both physical structures and the connections they once formed with streets, public spaces, and neighbouring buildings. The remaining monuments may still be recognised, but the wider setting to which they belonged can become difficult to read. Urban memory is connected with the relationships between surviving and absent layers as well as with the buildings themselves. Digital technologies offer additional ways of studying and communicating architectural layers that are no longer physically accessible (Ma et al., 2025).

Tophane shows this layered condition clearly. Following the Ottoman conquest of Constantinople, the area developed around Tophane-i Âmire as an important centre of military production. Foundries, factories, workshops, barracks, administrative buildings, and storage facilities gradually formed a large military-industrial complex connected with Tophane Square and the waterfront. The construction of Tophane Fountain, Nusretiye Mosque, Tophane Pavilion, and Tophane Clock Tower also strengthened the monumental and representative character of the area. By the nineteenth century, military production, public life, maritime activity, and imperial representation were closely connected within the same urban setting (Ceylan, 2003; Çevik Azap, 2022; Özgencil Yıldırım, 2008).

This organisation changed considerably during the twentieth century. The military and industrial functions of Tophane gradually declined, while road works, demolitions, port development, and changes to the shoreline altered the relationship between the square, the waterfront, and Tophane-i Âmire. Several factories, barracks, and administrative buildings were removed during the 1950s. Tophane-i Âmire, Nusretiye Mosque, Tophane Fountain, and Tophane Pavilion remained, but much of the built environment that had connected them disappeared (Ceylan, 2003; Çevik Azap, 2022). In later years, new uses were introduced. Tophane-i Âmire was adapted as a culture and art centre, and museums and cultural institutions became part of the surrounding area. More recently, Galataport reopened access to the waterfront while bringing new commercial spaces and visitor activity to the shoreline (Erbil & Erbil, 2024).

Visitors to Tophane today encounter historical monuments, cultural institutions, open spaces, commercial developments, and traces of earlier urban arrangements within a relatively compact area. These elements belong to different periods and functions, but their historical relationships are not always apparent in the present setting. This condition is interpreted in the thesis through the metaphor of a fragmented urban Wunderkammer. Similar to a collection containing heterogeneous objects, Tophane brings together architectural and urban elements with different origins. However, they have not been deliberately arranged to communicate a shared narrative. How the area is understood depends partly on the movement and attention of the visitor.

The concept of the tourist gaze is relevant to this experience. Urry describes tourism as a socially organised way of seeing, shaped by expectations and existing representations of places (Urry, 2002). In Tophane, visually prominent monuments, museums, and the redeveloped waterfront influence what visitors recognise as worth seeing. Mobile devices have also become part of this process through the continuous production and circulation of photographs and videos. Han's discussion of digital visibility suggests that an increase in images and information does not necessarily lead to a deeper understanding of a place (Han, 2015, 2017). Within such a visual environment, less visible historical relationships can remain outside the immediate experience of the visitor.

Developments in museology offer another way of approaching this situation. Museums have gradually extended their role from preserving and displaying objects towards interpreting their contexts and involving visitors more actively. Digital and hybrid practices have also allowed cultural heritage to be presented beyond the physical museum building (F. Cameron & Kenderdine, 2007; Desvallées & Mairesse, 2010).

Casey's performing museum gives particular importance to movement, spatial organisation, and the experience created around the object (Casey, 2003). This perspective is relevant to Tophane because the buildings examined in this study cannot be separated from their former locations. Their significance also comes from their relationship with the square, the waterfront, and the structures that have survived.

Mobile augmented reality can bring a digital representation into direct contact with these locations while keeping the present environment visible. In architectural heritage, this makes it possible to view a demolished building in relation to its original setting rather than as an isolated model (Carmigniani & Furht, 2011; Liestøl, 2021). Movement through the site and comparison between the physical and digital layers then become part of the experience. The same mobile device commonly used to photograph and share a place can also support a slower process of looking, moving, and comparing. AR cannot by itself determine how visitors understand Tophane, but it creates the potential to direct attention towards historical and spatial relationships that are no longer immediately visible.
The study brings these subjects together through the source-based digital modelling of four demolished building groups associated with Tophane-i Âmire and their presentation through mobile AR. The models are placed within their estimated historical locations and viewed in relation to the surviving buildings and current spaces of Tophane. The research considers how lost architectural layers can be read within the contemporary city and how their on-site presentation may support a more attentive engagement with Tophane's urban memory.

1.2 Research Problem

The central problem addressed by this thesis is the loss of the spatial framework that once connected the military-industrial buildings of Tophane with the square, the waterfront, and the surviving monuments. The buildings demolished during the twentieth century had defined the boundaries, scale, and organisation of the area. Their removal changed more than its architectural appearance. It also weakened the relationships between Tophane-i Âmire, Nusretiye Mosque, Tophane Fountain, Tophane Pavilion, and the surrounding public spaces (Ceylan, 2003; Çevik Azap, 2022). These structures are still visible today, but the larger system to which they belonged can no longer be experienced directly on the site.

This absence also creates a problem of architectural representation. The demolished buildings cannot be documented through a present-day survey, and the surviving information is distributed across historical maps, photographs, engravings, and written records. These sources provide evidence about former locations, proportions, façade arrangements, and spatial relationships, but they do not offer a complete record of every building. Each source presents a different part of the former environment and must be considered in relation to the others. Digital modelling involves interpretation as well as documentation. The resulting models cannot be treated as exact copies of the lost buildings; they are source-based representations developed from the available evidence.

The way these models are presented is another part of the problem. A model viewed separately from the site can communicate architectural form, but it does not fully show how the building related to the dimensions, distances, and surviving elements of Tophane. These relationships become easier to recognise when the digital model is viewed in its estimated former location. Mobile AR is relevant here because it keeps the present environment visible while adding a digital architectural layer. However, placing a model on the site is not sufficient on its own. The digital and physical layers need to be connected in a way that helps the user compare them and understand why the absent building matters within the current setting.

The present character of Tophane makes this question particularly important. Visitors encounter well-known monuments, museums, cultural venues, and the Galataport waterfront, all of which contribute to the contemporary image of the area. The demolished military-industrial buildings

cannot attract attention in the same way because they no longer have a visible presence. As a result, the historical relationships that once organised the area may remain outside the visitor's immediate experience. In terms of the tourist gaze, what is currently visible and widely represented can become more noticeable than the layers that require interpretation (Urry, 2002). The fragmented urban Wunderkammer used in this thesis describes this coexistence of visible, transformed, and absent elements without a shared narrative connecting them.

The research problem concerns how these missing architectural layers can be interpreted, represented, and brought back into relation with contemporary Tophane. It is both a question of architectural modelling and a question of how the resulting models are experienced. By presenting the demolished buildings in their estimated locations, AR may turn movement through the site and comparison with the existing environment into part of the interpretive process. This creates a possible connection with the performing museum, where meaning develops through spatial experience rather than through the isolated display of an object (Casey, 2003). The challenge is to make the lost relationships more perceptible without presenting the digital models as complete or certain reproductions of the past.

Within this framework, the study examines whether source-based modelling and on-site AR can work together as a method for reading an altered historical environment. The issue is not limited to making demolished buildings visible again. It also concerns whether their digital presence can draw attention to the connections between past and present, place the surviving monuments within a wider historical setting, and support a more attentive understanding of Tophane's urban memory.

1.3 Aim and Objectives

The main aim of this thesis is to investigate how the demolished military-industrial buildings of Tophane can be represented through source-based digital modelling and viewed again within their estimated historical locations using mobile augmented reality. By bringing the digital models together with the present environment, the study seeks to make the former relationships between these buildings, the surviving monuments, Tophane Square, and the waterfront easier to perceive. The modelling and AR stages are treated as parts of the same process. Digital modelling provides a way to study and interpret architectural information gathered from historical sources. AR then places the resulting models within the site from which the buildings have disappeared. This allows their scale, location, and relationship with the existing environment to be considered while the present condition of Tophane remains visible.

The study also examines the interpretive potential of this encounter. Contemporary Tophane contains monuments, museums, cultural institutions, commercial spaces, and lost historical layers within the same urban area. This fragmented condition is considered through the metaphor of the urban Wunderkammer. By placing the demolished buildings within this setting, the AR experience may connect elements that are currently encountered separately and extend the museological experience beyond the physical museum. It may also encourage users to pause, move through the site, and compare the digital layer with their surroundings. The thesis considers the potential of AR to direct the tourist gaze towards historical and spatial relationships that are less visible in the current urban environment.

To address this overall aim, the study has the following objectives:

- To examine the historical and spatial transformation of Tophane and identify the demolished buildings that played an important role in the organisation of the area.
- To interpret the contemporary condition of Tophane in relation to urban memory, the fragmented urban Wunderkammer, the performing museum, and the tourist gaze.
- To develop source-based digital models of selected demolished buildings using historical maps, photographs, written records, and surviving architectural references.

• To place the digital models within their estimated historical locations through a mobile AR prototype and relate them to the present urban environment.
• To test the prototype on site and evaluate how the modelled buildings can be viewed, adjusted, and compared with the surviving structures and current spaces of Tophane.
• To discuss the potential and limitations of this approach as a method for communicating lost architectural layers and supporting a more attentive reading of the area.

1.4 Research Questions

The study is guided by one main research question:
How can source-based digital modelling and on-site augmented reality reconnect Tophane's demolished military-industrial buildings with the area's present urban context, and what interpretive possibilities can this relationship offer?

This main question is examined through three related sub-questions:

1. How can the lost architectural layers of Tophane be interpreted and digitally represented through available historical sources?

2. How can on-site augmented reality relate these digital representations to the surviving buildings and present urban context of Tophane?

3. How can the on-site AR prototype provide a basis for a more attentive reading of Tophane's lost spatial relationships and fragmented urban memory?

The first two questions are examined through historical and spatial analysis, source-based digital modelling, prototype development, and on-site testing. The third question is exploratory and is considered through the fragmented urban Wunderkammer, the performing museum, and the tourist gaze, together with the spatial comparisons made during the on-site tests. Since the study did not include a formal evaluation of visitor behaviour, it does not claim a measurable change in how visitors perceive Tophane. Instead, it considers how the prototype could provide a basis for a more developed, visitor-oriented AR experience and future visitor research.

1.5 Scope and Limitations

This thesis focuses on Tophane-i Âmire and the urban area immediately surrounding it, including Tophane Square and its connection with the waterfront. References to "Tophane" indicate this defined study area rather than the entire district. The historical account follows the changes directly related to the military-industrial complex and the spatial organisation of the square. Particular attention is given to its nineteenth-century condition, the demolitions of the mid-twentieth century, and the transformations that produced the present urban setting. A comprehensive social and architectural history of the wider district is beyond the purpose of the study.

Four demolished building groups associated with Tophane-i Âmire were selected for detailed examination: the Top Fabrikası and Tüfekhane-i Âmire, the Marangozhane-i Âmire, the Birinci Sanayi Alayı Kışlası ve Mektebi, and the Tophane-i Âmire Müşirlik Dairesi. In the same order, these building groups are referred to as Volumes A, B, C, and D throughout the documentation and modelling process. The selection reflects their former role in the organisation of Tophane Square and the availability of information about their locations and architectural characteristics. Other buildings that once formed part of the military-industrial complex are not included in the modelling stage.

Evidence for the selected buildings comes from historical maps, photographs, engravings, and written records. The Pervititch insurance maps provide information about approximate footprints and the relationship between the buildings and the surrounding urban fabric. Historical images show their massing, façade organisation, openings, and architectural details, although only from certain viewpoints.

Written sources contribute information about their functions, construction periods, and later transformations. Since each source records a different part of the former environment, they were evaluated together and compared with the structures that have survived. Even so, some dimensions and architectural details remain uncertain.

The digital models should be understood as source-based interpretations. Their dimensions and proportions were developed by comparing the available cartographic and visual evidence. Missing parts were interpreted through visible façade rhythms, repeated architectural elements, and relationships with nearby reference buildings. The modelling focuses on exterior massing, façade composition, openings, architectural details, and the position of each building within the site. Limited information about interior layouts, construction systems, and original materials prevented these aspects from being developed to the same level.

The AR application was developed as an initial mobile prototype. Its purpose was to test whether the modelled buildings could be positioned and viewed within the present-day environment. The site tests focused on the calibration and adjustment of the large digital volumes, their visibility under actual field conditions, and their relationship with the surviving buildings and current open spaces. The prototype also allowed the final combined views to be photographed. It is not presented as a completed public application or a permanently geolocated heritage platform. Its current form represents an early stage that would require further development before wider public use.

No formal visitor study was conducted during the on-site evaluation. The research does not claim to demonstrate a measurable change in the tourist gaze. This aspect is discussed conceptually through the theoretical framework and the possibilities suggested by viewing the models in their former locations. A future version of the application could build on this initial prototype by adding more detailed interpretive content and testing the experience with different visitor groups.

1.6 Methodology Overview

This study was structured as a qualitative and interpretive single-case study focused on Tophane. Its methodology combined theoretical research, historical and spatial analysis, source-based digital modelling, AR prototype development, and on-site testing. Rather than being treated as separate lines of work, these stages informed one another throughout the research. The theoretical framework guided the interpretation of Tophane, the historical evidence informed the drawings and digital models, and the on-site tests examined how these models related to the present environment.

The theoretical research began with the changing role of museums, particularly the shift from collecting and display towards interpretation, visitor experience, and digital access. This discussion was connected to the ways of looking shaped by museums, tourism, and digital media. Together with the concepts of urban memory and digital heritage, it provided a basis for reading Tophane as a fragmented urban Wunderkammer. It also helped to frame AR as a means of bringing demolished buildings into relation with the present city rather than presenting the digital models as isolated objects.

Historical research was conducted to understand the development of Tophane-i Âmire, Tophane Square, and the surrounding waterfront. Written sources were examined together with historical maps, engravings, and photographs. The research focused on the former military-industrial organisation of the area, the buildings that defined it, and the spatial changes that followed their demolition. The available evidence was then used to select the four building groups examined in detail.

The spatial analysis began with a comparison of the historical and present-day urban layouts. The Pervititch insurance map (Pervititch, 1927) was georeferenced in QGIS (QGIS Development Team, n.d.) and overlaid with current OpenStreetMap data (OpenStreetMap contributors, n.d.). Surviving

elements that could be identified in both contexts, particularly Nusretiye Mosque and Tophane Clock Tower, were used as control points during this process. The georeferenced map was then used to produce a series of analytical versions in which the selected buildings, present-day road network, and changes to the surrounding urban layout were highlighted or overlaid. These comparisons helped to establish the approximate footprints and former positions of Volumes A–D within the present urban setting.

Historical photographs, engravings, and other visual records were then examined to prepare the source-based elevation drawings. Perspective correction and proportional comparison were used where necessary. The known or estimated dimensions of surviving buildings, including Nusretiye Mosque, Tophane Fountain, and Tophane Pavilion, provided additional references for assessing the scale and proportions of the demolished structures. No single source was treated as complete or fully reliable. Plans, photographs, written descriptions, and surviving architectural references were compared throughout the drawing process. When the available evidence remained limited, the models were developed as informed architectural interpretations rather than exact reconstructions.

The architectural models were produced in Revit using the prepared plans and elevations. The main building forms were developed separately for each volume, while repeated architectural elements were organised by type. Parametric families and modular components were created for windows, columns, pilasters, façade profiles, and decorative elements. The models were checked against the historical sources throughout this process, and individual elements were revised when further comparison suggested a different proportion, form, or position. This method kept the models editable and allowed similar architectural elements to be used consistently across the four building groups.

After the models were completed, they were transferred from Revit through 3ds Max and then imported into Unity. The AR prototype included separate model, calibration, and interface groups for each volume. A local reference-based placement method was developed for positioning the models on site. In this system, P1 established the position of the model, while the line between P1 and P2 defined its direction. Scale was adjusted separately. Controls were also provided for correcting the height, direction, scale, and position of each volume before it was locked in place.

Some surviving monuments were used in both the map analysis and the AR placement, but they served different purposes in each stage. In QGIS, they helped to align the historical map with present-day spatial data. During the on-site placement process, references were selected separately for each volume to guide its initial position and direction. These site references included surviving buildings, monuments, road lines, and other visible features that could be related to the approximate historical position of the model.

The prototype was tested in Tophane using a mobile device. The field tests examined horizontal-plane detection, reference-point placement, model alignment, visibility, interaction controls, and the relationship between the digital volumes and the present environment. Conditions that could not be fully assessed on a computer, including viewing distance, outdoor light, physical obstructions, pedestrian movement, and the scale of the buildings, became visible during this stage. Observations made on site informed later adjustments to the prototype.

Because measured drawings of the demolished buildings were not available, the digital models could not be verified against a single definitive record. Their spatial and architectural consistency was instead assessed by comparing the georeferenced footprints, historical photographs, written sources, proportional relationships, and surviving monuments. Their placement was then examined visually within the present-day site. The aim was not to claim an exact reconstruction or verified geographical positioning, but to produce source-based digital representations that could support a direct spatial comparison between the former buildings and the current urban environment.

The on-site tests did not include interviews, questionnaires, or observations of visitor behaviour. They did not measure how the prototype affected visitors' understanding of Tophane or their ways of looking at the site. Within the scope of this study, the evaluation focused on whether the proposed workflow could make the demolished buildings and their former spatial relationships perceptible within the present environment. It also identified the technical and interpretive aspects that would require further development in a future visitor-oriented AR project.

1.7 Significance of the Study

In present-day Tophane, the surviving monuments and more recent cultural, touristic, and commercial uses form the most visible layers of the area. The military-industrial buildings that once defined the square are largely absent from this image. By focusing on four demolished building groups, the study draws attention to the wider spatial system that once connected Tophane-i Âmire with the square, the waterfront, and the surrounding monuments. It shifts attention from the loss of individual buildings to the relationships that gave the area its former organisation.

The research brings together different forms of historical evidence when the buildings themselves and their measured drawings are no longer available. Maps, photographs, written records, and surviving reference structures each provide a different part of the architectural information. Comparing these sources made it possible to develop the models while acknowledging the gaps and uncertainties in the historical evidence. The models do not resolve every missing detail, but they organise the available information within a coordinated and revisable digital form.

The use of Revit adds a methodological contribution to this process. The models could be adjusted as the sources were reconsidered, while repeated architectural elements could be developed through parametric families and modular components. This was particularly useful for façades containing similar elements in different dimensions and arrangements. The process suggests how BIM-based methods can support the study of demolished buildings without presenting incomplete historical evidence as a complete reconstruction.

Mobile AR adds a spatial dimension that cannot be obtained from drawings or standalone three-dimensional views. It allows the digital volumes to be viewed in relation to surviving buildings, present open spaces, and actual viewing distances on the site. The field tests also identified practical issues connected with large architectural volumes, outdoor light, physical obstructions, and manual placement. These observations provide a practical basis for the further development of AR projects dealing with demolished buildings at an urban scale.

The theoretical significance of the study lies in connecting this digital process with museum experience and the act of looking. Reading Tophane as a fragmented urban Wunderkammer draws attention to the coexistence of its visible, transformed, and absent layers. By placing the digital models within their present setting, the prototype provides a way of viewing some of these layers together. The site becomes part of the interpretive experience, allowing the museological encounter to extend beyond the physical museum building.

Future work could build on the digital models, placement method, and field-test observations to develop a more detailed visitor-oriented AR project. Such a project could combine the models with historical narratives, source information, and on-site guidance. Visitors could then be encouraged to compare the digital layer with the physical environment rather than viewing the models separately

from their surroundings. Through this comparison, present-day open spaces, interruptions, and surviving structures could become part of the evidence through which the transformation of Tophane is interpreted. The broader contribution of this approach lies in shifting attention from isolated urban objects towards the relationships between what remains, what has changed, and what has disappeared.

1.8 Structure of the Thesis

The thesis is organised into eight chapters. This introductory chapter presents the background and research problem, followed by the aim, objectives, and research questions. It also defines the scope and limitations of the study, summarises the methodology, and explains the significance of the research.

Chapter 2 establishes the theoretical framework. It begins with the changing role of museums, from collecting and display to interpretation, visitor experience, and digital practices. The discussion then turns to the museum gaze, the tourist gaze, and the influence of digital media on the act of looking. The chapter also examines digital heritage, urban memory, and the use of AR as a spatial narrative tool. These subjects come together in the final section, where contemporary Tophane is interpreted as a fragmented urban Wunderkammer.

Chapter 3 examines the historical and spatial development of Tophane-i Âmire and its surroundings. It follows the formation of the military-industrial complex, Tophane Square, and the waterfront, with particular attention to their nineteenth-century organisation. The chapter then discusses the demolitions and road-widening works of the twentieth century, the later transformation of the waterfront, and the fragmented condition of the area today. It concludes by introducing the four demolished building groups selected for detailed study and digital modelling.

Chapter 4 explains how the historical sources were translated into architectural information. The Pervititch map is compared with the present urban layout to establish the approximate locations and footprints of Volumes A–D. Historical photographs, written records, and surviving reference buildings are then used to interpret their scale, proportions, and façade organisation. The chapter presents the development of the source-based plans and elevations while identifying the parts for which the available evidence remains incomplete.

Chapter 5 describes the architectural modelling process in Revit. It explains the use of BIM-based methods, parametric families, and modular components in developing the four building groups. Windows, columns, pilasters, façade profiles, and decorative elements are examined according to the methods used to model them. The chapter concludes with the completed digital models prepared for the AR stage.

Chapter 6 presents the transfer of the models from Revit through 3ds Max into Unity and the development of the mobile AR prototype. It describes the organisation of the models, calibration groups, interface controls, and local reference-based placement method. The chapter then documents the on-site tests conducted in Tophane and the revisions made in response to field conditions. It reports the technical and spatial observations that provide the basis for the following discussion.

Chapter 7 discusses the results in relation to the theoretical framework and research questions. It considers the digital models as source-based architectural interpretations and examines how their placement within Tophane made former spatial relationships available for comparison with the present environment. The discussion then connects these observations to the reading of Tophane as a fragmented urban Wunderkammer, the idea of a performing museum, and the possibility of directing attention towards absent urban layers. The limits of the prototype and the absence of formal visitor research are also considered.

Chapter 8 concludes the thesis by bringing together the historical research, source-based modelling process, AR development, and findings from the field tests. It responds to the research questions, summarises the contributions and limitations of the study, and identifies areas for further development. It also considers how a later visitor-oriented AR project could build on the prototype to support a more attentive reading of Tophane's former spatial relationships and fragmented urban memory.

2. Theoretical Framework

2.1 The Transformation of Museology: From Collecting to Digital Experience

2.1.1 Collecting Practices and the Origins of the Museum

Today, museums are commonly included in travel routes. A museum visit can turn an ordinary trip into an experience of learning and reflection. Museums bring together related objects, events, or ideas within a conceptual framework. This organisation helps visitors consider the exhibited objects together with the cultural and historical context they represent.

From this perspective, collecting and museology are closely related, but they do not have the same meaning. A collection is formed by selecting and bringing together material or intangible objects as a meaningful group. Museology examines the museum field more broadly, including collecting, preservation, interpretation, and display (Desvallées & Mairesse, 2010, pp. 25–26, 54–55). Collections form an important basis for museums, while museums place them within a public and interpretive context.

According to Simmons, archaeological evidence suggests that hominid ancestors began collecting after they became bipedal. He connects this behaviour to the way humans used objects to understand and navigate the world around them (Simmons, 2016, p. 2). In this account, collecting is closely related to human observation and learning.

Collecting can also be observed in everyday life. Cameron (1971) describes a child who gathers objects such as stones, leaves, and shells, and then arranges and examines them. The example shows how collecting can begin through curiosity and the desire to understand unfamiliar surroundings. As people's interests, experiences, and memories change over time, collecting may also connect objects with personal identity and the past. The long-standing tendency to collect and preserve objects contributed to the development of the museum as an institution. Over time, museums changed as ideas about knowledge, art, and society also changed. Their meaning and purpose were repeatedly redefined according to the interests and perspectives of different periods.

The word "museum" comes from the Greek term mouseion, which referred to a sacred place devoted to the Muses, the mythological daughters of Zeus and Mnemosyne. The Muses were associated with fields such as literature, art, history, and astronomy. For this reason, the mouseion was connected with worship as well as intellectual and artistic activity (Di Pasquale, 2005, p. 1). During the Hellenistic period, the term also became associated with institutions of learning and research. One of the best-known examples was the Museum of Alexandria, established under Ptolemy I in the early third century BCE. The Museum provided a setting where scholars could meet, exchange ideas, and conduct research. The Library associated with the Museum aimed to gather written works from across the known world (Di Pasquale, 2005, pp. 1–5).

Although the ancient mouseion represented an early space for knowledge, research, and intellectual exchange, the relationship between collecting, display, and visual curiosity became more visible during the Renaissance. In this period, cabinets of curiosity emerged as important spaces where diverse objects were gathered, arranged, and interpreted in order to produce wonder, knowledge, and prestige.

2.1.2 Wunderkammer: Heterogeneous Collections and the Production of Wonder

During the Renaissance, collecting began to take on a new intellectual and cultural role.
Curiosity about the unknown and the wish to understand humanity's place in the universe also grew stronger. Collecting offered a practical way to explore such questions, as objects could be observed, compared, and arranged. The resulting collections reflected an effort to study and represent the world through material objects (van Reenen, 2018, pp. 1–2).

For European rulers and elites, owning a collection could express wealth, knowledge, and social status. Emperor Rudolf II's Kunstkammer, for example, brought together artworks, natural objects, scientific instruments, and other rare materials. It also served as a form of imperial self-representation and expressed his political power (Kaufmann, 1978, pp. 22–24). Wunderkammern may appear crowded or disordered from a modern perspective. However, van Reenen (2018) explains that this interpretation can be misleading, since these collections reflected Renaissance systems of classification and knowledge (pp. 12–13). They were understood as miniature representations of the world, where different types of objects could be studied in relation to one another (van Reenen, 2018, pp. 1–2).

The significance of the Wunderkammer is not limited to its role in the early history of museums. It also demonstrates how meaning can be produced by bringing together diverse objects, materials, and forms of knowledge within the same space. Rather than presenting a single linear narrative, the cabinet of curiosity created meaning through the coexistence of fragments and the relationships formed between them. For this thesis, the Wunderkammer provides useful conceptual ground for understanding historical environments where different traces of the past coexist but are not always clearly connected within the contemporary urban experience.

In the late Renaissance and early modern period, collectors developed more detailed systems for arranging and interpreting objects. These systems did not follow modern scientific categories, but they were not random. A defining feature of Wunderkammern was the inclusion of both naturalia, objects from nature, and artificialia, objects made by humans, within the same collection. Scientific instruments and tools could also be displayed alongside them (van Reenen, 2018, pp. 1–2, 19–20). An important example is Samuel Quiccheberg's Inscriptiones, published in 1565. It was one of the earliest texts to explain how a Kunst- and Wunderkammer could be assembled, classified, and displayed. Quiccheberg imagined the collection as a universal theatre in which different kinds of objects could be observed and compared. However, his proposal was not a public museum in the modern sense. It was an ideal system for organising objects and knowledge within a courtly setting (van Reenen, 2018, pp. 21–24).



Figure 2.1
Ferrante Imperato's cabinet of curiosities, illustrated in Dell'Historia Naturale, Naples, 1599.
Source: Ferrante Imperato, Dell'Historia Naturale (Naples, 1599), Houghton Library, Harvard University, Typ 525.99.461. Public domain.

2.1.3 From Public Museum to New Museology

The Public Museum and the Educational Role of Collections

By the seventeenth century, the private culture of collecting that had developed during the Renaissance was beginning to take more institutional forms. Collections were still closely connected to courts and private scholars, but the idea of the museum was gradually expanding beyond the individual cabinet. During the sixteenth and seventeenth centuries, the term musaeum came to describe spaces in which objects, books, and different fields of knowledge were brought together. Findlen relates this development to the encyclopaedic character of Renaissance collecting (Findlen, 1989). These changes did not yet create the modern public museum, but they prepared the ground for collections with broader scholarly and educational roles.

One of the clearest examples of this transition was the Ashmolean Museum in Oxford. It opened in 1683 as Britain's first public museum and the world's first university museum. Its founding collection was based mainly on objects gathered by John Tradescant and his son, which later passed to Elias Ashmole and were given to the University of Oxford. The collection included botanical, geological, and zoological specimens as well as human-made objects. The original building also contained a chemistry laboratory and rooms for university lectures. Members of the public were admitted from the beginning, while the collections were used for research and teaching (Ashmolean Museum, n.d.). The Ashmolean brought public access, university education, and collection-based research together within a single institution.

The impact of Enlightenment ideas gradually gave collections a wider educational role. Expanding trade, exploration, and scientific study brought new materials and ideas to Europe. Objects were increasingly arranged for observation, comparison, and classification.

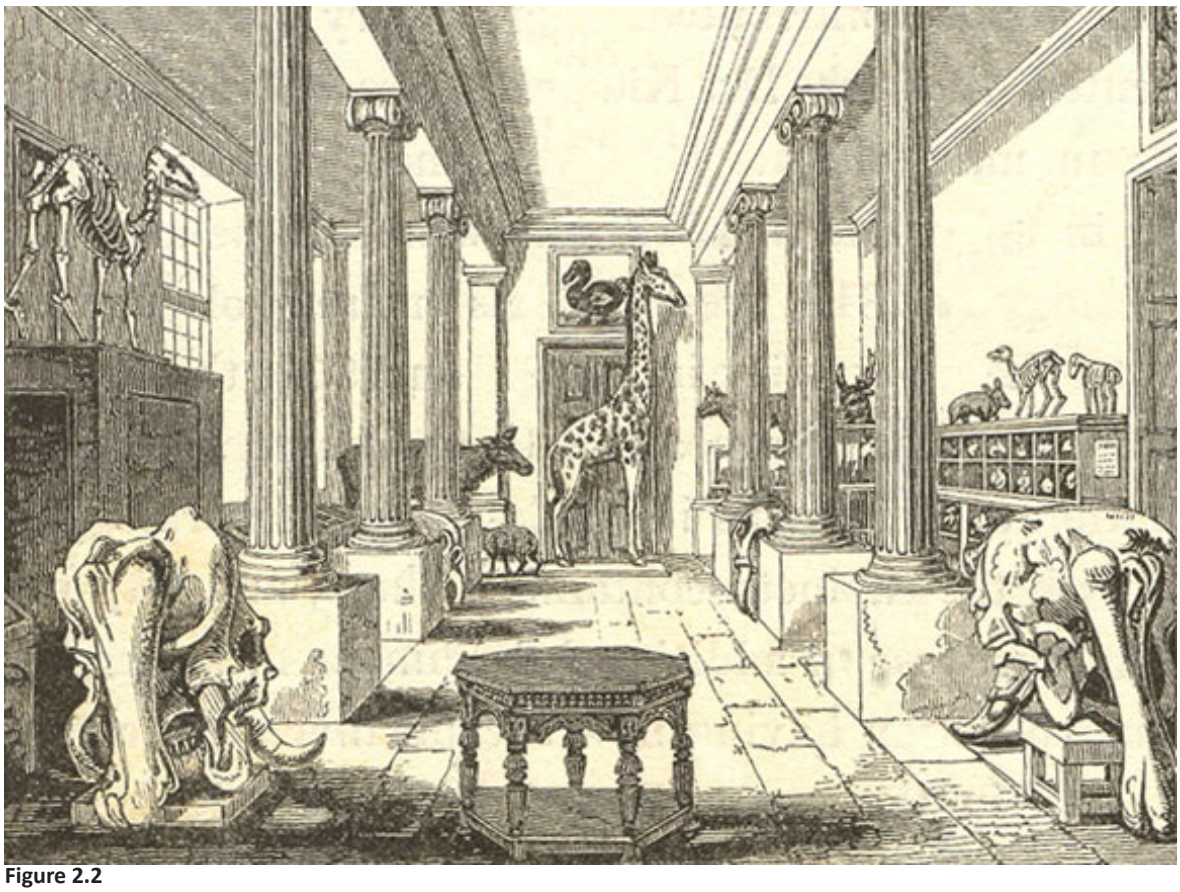


Figure 2.2
Interior view of the Old Ashmolean Museum, Oxford, 1834.
Source: William Alfred Delamotte and Orlando Jewitt, 1834. Department of Special Collections, Memorial Library, University of Wisconsin–Madison, AM 101.O82. Public domain.

This reflected the Enlightenment interest in order and rational inquiry. The transition from private collections to public museums was a gradual process. Abt explains that institutions such as the Ashmolean and, later, the Louvre were important points in a much longer history connecting objects, display, learning, and communities (Abt, 2006, pp. 115–134). Museums gradually became places where knowledge could be preserved, studied, and communicated to wider audiences.

As public museums developed during the late eighteenth and nineteenth centuries, they also gained cultural and political importance. Their displays did more than make objects visible: they arranged knowledge and influenced how visitors moved, observed, and understood the world. Bennett uses the term "exhibitionary complex" for museums, international exhibitions, and related institutions that combined public display with education and social regulation. In these spaces, visitors observed the displays while also becoming visible to one another. Museums could contribute to ideas of public behaviour, citizenship, and national identity (Bennett, 1995, pp. 59–88).

Museums, Progress, Empire and National Representation

The growth of industrial modernity and European colonial expansion gave museums a wider social and political role during the nineteenth century. New collections presented developments in science, technology, industry, and natural history as signs of progress. At the same time, many artefacts, specimens, and artworks entered European museums through colonial networks and unequal relations of power. Their classification and display often supported ideas of cultural hierarchy and placed European societies at the centre of narratives about civilisation (Bennett, 1995, pp. 89–92). The Great Exhibition, held at the Crystal Palace in London in 1851, brought industrial products and materials from Britain, its empire, and other countries into one large display. Its organisation connected technological achievement with imperial comparison and national representation (London Museum, n.d.). Nineteenth-century museums and exhibitions reflected the political and economic structures of their time as well as interests in science and education.

Post-War Heritage Awareness: UNESCO and ICOM

After the Second World War, the destruction, theft, and displacement of monuments, artworks, books, archives, and museum collections drew greater international attention to the protection of cultural heritage. This concern was later reflected in the 1954 Hague Convention, which included museums, libraries, archives, monuments, and important collections within its definition of cultural property (UNESCO, 1954). UNESCO and ICOM were established in the same post-war period to support international cooperation in education, culture, heritage protection, and museum work. These developments did not result from a single change in the meaning of museology. However, they strengthened the role of museums in preserving collections and communicating cultural memory.

UNESCO (United Nations Educational, Scientific and Cultural Organization) emerged from the international cooperation established after the Second World War. Its Constitution was adopted in London on 16 November 1945 and entered into force on 4 November 1946. The organisation was created to support peace through cooperation in education, science, and culture. Its Constitution also included the conservation and protection of books, works of art, and monuments of historical or scientific importance among its responsibilities (UNESCO, 1945).

ICOM (International Council of Museums) was established on 16 November 1946 at the Louvre Museum in Paris. It was created as an international organisation of museums and museum professionals, with the aim of encouraging cooperation across national borders. UNESCO supported ICOM from the beginning by hosting it at its headquarters and establishing formal relations with it (ICOM, 2021). The two organisations had different structures. UNESCO operated as an intergovernmental agency, while ICOM developed as a non-governmental professional organisation. Over time, ICOM provided a platform for museum professionals to exchange knowledge and develop professional and ethical standards for museum work (ICOM, n.d.).

Critical Turns in Museology: Cameron and Vergo

During the decades after the Second World War, discussions in museology increasingly questioned how museums related to society. Preservation and education remained central responsibilities, but museums were also criticised for serving limited audiences and presenting the values of cultural and academic elites. These debates raised questions about whose values museums represented and whether they could provide space for criticism and public discussion (Cameron, 1971, pp. 11–19).

Duncan F. Cameron addressed this issue in his 1971 essay "The Museum, a Temple or the Forum?" He described the traditional museum as a "temple" in which selected objects and established cultural values were preserved and presented with authority. The "forum," by contrast, provided a place for confrontation, experimentation, and debate. Cameron did not argue that a museum could easily perform both roles within the same space. He treated the temple and the forum as related but distinct institutions and warned that the authority of the museum could restrict the openness required by a forum. In his view, society needed museums to preserve and interpret established knowledge, as well as forums where new ideas and challenges to existing values could be expressed (Cameron, 1971, pp. 19–24).

Cameron's essay questioned the museum's relationship with society, while later discussions associated with new museology examined the purposes and practices of museums more broadly. In the introduction to The New Museology, Vergo criticised an older approach that concentrated on museum methods without giving enough attention to the purposes of museums (Vergo, 1989a, pp. 1–5). His chapter "The Reticent Object" developed this discussion by focusing more specifically on the relationship between museum objects and their interpretation.

Vergo used the idea of the "reticent object" to show that an object does not automatically communicate a clear or complete meaning to every visitor. Its interpretation is influenced by the context in which it is displayed and by the explanatory information presented with it. Vergo drew attention to the way objects and explanatory material work together in an exhibition (Vergo, 1989b, pp. 41–59). From this perspective, an exhibition cannot be treated as a neutral presentation of objects, since curatorial choices influence how visitors understand what they see.

Together, Cameron and Vergo reflect two related areas of debate in later museological thought. Cameron distinguished the museum's established role from the need for a separate forum for public debate, while Vergo examined how display and interpretation influence the meaning of objects. These perspectives support an understanding of museums as institutions that preserve material culture while also shaping its public interpretation. This is relevant to the thesis because the proposed AR experience also depends on selection and interpretation. By placing digital models of lost buildings within the present-day site, it directs attention to historical relationships that are no longer visible.

The Expanding Role of Museums in the 1990s

By the 1990s, museums had become increasingly connected with broader culture-led urban policies. In several Western European cities, investment in cultural institutions formed part of strategies aimed at renewing declining urban areas, attracting visitors and reshaping the public image of the city (Bianchini, 1993, pp. 1–20). Museums were discussed in relation to urban regeneration and local development alongside their established roles in preservation and education.

One of the best-known examples was the Guggenheim Museum Bilbao, designed by Frank Gehry and opened in 1997 on a former industrial wharf. The project formed part of the redevelopment of the riverfront for cultural and leisure uses and soon became an international symbol of the city (Guggenheim Museum Bilbao, n.d.-a). The museum attracted large numbers of visitors and contributed to discussions of the "Bilbao effect" (Plaza, 2000, pp. 1055–1058). However, it was one part of a wider urban strategy, and Bilbao's economic and spatial transformation cannot be attributed to the museum building alone (Gómez & González, 2001, pp. 898–900).

At the same time, museums gave more attention to visitors and their public responsibilities. Desvallées and Mairesse describe a “turn towards the public” from the end of the 1980s, when museums increasingly considered visitor needs and groups that had previously remained outside their usual audiences (2010, pp. 71–72). This development broadened museum practice beyond collections and preservation by giving greater importance to public access, interpretation and relationships with communities.

Digital technology also began to play a more visible role in museum work during the 1990s. Computers were used for collections documentation and information management, while digital imaging, multimedia and networked systems created new possibilities for exhibitions and public access (Jones-Garmil, 1997). These developments were not adopted at the same rate by every institution, but they connected collection management with new ways of presenting and sharing information.

Taken together, these developments show that the expansion of museums during the 1990s was not limited to the construction of new buildings. Museums became involved in urban development and tourism, while also giving more attention to visitors and beginning to use digital tools in collection management and exhibition. These changes did not produce a single model of the contemporary museum. Instead, they opened several directions that continued to develop in the twenty-first century.

The digital tools introduced during the 1990s became more important in the following decades. Their use extended from internal documentation and collection management to online access and visitor-facing media, forming the basis of digital museology (Parry, 2007).

Figure 2.3
Exterior of the Guggenheim Museum Bilbao
Source: Guggenheim Museum Bilbao (n.d.-b).



2.1.4 Digital Museology and the Hybrid Museum Experience

Digitisation and Online Access

Digital museology developed through several related practices, including the digitisation of collections, online access and the use of digital media in exhibitions. Digitisation allowed museums to convert collection records and images into digital formats, making them easier to manage, search and share. Museum websites and online catalogues then extended access beyond the physical building. Within exhibitions, multimedia and interactive systems provided additional ways of presenting and interpreting objects (F. Cameron & Kenderdine, 2007).

As digital systems became more common, their use moved from collection documentation into exhibition spaces. Museums installed video displays, interactive computer stations and other forms of gallery-based media to provide additional information about objects and exhibition themes (Sayre, 2005). These systems could support individual exploration, although their effect depended on the content, placement and design of the installation. Digital reconstructions also made it possible to present buildings and historical environments that had been altered or were no longer visible (F. Cameron & Kenderdine, 2007).

Interactive Technologies and the Mobile Museum Experience

Mobile technologies added another layer to this development. Before smartphones became common, museums were already experimenting with audio guides, mobile phones, MP3 players and PDAs. Smartphones later brought audio, images, maps and internet access together in a device already carried by many visitors. This reduced dependence on fixed displays or museum-owned guide devices and allowed information to be accessed while moving through an exhibition (Tallon & Walker, 2008; Giannini & Bowen, 2019).

Mobile content could combine collection information, maps, images, audio and links within the same system. However, the development of a museum application did not by itself create a more personal experience. Proctor argued that mobile interpretation should begin with visitor needs and the organisation of content rather than with the choice of a particular device or application (Proctor, 2010). This approach allowed museums to provide material for both on-site and remote users while giving visitors more choice over the content they accessed.

Social media extended these developments beyond museum applications and websites. Blogs, podcasts, image and video sharing, tagging and annotation allowed users to respond to museum content and, in some cases, contribute material of their own. Russo and Peacock (2009) point out that providing these tools does not automatically create sustained participation. Museums also need to understand why people participate and how they wish to interact with an institution. Participation needs to be designed and evaluated rather than treated as an automatic result of technology.

AR, Smart Museums, and Distributed Museum Practices

During the same period, location-based mobile tools and augmented reality (AR) applications introduced new ways of connecting digital content with physical places. Visitors could access information as they moved through museum spaces and other locations. Bautista and Balsamo (2011) describe these practices through the idea of the “distributed museum,” in which the museum extends beyond a single building across physical and virtual, fixed and mobile spaces.

By the mid-2010s, mobile devices and sensor-based systems were being used to provide information according to a visitor’s location and needs. Ayala et al. (2014) describe a system that combined a mobile guide with context-aware services for visitors and museum staff. Chianese and Piccialli (2014) used the term “smart museum” for an approach that connected cultural heritage with Internet of Things technologies.

COVID-19 and the Acceleration of Digital Transformation

The COVID-19 pandemic increased the use of digital technologies in museums. As physical access to cultural institutions was restricted during lockdowns, online platforms became central to maintaining contact with audiences (Noehrer et al., 2021). Approximately 90% of museums worldwide temporarily closed at the beginning of the pandemic (UNESCO, 2020). In response, institutions expanded access to digitised collections and social media, while also producing virtual exhibitions, curatorial talks and virtual tours (Noehrer et al., 2021).

Many museums had already used digital tools to catalogue collections and provide online access before 2020. Their level of preparation, however, varied considerably. Some institutions had established digital strategies, while others had difficulty integrating digital products into their wider operations (Noehrer et al., 2021).

The closure of physical spaces brought this work into a more central position within museum practice (Noehrer et al., 2021). This development involved more than placing existing collections online. Nikolaou (2024) describes digital transformation as a broader process that changes how an organisation operates, fulfils its mission and responds to its stakeholders. Curatorial and educational work also changed as institutions moved exhibitions online, streamed talks and tours, and invited audiences to contribute through social media (Burke et al., 2020; Noehrer et al., 2021). Some of these activities reached people beyond museums' usual local audiences (Burke et al., 2020).

The change also affected internal operations. Digital systems were used for communication, ticketing and collection management (Nikolaou, 2024). In the institutions examined by Noehrer et al. (2021), digital metrics and user behaviour data were increasingly used for decision-making, content planning and operational reporting. Measuring online reach, engagement and impact nevertheless remained difficult, particularly when such evidence was needed for fundraising.

As restrictions eased, attention turned to the relationship between on-site and online activity. Reopening required a more balanced approach to physical and digital operations (Noehrer et al., 2021). The main question was no longer how to provide temporary access during closure, but how online content could remain part of museum practice after reopening.

Museological Transformation and the Act of Looking

From the Renaissance Wunderkammer to contemporary digital and hybrid museum practices, museums have continuously changed according to how societies organise knowledge, produce meaning and engage with cultural memory. The Wunderkammer created meaning through the coexistence of heterogeneous objects, while public museums transformed collections into educational and civic institutions.

Later, new museology questioned the neutrality of display and emphasised interpretation, participation and social responsibility. In the twenty-first century, digital technologies have extended this transformation beyond the physical limits of the museum. Digitisation, mobile applications, AR, virtual exhibitions and distributed museum practices show that the museum is no longer only a place of preservation and display, but also a hybrid interface through which visitors encounter, interpret and participate in cultural heritage.

This transformation also reshapes the act of looking. As museums expand beyond preservation and display to include interpretation and participation, the visitor's gaze becomes an important part of the museum experience. The following section examines the concept of the gaze and its role in how visitors perceive, interpret and engage with cultural heritage.

2.2 The Concept of Gaze and the Museum Experience

2.2.1 Sartre and the Look of the Other

One important philosophical account of seeing and being seen appears in Jean-Paul Sartre's Being and Nothingness, first published in 1943. Sartre describes a person looking through a keyhole, completely absorbed in the act. At this point, the person observes without thinking of themselves as an object. When footsteps are heard in the corridor, the possibility of being watched changes the situation. The observer becomes aware of being visible to someone else and experiences shame. For Sartre, the "look of the Other" reveals the subject as an object for another person and produces a new form of self-consciousness (Sartre, 1943/2003, pp. 282–286).

2.2.2 Lacan and the Psychoanalytic Gaze

Jacques Lacan develops the question of the gaze within psychoanalysis. In The Four Fundamental Concepts of Psycho-Analysis (1973/2004), especially in the section titled "Of the Gaze as Objet Petit a," he examines the relation between the eye, vision and the gaze. This section contains four chapters: "The Split between the Eye and the Gaze," "Anamorphosis," "The Line and Light," and "What Is a Picture?" (Lacan, 1973/2004, pp. 67–119).

For Lacan, vision is not a neutral process controlled entirely by the viewer. The subject sees from a particular position, but is also situated within a visual field that exceeds that position. Seeing does not give the viewer complete mastery over what is seen; the subject is also visible within the same field (Lacan, 1973/2004, pp. 72–75).

A central point in Lacan's discussion is the distinction between the eye and the gaze. The eye is connected with the act of seeing, whereas the gaze concerns the position of the subject within the visual field. It is not simply another person's physical eye looking at us. Lacan writes, "The gaze I encounter […] is, not a seen gaze, but a gaze imagined by me in the field of the Other" (Lacan, 1973/2004, p. 84). The gaze can be experienced even when no observer is directly visible.
Here, the capitalised "Other" does not refer only to another individual. In Lacanian theory, it is also associated with the symbolic order of language and law through which the subject relates to others (Evans, 1996, pp. 132–133). The "field of the Other" places the gaze beyond a direct encounter between two people. It indicates that the subject's position as viewer is not entirely self-contained.

In the example discussed above, Sartre focuses on the moment in which a person becomes aware of being seen by another. Lacan draws on this account of the look but reworks it through the distinction between the eye and the gaze and through the field of the Other (Lacan, 1973/2004, pp. 72–84). This distinction becomes especially relevant in museums, where objects are encountered through particular forms of selection, arrangement and interpretation.

2.2.3 Casey and the Museum Gaze: From Object to Experience

In "The Museum Effect," Casey examines the evolution of museum practice through the concept of the gaze and the changing relationship between visitor and object. Her framework connects changes in museum practice with changes in the visitor's way of looking. Rather than treating display as neutral, Casey argues that museums organise ways of seeing and produce cultural meaning through the selection and presentation of objects. She identifies three overlapping typologies: the legislating museum, the interpreting museum and the performing museum (Casey, 2003). Although these typologies overlap, Casey also presents them as a broad historical movement from the authority of the object towards the increasing role of interpretation and performance.

Legislating Museum: Direct Relationship

In the legislating museum, the object is presented as if it carries its meaning directly. The museum gives the artefact authority through its selection and presentation while providing little contextual information. Although the encounter appears to take place directly between visitor and object, it

is already shaped by institutional codes and by the behaviour expected within the museum. The visitor's gaze is guided even when the museum appears to remain silent (Casey, 2003).
Casey's diagram of the legislating museum shows direct relationship between the subject and the object, together with the reversibility of the gaze. The visitor looks at the object while also becoming aware of being seen. In this model, the museum taught visitors how to view objects and behave in front of them (Casey, 2003).

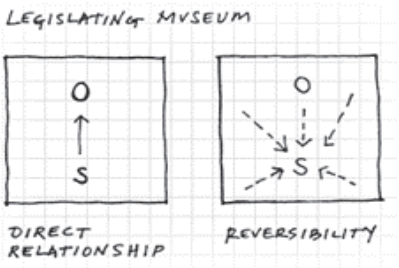


Figure 2.4
Casey's model of the legislating museum: The direct and reversible relationship between subject and object.
Source: Casey (2003, p. 5).

Interpreting Museum: Mediated Communication
In the interpreting museum, labels, guided tours and multimedia support the encounter between visitor and object. These tools provide context, but they also influence what is noticed and how the object is understood. Meaning is formed through both the object and the interpretive structure around it (Casey, 2003).

The diagram places mediation between the visitor and the object. This layer can support understanding, but it may also divide attention between the object and its explanation (Casey, 2003).

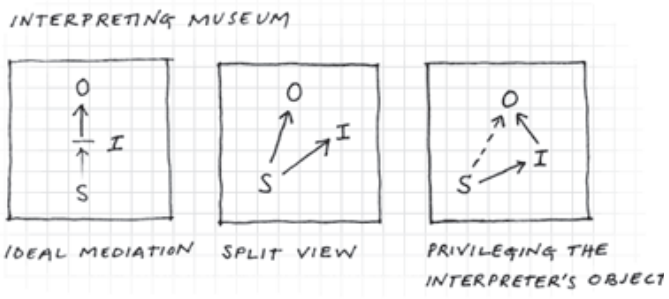


Figure 2.5
Casey's model of the interpreting museum: Interpretation mediating the relationship between subject and object.
Source: Casey (2003, p. 6).

Performing Museum: From Object to Experience
In the performing museum, the emphasis shifts from the isolated object to the experience created around it. Exhibition design, spatial atmosphere, narrative and movement become central to meaning. The museum becomes a staged environment that shapes how the object is experienced (Casey, 2003). This makes the model useful for examining immersive and digital practices, where presentation often plays a central role.

Casey's final diagram shows that the object remains present but is no longer the only focus of the exhibition. Interpretation and exhibition design place it within a wider experience shaped by narrative, spatial design, re-enactment and movement. The visitor experiences the object through this organised setting rather than as an isolated artefact (Casey, 2003).

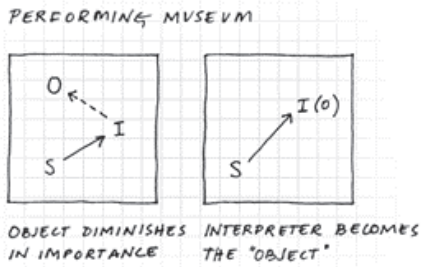


Figure 2.6
Casey's model of the performing museum: The object becoming part of a staged interpretive experience.
Source: Casey (2003, p. 10).

2.3 Tourist Gaze, Media and Digital Visibility

2.3.1 John Urry's Concept of the Tourist Gaze and the Social Construction of Tourism

Tourism as a Socially Constructed Practice

Sociologist John Urry describes tourism as a socially organised way of seeing rather than the result of individual choice alone. The tourist gaze is directed towards places and experiences that appear different from the routines of everyday life. Travel provides a temporary departure from home and work, while expectations about what is worth seeing are shaped by social practices and cultural representations (Urry, 2002, pp. 1–3).

Urry explains that the tourist gaze changes across societies, social groups and historical periods (Urry, 2002, pp. 1–3). By the end of the seventeenth century, the Grand Tour was already established among young men from aristocratic and landowning families, and by the late eighteenth century it had spread to the professional middle class. The classical Grand Tour focused on galleries, museums and other objects associated with high culture. For the English upper classes, travel was also considered part of a young man's education (Urry, 2002, pp. 3–4).

In the nineteenth century, leisure travel became more common among Britain's industrial working class. Railway connections helped make trips to seaside resorts more accessible. Blackpool, in particular, developed into a major destination for day visitors and holidaymakers from industrial towns. Unlike the educational aims associated with the Grand Tour, these visits were more closely connected with rest and popular entertainment. Class and access to transport influenced the forms that tourism took during this period (Urry, 2002, pp. 16–23).

Media, Culture, and the Reproduction of the Tourist Gaze

The tourist gaze is also shaped by media and other cultural forms. Before visiting a place, tourists may encounter representations of it in films, literature, magazines and photographs. These representations create expectations about what is worth seeing and how a destination may be understood. Urry explains that such anticipation is constructed and sustained through cultural practices, while photographs, postcards and films allow the gaze to be reproduced (Urry, 2002, p. 3). Tourists do not approach a destination without prior expectations. They interpret its streets, buildings and landscapes through familiar signs and cultural associations. Urry gives the example of tourists who see two people kissing in Paris and understand the scene as "timeless romantic Paris" (Urry, 2002, p. 3). In this case, the physical place is understood through an image already associated with it.

2.3.2 Human Typologies Shaped by Media: From Homo Typographicus to Homo Digitalis

Marshall McLuhan describes media as extensions of human faculties rather than simply as tools for carrying information. Technologies may extend parts of the body or the nervous system, and their use can change the balance between the senses. He connects print with the visual faculty and electric media with the extension of the central nervous system (McLuhan, 1964, pp. 3–4, 45–49, 186–187). Media influence both perception and the organisation of experience.

In The Gutenberg Galaxy, McLuhan examines "typographic man," the human subject shaped by print culture. He associates this culture with visual emphasis, linear organisation and individualism (McLuhan, 1962, pp. 123–124, 158). He also links print with the growth of nationalism and relates its visual organisation to the development of modern science (McLuhan, 1962, pp. 181–184, 217–235).

The electronic age introduced a different media environment from that of print culture. McLuhan associates electronic media with simultaneity and the extension of the central nervous system across distance. Radio and television connected dispersed audiences within what he called the "global village" (McLuhan, 1964, pp. 3–6, 324–349). Han later refers to the subject associated with mass electronic media as Homo electronicus (Han, 2017, p. 11).

Han distinguishes Homo digitalis from this mass-media subject. Homo digitalis participates in the digital swarm but retains a private identity, generally presenting and adjusting an online profile while seeking attention (Han, 2017, p. 11). This emphasis on digital visibility shifts the discussion from McLuhan's analysis of print and electronic media to Han's critique of digital communication. Han describes the society of transparency as a society of information. He argues that increasing amounts of information do not necessarily produce truth or make the world easier to understand. Information and images may continue to accumulate and circulate while lacking the direction needed for interpretation (Han, 2015, pp. 8, 39–41). Transparency also encourages visibility and voluntary self-exposure, particularly through digital media (Han, 2015, pp. 45–49). These conditions are reflected in Homo digitalis, who maintains an online profile and seeks attention through digital communication (Han, 2017, p. 11).

In tourism, this framework helps explain how places enter the circulation of digital images and information. Visitors encounter photographs, videos, reviews and other representations of a destination, and they may later share their own material through social media (Urry, 2002, p. 3; Munar & Jacobsen, 2014, pp. 46–54). When they do so, they take part in both viewing existing representations and producing new ones. This circulation can increase the visibility of a cultural site, but Han's critique suggests that greater visibility and more information should not automatically be treated as evidence of deeper understanding (Han, 2015, pp. 39–41).

2.4 AR, Digital Heritage and Urban Memory

2.4.1 From Cultural Heritage to Digital Architectural Memory

Cultural heritage includes both tangible and intangible forms. UNESCO defines tangible cultural heritage through monuments, groups of buildings and sites. Intangible cultural heritage includes practices, expressions, knowledge and skills recognised by communities and transmitted between generations (UNESCO, 1972, Art. 1; UNESCO, 2003b, Art. 2). Architectural heritage is usually discussed as tangible heritage, although the significance of a building or site is not limited to its physical fabric. Buildings and sites can also carry evidence of past uses, meanings and social life. Digital technologies do not replace physical conservation, but they provide other ways to document and communicate these layers. Three-dimensional modelling, VR and AR can record architectural form, connect it with historical information and support the interpretation of heritage that has been altered, damaged or made inaccessible (Ma et al., 2025).

The growing use of these technologies has also brought the concept of digital heritage into focus. UNESCO defines digital heritage as unique resources of human knowledge and expression that are either created digitally or converted from existing analogue sources. These resources may include texts, databases, images, audio, graphics, software and web pages. Resources with lasting cultural, educational, scientific or administrative value may form part of this heritage and require preservation (UNESCO, 2003a, Arts. 1–2). Digital heritage is more than a technical copy or archive. Its significance also lies in keeping selected knowledge and forms of expression accessible over time.

Roggio et al. (2025) provide an example of how digital tools can be used to interpret architectural heritage beyond its present physical condition. In their study of the Church of Santa Croce in Ravenna, reality-based 3D models were used to represent different construction phases and to visualise the building's transformations in an interactive virtual environment. The model records changes in the building and makes phases that are no longer visible easier to examine and communicate.

2.4.2 Augmented Reality as a Spatial Narrative Tool

Milgram and Kishino (1994) introduced the Reality–Virtuality Continuum to describe the relationship between real and virtual environments. The continuum extends from a completely real environment to a completely virtual one, with Augmented Reality (AR) and Augmented Virtuality (AV) positioned between these endpoints. AR adds virtual elements to a view of the real environment, whereas AV introduces real elements into a mainly virtual environment (Carmigniani & Furht, 2011).

Within this model, Mixed Reality (MR) covers environments in which real and virtual worlds are combined (Milgram & Kishino, 1994). Smartphones, tablets and wearable displays have expanded the range of devices through which AR can be used. Its applications now include education, healthcare, tourism and museum interpretation (Arena et al., 2022). Unlike VR, AR presents digital information in relation to the user's physical environment rather than replacing it (Carmigniani & Furht, 2011).

Within architectural heritage, the relationship between real and virtual environments creates new possibilities for visualisation and interpretation. Digital models can represent building phases or elements that are no longer visible in the surviving structure (Roggio et al., 2025). Okanovic et al. (2022) describe interactive digital storytelling as a way of presenting cultural heritage through multimedia content and user interaction. AR can function as a spatial narrative tool, allowing historical information to be explored through movement and observation within a heritage setting.

This narrative role is particularly relevant when heritage objects have been separated from their original spatial contexts. Liestøl (2021) notes that museums may preserve an original object while losing its initial context, whereas a heritage site may retain the context without the displaced object. Mobile AR can address this separation by returning a digital copy of an artefact to its original site or by presenting a digital representation of the original environment around an object displayed in a museum. This approach reconnects separated heritage elements and makes their spatial relationships easier to understand.

2.4.3 Urban Memory and the Layered City

Cities carry their past through what they preserve, transform, demolish, and continue to represent. Urban memory develops through the relationship between these physical traces, shared experiences, and the meanings attached to earlier periods from the present. Halbwachs argues that memory is formed within social groups and continually reorganised according to present circumstances (Halbwachs, 1992). Urban memory cannot be reduced to the survival of historical fabric. It also depends on the connections that communities establish between places, events, practices, and meanings. Some layers remain visible in the city, while others become difficult to recognise after physical and social change.

Rossi considers the same question at the scale of the city. He treats urban artefacts as elements that carry collective experience through continuity and change (Rossi, 1982). A building gains meaning from its age and function, but also from its position among surrounding streets and spaces. Some of these connections may remain visible when the building survives, even if its use changes. Demolition alters these relationships. Boundaries disappear, routes change, and neighbouring buildings acquire a different scale and context. A demolished structure may remain documented in photographs, maps, or written records, yet its former urban role becomes difficult to understand after the system it helped organise has changed. This is particularly important in Tophane, where the removal of large military-industrial buildings altered the setting in which the surviving monuments and open spaces are now experienced.

Boyer shifts the discussion from physical continuity to the representation of the city. She identifies three broad models: the city as a work of art, the city as panorama, and the city as spectacle (Boyer, 1994). The first describes the traditional city as a civic and symbolic composition formed by monuments, public spaces, and shared forms. The city as panorama belongs more closely to the modern period, when the urban environment came to be viewed from a distance as a whole that could be observed, mapped, and planned. In the contemporary city, images, consumption, entertainment, and staged settings become more prominent. Each model places the viewer in a different position and brings particular parts of the city's history forward. What becomes visible, memorable, or meaningful changes with the form of representation.

This point is directly relevant to Tophane. The demolished military-industrial buildings have little presence in the images and narratives through which the area is currently understood. Attention is directed mainly towards the surviving monuments, the waterfront, and the cultural and commercial settings. The on-site AR prototype introduces the former military-industrial layer into this view. It makes this layer visible and spatially comparable without giving it a single fixed meaning. The digital volumes could be read in different ways. One viewer might focus on architectural style and façade composition; another might notice the spatial organisation of the buildings and square; another might consider the scale of military production and the power expressed by the complex. AR makes the absent layer available for observation, while its interpretation remains with the viewer. The technology connects historical evidence with the present setting but does not determine what should be understood from that connection.

In this thesis, fragmented urban memory refers to the different ways in which parts of the same historical system have survived. Some remain physically present as monuments. Others are recorded in maps, photographs, and written sources. The missing buildings can also be traced indirectly through open spaces, road alignments, interrupted building lines, and the separation of structures that once belonged to the same setting. These fragments do not produce a continuous account of the past by themselves. The AR prototype brings one source-based interpretation of the missing layer into the present site. The meeting of surviving, transformed, and digitally represented elements leads to the reading of Tophane as a fragmented urban Wunderkammer in the following section.

2.5 Relevance to the Case Study: Reading Tophane as a Fragmented Urban Wunderkammer

The previous sections examined changes in museum practice, the tourist gaze, digital heritage, augmented reality, and the ways urban memory is formed through physical traces and representations of the city. Together, these discussions establish a theoretical basis for considering museums and heritage sites as spaces of interpretation, interaction, and engagement with memory, rather than as settings for the display of individual objects alone. This framework is useful in Tophane, where architectural, cultural, commercial, and historical layers coexist in a fragmented setting.

In this thesis, Tophane refers to both the Tophane-i Âmire complex, which forms the main architectural focus of the study, and its surrounding urban context. This wider area includes nearby monuments, cultural institutions, commercial developments, and historical layers that have been lost or transformed.

The term “urban Wunderkammer” is used in this thesis as an interpretive metaphor for the contemporary condition of Tophane. Like a cabinet of curiosities, the area contains elements from different periods and with different functions. Unlike a deliberately arranged collection, however, these elements are not connected by a clear narrative. Tophane can thus be read as a group of historically significant but disconnected urban fragments. Fragmentation concerns not only the coexistence of elements from different periods, but also the unequal visibility of the layers to which they belong. Some remain physically present, while others can be traced only through historical sources, altered building lines, and the spaces left by demolition.

This fragmented condition is closely connected to physical changes in the area. Road-widening works undertaken during the second half of the 1950s led to the demolition of the Müşirlik building, military barracks, and other structures around Tophane-i Âmire. The surviving foundry buildings had once belonged to a larger military and production complex containing barracks, workshops, storage buildings, and other service structures. Only a small part of this complex remains today (Ceylan, 2003; Çevik Azap, 2022). In later decades, new cultural and commercial uses were introduced, while the Galataport project reshaped the waterfront through large-scale investment centred on tourism and commerce (Erbil & Erbil, 2024). These interventions further altered the spatial character of Tophane.

This reading is developed further through John Urry's concept of the tourist gaze and Valerie Casey's model of the performing museum. Urry describes the tourist gaze as a socially organised way of seeing, directed towards features perceived as different from everyday life (Urry, 2002, pp. 1–3). Casey examines the increasing importance of display and performance in shaping the museum experience (Casey, 2003, pp. 2, 9–10).

Tophane provides a suitable setting for this discussion because different forms of tourist attraction occupy a relatively compact urban area. Visitors encounter historical monuments and architectural remains alongside museums, cultural institutions, and the Galataport waterfront redevelopment (Erbil & Erbil, 2024). In Urry's terms, this coexistence contributes to what visitors recognise as worth seeing. At the same time, the historical and contemporary elements do not form a single coherent urban narrative.

Byung-Chul Han's discussion of digital communication extends this discussion to contemporary tourism. Han uses homo digitalis to describe an individual who maintains a visible online profile and participates in digital communication (Han, 2017). In tourism, visitors do more than observe a site; they also circulate their experiences through photographs, videos, social media posts, and online reviews. Repeated images contribute to the public image of a place and may bring certain features forward while leaving less visible historical layers outside its common representations.

Casey's model of the performing museum can also be applied to a historical area shaped by fragmented development. It gives display and visitor experience greater importance than the individual object (Casey, 2003, pp. 9–15). The AR project developed in this thesis applies this approach to Tophane-i Âmire and its surroundings. The prototype allows the digital models to be viewed while moving through the site and compared with the present setting. It does not determine how the missing layer should be understood, but makes it available for spatial observation.

The proposed approach seeks to bring the less visible historical layers of Tophane into the present experience of the site. Urry's tourist gaze and Casey's model of the performing museum are used here to question a form of tourism centred on the rapid visual consumption of places (Urry, 2002; Casey, 2003). The AR experience creates a point of comparison between the demolished buildings and the present setting rather than presenting a fixed account of the past. It opens one historical layer to observation, while the relationships and meanings drawn from it remain open to the viewer.

3. Historical and Urban Context of Tophane-i Âmire

Following the theoretical framework discussed in the previous chapter, this chapter examines the historical and spatial development of Tophane-i Âmire and its surrounding area. Rather than presenting a complete history of the wider Tophane district, it focuses on the transformations that shaped Tophane Square, the waterfront, and the military-industrial buildings associated with Tophane-i Âmire. The discussion focuses on the nineteenth-century organisation of the area, the demolitions and road works of the mid-twentieth century, and the later transformation of the waterfront. This historical framework is necessary for understanding the buildings selected for digital modelling and the fragmented relationship between the surviving monuments and the lost urban fabric. It also provides the spatial context for examining how augmented reality can make these lost or altered layers visible within the contemporary city.

3.1 Pre-Ottoman and Early Ottoman Tophane



(a) Buondelmonti, 1422



(b) Matrakçı Nasuh, 1537

During the Byzantine period, the area outside the Galata walls was referred to in some sources as “Metopon” (Çevik Azap, 2022, p. 2). Following Sultan Mehmed II’s conquest of Constantinople in 1453, the area gained strategic importance. The effectiveness of artillery during the siege led Mehmed II to give greater attention to cannon production and to establish a cannon foundry in the area that later became known as Tophane (Çevik Azap, 2022, pp. 1–2).

The location of the foundry was closely related to the area’s strategic position, access to the sea, and topographical conditions. Tophane stood at the entrance to the Golden Horn and opposite Topkapı Palace, making it suitable for defence and control. Its connection to the sea also made it easier to load the cannons and cannonballs produced in the foundry onto ships. In addition, the slope of the land supported the production and movement of heavy metal objects. The foundry facilities were established at a higher level, which helped organise both the production process and the movement of materials toward the waterfront (Ceylan, 2003).

The change between the late Byzantine and early Ottoman periods can also be seen in two historical depictions. Buondelmonti’s 1422 image shows Pera as a fortified settlement, with the future Tophane area located outside its main built-up zone. In Matrakçı Nasuh’s 1537 miniature, the same waterfront appears as part of the early Ottoman city following the establishment of Tophane-i Âmire. Although neither image is a measured map, together they provide a visual comparison of the area before and after the Ottoman conquest (Buondelmonti, 1422; Matrakçı Nasuh, 1537).

Figure 3.1. The eastern Galata waterfront before and after the Ottoman conquest: (a) Buondelmonti, 1422; (b) Matrakçı Nasuh, 1537. Sources: Bibliothèque nationale de France; İstanbul University Library, Rare Works Collection, T. 5964, fols. 8b–9a.

3.2 Tophane Waterfront and the Formation of the Square

The Tophane waterfront began to take a more defined form in the second half of the sixteenth century, as military production, maritime transport, and new construction became increasingly concentrated along the shoreline. One of the major architectural interventions of this period was the construction of the Kılıç Ali Paşa Complex. According to İnciciyan, as cited in the annotated edition of Kömürciyan's History of Istanbul, the site of the mosque and its auxiliary buildings, together with a large part of Tophane Square, had previously been a bay. Before constructing the complex, Kılıç Ali Paşa had this area filled to create new land along the waterfront (Kömürciyan, 1988, pp. 248–249). This intervention can be understood as one of the earliest documented changes to the shoreline that contributed to the later spatial development of Tophane Square.

During the eighteenth century, Tophane Square became more clearly defined as both a military and social space. The square had initially developed around the Kılıç Ali Paşa Complex and the nearby pier. The construction of the Tophane Fountain in 1732 strengthened the spatial definition of the square and contributed to its development as an important meeting place in the city (Özgencil Yıldırım, 2008, p. 255).

Tophane Fountain belongs to the eighteenth-century tradition of monumental square fountains. Melling's depiction of Tophane Square shows its original roof with projecting eaves and a dome (Özgencil Yıldırım, 2008, p. 256). In Melling's 1819 engraving, the fountain stands at the heart of the composition, together with Kılıç Ali Paşa Mosque and Tophane-i Âmire. This representation indicates that the fountain was a major visual and spatial focus of Tophane Square (Özgencil Yıldırım, 2008, pp. 256–257; Fer, 2016, pp. 145–152).

The large scale of production at Tophane-i Âmire generated a continuous movement of people and materials between the foundry, the square, and the waterfront. Its production activities depended on the regular supply of materials such as iron, bronze, timber, oilcloth, textiles, pitch, and tar (Ceylan, 2003, p. 45). At the same time, the area around the fountain supported everyday activities beyond military production. Melling's engraving depicts sellers, porters, water carriers, soldiers, women, and children gathering around the fountain, while the later engravings by Allom and Bartlett show market activity in the same area. Together, these visual sources suggest that Tophane Fountain functioned not only as a water structure but also as an important social focus within the square (Fer, 2016, pp. 106, 145–150).



Figure 3.2 *View of Tophane Square and the Fountain of Mahmud I, with Kılıç Ali Paşa Mosque in the background, Antoine Ignace Melling, 1819.*
Source: Aikaterini Laskaridis Foundation Library, Travelogues Digital Collection, via Wikimedia Commons (public domain).

3.3 Nineteenth-Century Transformations

At the beginning of the nineteenth century, Tophane Square was extensively rebuilt and reorganized during the military reforms of Mahmud II. In March 1823, the Firuzağa Fire severely damaged part of the cannon foundry, as well as the Topçu and Top Arabacı barracks in the square. Mahmud II had the damaged structures rebuilt within a year, while Nusretiye Mosque was constructed between 1823 and 1825 in place of the earlier barracks mosque. With its Baroque and Empire-style elements, the mosque introduced a new architectural character to the square and reflected the reform-oriented visual language of Mahmud II's reign (Çevik Azap, 2022, pp. 267–268; Özgencil Yıldırım, 2008, pp. 255, 259).

When it was first built, Nusretiye Mosque stood directly along the shoreline. Later land reclamation extended the coast towards the sea, leaving the mosque farther inland. Its waterfront-facing position and visibility within the open square made it a central visual reference in Tophane. Together with the rebuilt barracks and surrounding military spaces, the mosque contributed to the new spatial organisation and monumental character that Tophane Square acquired during the nineteenth century (Özgencil Yıldırım, 2008, pp. 254–259; Çevik Azap, 2022, p. 281).

The rebuilt Topçu and Top Arabacı barracks played a central role in shaping the nineteenth-century spatial organisation of Tophane Square. Extending parallel to the shoreline, the barracks provided accommodation for artillerymen, cannon-carriage personnel, and foundry workers. The surrounding courtyard and open areas were used for military equipment and training activities. Since the barracks were primarily wooden structures, they were repeatedly damaged by fires and rebuilt over time. Despite these changes, they remained central to the spatial organisation of the square and maintained its military character (Çevik Azap, 2022, pp. 281–282).

The earlier organisation of this military landscape can be seen in Melling's late-eighteenth-century engraving. The image shows the open area beside the barracks being used for Nizam-ı Cedid military drills. Nusretiye Mosque had not yet been constructed, and the engraving documents the square before Mahmud II's nineteenth-century rebuilding. Dense boat traffic, shops along the shoreline, and military formations appear together within the same view. The engraving shows that military training, maritime transport, and everyday public activity already overlapped in Tophane Square before its later reorganisation (Özgencil Yıldırım, 2008, pp. 256–257).

During the nineteenth century, Tophane-i Âmire functioned within a dense network of workshops, barracks, residences, and supporting facilities rather than as an isolated foundry. The construction of Nusretiye Mosque and the rebuilding of the barracks after the 1823 fire reorganized the relationship between military production, residential buildings, training areas, and the waterfront. These changes strengthened the role of Tophane Square as the spatial centre of the wider military-industrial complex (Mantran, 2001; Çevik Azap, 2022, pp. 281–282, 297–298).

Another important element in the transformation of the square was Tophane Pavilion. Designed by the British architect William James Smith, the pavilion was constructed between 1847 and 1851 during the reign of Sultan Abdülmecid. Its masonry construction and English Neoclassical style introduced a more representative and ceremonial architectural language to the square. This character distinguished the pavilion from the more utilitarian military and industrial buildings surrounding it (Çevik Azap, 2022, pp. 272–274; Can, 1993).

Tophane Pavilion extended the role of the square beyond military production and maritime transport. Used by the sultan during his visits to Tophane and for official receptions, it introduced an imperial and ceremonial function to the area. In this way, the pavilion strengthened the representative character of the square and contributed to its symbolic importance within the mid-nineteenth-century urban landscape (Çevik Azap, 2022, pp. 272–274; Ceylan, 2003).

The Tophane Clock Tower also contributed to this representative character. Constructed during the reign of Sultan Abdülmecid in Talimhane Square, between Tophane Barracks and Nusretiye Mosque, the tower was completed in October 1848. Its construction formed part of the effort to give the military drill ground a ceremonial character. Together with Nusretiye Mosque, Tophane Pavilion, Tophane Fountain, and the surrounding barracks, the clock tower contributed to the monumental composition of Tophane Square in the mid-nineteenth century (Çevik Azap, 2022, pp. 275–276; Özgencil Yıldırım, 2008, p. 255).



Figure 3.3.
View of Tophane from the sea, showing Nusretiye Mosque, Tophane Clock Tower, and the surrounding military complex, 1880s.
Source: Abdullah Frères, Vue de Tophané, 1880s, Pierre de Gigord Collection, Getty Research Institute, 96.R.14 (C17.7b), neg. no. 441.

3.4 Demolitions, Road Widening, and Spatial Rupture

In the early years of the Republic, Tophane gradually lost the military-industrial role that it had maintained until the final years of the Ottoman period. Following Ankara's designation as the capital, new arms-industry facilities began to be established there. Although cannons cast at Zeytinburnu continued to be processed in Tophane for a time, the foundry buildings gradually lost their importance and remained unused for many years (Ceylan, 2003, p. 45). Tophane Barracks, which had been occupied by British forces in 1920 and evacuated in September 1923, also became disused over the following decades (Çevik Azap, 2022, p. 282). As a result, the military production system that had previously connected the foundries, barracks, workshops, square, and waterfront could no longer be sustained.

The road-widening programme initiated in 1956 and continuing until 1959 brought one of the most radical physical transformations of Tophane. Within this broader programme, the interventions carried out between 1957 and 1959 gave the district much of its present appearance (Özgencil Yıldırım, 2008, p. 254). During this process, many buildings belonging to the historic military-industrial complex were demolished. Between 1956 and 1959, the Tophane-i Âmire Müşirlik Dairesi, the Birinci Sanayi Alayı Kışlası ve Mektebi, and the Tophane Barracks were demolished as part of the road-widening works. These buildings had previously defined the boundaries of Tophane Square and connected the surviving monuments to the wider military-industrial complex. Their removal changed the scale and spatial organisation of the square, leaving the remaining monuments separated from their original urban context.

The weakening of this multifunctional role had begun earlier, in the second half of the nineteenth century, when the coffeehouses and shops were removed and Tophane Pier gradually lost its importance. Later land reclamation and the road-widening works of the 1950s further weakened the connection between the square and the waterfront and gave vehicular circulation a stronger role in the area. Although these interventions created a more open space, they reduced the visibility of Tophane's earlier functions as a marketplace, maritime transport point, military drill and ceremonial ground, and social meeting place. The surviving monuments remained visible, but the spatial and functional relationships between them became increasingly fragmented (Özgencil Yıldırım, 2008, p. 254; Çevik Azap, 2022, pp. 269, 282; Ceylan, 2003, p. 44).



Figure 3.4
Tophane after the road-widening works, showing Nusretiye Mosque, Tophane Pavilion, and the expanded coastal road.
Source: Unknown photographer, 1959–1960, Foto Atlas, FA No. 63762.

3.5 Contemporary Tophane: Fragmentation and Waterfront Redevelopment

During the second half of the twentieth century, the Salıpazarı waterfront was largely occupied by port, customs, and storage facilities. The port buildings and warehouses constructed along the shoreline separated Tophane Square from the sea and restricted public access to the waterfront. The construction of new port buildings to the east of Tophane Pavilion in 1958 also interrupted its direct relationship with the coast (Çevik Azap, 2022, pp. 274, 282). Port operations consequently became the dominant use of the waterfront, while road traffic increasingly shaped the square and displaced many of its earlier maritime and public activities (Özgencil Yıldırım, 2008, p. 254).

From the 1990s onward, a new phase began with the cultural reuse of the surviving industrial buildings. In 1992, the surviving Tophane-i Âmire foundry buildings were transferred from the Ministry of National Defence to Mimar Sinan University. Following their restoration and adaptive reuse, they opened as the university's Culture and Art Centre in 1998. This new function brought part of Tophane's military-industrial heritage back into urban life through cultural and artistic events (Çevik Azap, 2022, p. 269; Ceylan, 2003, pp. 43, 55). Yet the intervention remained limited to the surviving buildings and did not re-establish their former spatial connections with the square or the waterfront.

The most recent large-scale transformation of the waterfront took place with the Galataport project. Before its redevelopment, the coastal strip between Karaköy and Tophane had remained largely inaccessible to the public because of its port and customs functions. In the project's official account, the underground cruise terminal and retractable hatch system allow port operations to continue while making the shoreline available for pedestrian use. When ships are docked, the hatch system creates a temporary customs and security area; at other times, this area becomes part of the waterfront promenade (Galataport İstanbul, n.d.). The project restored physical access to the shoreline and established a more continuous pedestrian route along the coast.

Public access, however, does not necessarily make the waterfront an entirely public urban space. Galataport combines the cruise terminal with restaurants, cafés, shops, offices, a hotel, and cultural institutions. Erbil and Erbil (2024) examine the project as part of a broader approach to waterfront redevelopment in which former port areas are integrated into tourism-led investment and high-end commercial programmes. The project also created a clearer pedestrian connection between Tophane Square, its surviving monuments, and the shoreline, but this route passes through an environment shaped by commercial uses, security systems, and private management. Korkut and Nalbantoğlu (2023) describe Galataport as a semi-public urban space, while Sayar and Arat (2025) question the relationship between its public-space discourse and its controlled, consumption-oriented character. The waterfront is now physically accessible, but the conditions under which it is used are strongly influenced by commercial activity and private control.

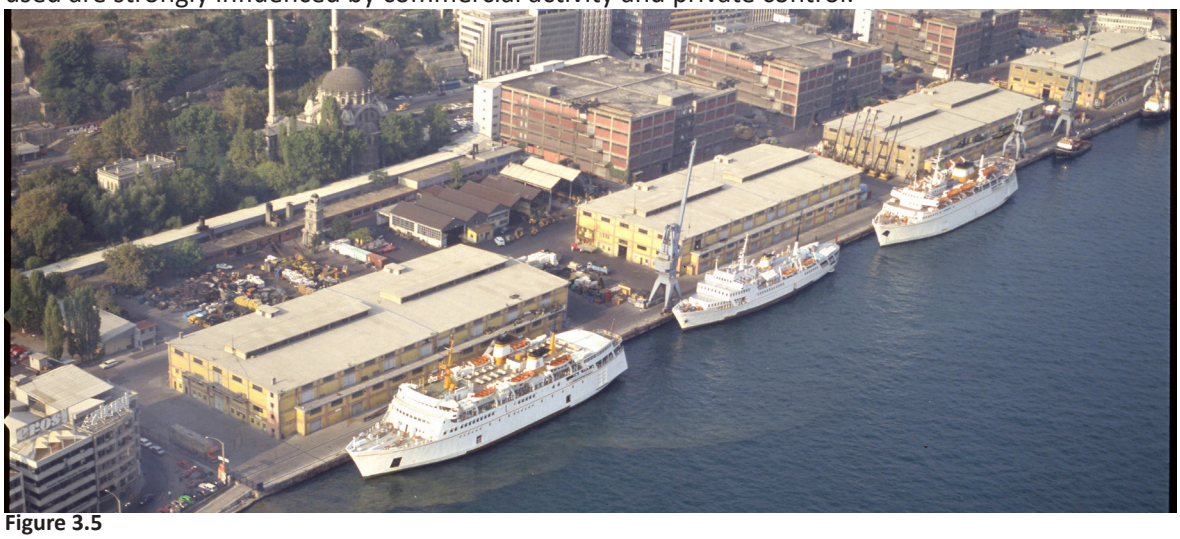


Figure 3.5
The Salıpazarı waterfront before the Galataport redevelopment, showing the port warehouses, docked ships, and Nusretiye Mosque in the background. Photograph by M. Erem Çalıkoğlu. Source: SALT Research, CALIST030503.



Figure 3.6
The Tophane waterfront after the Galataport redevelopment, viewed from the Bosphorus.
Photograph by the author, 2026.

From the early Republican period to the present, the loss of military-industrial functions, the demolition of several buildings, road-widening works, land reclamation, and port development altered the relationships between Tophane Square, its monuments, and the waterfront. Tophane-i Âmire, Nusretiye Mosque, Tophane Fountain, and Tophane Pavilion remained in the area, but they were no longer part of the continuous spatial system that had previously connected production, public life, and maritime activity (Çevik Azap, 2022; Ceylan, 2003; Özgencil Yıldırım, 2008). The adaptive reuse of Tophane-i Âmire and the opening of the Galataport promenade later brought new cultural functions and improved access to the shoreline, but neither intervention restored the demolished urban fabric. The historical layers of Tophane are still visible, although they are now experienced as separate elements within an environment shaped by roads, cultural venues, tourism, and commercial waterfront uses. A closer examination of the demolished buildings is necessary to understand the spatial relationships that are no longer visible in the present-day square.

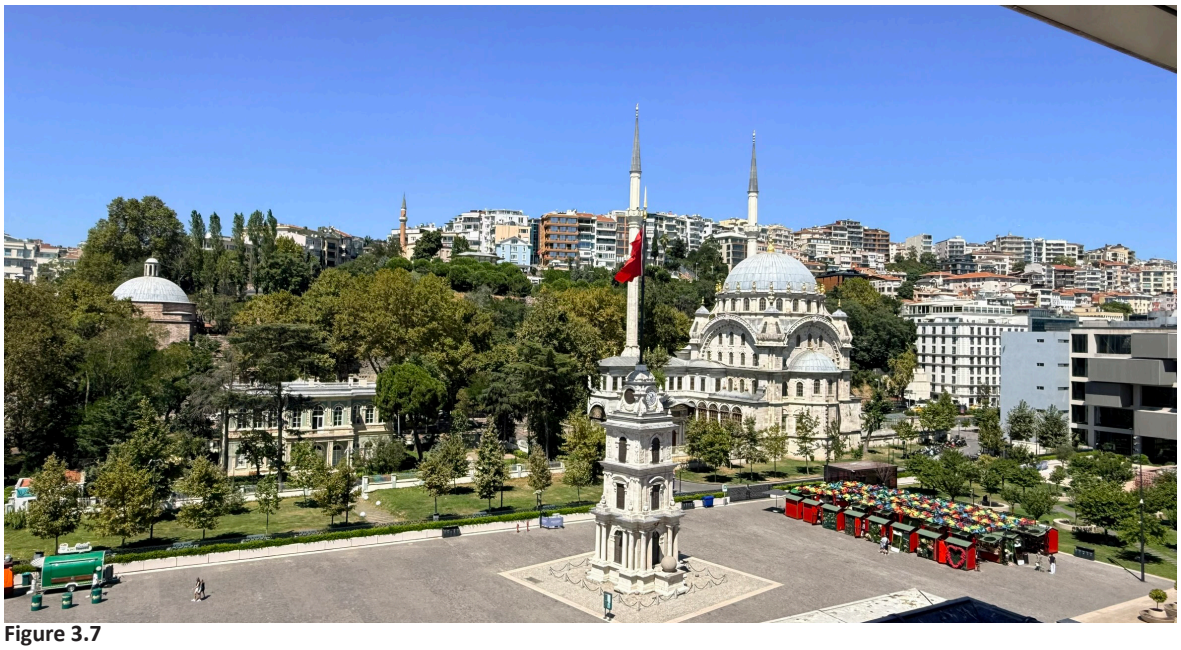
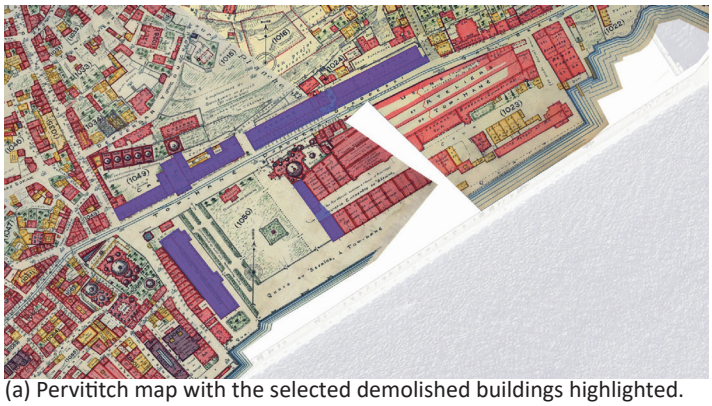


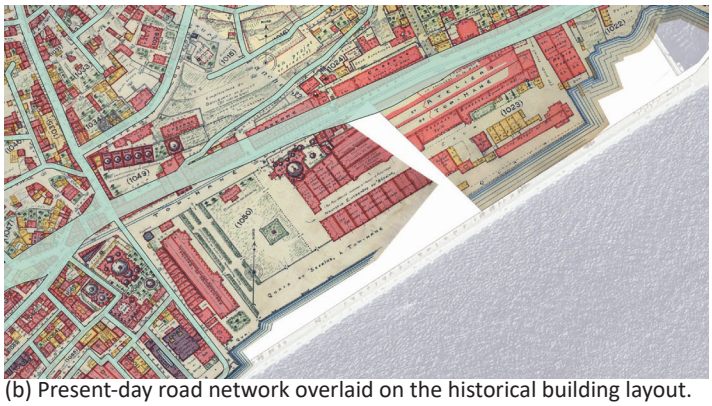
Figure 3.7
Contemporary view of Tophane Square, with Nusretiye Mosque, Tophane Clock Tower, and Tophane Pavilion.
Photograph by the author, 2026.



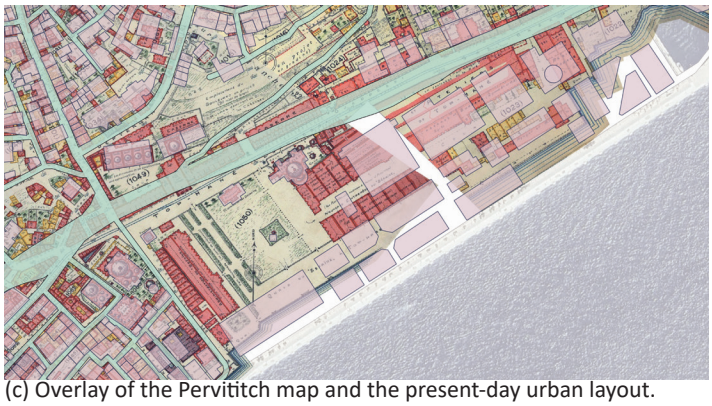
Figure 3.8
Contemporary view of Tophane Square, with Tophane Pavilion, Kılıç Ali Paşa Mosque, and Tophane Fountain.
Photograph by the author, 2026.



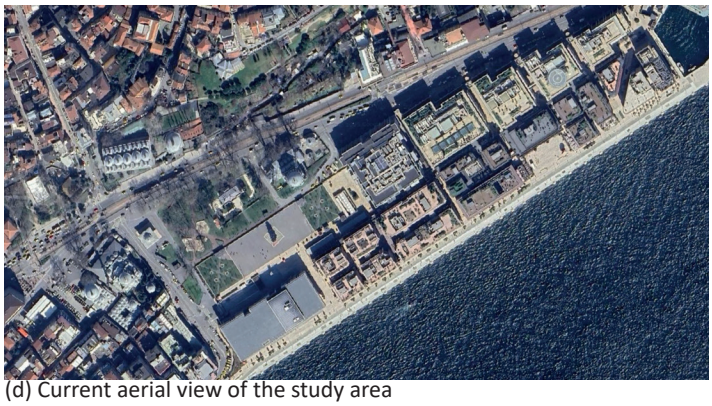
(a) Pervititch map with the selected demolished buildings highlighted.



(b) Present-day road network overlaid on the historical building layout.



(c) Overlay of the Pervititch map and the present-day urban layout.



(d) Current aerial view of the study area

3.6 Lost Military-Industrial Buildings of Tophane Square

The discussion now turns to four demolished building groups selected for detailed study and digital modelling. These groups do not represent every structure that once belonged to Tophane-i Âmire. They were selected because they played important roles in the organisation of Tophane Square and because information about their locations and architectural characteristics could be gathered from historical maps, photographs, and written sources. The four groups are the Top Fabrikası and Tüfekhane-i Âmire; the Marangozhane-i Âmire; the Birinci Sanayi Alayı Kışlası ve Mektebi; and the Tophane-i Âmire Müşirlik Dairesi.

The buildings served different parts of the military-industrial system. The Top Fabrikası and Tüfekhane-i Âmire were used for cannon processing and rifle production, while the Marangozhane-i Âmire produced wooden military equipment. The Birinci Sanayi Alayı Kışlası ve Mektebi provided accommodation and technical training for military personnel, and the Müşirlik Dairesi functioned as the administrative centre of Tophane-i Âmire. Their positions around the square connected production, training, administration, and maritime transport within the same urban setting. Their demolition changed the boundaries of the square and separated the surviving monuments from the buildings that had once surrounded them. Figure 3.9 shows the historical positions of the four groups in relation to the surviving monuments and the former shoreline (Çevik Azap, 2022, pp. 137–151, 268–270, 297–303).

Figure 3.9
Spatial relationship between the demolished military-industrial buildings and the present-day urban layout of Tophane Square.
Source: Author's elaboration in QGIS based on the Pervititch map, OpenStreetMap data, and Google Earth imagery.

3.6.1 Central Factories of Tophane-i Âmire

The central factories were located on the waterfront side of Tophane Square, opposite the Tophane-i Âmire Müşirlik Dairesi and close to Nusretiye Mosque. This group included the Top Fabrikası, Tüfekhane-i Âmire, Marangozhane-i Âmire, and several smaller service buildings. The Top Fabrikası and Tüfekhane-i Âmire stood next to each other, while the Marangozhane-i Âmire was positioned closer to the sea. In this way, different parts of military production were gathered in the same area of the complex (Çevik Azap, 2022, p. 298).

Construction of the Top Fabrikası began in 1836. Machinery brought from Britain was used to process cannons that had been cast at Zeytinburnu and transported to Tophane in an unfinished state. The Tüfekhane-i Âmire was built beside it between 1836 and 1837 for the production and assembly of rifles. Both factories were later enlarged as their production areas became insufficient, and the complex gradually expanded towards the Salıpazarı waterfront (Çevik Azap, 2022, pp. 299–301).

The Marangozhane-i Âmire supported these factories by producing wooden gunstocks, artillery carriages, wheels, and other equipment required by the army. It also contained storage spaces and a Nakkaşhane. The building was repaired at different times and received an additional section in 1885 (Çevik Azap, 2022, pp. 301–302).

These factories did not form a single uniform building. They consisted of adjoining production, storage, and service spaces that changed as the complex expanded. Historical photographs show long masonry façades, repeated arched openings, and connected roof forms facing the square. For this study, their importance lies not only in their former production functions but also in the continuous built edge they created along Tophane Square. Their demolition removed this edge and changed the relationship between the square and the waterfront.



Figure 3.10
Historical view of the factory buildings immediately beside Nusretiye Mosque, seen from the sea.

Source: İstanbul University Rare Works Library, item 90817-24; reproduced in Çevik Azap (2022, p. 298).



Figure 3.11
View of the central factory buildings of Tophane-i Âmire from Tophane Square, with Tophane Clock Tower in the foreground.
Source: Abdullah Frères, 1880–1893, Abdul-Hamid II Collection, Library of Congress, item 2003672033.

3.6.2 Birinci Sanayi Alayı Kışlası ve Mektebi

The Birinci Sanayi Alayı combined technical education with practical work in the factories of Tophane-i Âmire. Its members received training in military production and worked in the nearby factory buildings. The Birinci Sanayi Alayı Kışlası ve Mektebi provided accommodation and education for this personnel within the same complex. The close position of the school, barracks, and factories shows that training and production were directly connected in Tophane (Çevik Azap, 2022, pp. 137–140).

The building group was located on the northern side of the central complex, towards Fındıklı. It consisted of two long blocks with a barracks mosque between them. The blocks were first built with two storeys, but a third storey was later added as more accommodation was needed. A row of shops occupied the lower part of the buildings. According to Çevik Azap, the ground floor was approximately seven metres high, the two upper floors were each about four metres high, and the buildings were approximately twenty-four metres deep (Çevik Azap, 2022, pp. 150–151).

The educational use of the buildings continued after the administrative changes of 1909 and during the Republican period, when they were used as the Erkek Sanat Okulu. The long blocks and the shops beneath them extended the built edge of the complex towards Fındıklı. They were demolished during the road-widening works of 1956 and 1957. After their removal, the area around Nusretiye Mosque became more open, and the mosque was separated from the military buildings that had previously surrounded it (Çevik Azap, 2022, pp. 150–151).



Figure 3.12
Historical view of the Birinci Sanayi Alayı Kışlası ve Mektebi, showing the row of shops beneath the barracks, c. 1910–1915.
Source: Photographer unknown, Tophane Kışlası, 1910–1915, Eski İstanbul Fotoğrafları Arşivi; reproduced via Foto Atlas.

3.6.3 Tophane-i Âmire Müşirlik Dairesi

The Tophane-i Âmire Müşirlik Dairesi stood in front of Nusretiye Mosque and extended parallel to the shoreline. According to the 1927 Pervititch map, it was approximately 155 metres long. It was a three-storey masonry building with shops on the ground floor. The central part projected from the main façade and marked the principal entrance, while the other units were arranged along both sides of this section (Çevik Azap, 2022, pp. 268–269).

The administrative function of the building originated from the earlier Topçubaşılık building, which was used by the head of the artillery corps and his staff. This building was rebuilt during the reign of Mahmud II in 1826. After the establishment of the Tophane-i Âmire Müşiriyeti in 1832, it became the administrative centre of the institution and contained the office of the müşir (Çevik Azap, 2022, pp. 267–269).

The façade included semicircular arches, framed windows, shallow arched pediments, and plasterwork designed to resemble stone masonry. These elements were arranged regularly along the long façade, while the projecting central section made the main entrance more visible. Çevik Azap describes these features as part of the building's Western Neoclassical style (Çevik Azap, 2022, pp. 268–269).

After a fire in 1864, the Müşirlik Dairesi was rebuilt on a larger site that included an adjacent empty plot. It remained in use until its demolition during the road-widening works of 1956. With its long façade and central position, the building had formed one of the main boundaries of Tophane Square. Its removal opened the area in front of Nusretiye Mosque and weakened the spatial connection between the mosque, the square, and the factory buildings (Çevik Azap, 2022, pp. 269–270).



Figure 3.13

Historical view of the Tophane-i Âmire Müşirlik Dairesi, showing its long façade and ground-floor arched openings along Tophane Square.

Source: İstanbul University Rare Works Library (Nadir Eserler Kütüphanesi), 90839-26; reproduced in Çevik Azap (2022, p. 269).

3.6.4 Spatial Relationship and Selection for Digital Modelling

Together, the four building groups formed part of the built framework around Tophane Square. Their demolition removed not only individual structures but also the boundaries and connections that had linked the square to the military-industrial complex and the waterfront. They were selected for digital modelling because their former positions were important to this spatial arrangement and because historical maps, photographs, and written records provided enough information for further study. In Chapter 4, the four groups are treated as separate study units and introduced as Volumes A–D for the documentation and modelling process.

4. Source-Based Digital Modelling of Demolished Military-Industrial Buildings

4.1 Source-Based Digital Modelling Workflow

The previous chapter identified four demolished military-industrial building groups and examined their former positions within Tophane Square. This chapter explains how the available historical evidence was used to develop source-based digital models of these buildings. For documentation and modelling, the selected groups are referred to as Volumes A–D. Since complete measured drawings were not available, each volume was studied through the comparison of written records, historical maps, photographs, engravings, and the surviving urban context. Each source provided a different type of architectural information. Maps indicated location and building footprints, while photographs and engravings supported the interpretation of façades, proportions, openings, and roof forms. Surviving monuments and the present site provided additional references for scale and spatial relationships.

Figure 4.1 presents the complete workflow in five connected stages. The process began with the review of historical and visual sources. The Pervititch map was then georeferenced in QGIS and compared with the present road network, shoreline, and surviving buildings. This comparison established the approximate positions of the demolished structures and their relationships with Tophane Square. In the next stage, photographs and engravings were examined together with the mapped footprints. Perspective correction and two-dimensional drawing helped identify façade outlines, repeated proportions, floor levels, openings, and architectural rhythms. The interpreted information was then transferred to Revit, where the building volumes and their architectural elements were modelled. The final models were prepared for transfer to Unity and subsequent on-site AR testing.

Although the diagram presents these stages as a sequence, the work was not entirely linear. New comparisons sometimes required earlier decisions to be reconsidered, particularly where photographs were incomplete or different sources provided limited information. The resulting models are source-based architectural interpretations, and their level of detail reflects the evidence available for each volume. The following sections explain how this workflow was applied to Volumes A–D and identify the sources and modelling decisions used for each building group.

Figure 4.1
Workflow of the source-based digital modelling and AR visualization process. The diagram summarises the five main stages, from source review and urban context analysis to architectural modelling and on-site AR testing.
Source: Author.

01
SOURCE REVIEW

Historical and visual data
Written sources, photographs, maps, engravings, and current site condition

02
URBAN CONTEXT ANALYSIS

QGIS-Map overlay and location analysis
Georeferencing of the Pervititch map with the current urban map; interpretation of shoreline, roads, and building positions

03
2D DRAWING & VISUAL READING

Photoshop , AutoCAD
Façade and plan interpretation
Perspective correction, extraction of outlines, proportions, façade rhythm, and spatial relations

04
ARCHITECTURAL MODELLING

Revit-Source-based architectural reconstruction
Modelling of Volumes A–D, façade elements, roofs, openings, and mass relationships

05
AR VISUALIZATION

Unity-AR integration and testing
Model transfer, scale adjustment, placement, horizontal plane detection and reference-point calibration, visualization tests



4.2 Mapping and Location Determination

4.2.1 Locating the Study Area

Figure 4.2
Location and study area maps showing the position of Tophane within Turkey, Istanbul, and Beyoğlu
Source: Maps by the author, based on OpenStreetMap data.

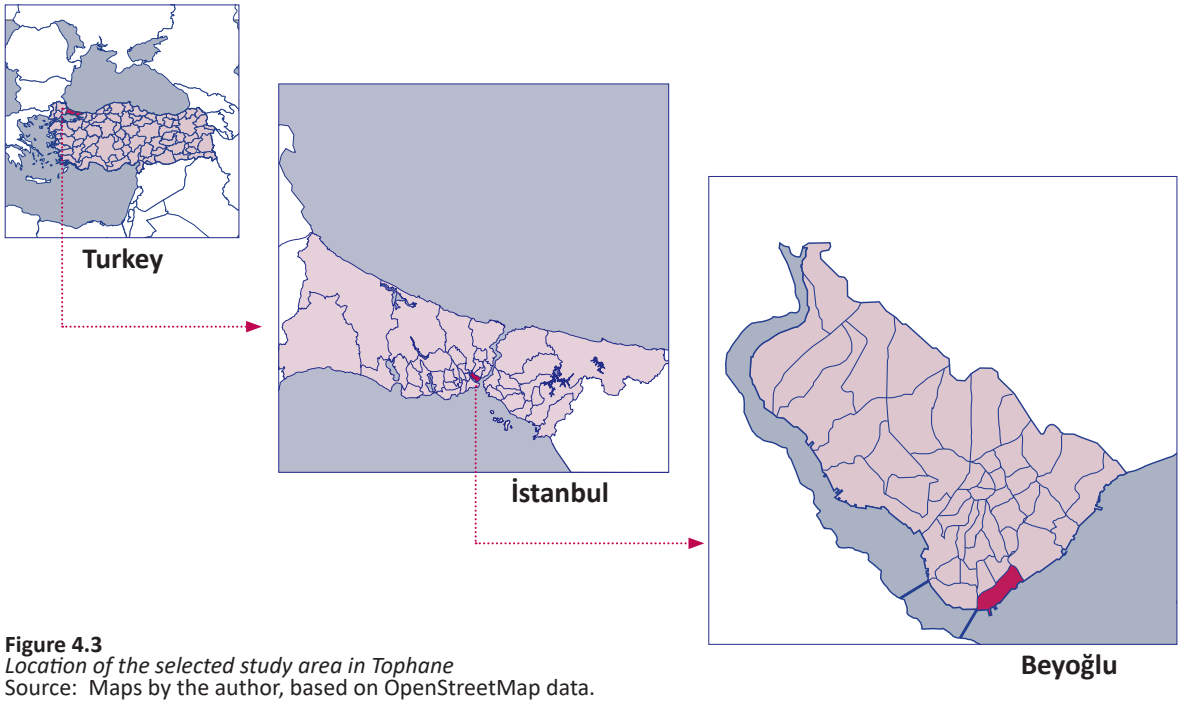
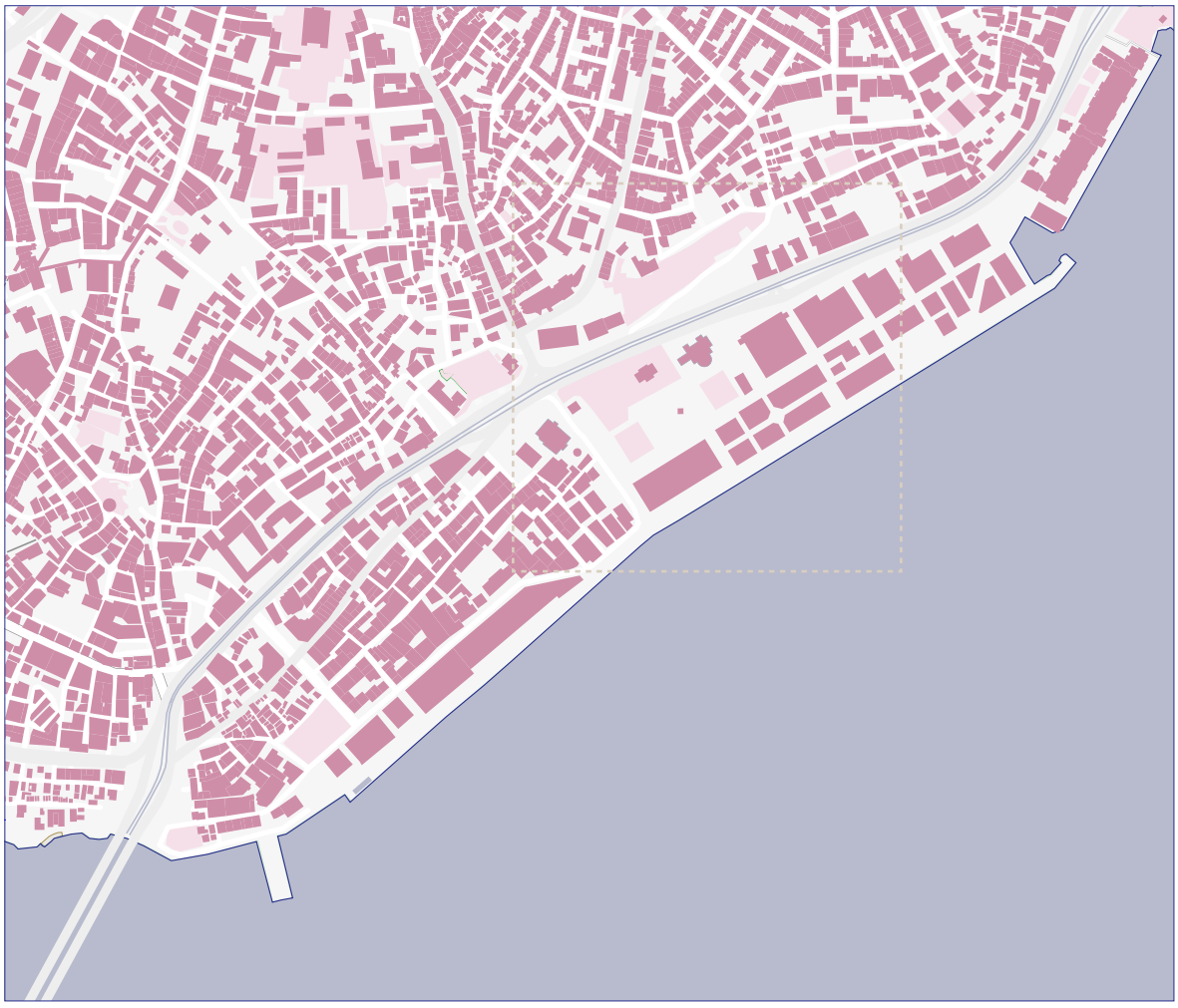


Figure 4.3
Location of the selected study area in Tophane
Source: Maps by the author, based on OpenStreetMap data.



4.2.2 Georeferencing and Overlay of Historical and Current Maps

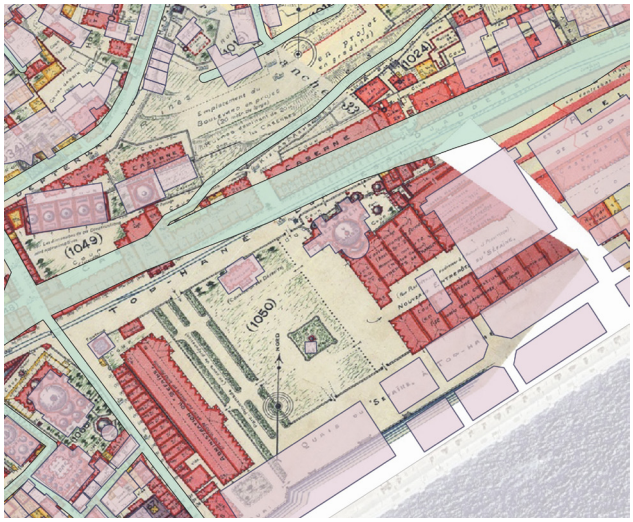
Figure 4.4
Pervititch insurance map of the Tophane study area
Source: From the Pervititch insurance map of Tophane.



Figure 4.5
Current map of the Tophane study area
Source: From OpenStreetMap. Map data retrieved and edited by the author.



Figure 4.6
Overlay of the Pervititch map and current urban fabric in QGIS
Source: Adapted from the Pervititch insurance map of Tophane and OpenStreetMap data. Overlay and visual editing by the author in QGIS.



Pervititch insurance maps were used as the primary source for determining the locations of the demolished buildings. Prepared by Jacques Pervititch between 1922 and 1945 for different districts of Istanbul, these maps are important cartographic documents that show building locations, parcel relationships, street patterns, and architectural-scale details (Sabancıoğlu, 2003). For the Tophane area, they provide one of the clearest plan-based references for understanding the position of buildings that no longer exist or have been significantly transformed. They were used as a fundamental source for identifying the approximate footprints and spatial relationships of the reconstructed volumes.

After selecting the Pervititch map sheets covering the study area, the relevant parts were combined and imported into QGIS. QGIS was used because it allows historical maps to be georeferenced and compared with current map data within the same spatial environment. In this process, fixed elements that are visible in both the historical and current conditions, such as the Nusretiye Mosque and the Tophane Clock Tower, were selected as reference points. By matching these points, the historical map could be aligned with the present urban layout and evaluated in relation to today's street network, open spaces, and surviving monuments.

This overlay process made it possible to locate the demolished buildings approximately within the current urban context. The comparison also helped clarify how the historical building traces correspond to the present-day site conditions. This base map provided the starting framework for positioning the reconstructed masses and developing the architectural modelling process.

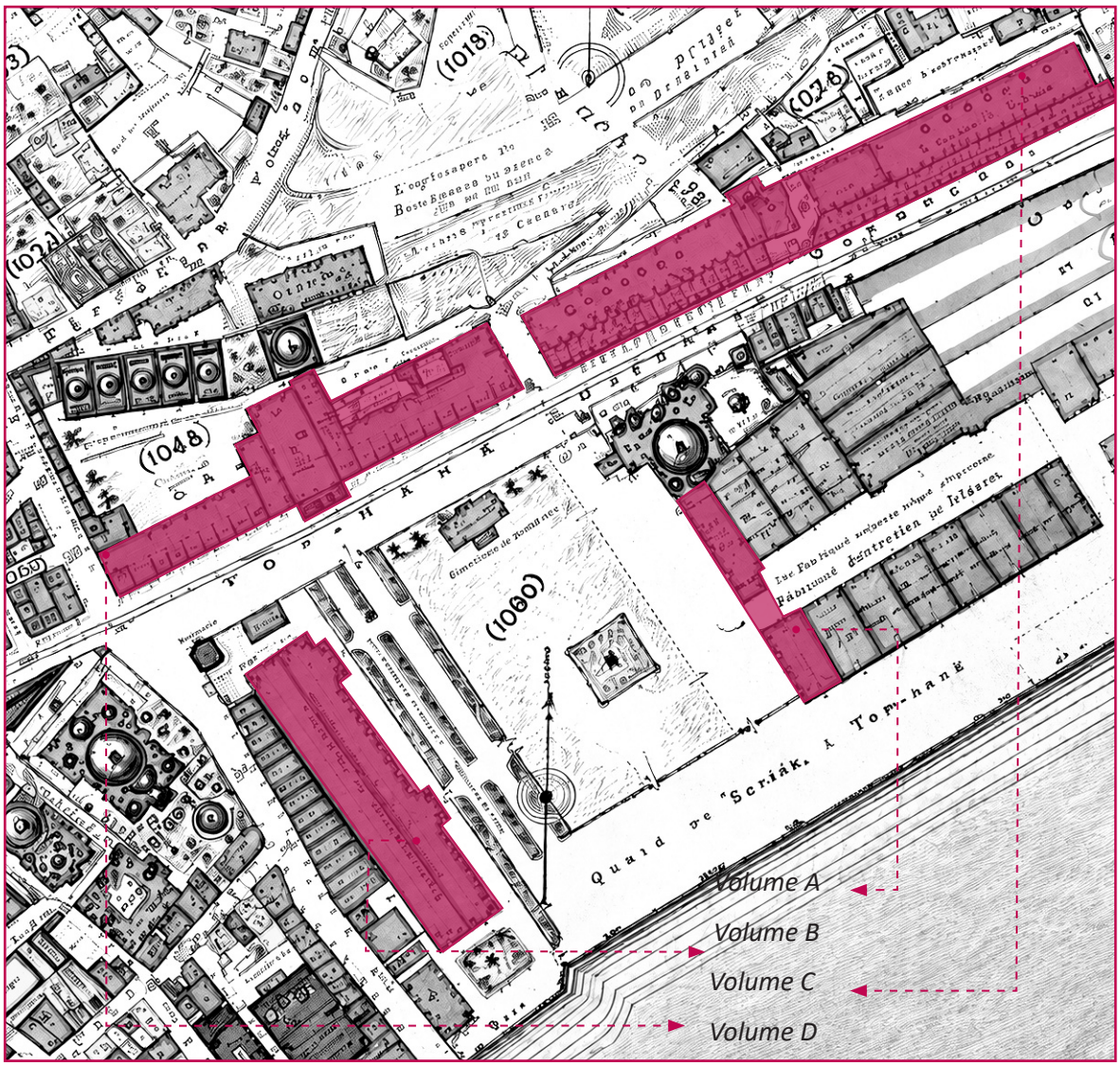
The historical map, present-day map, and georeferenced overlay are presented in Figures 4.4–4.6.

4.2.3 Identification of Volumes A–D on the Historical Map

The Pervititch insurance map was used as the main planimetric reference for locating the digital volumes within the historical urban context of Tophane. It shows the selected structures in relation to the surrounding street network, open spaces, and waterfront. Measured architectural plans of the selected demolished buildings were not available. The map was used to identify their approximate footprints, positions, and spatial relationships.

The selected buildings are labelled as Volumes A, B, C, and D to provide a consistent reference system throughout the mapping, modelling, and AR stages. These labels refer to the historical buildings discussed in Chapter 3. The map served as a guide to their spatial arrangement rather than as a measured architectural survey. The identification of Volumes A–D is shown in Figure 4.7.

Figure 4.7
Identification of Volumes A–D on the Historical Map
Source: Adapted from the Pervititch insurance map of Tophane; labels and visual editing by the author.



4.3 Source-Based Elevation Development of Volume A

4.3.1 Planimetric and Visual Sources

Figure 4.8
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

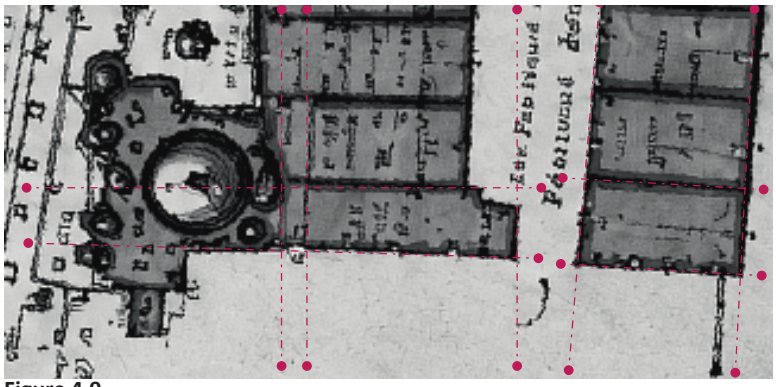


Figure 4.9
View of Tophane, 1889
Source: From Tophane, 1889, by Eski İstanbul Fotoğrafları Arşivi, n.d.



Figure 4.10
Tophane and Nusretiye Mosque, Abdullah Frères photograph
Source: From Tophane ve Nusretiye Camii / Abdullah Frères Fotoğrafı, by Abdullah Frères, Eski İstanbul Fotoğrafları Arşivi, n.d.

The modelling process started with Volume A, located next to the Nusretiye Mosque. Historical photographs show that the north-eastern part of this volume was directly connected to the mosque complex. For this reason, this junction was used as one of the main reference points during the reconstruction process.

Since no measured architectural drawings of Volume A were available, the measured survey drawings of the adjacent Nusretiye Mosque Hünkâr Pavilion were used as a dimensional reference. The measurements obtained from these drawings were compared with the proportions visible in historical photographs and with the plan information derived from the Pervititch map. Through this comparison, the approximate scale, massing, façade rhythm, and opening arrangement of Volume A were interpreted, and the source-based elevation drawing was developed.





Figure 4.11
Southwest and northeast elevation drawings of the Nusretiye Mosque Hünkâr Pavilion
Source: From Nusretiye Cami Hünkâr Kasrı Rölövesi, drawing no. 23.10, by Nuran Nar, Yıldız Technical University, Faculty of Architecture, Restoration Program, 2001.

4.3.2 Façade Analysis and Elevation Development

The photograph by Abdullah Frères was important for understanding the window arrangement between the two doors of Volume A. Fourteen openings can be identified: three are smaller, while the others have larger, regular proportions. As the photographs do not show the entire building, selected images were corrected for perspective in Photoshop. This clarified the relationships between the windows, vertical axes, floor levels, and façade divisions, allowing the repeated window rhythm to guide the modelling.

The corrected photographs were then compared with the footprint information obtained from the Pervititch map. The photographs and plan data were considered together to estimate the positions of windows, doors, and repeated façade elements and to complete the unseen parts more consistently. The resulting elevation is a source-based architectural interpretation developed from historical photographs, measured reference drawings, and planimetric evidence, rather than a definitive measured restitution.

Figure 4.12
Corrected and annotated façade detail used for proportional analysis
Source: Adapted from Tophane, 1889, by Eski İstanbul Fotoğrafları Arşivi, n.d. Perspective correction, scaling, and annotations by the author.

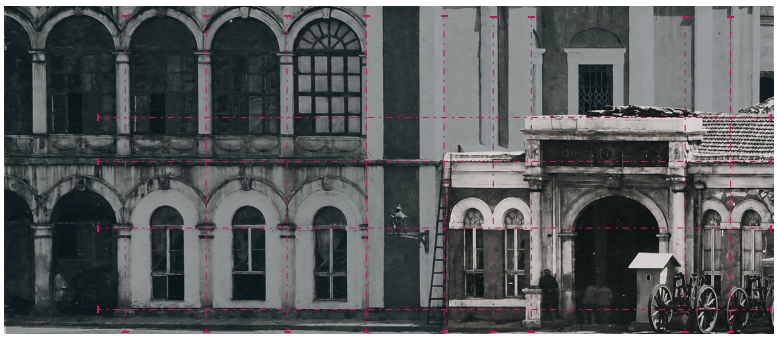


Figure 4.13
Corrected and annotated façade detail used for proportional analysis
Source: Adapted from Tophane ve Nusretiye Camii / Abdullah Frères Fotoğrafı, by Abdullah Frères, Eski İstanbul Fotoğrafları Arşivi, n.d.

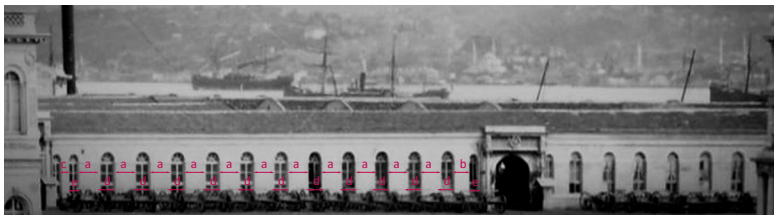


Figure 4.14
Corrected and annotated façade detail used for proportional analysis
Source: Adapted from Tophane, 1889, by Eski İstanbul Fotoğrafları Arşivi, n.d. Perspective correction, scaling, and annotations by the author.

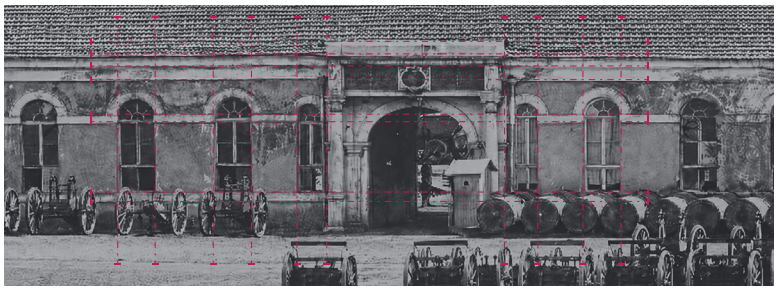
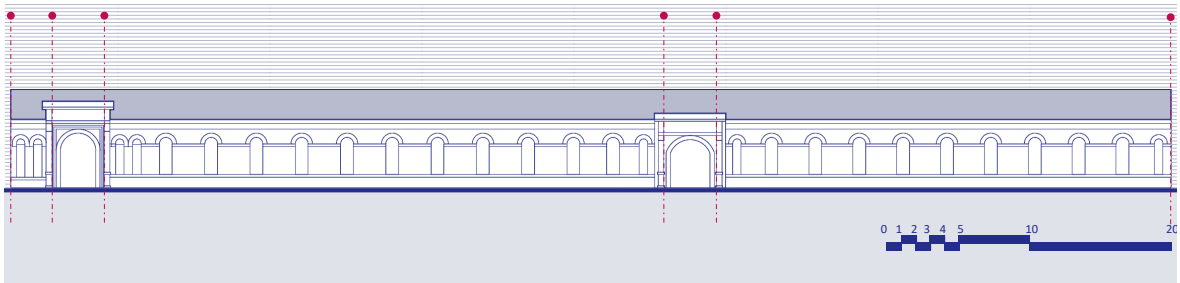


Figure 4.15
Reconstructed elevation drawing of Volume A
Source: Drawing by the author, based on historical photographs and Pervititch map references.



4.4 Source-Based Elevation Development of Volume B

4.4.1 Planimetric and Visual Sources

Figure 4.16
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

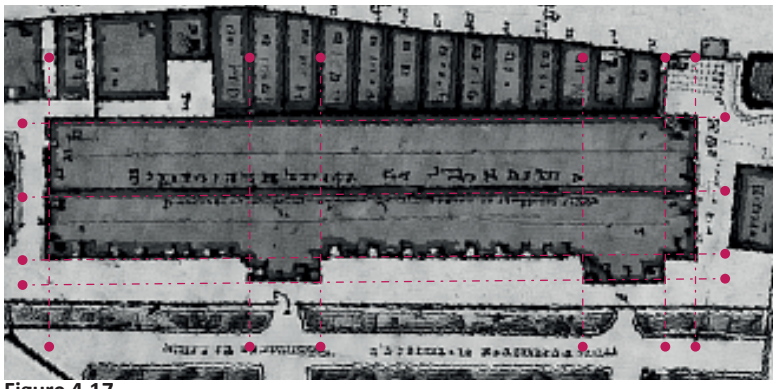


Figure 4.17
View of Tophane in the 1930s
Source: From 1930'lu Yıllarda Tophane, Eski İstanbul Fotoğrafları Arşivi, n.d.

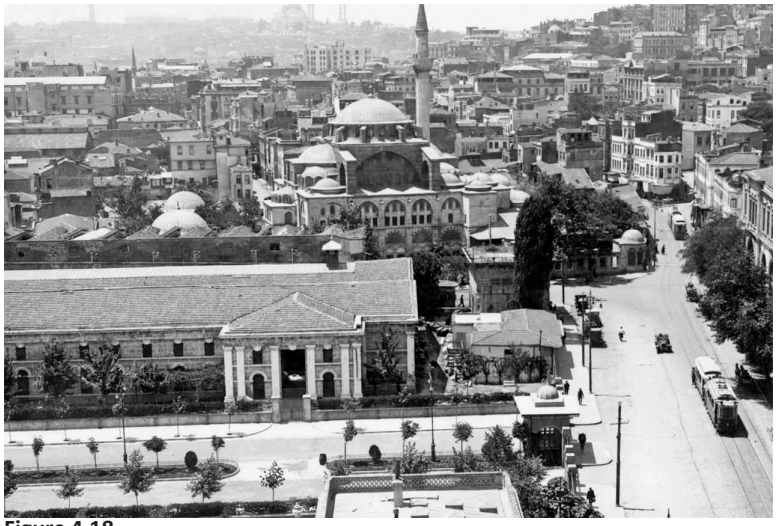


Figure 4.18
General view of Tophane Barracks, 1890
Source: From Tophane Kışlası Genel Görünümü, by Guillaume Berggren, 1890, Eski İstanbul Fotoğrafları Arşivi.



Following the same source-based approach used for Volume A, the reconstruction of Volume B started with the planimetric information obtained from the Pervititch insurance map. The map was used to interpret the footprint, position, and general massing of the volume. In addition, the Tophane Fountain, which is located close to the building and has survived until today, was used as an important proportional reference for estimating the scale and height of the volume.

Historical photographs were then used to understand the height, façade rhythm, openings, and architectural character of the building. In particular, the photograph taken by Guillaume Berggren provides a clear view of a part of the façade. In order to use this image more effectively, the façade detail was digitally adjusted through perspective correction. This corrected view made it possible to compare the proportions of the openings, floor levels, and vertical divisions with the information obtained from the map and the Tophane Fountain.

4.4.2 Façade Analysis and Elevation Development

The façade facing the inner courtyard includes two projecting entrance sections. Since these parts have a different façade arrangement, another photograph taken from an elevated viewpoint was also examined. This image helped interpret the position and proportions of the projecting elements.

Figure 4.19
Mass relationship between Volume B and the Tophane Fountain
Source: From Tophane Kasrı ve Kılıç Ali Paşa Camii / James Robertson Fotoğrafı, by James Robertson, 1853–1858, Eski İstanbul Fotoğrafları Arşivi.



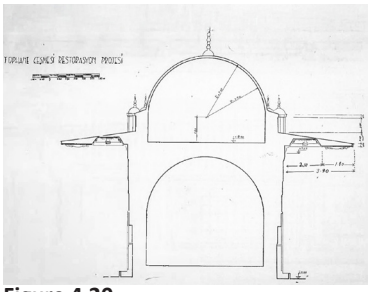


Figure 4.20
Section drawing of the Tophane Fountain
Source: From Tophane Çeşmesi, İstanbul Belediyesi Sular İdaresi Müdürlüğü Yayınları, no. 4, 1958.

Figure 4.21
Corrected and annotated façade detail used for proportional analysis
Source: Adapted from Tophane Kışlası Genel Görünümü, by Guillaume Berggren, 1890, Eski İstanbul Fotoğrafları Arşivi.

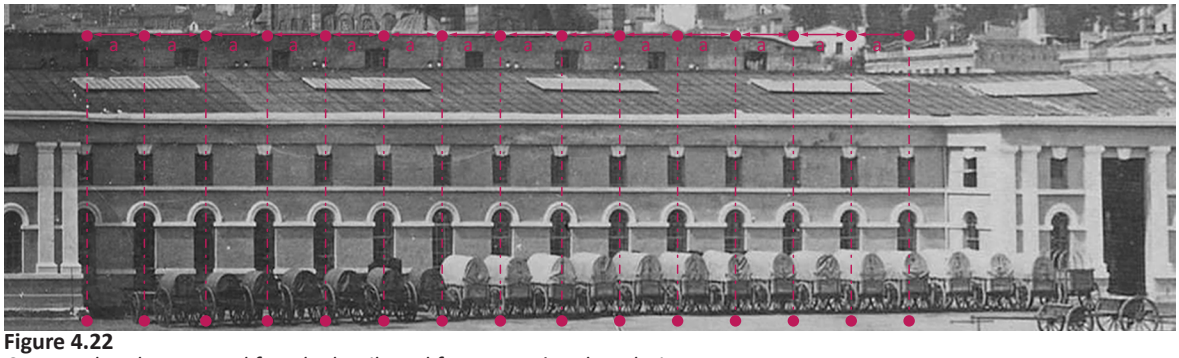
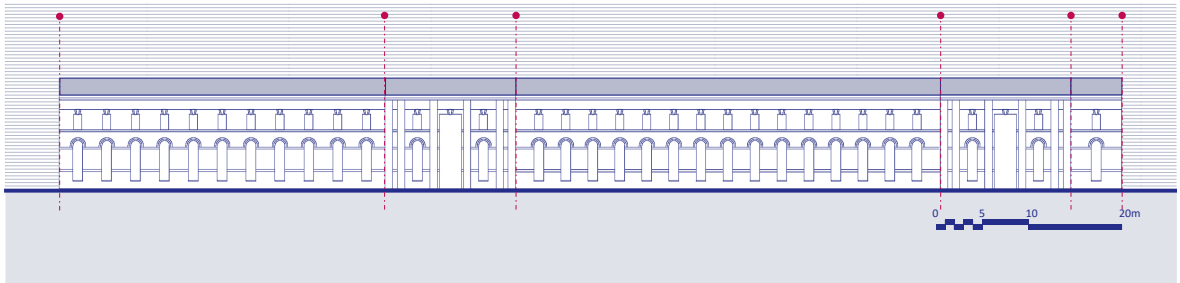


Figure 4.22
Corrected and annotated façade detail used for proportional analysis
Source: Adapted from 1930'lu Yıllarda Tophane, Eski İstanbul Fotoğrafları Arşivi, n.d.



Figure 4.23
Reconstructed elevation drawing of Volume B
Source: Drawing by the author, based on historical photographs and Pervititch map references.

The elevation drawing of Volume B was developed through a comparative interpretation of the Pervititch map, the Tophane Fountain, and historical photographs. The drawing does not claim to represent a definitive measured restitution; instead, it translates the available visual and planimetric evidence into a source-based architectural reconstruction.



4.5 Source-Based Elevation Development of Volume C

4.5.1 Plan and Massing Interpretation

Figure 4.24
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

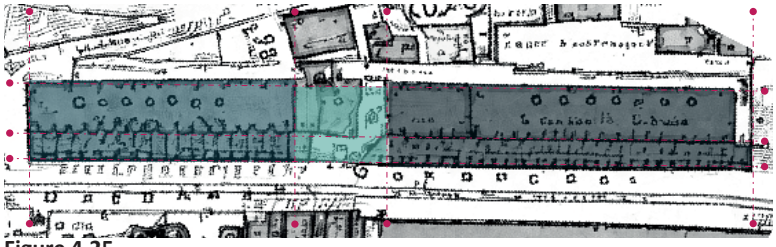


Figure 4.25
Annotated historical photograph showing the mass outline of the Tophane Barracks
Source: Adapted from Tophane / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-b. Annotations by the author.

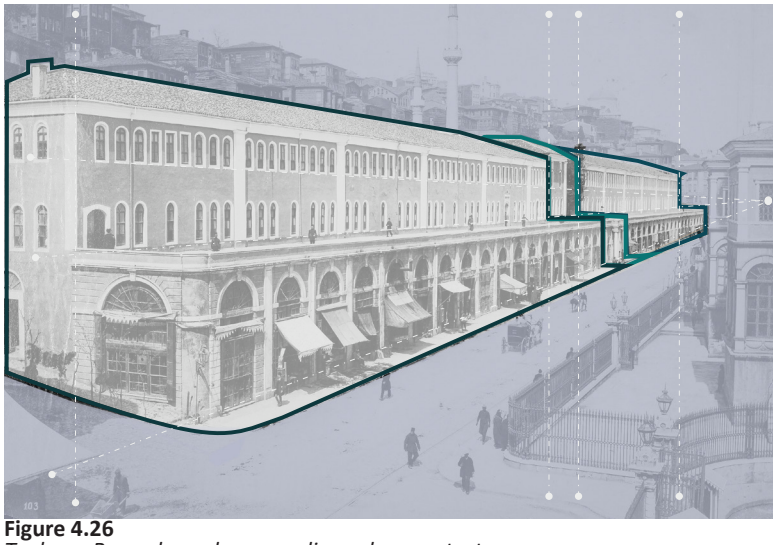


Figure 4.26
Tophane Barracks and surrounding urban context
Source: From Tophane / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-b



Volume C is located opposite the Nusretiye Mosque as a long and narrow building mass extending along the street. In the reconstruction process, the planimetric data from the Pervititch insurance map and the historical photographs were first evaluated together. Due to the building's elongated character, the mass was divided into three main sections in order to make the façade rhythm and proportional relationships more readable.

The photographs of Volume C could not be directly transformed into a flat elevation view because of the building's position, length, and strong perspective effect. Instead of a method based on perspective correction, the repeated façade elements visible in the photographs were compared with the footprint traces shown on the Pervititch map.

Figure 4.27
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

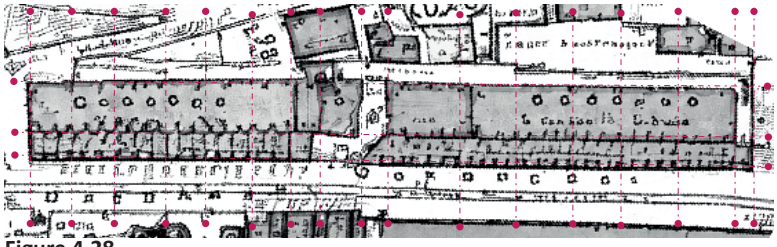


Figure 4.28
Annotated historical photograph showing the mass outline of the Tophane Barracks
Source: Adapted from Tophane / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-b. Annotations by the author.

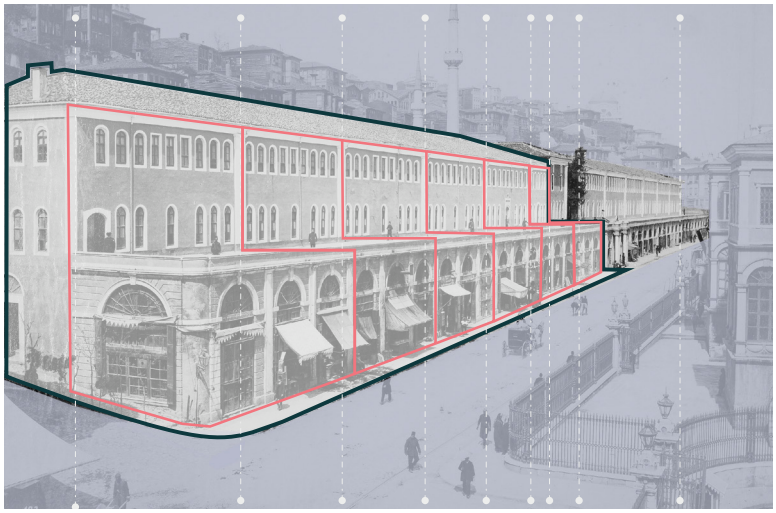




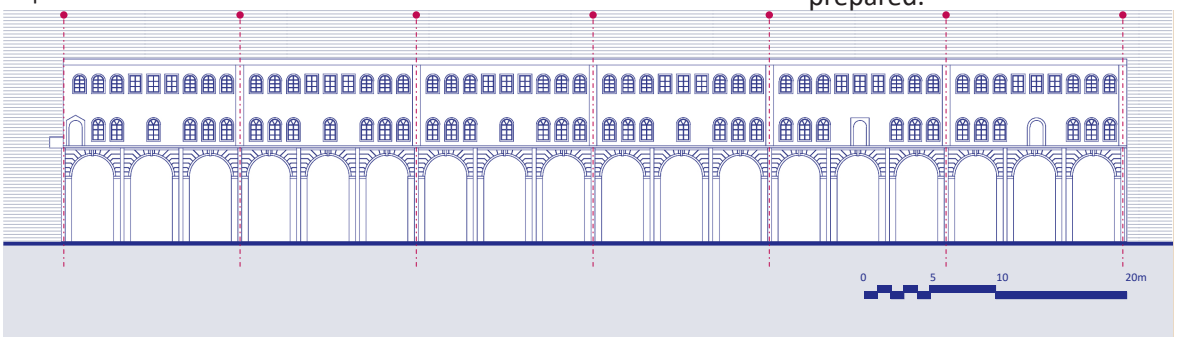
Figure 4.29
Reconstructed elevation drawing of Volume C
Source: Drawing by the author, based on historical photographs and Pervititch map references.

Through this comparison, the approximate mass divisions, façade axes, and opening arrangement of the building were interpreted in a source-based manner.

4.5.2 Façade Analysis and Elevation Development

The photographs show that the ground floor contained arched shop units opening onto the street. Above these shops, a horizontal intermediate level can be read in some parts, suggesting a terrace or semi-open use. On the upper floors, regularly repeated window rows, vertical dividing elements, and different façade compositions are visible. In particular, three arched shop openings appear to correspond to one façade block on the upper level. This proportional relationship was used as one of the main references for establishing the façade organisation.

On the upper façades, the window rows are separated by white vertical elements. This arrangement creates a rhythmic and modular composition along the long façade of the building. For this reason, the arched ground-floor openings, upper-floor window blocks, and vertical façade divisions were evaluated together. The resulting proportions were then compared with the building footprint on the Pervititch map, and a source-based elevation drawing was prepared.



4.6 Source-Based Elevation Development of Volume D

4.6.1 Planimetric and Visual Sources

Figure 4.30
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

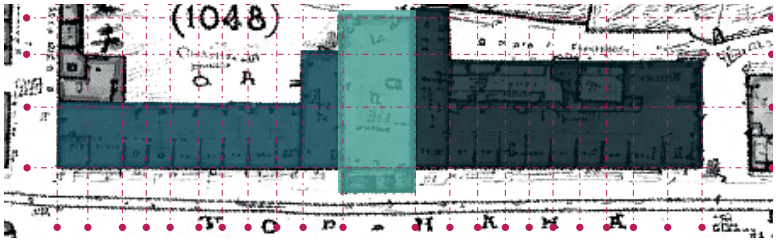


Figure 4.31
Annotated Volume D photograph used for façade analysis
Source: Adapted from Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c



Figure 4.32
Historical photograph of Volume D used for façade analysis
Source: From Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c

Volume D is located opposite the Tophane Pavilion as a long and narrow building mass extending along the road. According to the information obtained from historical photographs and the Pervititch map, the building has a linear façade organisation, while also containing more decorative elements and façade details compared to the other volumes. For this reason, the building was first divided into three main masses in order to make the analysis more readable.

4.6.2 Façade Division and General Elevation Scheme

The smaller mass located in the middle part of the building does not continue on the same façade line as the two adjacent masses. Instead, it appears as a projecting entrance unit positioned slightly forward. In this section, arched openings and structural elements can be observed on the ground floor, while the upper floor includes oval-headed windows and horizontal and vertical decorative elements that articulate the façade.



Figure 4.33
Annotated Pervititch map detail used for footprint analysis
Source: Adapted from the Pervititch insurance map of Tophane. Annotations by the author.

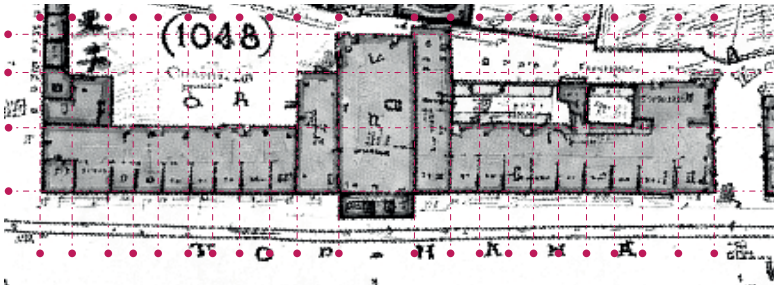
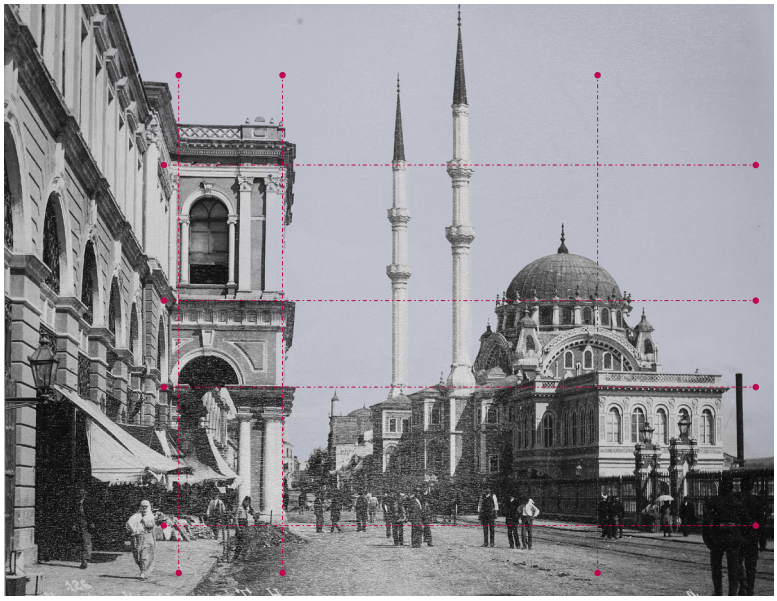


Figure 4.34
Annotated historical photograph of Volume D used for façade and scale analysis
Source: Adapted from Tophane, 1919, Eski İstanbul Fotoğrafları Arşivi, n.d. Guide lines, scale reference, and annotations by the author.



Figure 4.35
Annotated historical photograph showing the height relationship between the Volume D and Nusretiye Mosque
Source: Adapted from Tophane ve Nusretiye Camii / Abdullah Frères Fotoğrafı, by Abdullah Frères, Eski İstanbul Fotoğrafları Arşivi, n.d. Guide lines and annotations by the author.



The longer façade sections extending on both sides of the central mass appear to follow a similar rhythm, as far as can be read from the photographs. On the ground floor, arched shop units opening onto the street are visible, similar to Volume C. However, Volume D has a more ornamented façade composition than Volume C. On the upper floors, rhythmically repeated windows, triangular and oval pediments, horizontal mouldings, and vertical dividing elements create a richer façade arrangement.

The planimetric data obtained from the Pervititch map provided a basic reference for the length of the building, its mass divisions, and the arrangement of the ground-floor openings. These data were compared with the façade elements visible in the historical photographs in order to interpret the approximate height and proportional relationships of the building. At this stage, the perspective effect of the photographs, the camera angle, and other fixed visual references within the images were taken into consideration in order to reach a consistent façade proportion.

When the plan data were examined, it became clear that the arched openings on the ground floor did not all have the same width and depth. These arched openings were first grouped and analysed separately. Based on the approximate dimensions and proportional relationships obtained from this process, a second diagram was prepared in order to examine the façade more systematically.

4.6.3 Proportional Analysis of Façade Groups

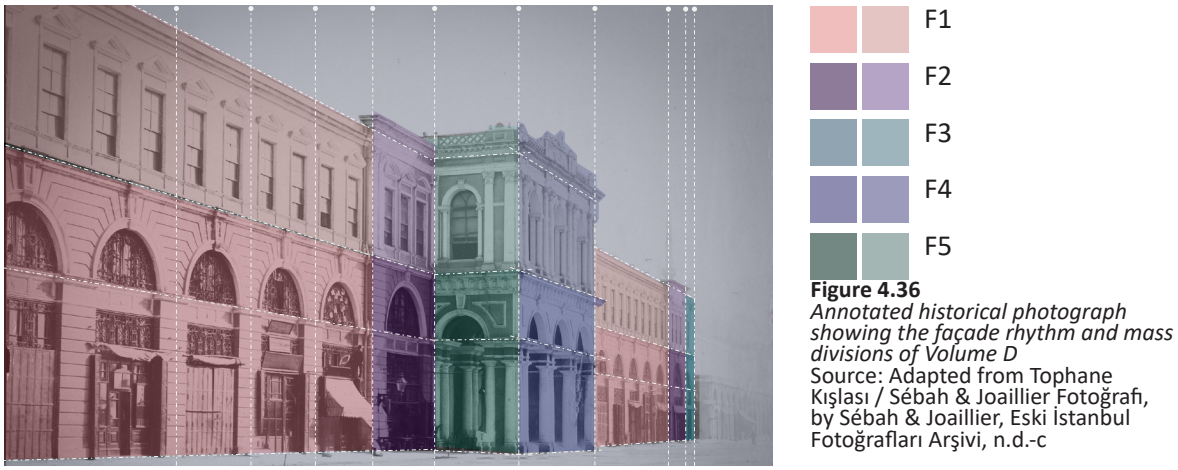


Figure 4.36
Annotated historical photograph showing the façade rhythm and mass divisions of Volume D
Source: Adapted from Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c

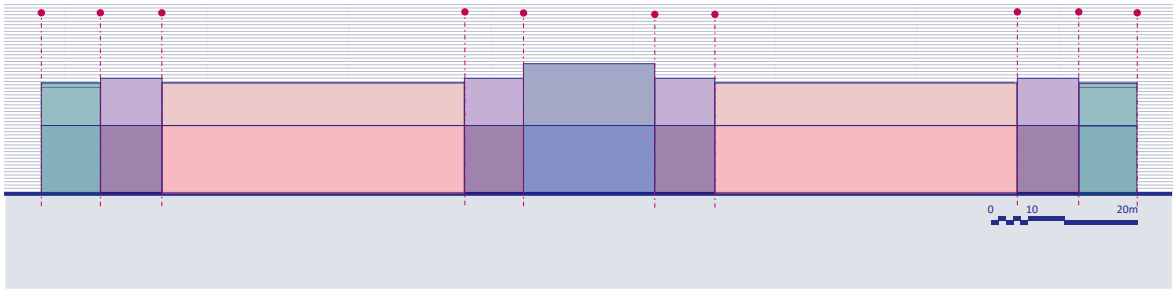
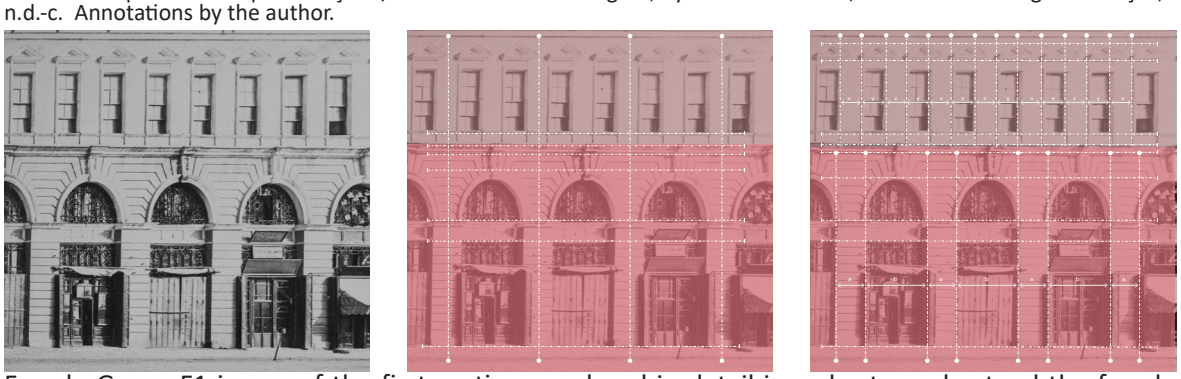


Figure 4.37
Schematic elevation diagram showing the mass divisions and façade rhythm of Volume D
Source: Drawing by the author, based on historical photographs and façade analysis.

This diagram combines the plan information from the Pervititch map with façade data from historical photographs to define the general elevation scheme of Volume D. Each façade group was then analysed in more detail.

Façade Group F1

Figure 4.38
Sequential analysis of the Volume D façade: original detail, mass alignment, and proportional guide lines
Source: Adapted from Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c. Annotations by the author.



Façade Group F1 is one of the first sections analysed in detail in order to understand the façade organisation of Volume D. At this stage, the photograph was first corrected in Photoshop to reduce the perspective effect and to bring the façade closer to a readable elevation plane. First, the floor heights, horizontal alignments, and rhythmic organisation of the façade were examined through the corrected photograph. Based on this photographic reading, each arched ground-floor unit appears to correspond approximately to two window openings on the upper floor. This relationship was not treated as an exact measurement, but as a proportional reference for defining the façade module. Then, the distances between the windows, the dimensions of the arched openings, the column spacing, and the proportions between the horizontal and vertical decorative elements were compared.

The proportions obtained from this analysis were used as a reference for developing the drawing of Façade Group F1.

Façade Group F2

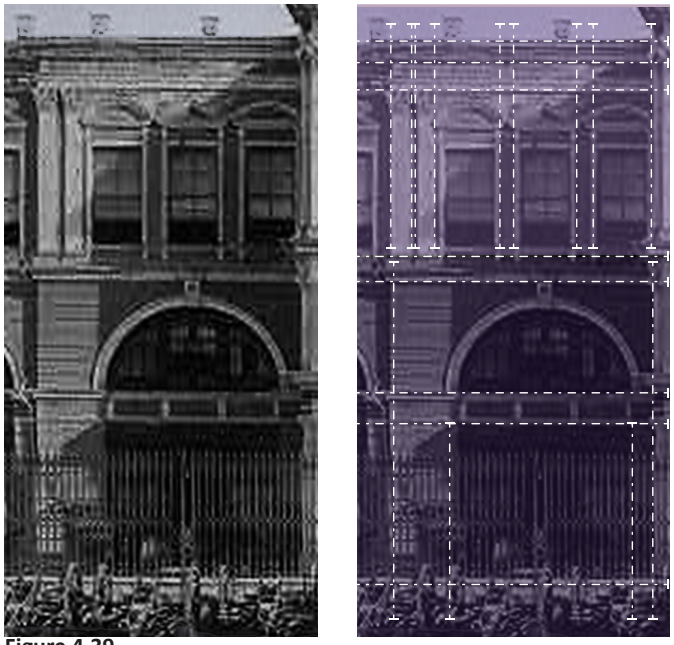


Figure 4.39
Proportional analysis of a side façade bay of Volume D
Source: Adapted from Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c. Crop and guide lines by the author.

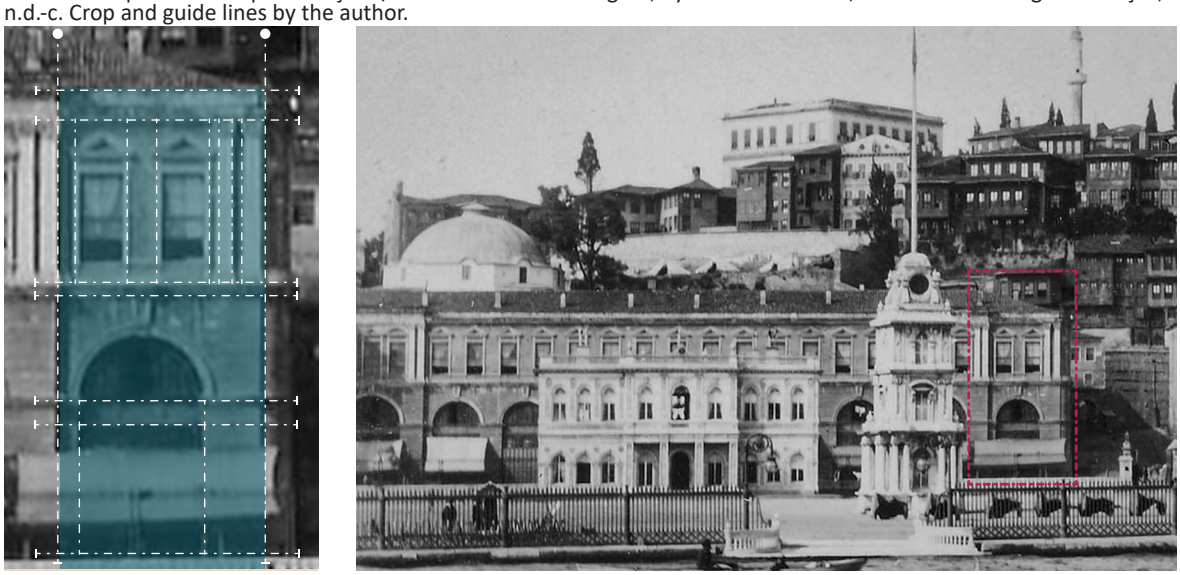
In Façade Group F2, the arched openings are wider than those in F1, and this section can be read as a slightly projecting mass from the main façade line. This projection makes F2 a more emphasized intermediate section within the overall façade composition. In addition, an additional pediment / upper termination element is visible at roof level, which further distinguishes this mass from the other façade groups. The ground floor follows a similar arched arrangement to F1, while the upper floor has a different window composition. Above the arch, three windows are visible: the two side windows appear to have oval pediments, while the central window has a triangular pediment. After the three-window sequence, two vertical decorative elements resembling slender pilasters can be seen.

The proportions of F2 were developed by using the basic measurements derived from F1 as a reference. The projection, roof-level pediment, window arrangement, and decorative elements were then evaluated through the historical photograph, and the approximate proportions of this façade group were calculated.

Façade Group F3

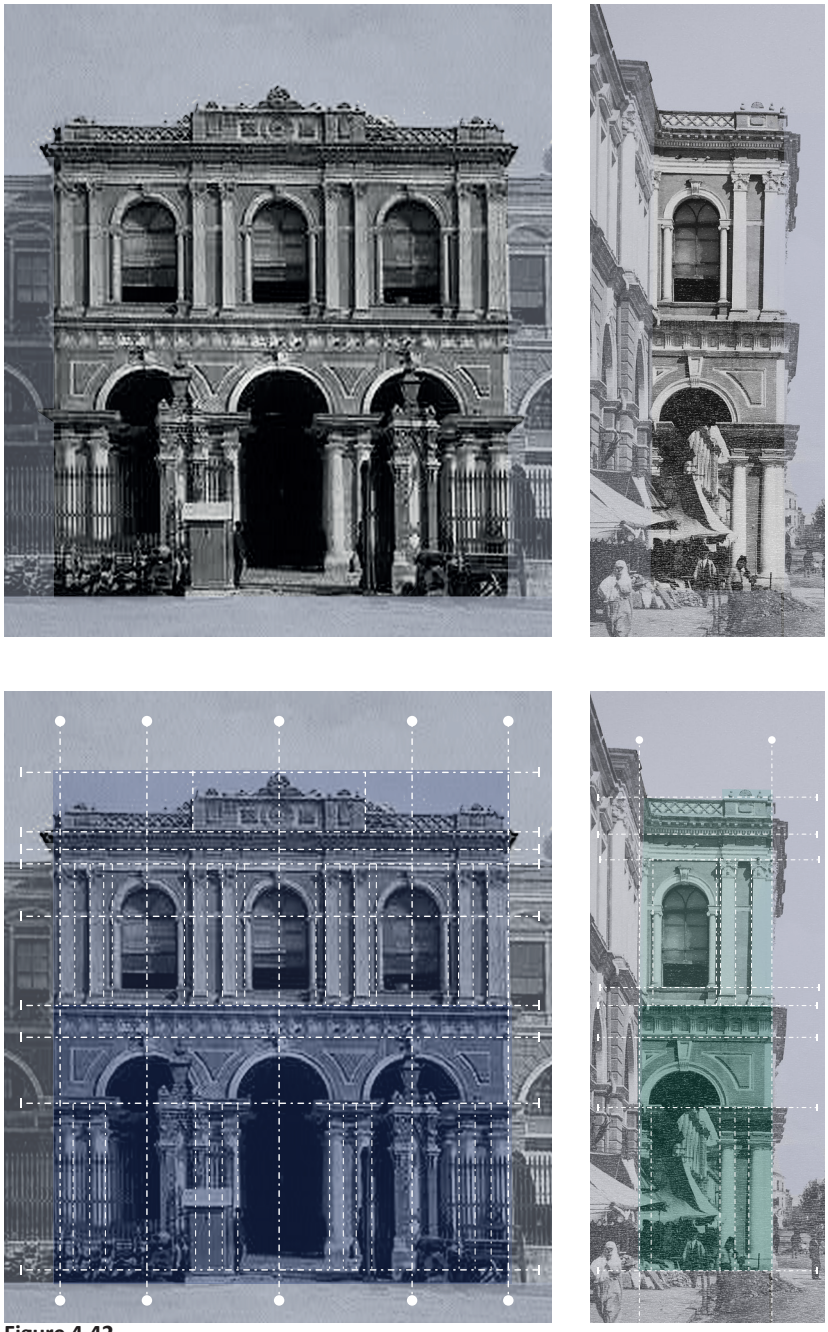
Façade Group F3 has a ground-floor arrangement similar to F1 and F2. Its arched opening appears wider than F1 but narrower than F2, so it was considered an intermediate module within the façade rhythm. On the upper floor, two windows with triangular pediments are visible above the arch. Near the end of this façade section, two vertical decorative elements can also be seen. The proportions of F3 were calculated by comparing these elements with the proportional references derived from F1 and F2.

Figure 4.40
Location and proportional analysis of the side bay on the Tophane Barracks façade
Source: Adapted from Tophane Kışlası / Sébah & Joaillier Fotoğrafı, by Sébah & Joaillier, Eski İstanbul Fotoğrafları Arşivi, n.d.-c. Crop and guide lines by the author.



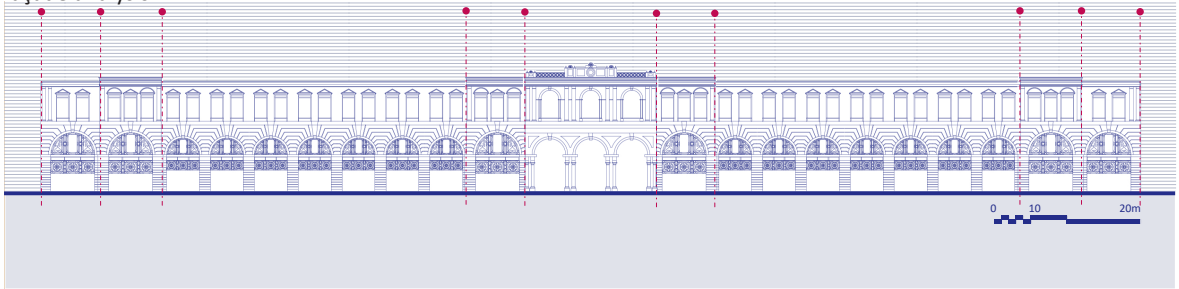
Façade Group F4 and F5:

Figure 4.41
Comparative analysis of the central entrance volume of Volume D
Source: Adapted from Tophane Kışlası by Sébah & Joaillier (n.d.-c) and the 1919 photograph Tophane, 1919 from Eski İstanbul Fotoğrafları Arşivi; crops, guide lines, and annotations by the author.



Façade Groups F4 and F5 differ from the other sections of Volume D, but they show a continuous façade organisation within themselves. The horizontal mouldings and floor alignments from the adjacent façade groups continue in these sections, creating visual continuity across the elevation. The ground floor is characterized by arched openings supported by columns, while oval-headed windows and vertical decorative elements define the upper-floor façade. Unlike the other groups, the upper part includes more pronounced decorative details and a distinct roof-level termination. In the proportional analysis, the horizontal alignments and floor levels of the adjacent façade groups were used as references. The corrected photographs were then used to calculate the approximate proportions of the windows, columns, arches, and decorative elements. The upper decorative part was also redrawn digitally based on the forms visible in the photographs.

Figure 4.42
Source-based reconstructed elevation drawing of Volume D
Source: Drawing by the author, developed from historical photographs, Pervititch map references, and proportional façade analysis.



5. Architectural Modelling in Revit

The source-based elevation drawings developed in Chapter 4 were used as working references for the Revit models. The plan footprints established the main outlines and dimensions of the buildings, while the elevation drawings guided the floor levels, heights, façade divisions, and roof forms. Once the primary volumes had been created, windows, columns, pilasters, and decorative façade elements were added. Historical photographs and other available sources continued to be checked during this stage. When further comparison indicated a difference, the relevant dimensions or components were revised.

The modelling concentrated on the external building masses and façade features that could be interpreted from the available evidence. Interiors, structural systems, and undocumented construction details were not included. If an element was only partly visible, its geometry was completed by comparing repeated proportions and related façade features. A completed digital model does not mean that every part is historically certain. The models remain source-based interpretations of the available architectural information.

Many façade elements follow a similar architectural logic, although their dimensions and details vary across the four volumes. Modelling every occurrence as unrelated geometry would have made later revisions difficult. Building Information Modelling (BIM) was suitable for this work because individual components could be developed separately while remaining connected within the complete building model. Geometry and information about the properties and relationships of the components could be managed together in a coordinated system (Eastman et al., 2008, pp. 12–14). Plans, sections, elevations, and three-dimensional views were also linked to the same model, allowing changes made to one element to appear in the related views (Eastman et al., 2008, pp. 13–16).

Autodesk Revit was selected because its parametric family system supported the reuse and adjustment of repeated architectural elements. Reference planes, constraints, dimensions, and parameters were used to control the geometry of each family (Autodesk, 2025a). Elements with a similar form could be developed from the same family structure and adapted to different façade conditions (Autodesk, 2025b). This was useful for windows, columns, and decorative elements that shared a common character but differed in size or detail. The connection between the project views also helped maintain consistency when the historical sources were examined again and modelling decisions were revised (Autodesk, 2025d). Revit functioned as a working environment for organising and revising the interpreted architectural information throughout the modelling process.

The buildings were modelled in the order of Volumes A, B, C, and D. Since several modelling methods were used across more than one volume, the chapter is organised by architectural element type. Representative families are explained in detail, while closely related variations are presented comparatively. The following sections examine window families, columns and pilasters, façade profiles, and custom decorative components. This organisation allows the modelling choices used in different buildings to be discussed together.

5.1 Window Family Typologies and Modelling Variations

5.1.1 Basic Window Family Modelling

In Revit, window elements were created as editable family components instead of fixed geometric objects. This allowed the same window logic to be reused and adapted to different façade conditions when necessary. The modelling process started with the definition of the main reference planes, which formed the geometric framework of each window family. The width, height, centre line, and wall position of the window were first controlled using these reference planes. Then, each modelled component (frames, glass panels, fanlight divisions, and decorative parts) was aligned and locked to them. This step was important because it allowed the family to respond correctly when its dimensions were modified. If the elements are not constrained to reference planes, the geometry may shift, deform, or lose its correct position when different size variations are created.

W-A1 was modelled in the Revit window family environment as a round-arched window with a fanlight. The main geometry of the window was created using the Extrusion and Sweep tools. The upper arched part was produced with Extrusion, which allows a drawn two-dimensional profile to be extended to a defined depth. This made it suitable for the arched front profile of the window. The fanlight divisions and the glass panels were also created as extrusion elements, since they required thin and front-facing geometric forms. In this way, the glass surfaces could be represented as separate transparent components within the family.

The lower frame elements were produced with the Sweep tool. Unlike extrusion, sweep creates a form by carrying a selected profile along a defined path. For this reason, it was suitable for the vertical and horizontal frame elements, where a continuous section needed to follow the outline of the window frame. After the arched frame, lower frame members, fanlight divisions, and glass panels were completed, the family was loaded into the main Revit project and placed on the façade of Volume A.

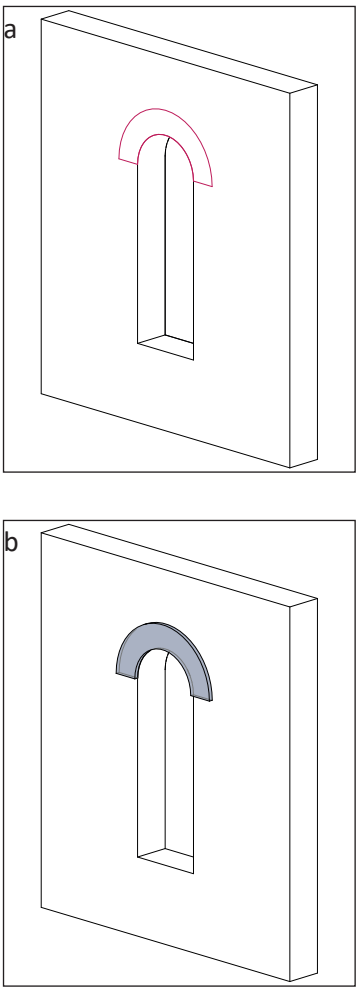
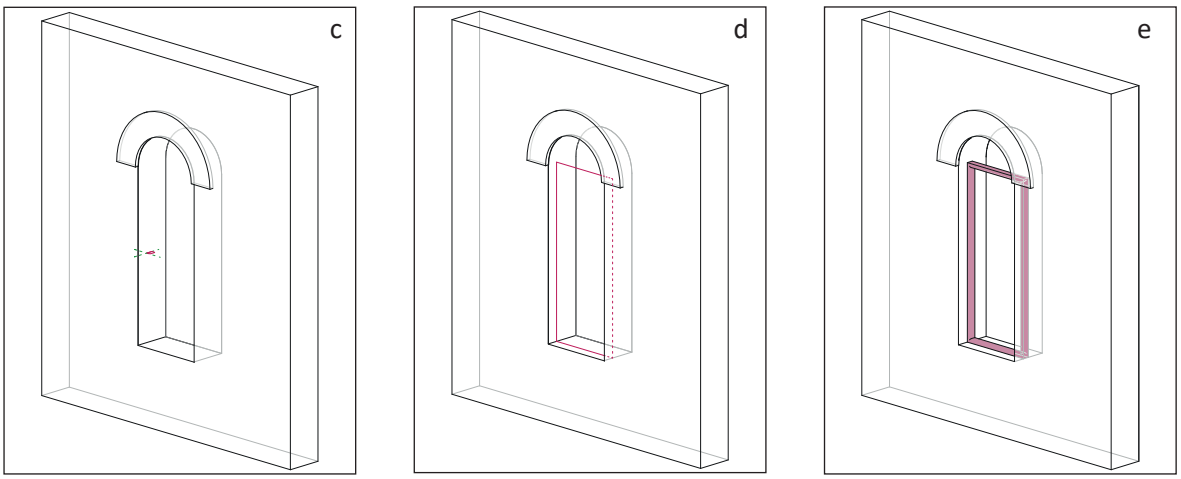


Figure 5.1
Extrusion-based arch formation and Sweep-based frame modelling in the W-A1 window family: (a–b) creation of the upper arched form with Extrusion; (c–e) creation of the lower frame elements with Sweep.
Source: Images by the author, generated from the Revit model.



W-A1 Round-Arched Window with Fanlight

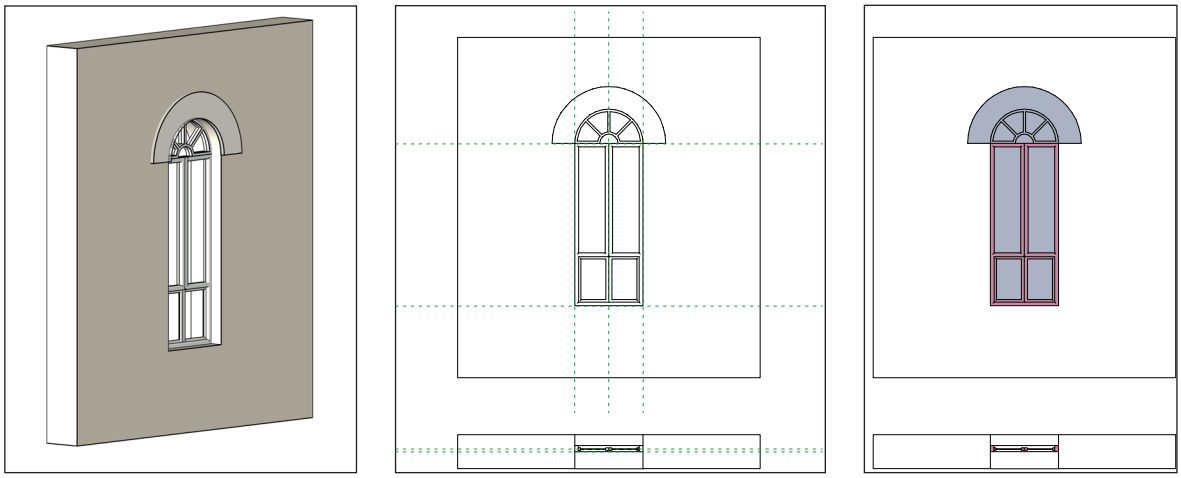


Figure 5.2
Different representations of the W-A1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-A1
Variations	W-A2
Used in	Volume A
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

W-B1 Rectangular Window with Splayed Reveal

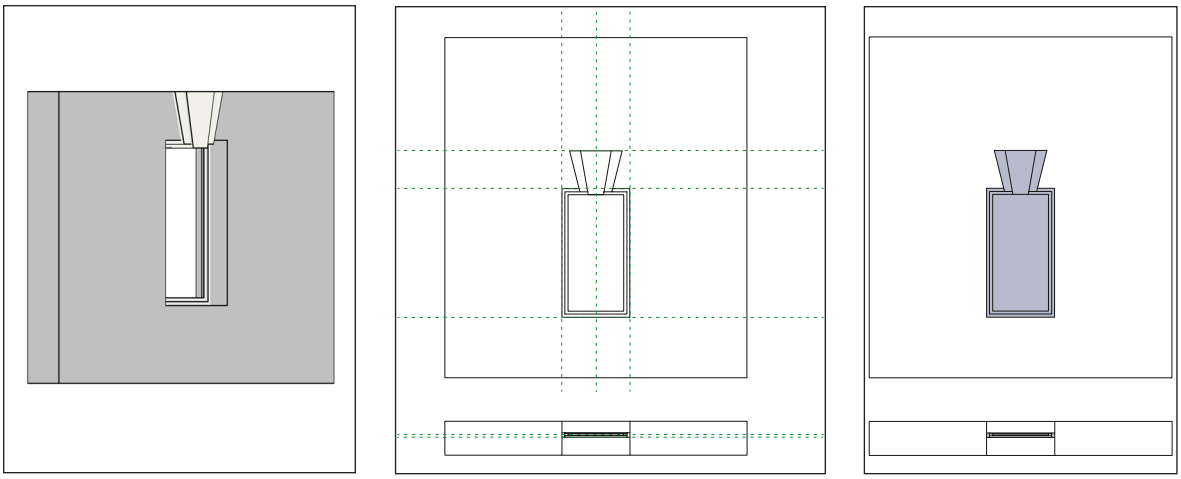
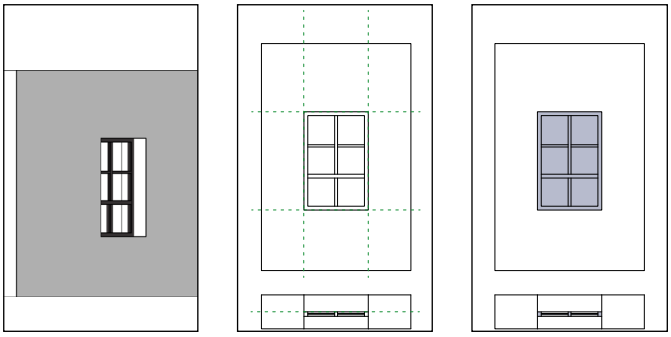


Figure 5.3
Different representations of the W-B1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-B1
Variations	-
Used in	Volume B
Main Revit Tools	Extrusion

	Used Revit Tools
	Extrusion

W-C1 Rectangular Window

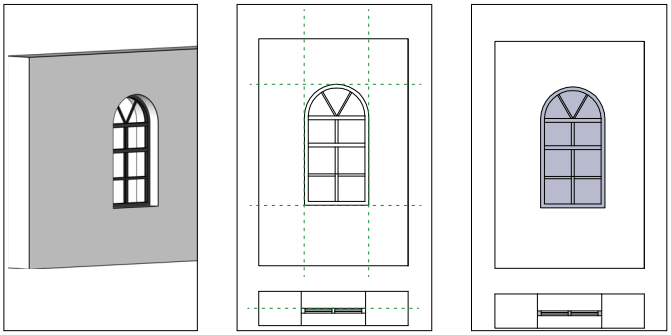


Element Code	W-C1
Variations	W-C1 A
Used in	Volume C
Main Revit Tools	Extrusion

	Used Revit Tools
	Extrusion

Figure 5.4
Different representations of the W-C1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

W-C2 Round-Arched Window



Element Code	W-C2
Variations	W-C2 A
Used in	Volume C
Main Revit Tools	Extrusion

	Used Revit Tools
	Extrusion

Figure 5.5
Different representations of the W-C2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

5.1.2 Parametric Window Families with Adjustable Elements

After modelling the basic window families, some window types required additional control over certain elements. In these cases, the family was developed not as a fixed object but as a parametric element that could be adjusted according to different façade conditions. This method was especially useful when certain decorative parts needed to change in length, position, or proportion while the main window geometry remained unchanged. This method was particularly applied to the W-B2 window type in Volume B. When the façade of Volume B was examined, the horizontal decorative bands continuing along the wall surface appeared as one of the defining façade characteristics. In Revit, these horizontal moulding or stringcourse elements can be modelled with the Wall Sweep tool. However, in this case, the bands did not continue only on the flat wall surface; they also turned around the wall area where the window openings were located. The Wall Sweep tool was not able to describe this as it can stop or cut the moulding elements at the window opening.

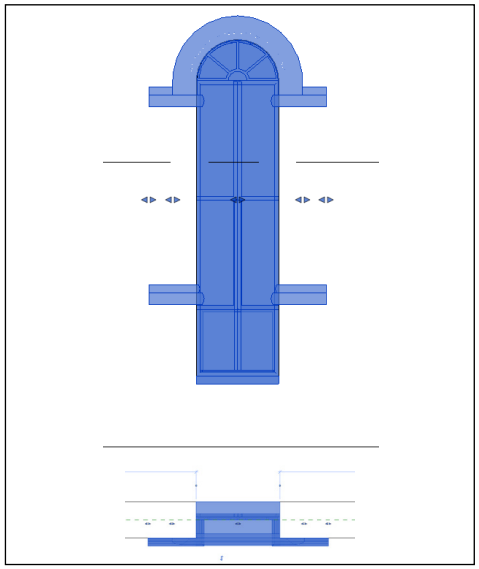


Figure 5.6
Revit family view of W-B2, showing the adjustable horizontal stringcourse bands controlled by reference planes and parameters

For this reason, the horizontal decorative bands were not modelled directly as wall sweeps. They were created as adjustable components within the window family itself. The length of the bands extending from both sides of the round-arched window was controlled by reference planes, dimensions, and locked relationships in the family environment.

The horizontal decorative bands were created as separate adjustable components within the window family. First, additional reference planes were added on both sides of the window to define the end points of the bands. The band elements were then modelled as simple sweeps and aligned to these reference planes.

After that, dimensions were placed between the window centre line and the outer reference planes, and these dimensions were assigned as adjustable parameters. By locking the band geometry to the reference planes, the length of the horizontal bands could be changed without affecting the main arched window geometry. When the family was loaded into the project, these parameters allowed the bands to be extended or shortened according to their position on the façade.

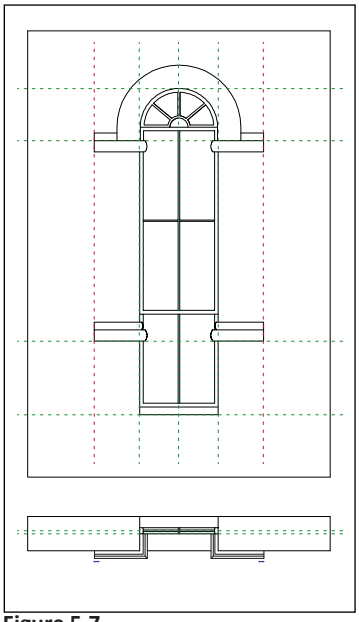


Figure 5.7
Parametric setup of W-B2 in the Revit family editor, showing the adjustable horizontal stringcourse bands controlled by reference planes and dimensions.
Source: Screenshot by the author, taken from the Revit interface.

W-B2 Round-Arched Window with Adjustable Double Stringcourse Bands

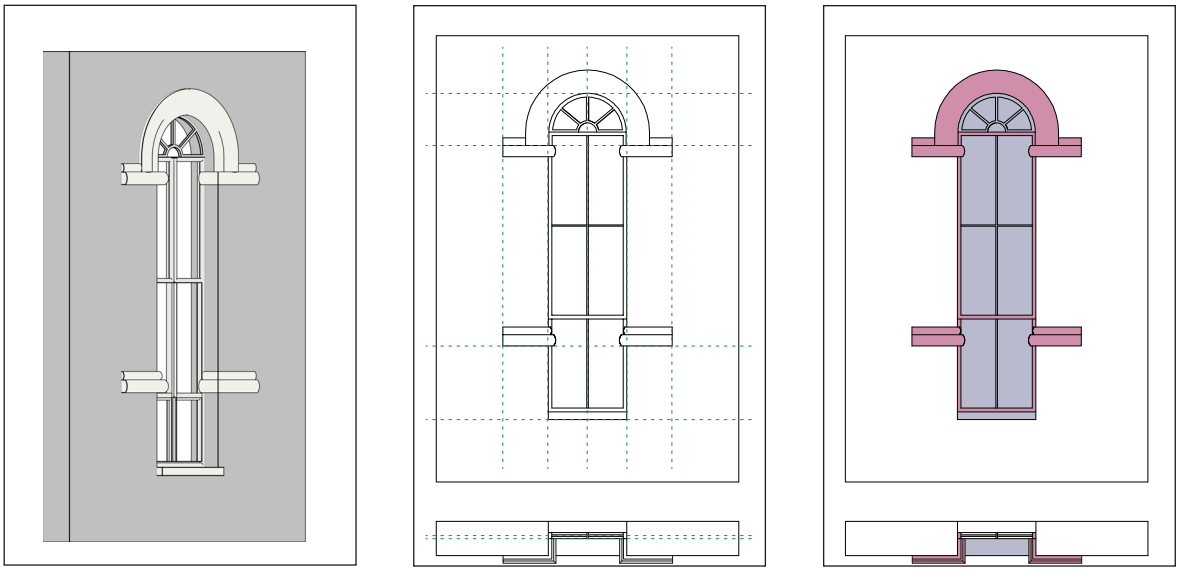


Figure 5.8
Different representations of the W-B2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-B2
Variations	-
Used in	Volume B
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

W-B3 Round-Arched Window with Adjustable Stringcourse Bands

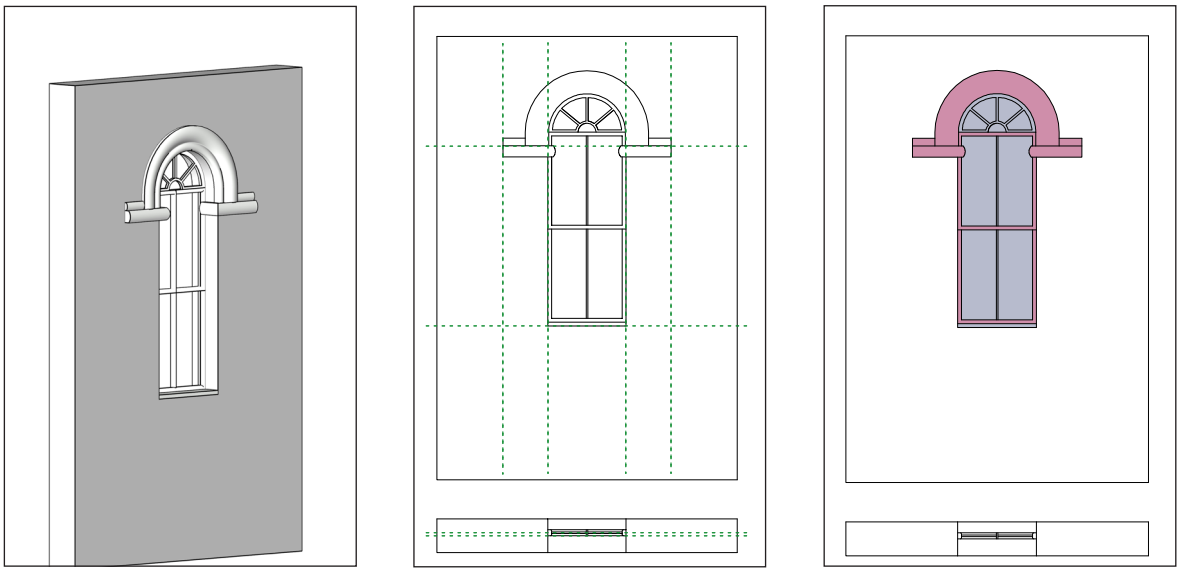


Figure 5.9
Different representations of the W-B3: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

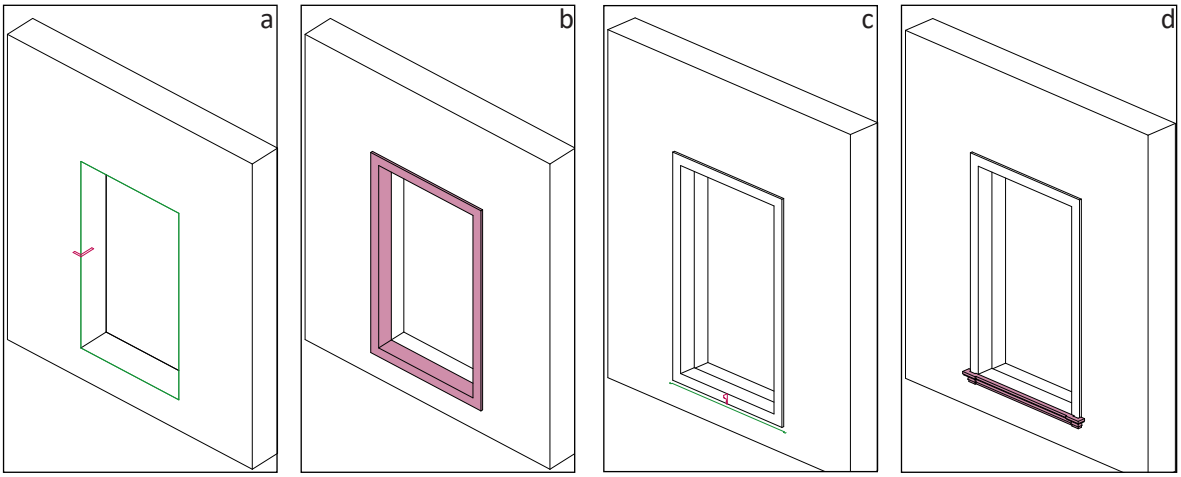
Element Code	W-B3
Variations	-
Used in	Volume B
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

5.1.3 Ornamented and Complex Window Families

The ornamented window families of Volume D were developed through a layered modelling process. Unlike the basic window types, these elements were not limited to the main opening and frame, but also included sill profiles, horizontal mouldings, upper pediments, and additional decorative details. W-D1, was designed as a rectangular window with a triangular pediment. It has a tall rectangular opening, divided glass panels, a lower sill, and a prominent triangular upper element that gives the window a more formal appearance.

Extrusion was used for front-facing elements with a defined depth in this process (glass panels, pediment surfaces, flat decorative parts). Sweep was used for continuous frame and moulding profiles that must follow a specific path. By combining these tools, the window family was gradually built from the main rectangular frame to more detailed decorative layers.



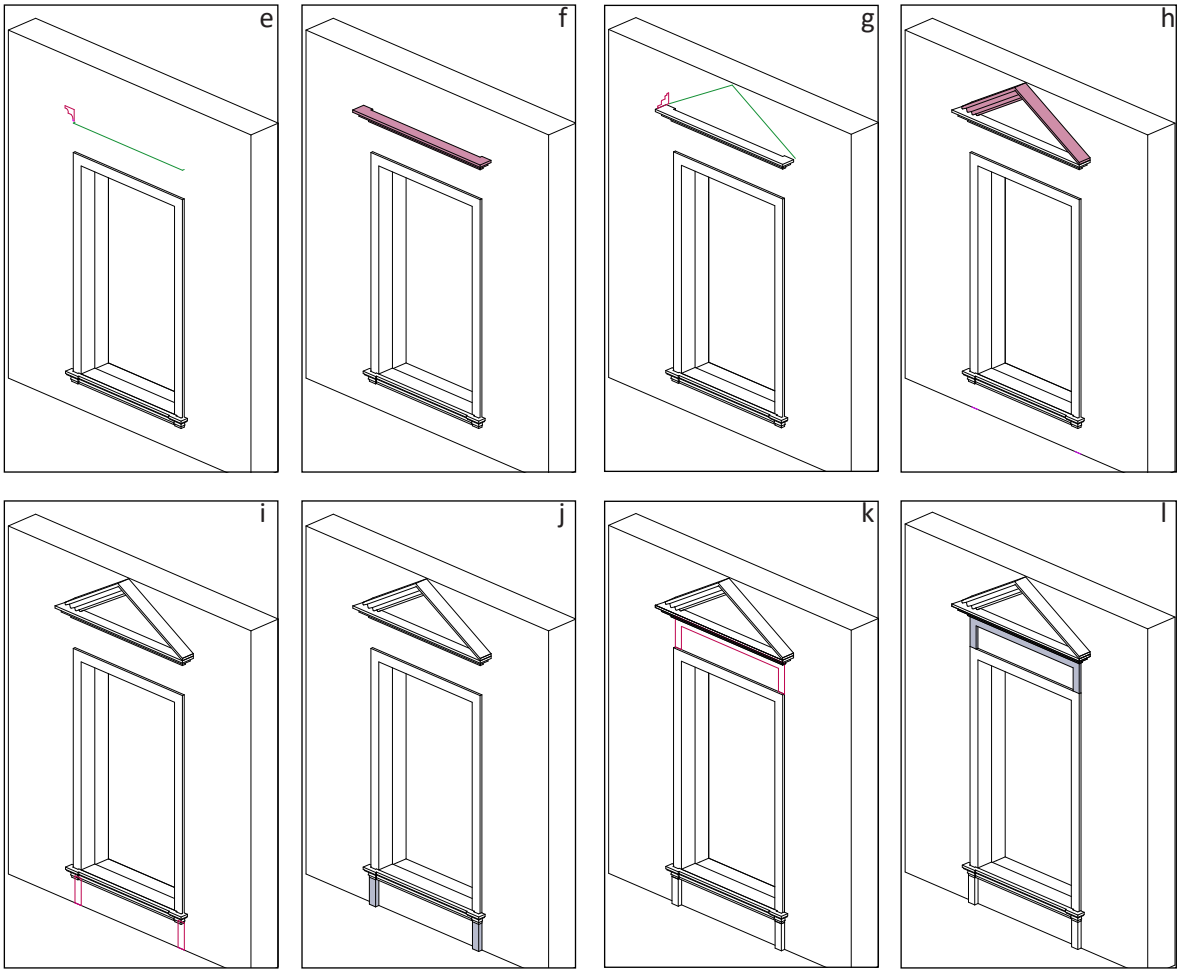


Figure 5.10. Use of Sweep and Extrusion tools in the W-D1 window family. Sweep-based frame and moulding components (a-h), Extrusion-based decorative elements (i-l).

Source: Images by the author, generated from the Revit model.

W-D1 Rectangular Window with Triangular Pediment

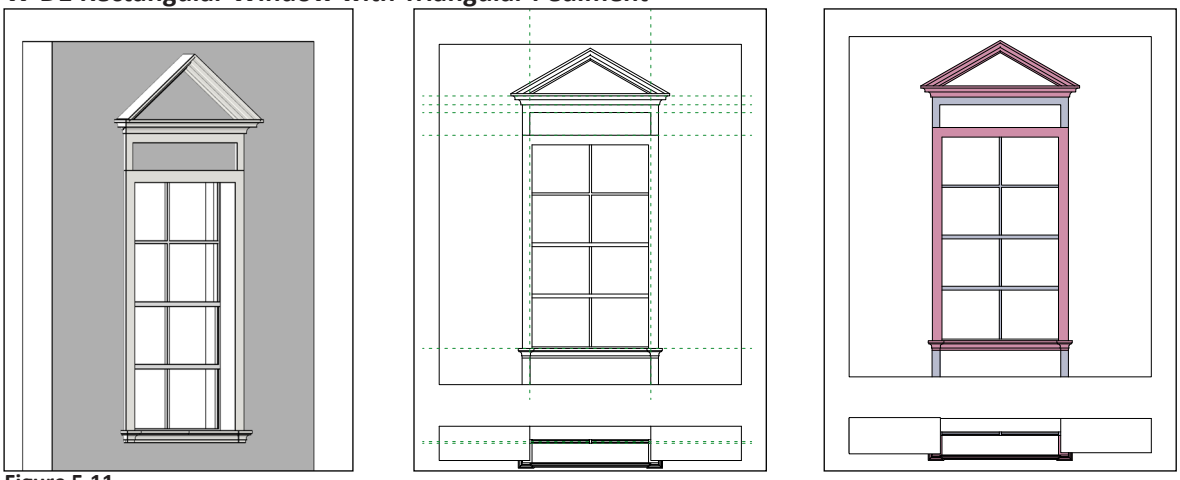


Figure 5.11
Different representations of the W-D1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-D1
Variations	W-D2 (Segmental Pediment)
Used in	Volume D
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

W-D2 Rectangular Window with Segmental **Pediment**

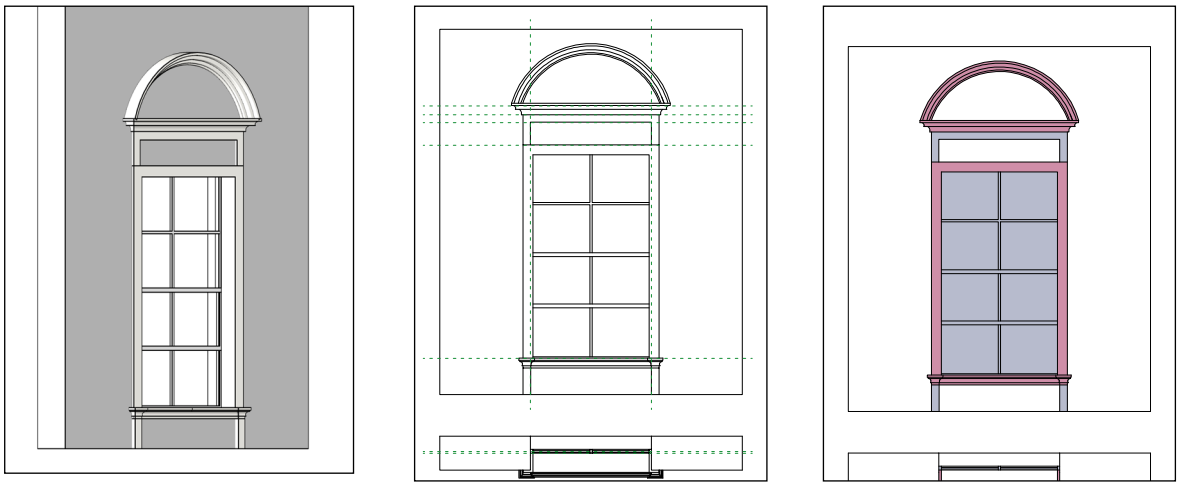


Figure 5.12
Different representations of the W-D2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-D2
Variations	-
Used in	Volume D
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

W-D3 Ornamented Round-Arched Window with Colonettes

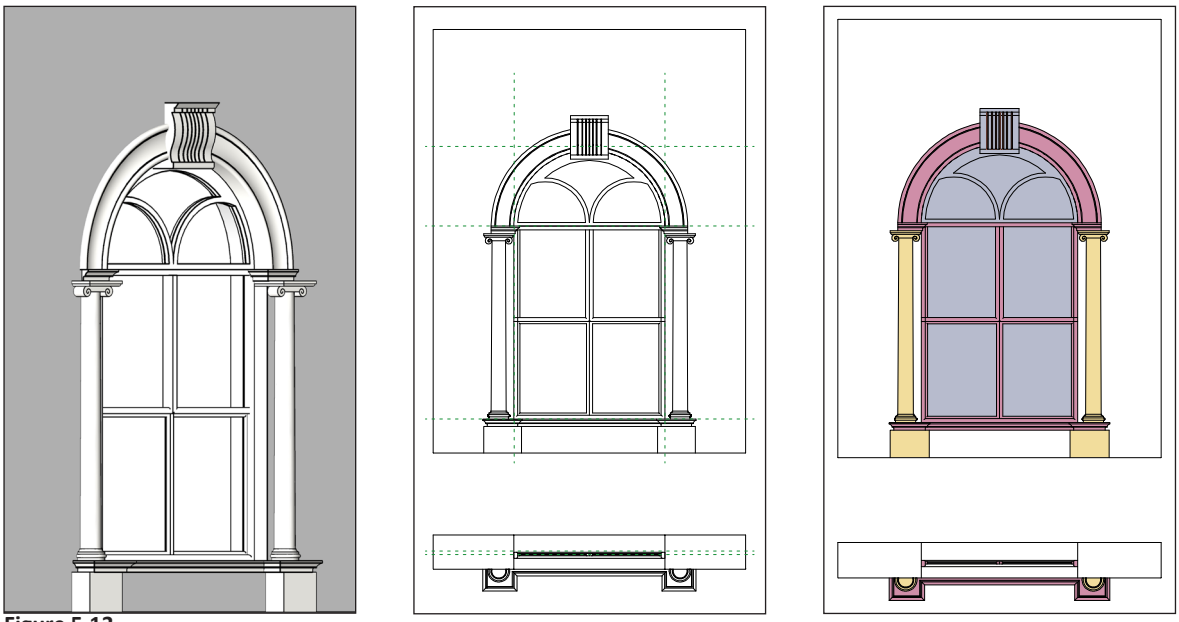


Figure 5.13
Different representations of the W-D3: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	W-D3
Variations	-
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Void Extrusion, Load Family / Nested Component

	Used Revit Tools
	Sweep
	Extrusion
	Void Extrusion
	Load Family

W-D3 represents the most ornamented window family developed for the project and was used in Volume D. It consists of a rectangular lower opening, a round-arched upper section, curved fanlight divisions, side colonettes, a pronounced arched frame, and a small central ornament above the arch. Compared to the other window types, this family required a more layered modelling process in order to represent the richer decorative character of the façade.

The main arched frame, glass panels, and fanlight divisions were created using Extrusion, while the continuous frame profiles and mouldings were modelled with Sweep.

The small central ornament above the arch was produced by combining Extrusion and Void Extrusion: the main solid form was first created with Extrusion, and Void Extrusion was then used to cut and refine the decorative profile.

Instead of modelling the side colonettes directly within the same family, they were loaded as external Revit families and inserted as nested components. This approach made the modelling process more manageable and prevented the main window family from becoming unnecessarily complex.

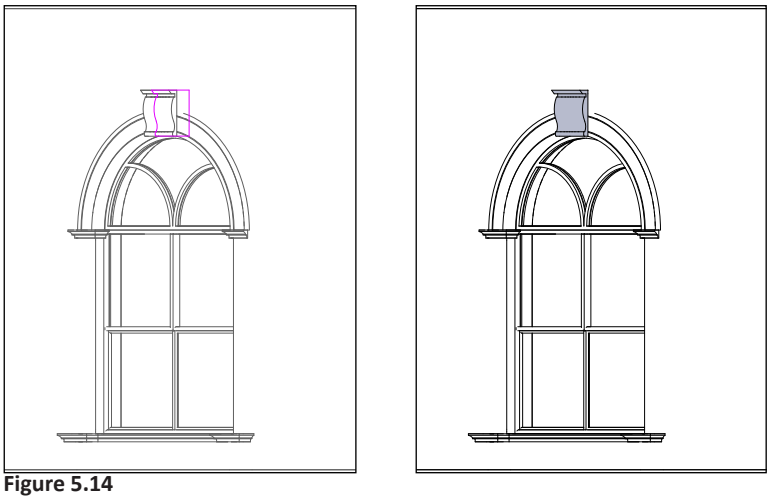


Figure 5.14
Extrusion-based formation of the central decorative ornament above the arch in the W-D3 window family.
Source: Images by the author, generated from the Revit model.

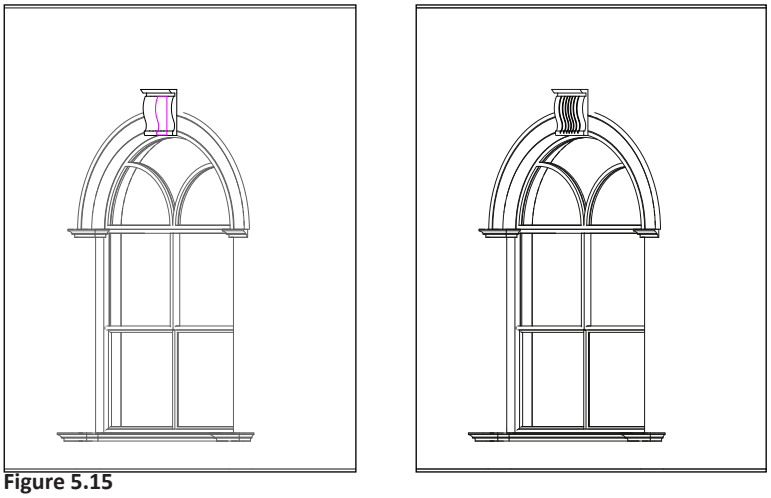


Figure 5.15
Refinement of the central decorative ornament using Void Extrusion to cut and shape the final profile.
Source: Images by the author, generated from the Revit model.

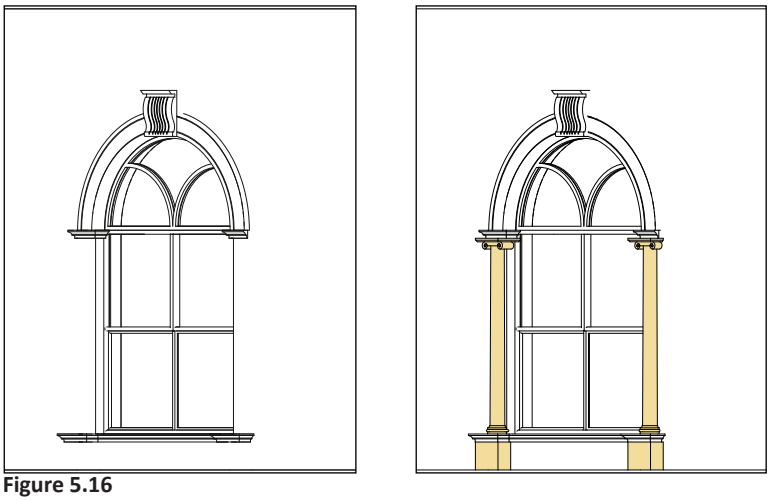


Figure 5.16
Integration of side colonette elements as nested components within the W-D3 ornamented window family.
Source: Images by the author, generated from the Revit model.

5.2 Parametric Modelling of Column and Pilaster Families

5.2.1 Parametric Framework for Column Families

The column families developed in this study were constructed through a reference-based parametric framework. The process began with the selection of an appropriate two-level-based family template, which established the category, placement behaviour, reference levels, and initial plan and elevation views of the element. In the plan view, two perpendicular centre reference planes defined the family origin and the principal vertical axis of the column. Additional reference planes were then introduced to control the width, depth, or diameter of the shaft, as well as the separate dimensions of the base and capital.

The vertical organisation of the family was established in the elevation views. The lower and upper reference levels defined the overall limits of the column, while intermediate horizontal reference planes identified the boundaries of the base, shaft, capital, and decorative profiles. Permanent dimensions were placed between these planes and labelled with parameters, allowing the proportions of the different components to be modified without disrupting their alignment. After establishing and testing the reference framework, the three-dimensional geometry was added. Extrusions were generally used for prismatic shafts and planar components, while blends provided transitions between sections of different dimensions. Revolves and sweeps were preferred for circular mouldings and continuous profiles, and void forms were useful where recessed or carved details were required. Each geometric component was aligned and locked to the relevant reference planes so it followed the dimensional parameters of the family.

C-A1: Basic Column Family with Stepped Base and Capital

C-A1 was developed as a basic column family for Volume A. It consists of a rectangular shaft, a stepped base, and a simple capital. The base was created first by using sweep profiles along closed rectangular paths. The main shaft was then modelled with extrusion and aligned with the central reference planes of the family. The same sweep method was used at the top to form the projecting profiles of the capital. The colour-coded diagram distinguishes the extrusion used for the shaft from the sweep geometries of the base and capital. By modelling the parts as separate components, the family maintains a clear geometric hierarchy and allows the dimensions and profiles of the base, shaft, and capital to be altered without affecting their common alignment.

Figure 5.17
Geometric construction sequence of the C-A1 column family in Revit
Source: Images by the author, generated from the Revit model.

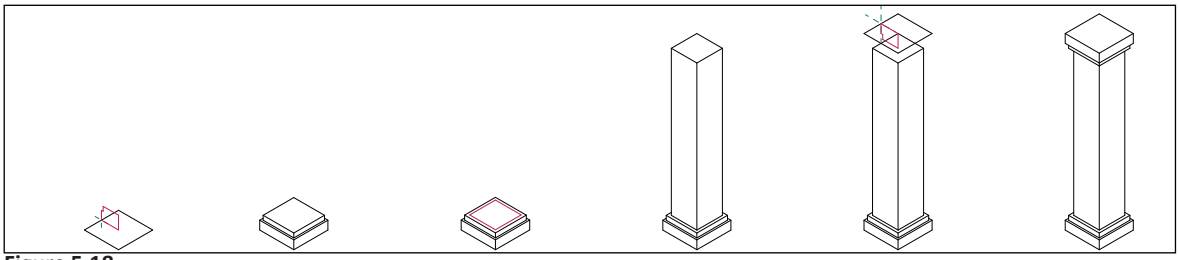
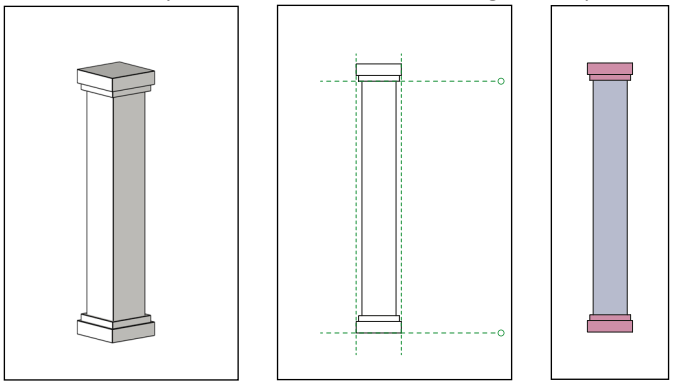


Figure 5.18
Different representations of the C-A1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.



Element Code	C-A1
Used in	Volume A
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

C-A2: Column Family with Nested Decorative Components

C-A2 was developed as a more detailed column family for Volume A. The capital and the base-pedestal assembly contain various geometric parts that require different modelling steps. For this reason, these parts were created as separate families and then added to the main column family as nested components. This method kept the main family structure clear and manageable while allowing the capital and base-pedestal components to be edited independently without affecting the shaft or the overall alignment of the column.

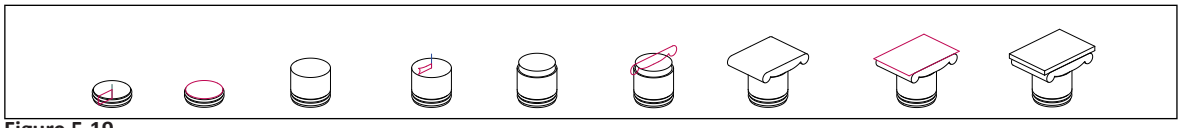
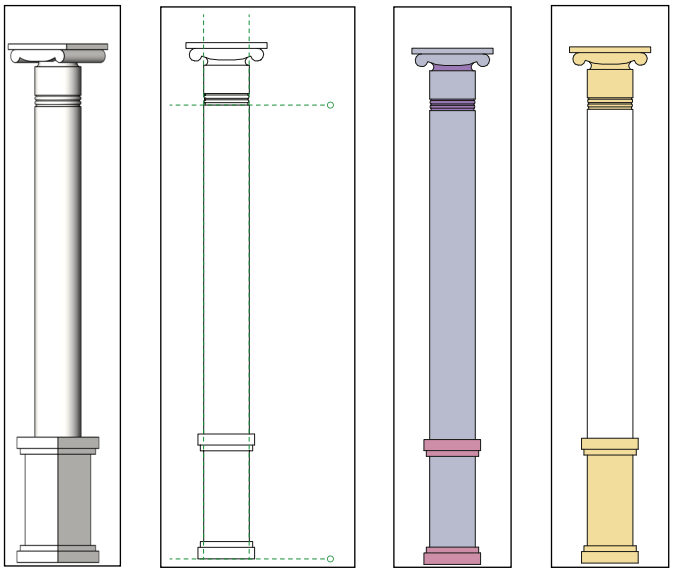


Figure 5.19
Geometric construction sequence of the C-A2 column capital with nested decorative components
Source: Images by the author, generated from the Revit model.

The base-pedestal part was modelled with a method similar to C-A1, but with a smaller overall height. The capital was first modelled with the Revolve tool, which creates a three-dimensional shape by rotating a two-dimensional profile around a defined axis. This was used to build the lower circular moulding, the cylindrical neck, and the additional circular layers. The curved side elements below the upper plate were then formed with extrusion by drawing their profiles in the elevation view, and extending them to the required depth. Finally, the rectangular upper plates and projecting profiles were added separately. All components were centred on the same reference axis to ensure alignment when the capital was loaded into the main column family. This example also demonstrates that the extrusion tool can create shaped decorative elements in addition to simple vertical forms.



Element Code	C-A2
Used in	Volume A
Main Revit Tools	Extrusion, Sweep, Revolve, Load Family / Nested Component

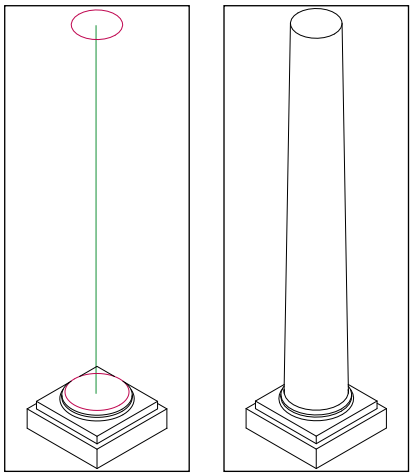
	Used Revit Tools
	Sweep
	Extrusion
	Revolve
	Load Family

Figure 5.20
Different representations of the C-A2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

C-D1: Doric-Inspired Tapered Column with Profiled Base and Capital

C-D1 was developed for Volume D and has a simplified Doric-inspired form. Its plain tapered shaft, circular transition below the capital, and square upper plate refer to the general character of the Doric order. The base and capital parts were modelled by combining sweep and revolve tools.

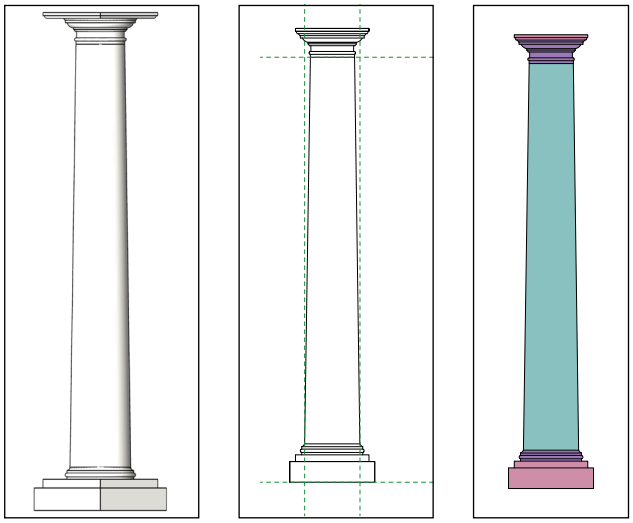
Sweep was used for the continuous mouldings following closed paths, while revolve was used for the circular profiles formed around the central axis. All components were aligned with the same vertical reference axis to maintain the continuity and proportions of the column.



The main shaft was created using the blend tool. In Revit, blend tool generates a solid form between two closed profiles drawn on separate parallel work planes. For this column, a larger circular profile was defined at the lower level and a smaller circular profile at the upper level. Revit connected these two profiles to create the gradual narrowing of the shaft. The lower and upper diameters could be controlled separately, while the vertical distance between the profiles determined the shaft height.

This example demonstrates how blend can be used to control a tapered main form, while sweep and revolve are suitable for creating the layered and curved details of the base and capital.

Figure 5.21
Use of the Blend tool in modelling the tapered shaft of the C-D1 column family.
Source: Images by the author, generated from the Revit model.



Element Code	C-D1
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Revolve, Blend

	Used Revit Tools
	Sweep
	Extrusion
	Revolve
	Blend

Figure 5.22
Different representations of the C-D1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

C-D2: Rusticated Pilaster with Layered Capital

C-D2 was modelled for Volume D and consists of a rectangular shaft divided by regularly spaced horizontal bands. These repeated projecting elements create a rusticated appearance and give the pilaster a strong and solid character. The lower part is completed with a simple layered plinth, while the upper part has a wide profiled capital formed by several projecting mouldings.

The modelling process began with the main rectangular shaft, which was created using the extrusion tool. The plinth was then developed as a series of separate layers around the lower part of the shaft. The first horizontal band above the plinth has a different profile and dimension from the remaining bands; it was modelled separately. A second standard band was created using the sweep tool by carrying a profile around a closed rectangular path. This band was then copied and placed vertically at regular intervals according to the elevation. Reusing the same sweep geometry ensured that the repeated bands remained consistent in size, projection, and alignment.

In the final stage, the capital was constructed from separate sweep elements. The lower transition profile, projecting mouldings, and upper plate were created individually and positioned around the top of the shaft. Using separate sweeps made it easier to control the height and projection of each layer. This example shows how the sweep tool provides an efficient method for creating continuous mouldings and repeated layered details around a rectangular architectural element.

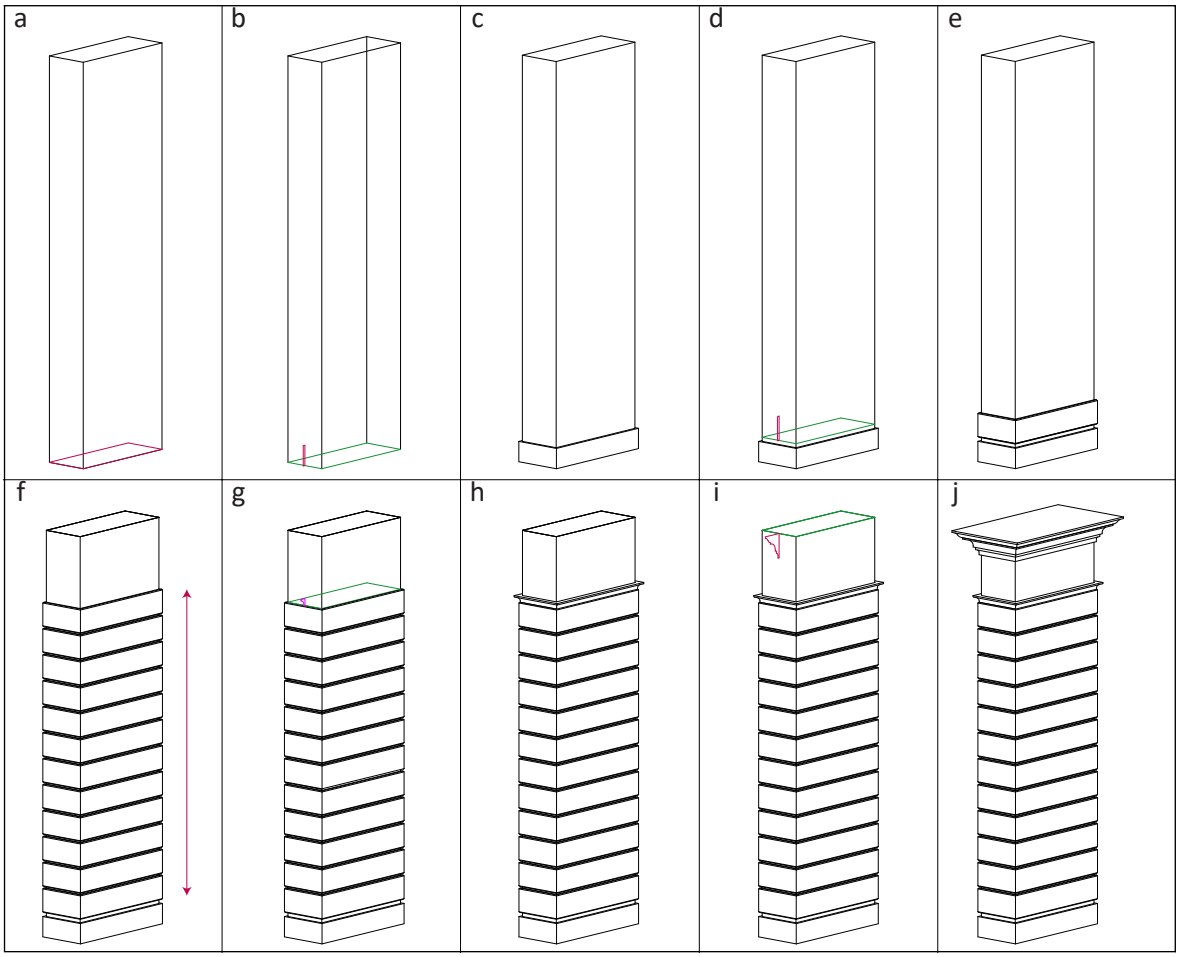
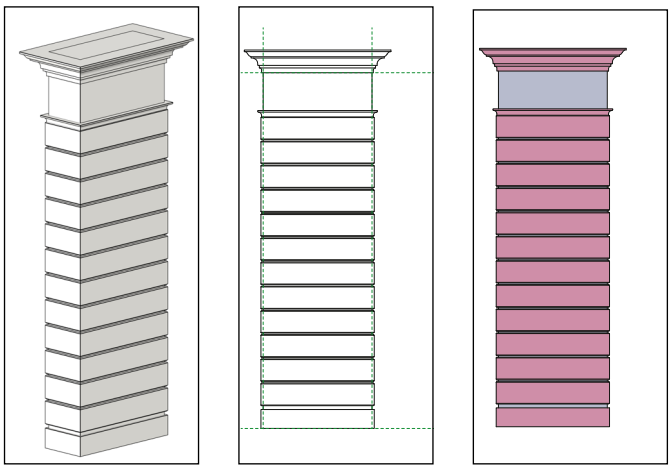


Figure 5.23
Geometric construction sequence of the C-D2 profiled rectangular column family
Source: Images by the author, generated from the Revit model. The sequence shows the formation of the shaft, stepped base, horizontal profile bands, and capital details.



Element Code	C-D2
Used in	Volume D
Main Revit Tools	Extrusion, Sweep

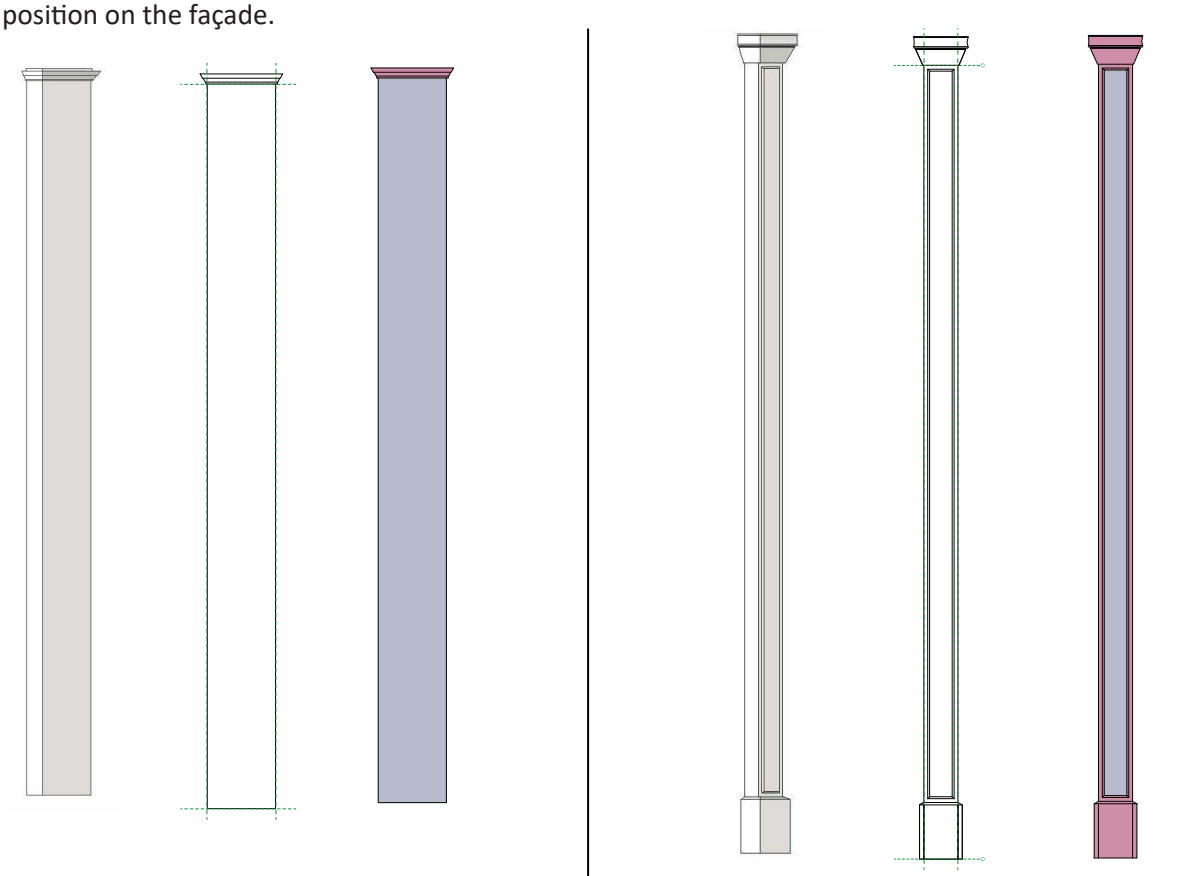
	Used Revit Tools
	Sweep
	Extrusion

Figure 5.24
Different representations of the C-D2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

5.2.2 Façade Pilaster Families

Unlike the freestanding columns presented in the previous examples, these elements were classified as pilasters based on their visible relationship with the façade surface. Their slender rectangular proportions, limited projection from the wall, and integrated appearance distinguish them from independent column families. Since no historical source was found to confirm their structural function, this classification is based on their architectural form and visual characteristics.

Four different pilaster families were developed according to their proportions, surface treatment, and base and capital details. All four types follow a similar modelling logic: the main rectangular shafts were created using the extrusion tool, while the bases, capitals, recessed panels, and horizontal profiles were formed with simple extrusions or sweep geometries. The diagram presents the four pilaster types comparatively, highlighting their shared modelling logic as well as the differences in their proportions and decorative details. Each pilaster was created as a separate family so that its height, width, wall projection, and decorative composition could be adjusted according to its position on the façade.



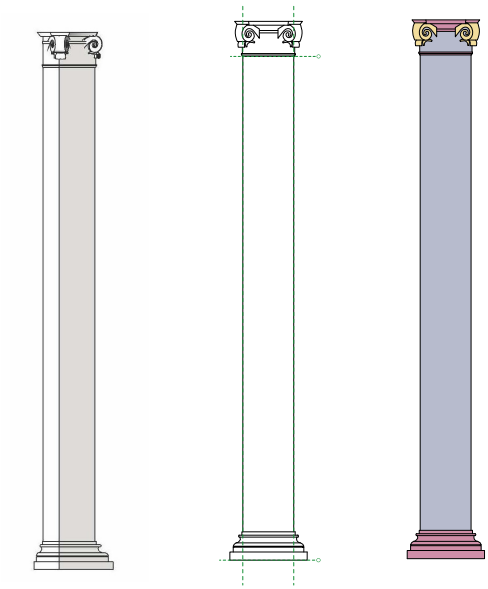
Element Code	P-C1
Used in	Volume C
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

Element Code	P-C2
Used in	Volume C
Main Revit Tools	Extrusion, Sweep

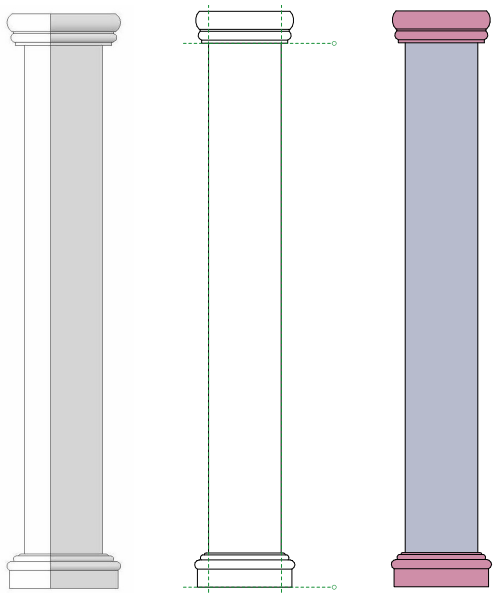
	Used Revit Tools
	Sweep
	Extrusion

Figure 5.25
Different representations of the P-C1 and P-C2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.



Element Code	P-D1
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Load Family

	Used Revit Tools
	Sweep
	Extrusion
	Load Family



Element Code	P-B1
Used in	Volume B
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

Figure 5.26
Different representations of the P-D1 and P-B1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

5.3 Façade Surface and Profile Modelling

5.3.1 Continuous Façade Profiles with Wall Sweep

The wall sweep tool in Revit is used to create projecting elements that follow a wall surface, such as cornices, string courses, base mouldings, and continuous decorative bands. The section of a wall sweep is controlled by a profile family. A profile family is a two-dimensional closed shape created with lines, dimensions, and reference planes. For wall sweeps, an appropriate hosted profile template is selected, and the profile is drawn in relation to the reference point that determines how it will connect to the wall. After the profile drawing is complete, it is loaded into the project library where it can be assigned to a wall sweep type. The wall acts as the host and carries this profile continuously along its surface.

It also made later changes easier because the changes made to the custom profile could be carried over to all wall sweeps using the same family.

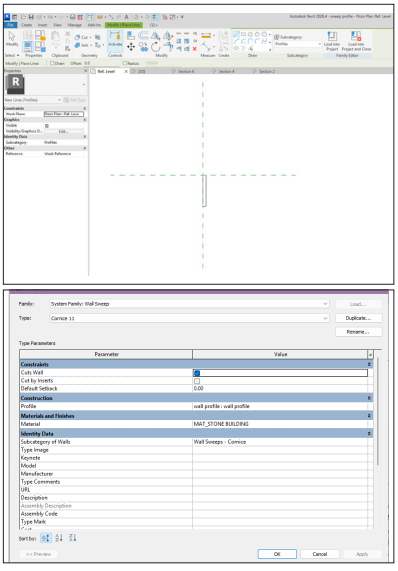


Figure 5.27
Modelling stages of a custom Wall Sweep profile in Revit
Source: Screenshots by the author, taken from the Revit interface. The images show the creation of a hosted profile family and its assignment to a wall sweep type.

In this project, custom profile families were created instead of using the standard profiles available in Revit. The shapes of these profiles were developed according to the mouldings identified in the historical images and reconstructed façade drawings. Each section was first drawn as a closed two-dimensional profile family and reference planes were used to control its position in relation to the wall surface. The final profile was then loaded into the project and selected in the type properties of the wall sweep. After placing the wall sweep, the height and offset were adjusted according to the position of the architectural detail on the façade. This allowed different cornices and horizontal bands to be created from their specific parts and to remain in contact with the wall.
Because the wall sweep remains hosted to the wall, it automatically adapts to window and door openings, reducing the need to trim each profile manually. For this reason, the tool was actively used throughout the modelling process to create continuous horizontal wall decorations and façade bands. The same method can be seen in the Volume A example below, where custom profiles were applied along the façade.

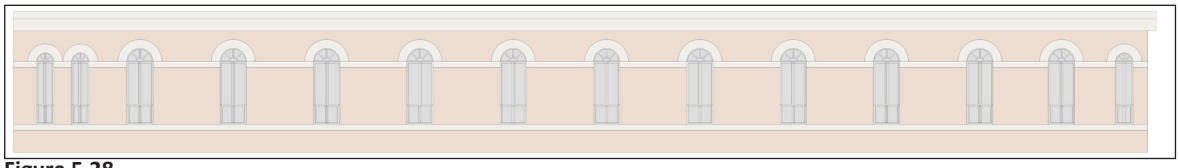


Figure 5.28
Application of custom Wall Sweep profiles on the Volume A façade
Source: Images by the author, generated from the Revit model. The custom profile families were applied as continuous horizontal façade bands.

5.3.2 Surface Differentiation with Split Face

The split face tool in Revit divides a selected wall face into separate surface regions without changing the wall thickness, layer structure, or overall geometry. The area is defined by sketching boundaries directly on the wall surface. After the face was divided, the Paint tool allowed a different material or colour to be applied to the new area. This method is useful when only the surface finish needs to change, as it avoids creating additional walls or separate model elements.

In this project, the tool was used on the upper floor of Volume C to reproduce the façade colour differentiation identified in the historical photograph. Different finishes were applied not only to the main exterior surfaces but also to the recessed wall returns within the window openings. By changing the colour of these inner surfaces with the paint tool, the depth and visual relationship between the windows and the surrounding façade could be represented more clearly. This approach helped create a model that was closer to the appearance observed in the photographic source.

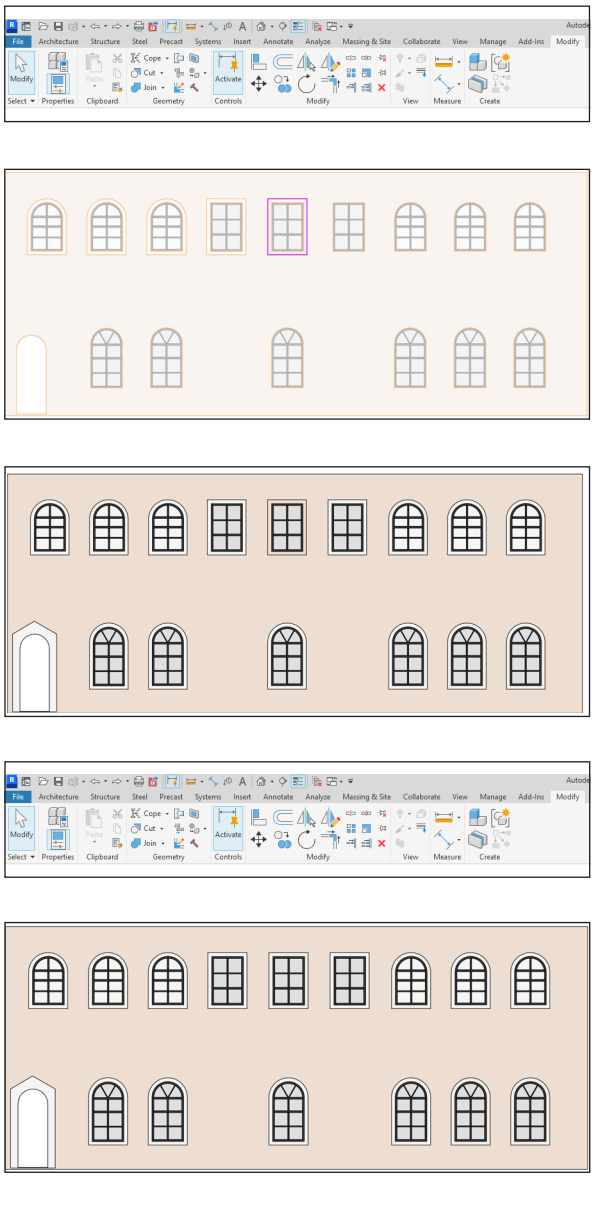


Figure 5.29
Use of the Split Face tool for façade surface differentiation in Volume C

Source: Images by the author, generated from the Revit model and Revit interface.

5.4 Custom Façade Component Modelling

After the main façade elements had been completed, other façade details were categorised according to their function and modelled separately. Each repeated or geometrically complex façade element was created as a separate family and loaded into the project as a component. This approach kept the main model clearer and easier to manage. It allowed the same elements to be reused in different locations and simplified later revisions, since changes made within the family could be applied to all placed components.

5.4.1 Shop Entrance Arch and Stone Decoration in Volume C

A wall-based family was used for the stone decoration surrounding the shop doors on the ground floor of Volume C. This family type kept the element attached to the wall surface and provided better control over placement on the façade. Despite its complex appearance, the element was modelled through a clear sequence of extrusion and sweep tools.

The main stone decoration was created as a single extrusion by drawing closed profiles over a two-dimensional reference and extending them to the required depth. The inward-turning surfaces at the lower part and at the connections with the arch were formed using the sweep tool. The layered arch was created using the sweep tool. Finally, the decorative element at the centre of the arch was added as a separate extrusion. This method shows how a visually detailed façade component can be produced in a controlled way using a limited number of modelling tools.

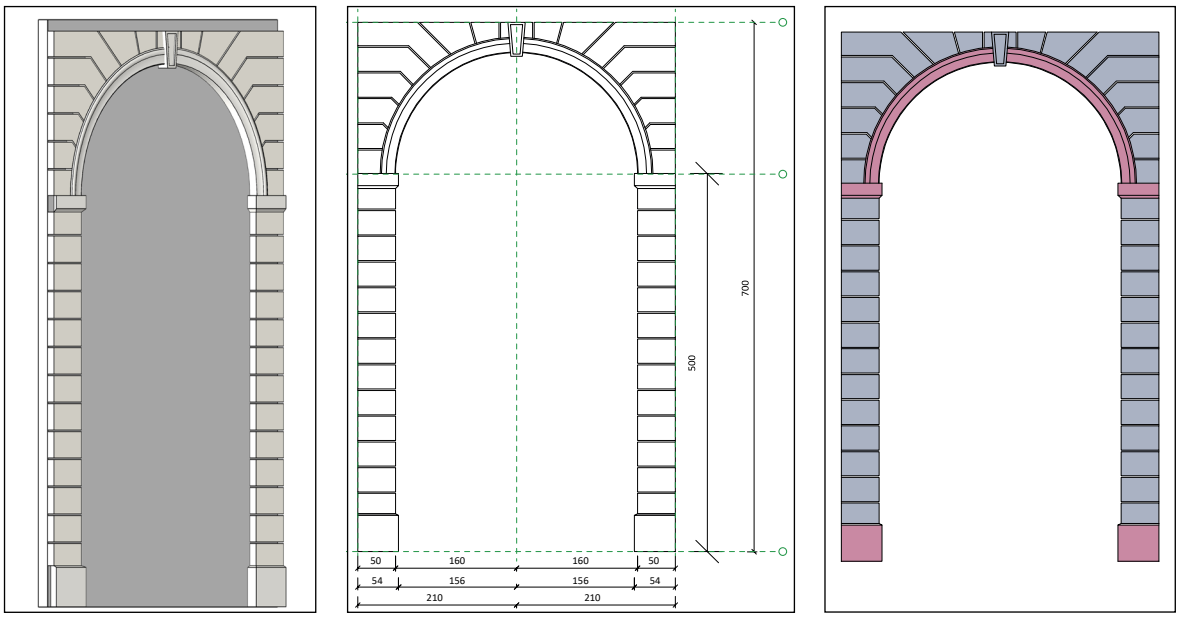


Figure 5.30
Different representations of the F-VC1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	F-VC1
Used in	Volume C
Main Revit Tools	Extrusion, Sweep

	Used Revit Tools
	Sweep
	Extrusion

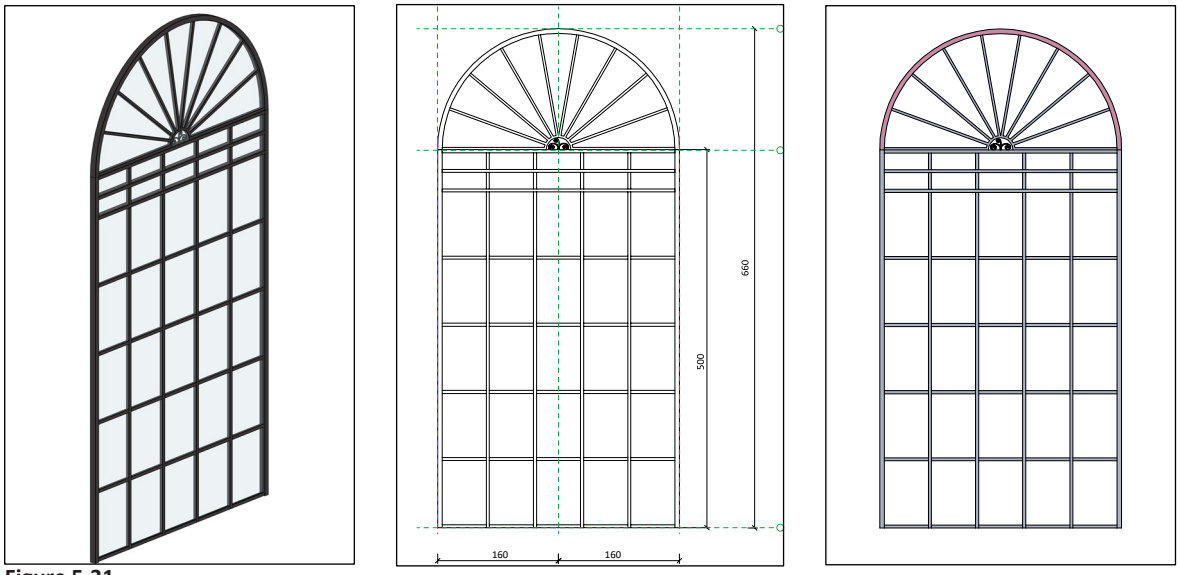
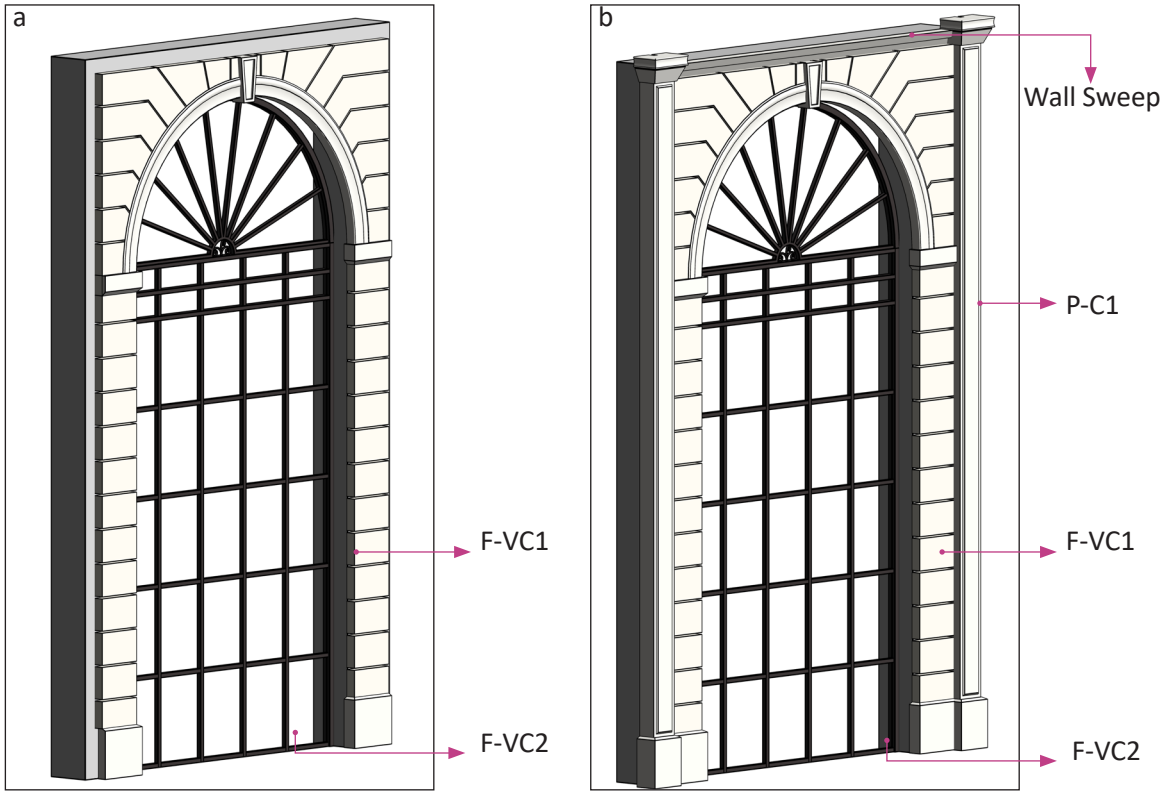


Figure 5.31
Different representations of the F-VC2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

Element Code	F-VC2
Used in	Volume C
Main Revit Tools	Extrusion, Sweep

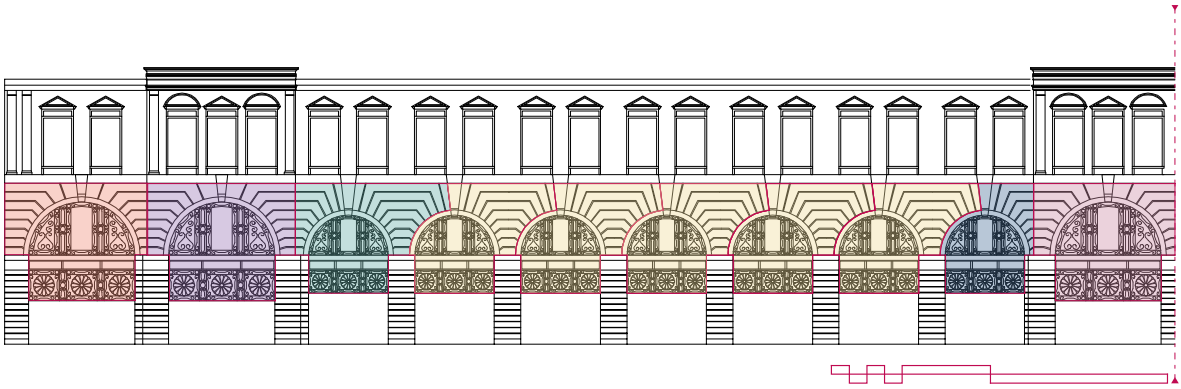
	Used Revit Tools
	Sweep
	Extrusion



(a) Combination of two façade component families

(b) Completed façade module with all component families

Figure 5.32
Assembly of façade family components in the Volume C façade module
Source: Images by the author, generated from the Revit model. The annotations identify the wall sweep, pilaster family, and façade component families used in the completed module.



Colour Legend						
Family Code	F-VD1	F-VD2	F-VD3	F-VD4	F-VD5	F-VD6

Figure 5.33
Colour-coded family distribution on the Volume D façade
Source: Drawing by the author, generated from the Revit model. Colours indicate different façade family types used in the modelling process.

5.4.2 Modular Modelling of Ground-Floor Arched Shop Units in Volume D

Volume D contains a series of repeated arched shop units on the ground floor. These units were considered together with the stone-covered surfaces surrounding the arches. The metal decorative elements placed within the window openings and the central ornaments located at the top of each arch. Although the units follow the same general composition, six variations were identified based on differences in proportion and detail. For this reason, each arched unit was divided into complementary parts and modelled through a modular system. This method allowed the stone pattern to be arranged more consistently along the façade and made the repeated elements easier to place in the main model. The different colours shown in the diagram represent this modular division and illustrate how the six façade variations were developed from a shared design logic.

Before the three-dimensional modelling stage, the two-dimensional elevation of each part was prepared separately. These drawings were then used as references in the family environment. The main geometries were created with the extrusion and sweep tools. The stone-covered surfaces and the decorative elements placed at the top of the arches were modelled by extending closed profiles to the required depth with the extrusion tool. The layered form of the arch was created with a single combined profile, which was carried along the curved arch path using the sweep tool.

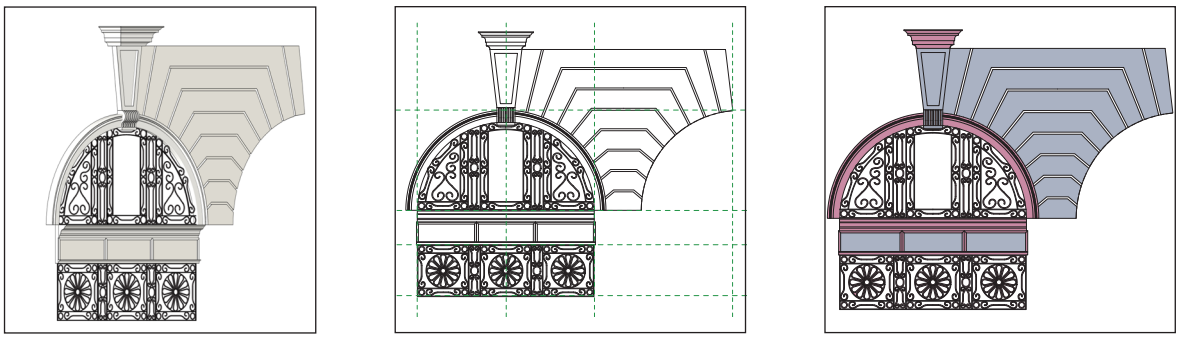
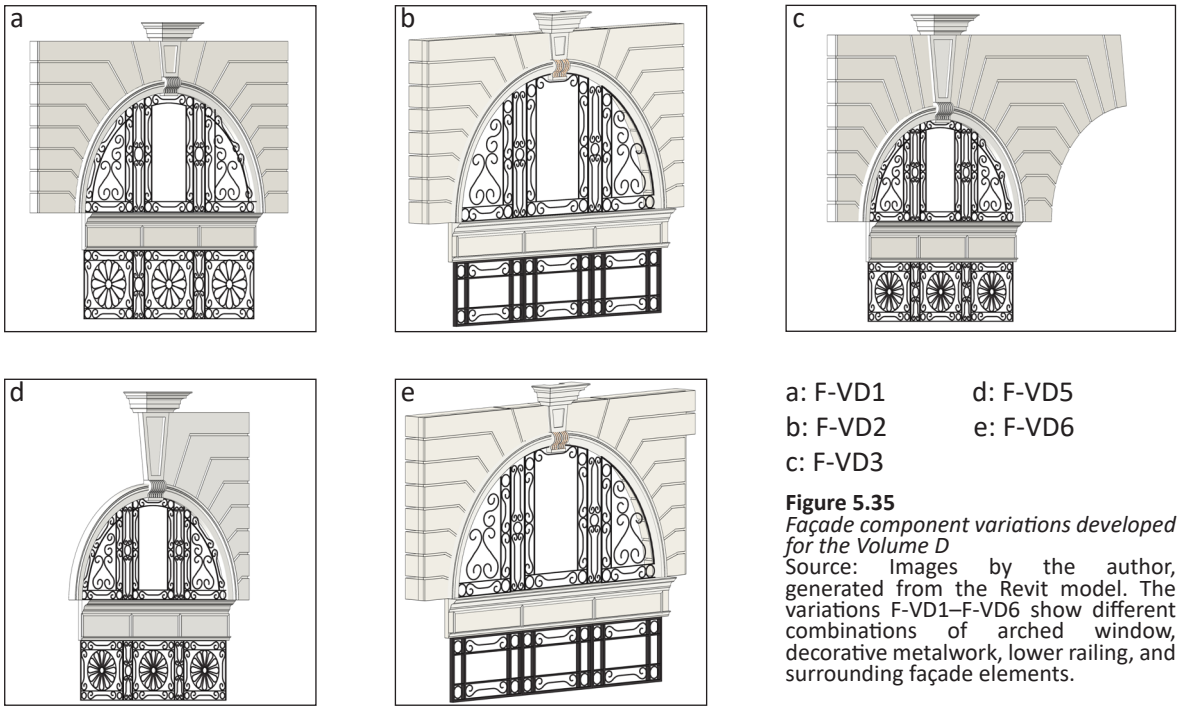


Figure 5.34
Different representations of the F-VD4: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

	Used Revit Tools
	Sweep
	Extrusion
	Void Extrusion

Element Code	F-VD4
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Void Extrusion



a: F-VD1
b: F-VD2
c: F-VD3
d: F-VD5
e: F-VD6

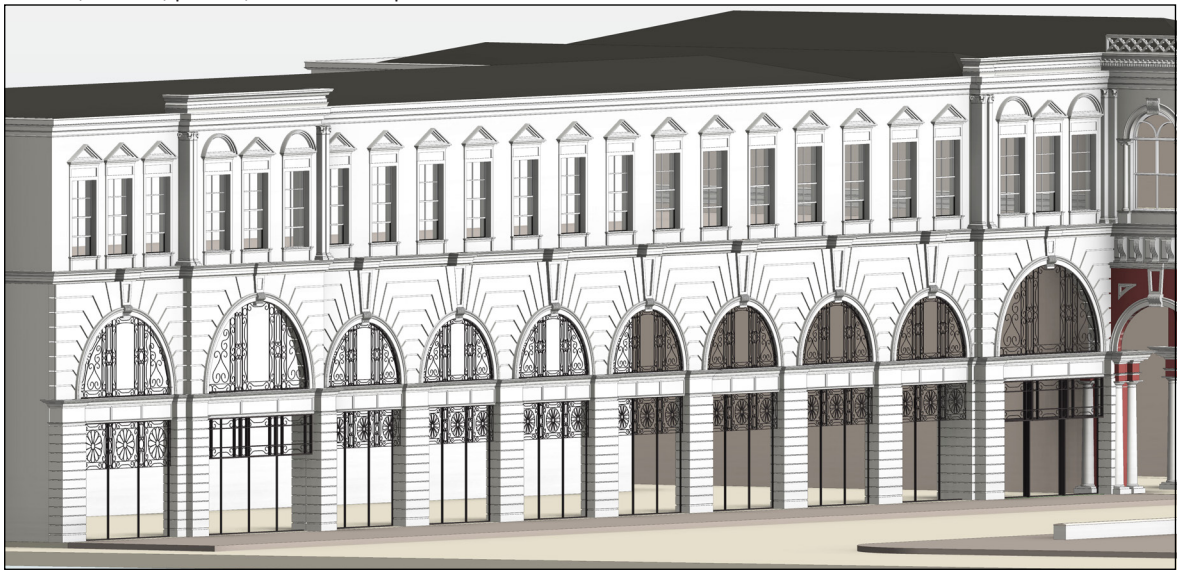
Figure 5.35
Façade component variations developed for the Volume D
Source: Images by the author, generated from the Revit model. The variations F-VD1–F-VD6 show different combinations of arched window, decorative metalwork, lower railing, and surrounding façade elements.

Unlike the F-VC1 example, a wall-based family was not used for these elements. Since the units needed to be reused in different positions without being limited to a single wall surface, a generic model family was selected. This approach provided greater flexibility when positioning the components in the main model and allowed the six variations to be organised within the same general system.

The metal window decorations were also developed as separate components within the family. Their straight and frame-like parts were created with the extrusion tool, while the curved, circular, and organic forms were modelled using sweep. The six completed variations were then loaded into the main project as separate components and placed according to their positions on the façade.

On the upper floor of Volume D, the previously developed window, column, and pilaster families were used, and the façade was completed by adding the horizontal profiles with the wall sweep tool.

Figure 5.36
Completed Volume D façade assembled from repeated family components
Source: Image by the author, generated from the Revit model. The façade was assembled using the previously developed window, column, pilaster, and wall sweep families.



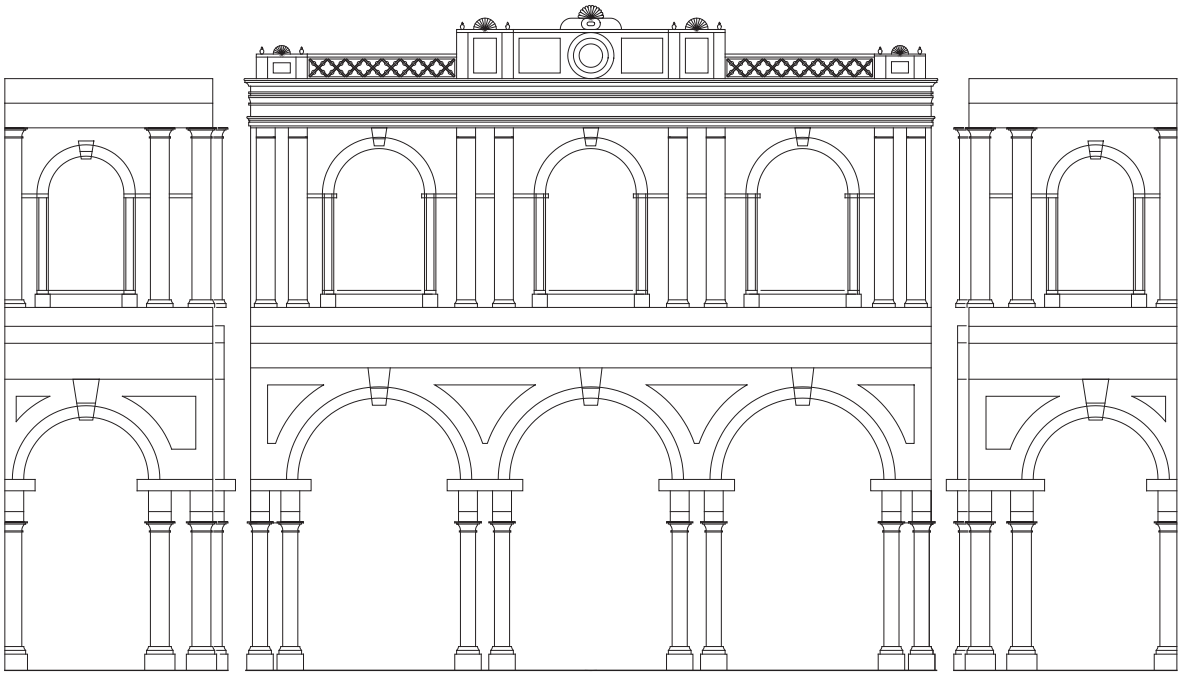


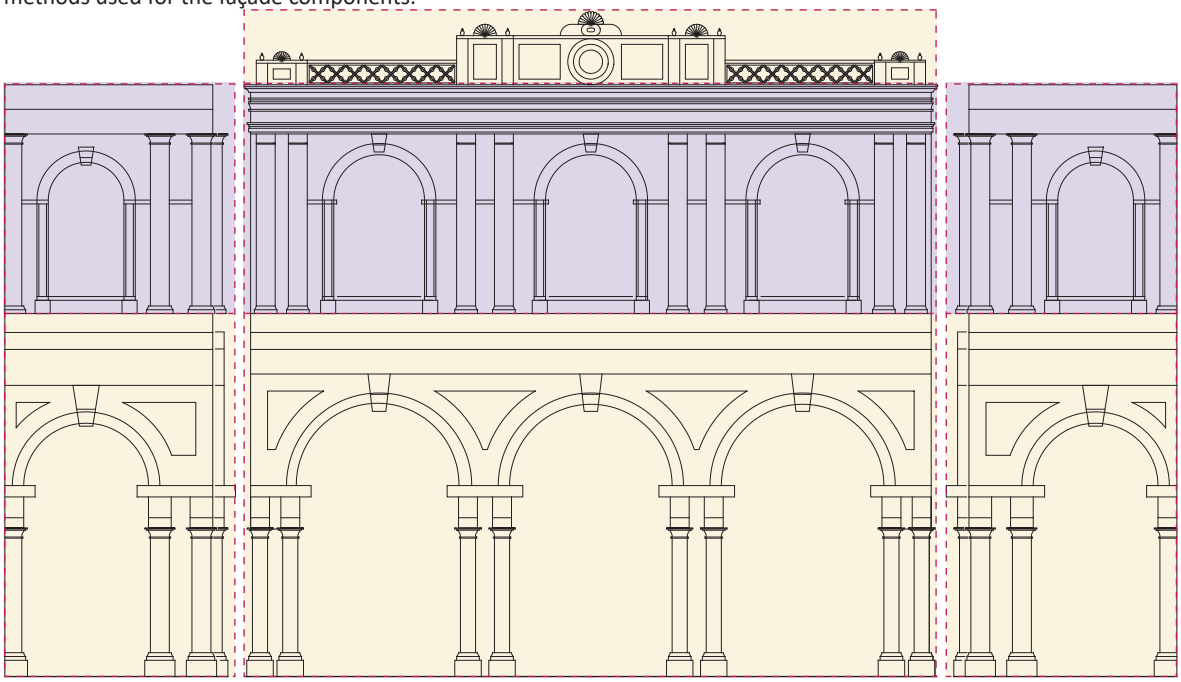
Figure 5.37
Elevation drawing of the central main mass in Volume D with its left and right side elevations
Source: Drawing by the author, generated from the Revit model.

5.4.3 Layered and Modular Modelling of the Central Mass in Volume D

The main mass located at the centre of Volume D has a different façade arrangement and a denser decorative composition than the contiguous buildings. Since different elements are used at the ground-floor, upper-floor, and roof levels, the modelling process was developed through an incremental and modular system rather than as a single element.

As shown in the diagram, the main ground-floor façade component, the three-dimensional decorations in the intermediate layer, and the roof ornament were modelled in separate family files and then loaded into the project. The upper-floor elements shown in purple were created directly in the main project together with the neighbouring buildings. This division allowed the parts with different levels of detail to be developed in a more controlled way.

Figure 5.38
Colour-coded elevation of the central main mass in Volume D and its left and right side elevations
Source: Drawing by the author, generated from the Revit model. The colours indicate the different Revit modelling methods used for the façade components.



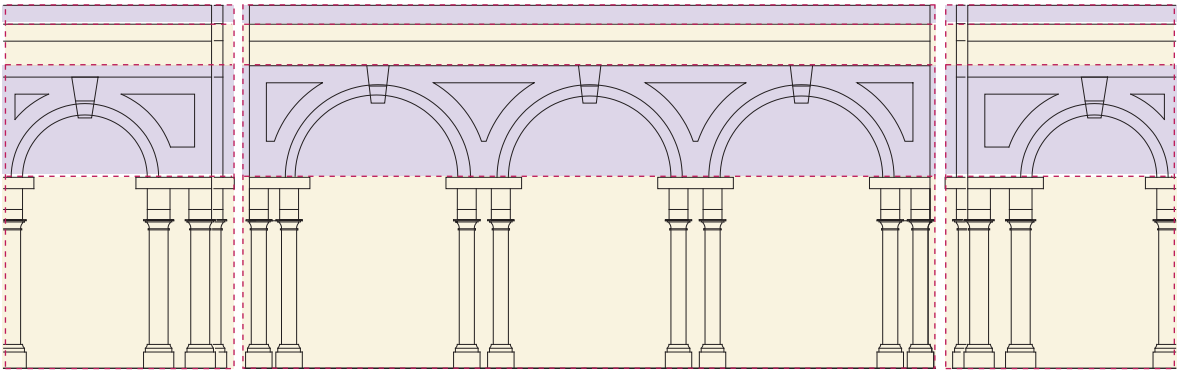


Figure 5.39
Colour-coded elevation of the ground-floor central mass block in Volume D indicating the modelling methods used
Source: Drawing by the author, generated from the Revit model. The colours indicate the different Revit modelling methods used for the façade components.

A layered modelling method was also used in the first family created for the ground floor. The column group and the decorative elements placed between the columns and arches have many geometric details. They were modelled in separate family files and later loaded into the main family. This method prevented the main family from becoming unnecessarily complex and made each component easier to edit, control, and update independently.

Modelling the F-VD7.1 Column Group

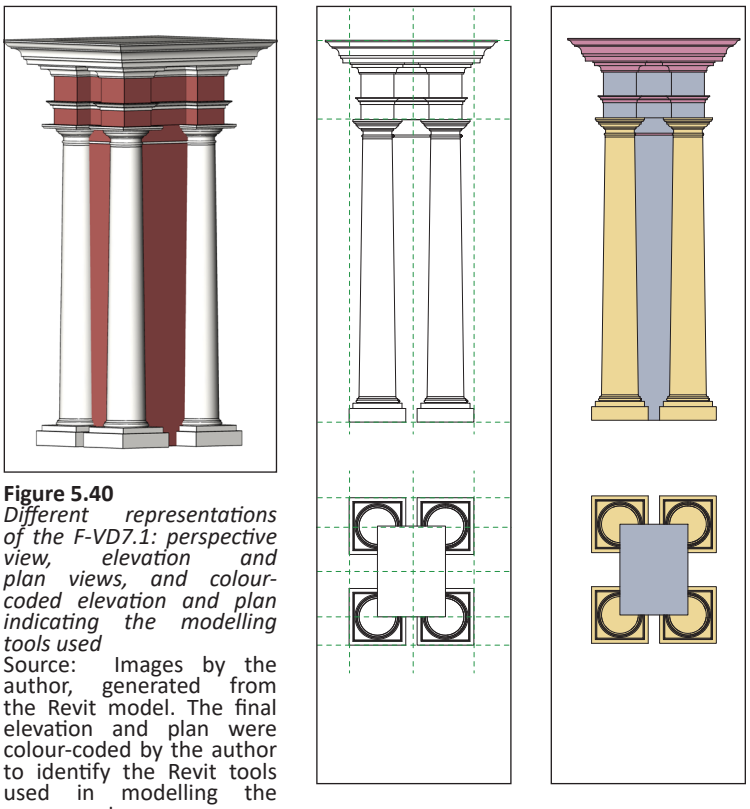


Figure 5.40
Different representations of the F-VD7.1: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

	Used Revit Tools
	Sweep
	Extrusion
	Load Family

Element Code	F-VD7.1
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Load Family / Nested Component

The modelling of the column group coded as F-VD7.1 began by loading the C-D1 column family, which had previously been developed in the column section. A rectangular central mass was first created with the extrusion tool to define the main core of the group. The four corners of this mass were then used as reference points for placing the columns. Reference planes were added in the plan view to control the position of each column. After the columns had been aligned and locked to these reference planes, their arrangement was checked in both plan and elevation views to ensure a symmetrical composition around the central mass.

The upper part of the group was then developed by adding the transition elements between the columns and the façade above. These elements were modelled with a combination of extrusion and sweep, following the proportions and profiles observed in the photographic sources.

Modelling and Assembly of the Ground-Floor Architectural Composition of Volume D

A floor-based family template was used for the main ground-floor component so that the completed assembly could be positioned and controlled in relation to the floor level. The previously modelled column group was first loaded into this family as a nested component. In the plan view, reference planes were created to define the centre lines, outer boundaries and the exact location of the group in the façade composition. The column assembly was then aligned with these reference planes and locked in place to prevent unintended movement during the later modelling stages. Its location was also checked in plan, elevation and 3D views in order to verify that the columns were symmetrical around the central mass and were properly aligned with the arched structure above. This initial setup provided a stable reference system for the development of the remaining ground-floor elements.

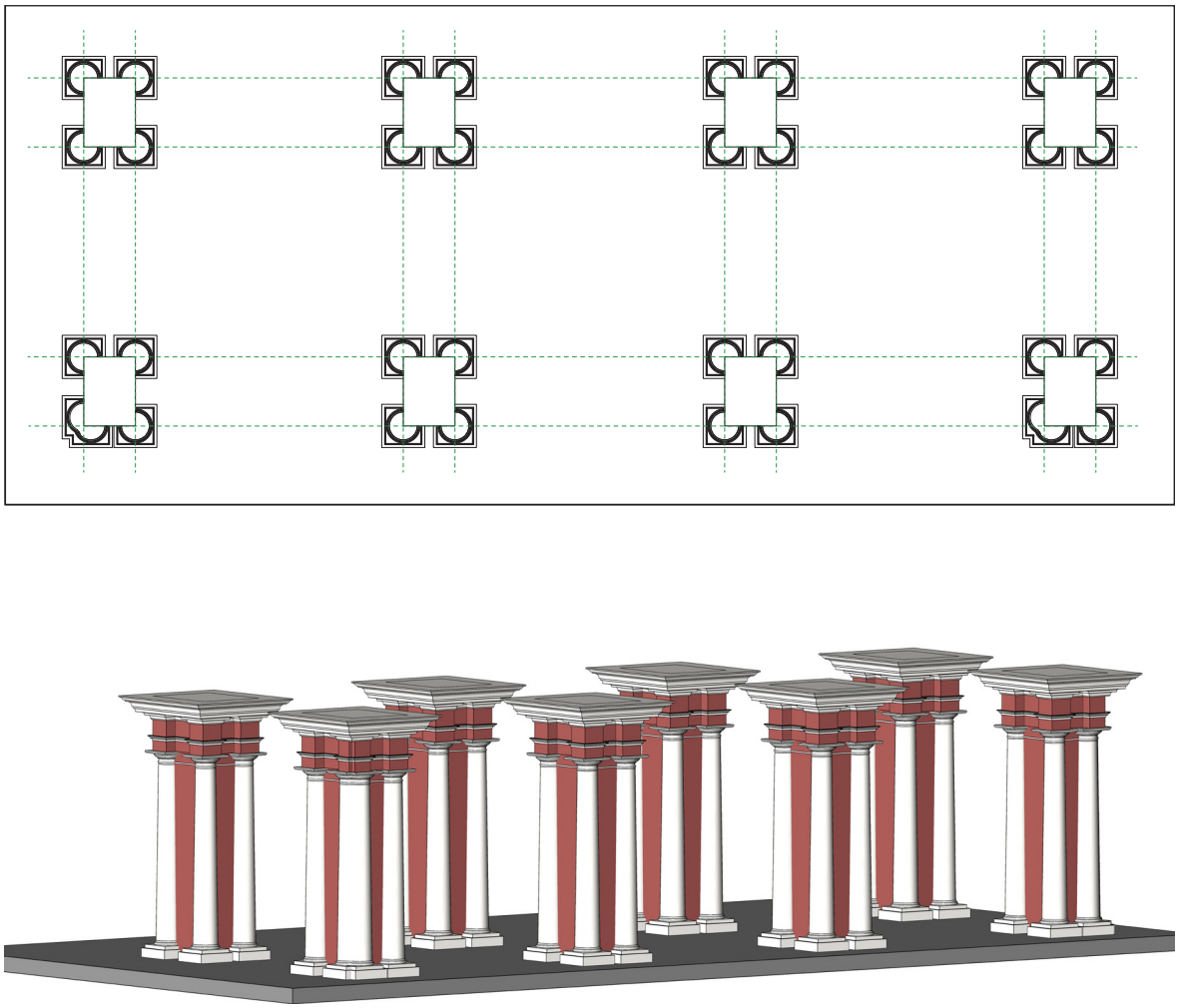


Figure 5.41
Integration of the ground-floor column group into the main family: plan alignment and 3D placement control
Source: Images by the author, generated from the Revit model. The plan view was used to align the column group with the reference planes, while the 3D view was used to check its position within the architectural composition.

The main arched wall surfaces were developed directly within the same family. Their outlines were derived from the two-dimensional elevation drawing, and the resulting profiles were created as solid forms using the Extrusion tool.the extrusion tool. The depth of these elements was controlled according to their relationship to the column group and the projecting façade layers.

After the main wall geometry was established, the frames around the arches were drawn as separate sweep elements. A profile of the layered part of the frame was drawn and carried along the curved path of each arch. This made it possible to reproduce the stepped depth of the mouldings while keeping the arch geometry continuous.

The raised decorative bands on the wall surface were also made with sweep, using different profiles for elements with different projections. The ornaments placed at the top of the arches were made with extrusion since their shapes were clearly defined from the elevation view and extended to a controlled depth. For the curved central ornament, the main volume was first made as a solid extrusion. Its recessed parts and internal openings were then made with void extrusion to create the detailed shape without dividing it into many separate solids. Once these elements had been completed, their depth, spacing, and relationship with the arches were checked in elevation and 3D views. This sequence allowed the wall, frame, and decorative layers to be developed as linked but independently controlled geometries in the same family.

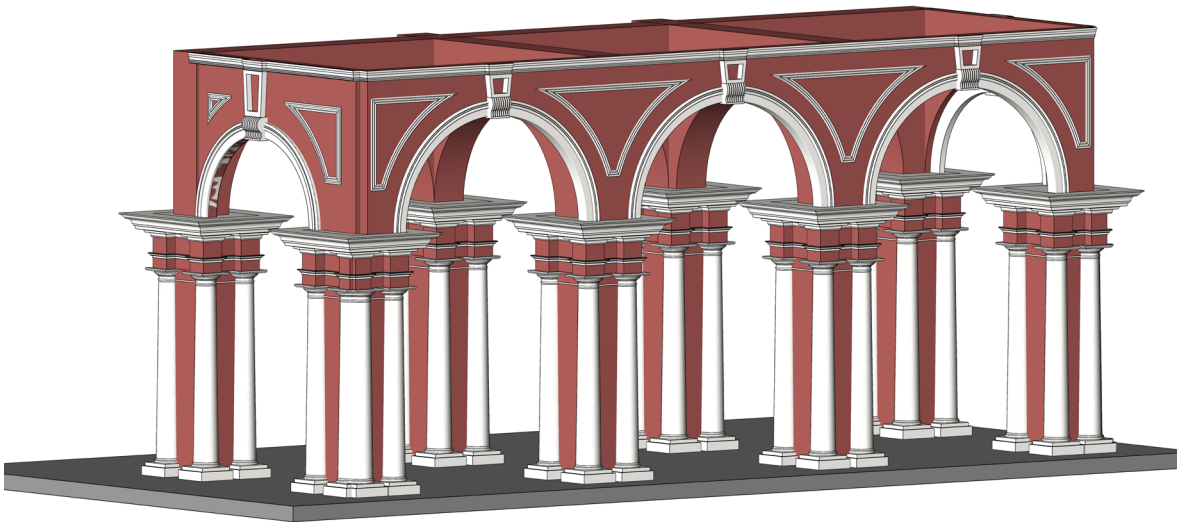
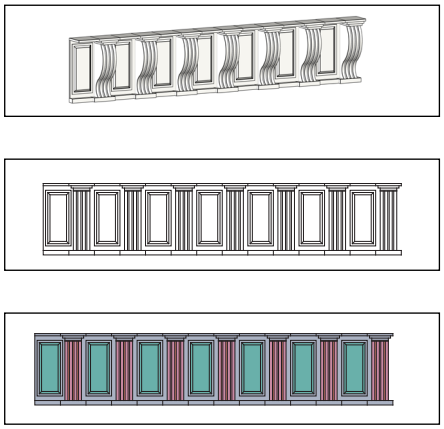


Figure 5.42
Assembled ground-floor composition of Volume D with column groups, arches, façade frames, and decorative bands
Source: Image by the author, generated from the Revit model.

In the next stage, a separate generic model family was created for the three-dimensional decorations extending across three faces of the structure. Before modelling, the dimensions taken from the main model were compared with the proportions observed in the visual sources, and a two-dimensional reference drawing was prepared to define the overall height, width, and spacing of the ornament. The decorative band was then divided into smaller modules according to changes in direction, depth, and form. Flat and projecting parts were created with extrusion, while continuous curved profiles were formed using sweep. Void extrusion was used to produce recessed areas and internal cut-outs within the ornament.



Element Code	F-VD7.2
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Blend, Void Extrusion

	Used Revit Tools
	Sweep
	Extrusion
	Blend
	Void Extrusion

Figure 5.43
Different representations of the F-VD7.2: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

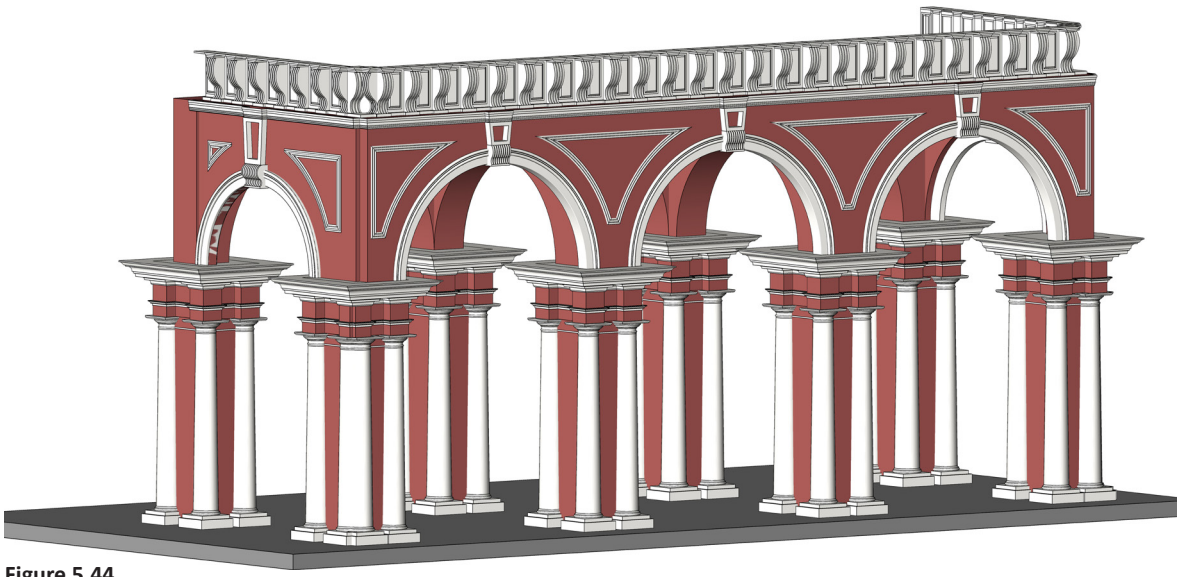
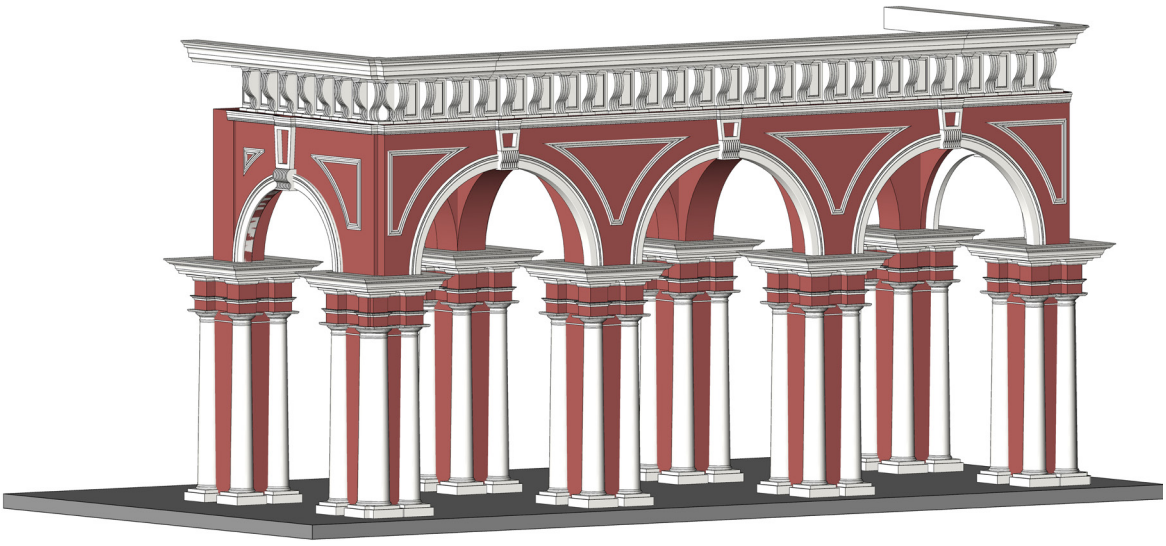


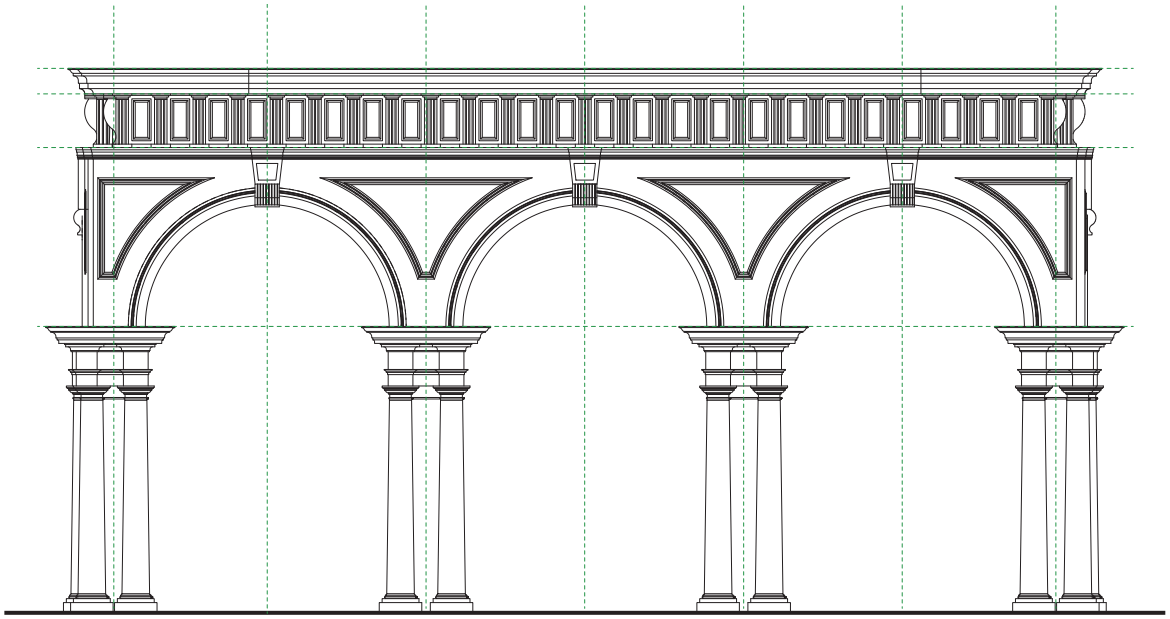
Figure 5.44
Integration of the three-dimensional decorative façade component into the ground-floor composition of Volume D
Source: Image by the author, generated from the Revit model.

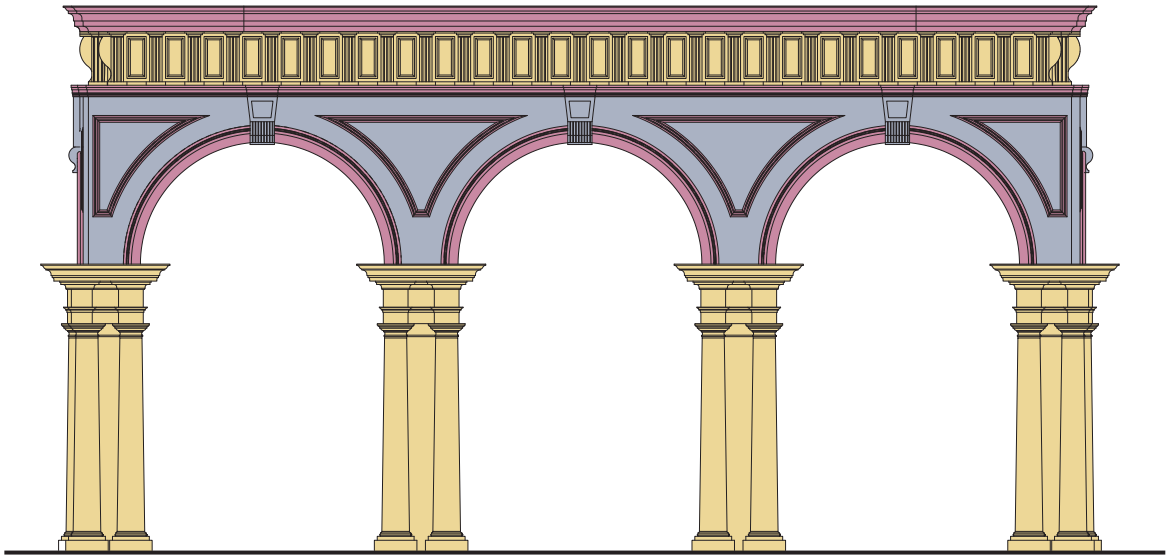
Particular attention was given to the corner transitions, since the decoration continues from one façade surface to another. The modules were placed at the edges of the structure and checked in plan and 3D views to verify that the profiles met at the corners. Their proportions and projections were also compared with the elevation reference before the family was complete. After the component was loaded into the main family, it was aligned with the reference planes and locked in position. Final checks were carried out in 3D, plan, and elevation views to confirm that the decorative band remained continuous and maintained a consistent depth across all three surfaces.

In the final stage, an additional layered horizontal profile was created above the raised decorative band using the sweep tool. After the required checks had been completed in plan and elevation views, the finished ground-floor block was loaded into the main project and fixed in its correct position. The upper floor was modelled using the previously developed window and pilaster families, while the horizontal façade decorations were added with the wall sweep tool. This method allowed the parts of the central mass with different levels of detail to be developed separately and then brought together as a consistent façade composition.

Figure 5.45
Completed ground-floor architectural composition of Volume D
Source: Image by the author, generated from the Revit model.



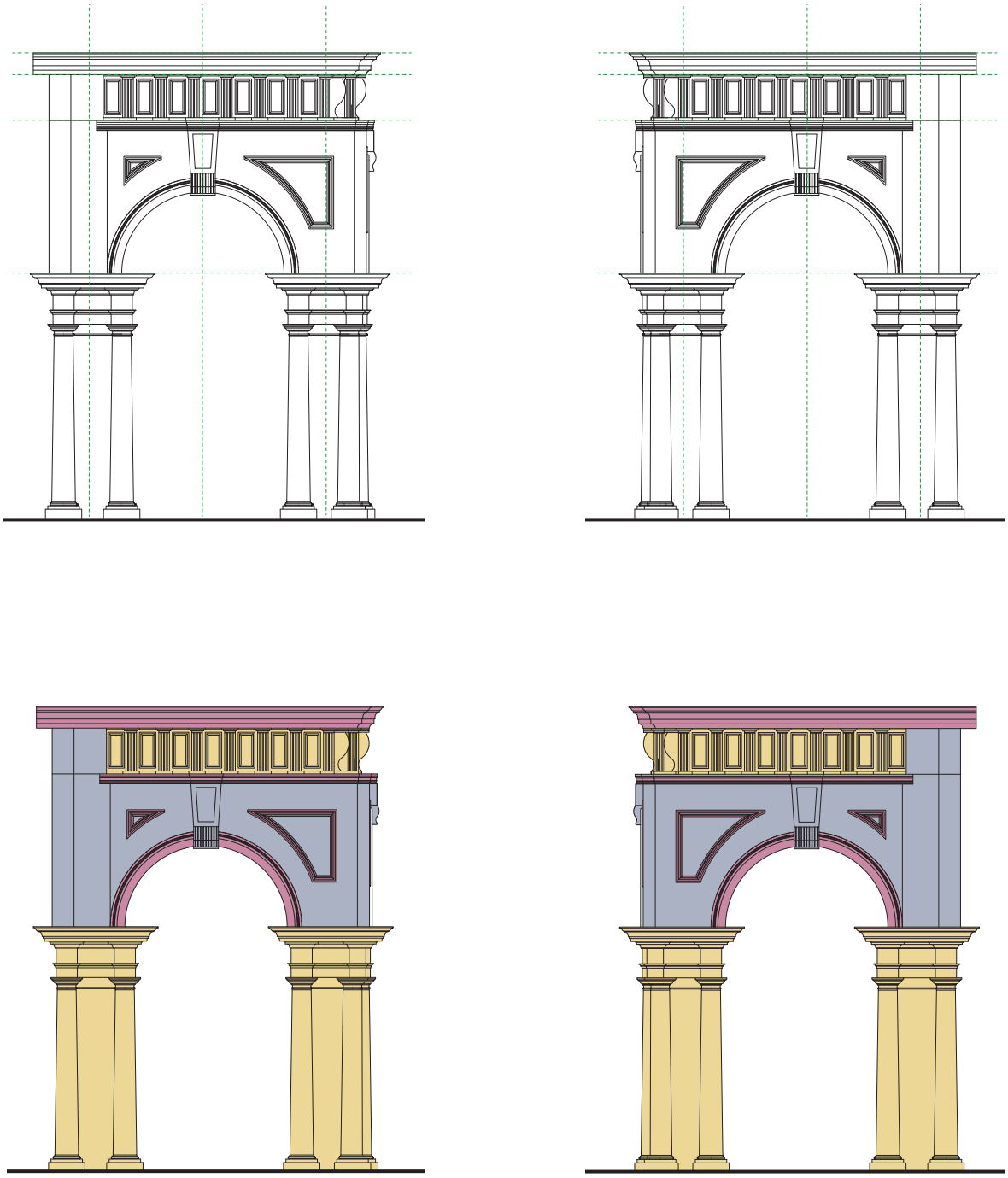




Element Code	F-VD7
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Blend, Load Family / Nested Component

	Used Revit Tools
	Sweep
	Extrusion
	Load Family
	Void Extrusion

Figure 5.46
Different representations of the F-VD7 front side: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.



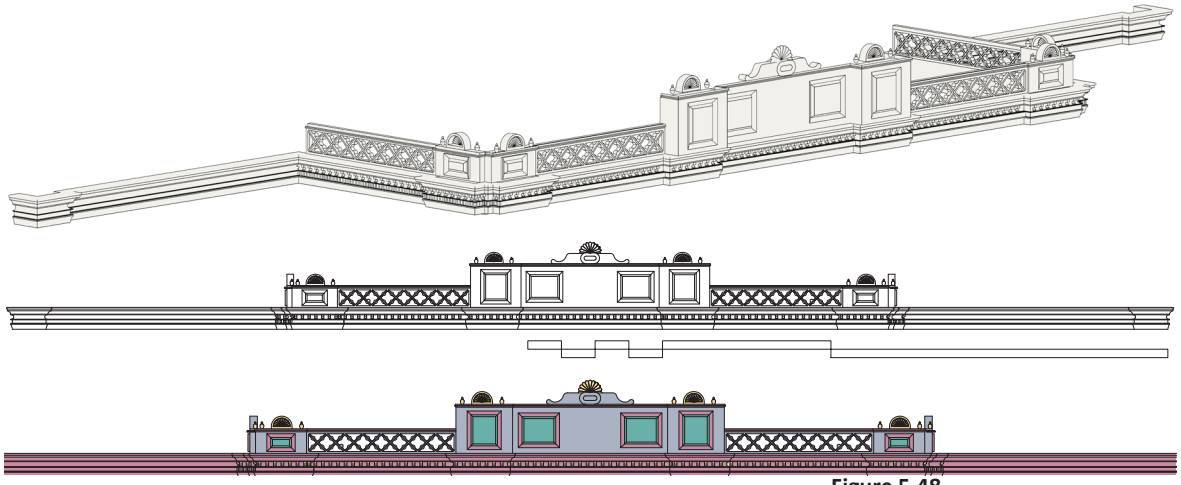
Element Code	F-VD7
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Blend, Load Family / Nested Component

	Used Revit Tools
	Sweep
	Extrusion
	Load Family
	Void Extrusion

Figure 5.47
Different representations of the F-VD7 right and left side: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

At the upper part of the main mass of Volume D, there is a decorative roof ornament that completes the façade composition. A separate family file was created for the modelling of this element, and two-dimensional reference drawings were used as the basis for the process. The main geometries were developed step by step and in layers using the sweep and extrusion tools. The continuous profiles and the decorative elements at different heights were arranged by comparing them with the two-dimensional elevations.

Some parts of the decorative bands running along the roof have repeated relief ornaments. Because these elements include more detailed geometry, the relief motif was first modelled in a separate family file and then loaded into the main family created for the roof ornament. Once the location of a single module was defined, the repeated elements were duplicated along the band using the array tool. Their placement and spacing were checked in plan, section, and 3D views and adjusted where necessary. Similarly, the decorative objects located on the upper part of the roof were modelled in separate family files and then loaded into the roof family. This approach made it easier to control the detailed elements independently and to place them correctly in the model. After the final checks, the completed roof ornament was loaded into the main project file and placed in its position on the central mass of Volume D.

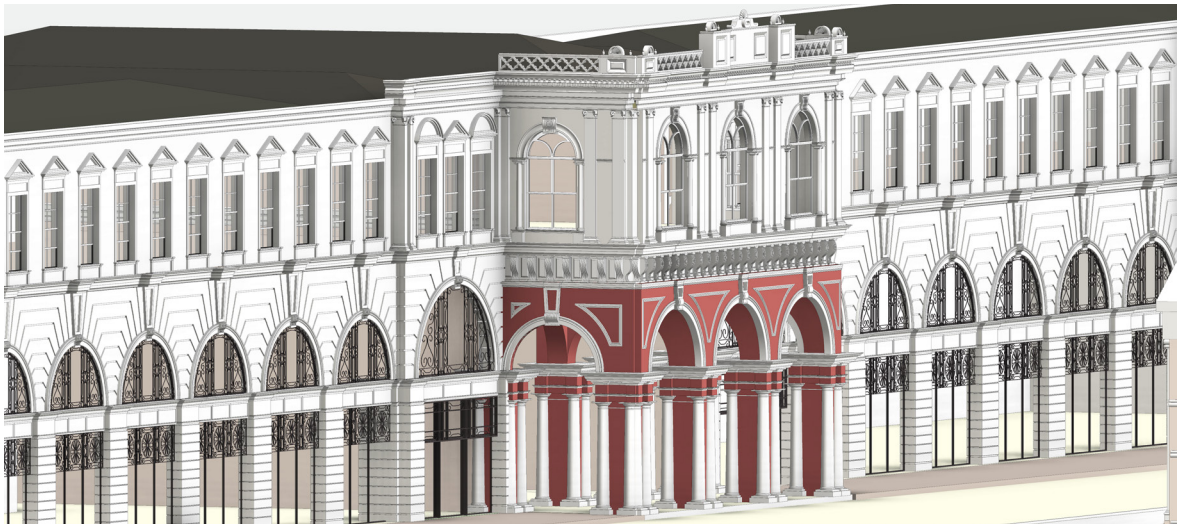


Element Code	F-VD8
Used in	Volume D
Main Revit Tools	Extrusion, Sweep, Load Family, Void Extrusion

	Used Revit Tools
	Sweep
	Extrusion
	Load Family
	Void Extrusion

Figure 5.48
Different representations of the F-VD8: perspective view, elevation and plan views, and colour-coded elevation and plan indicating the modelling tools used
Source: Images by the author, generated from the Revit model. The final elevation and plan were colour-coded by the author to identify the Revit tools used in modelling the component.

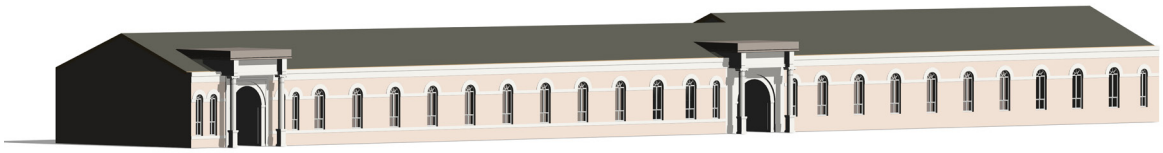
Figure 5.49
Completed central mass of Volume D with the decorative roof ornament placed on the façade composition
Source: Image by the author, generated from the Revit model.



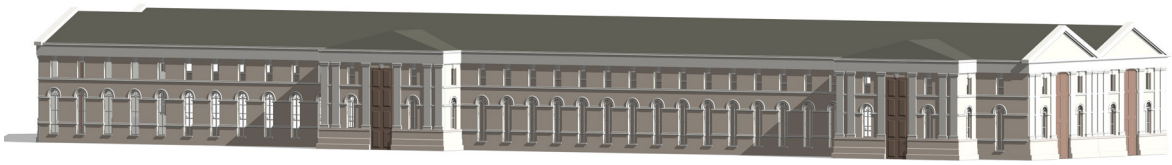
5.5 Completed Architectural Models

In this chapter, the architectural modelling of Volumes A, B, C, and D was developed through a combination of parametric families, modular components, and different Revit modelling tools. These methods allowed repeated elements to be reused in different parts of the buildings, while more complex façade and roof elements were modelled separately and later incorporated into the main project. During this process, models were compared with historical photographs and the source-based elevation drawings prepared in Chapter 4. This allowed for revision of the dimensions, proportions, and positions of individual elements when required. After the modelling process and final checks were completed, the digital models of the four volumes formed the basis for the next stage of the study. In the following chapter, they were transferred to an augmented reality environment in order to visualise and test them within the present-day urban context of Tophane.

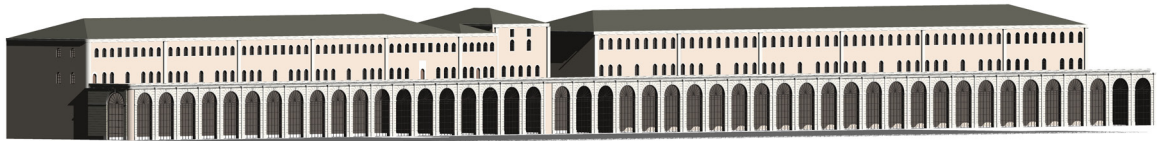
(a) Volume A



(b) Volume B



(c) Volume C



(d) Volume D



Figure 5.50
Completed Revit models of (a) Volume A, (b) Volume B, (c) Volume C, and (d) Volume D.
Source: Author.

6. Mobile AR Development and On-Site Testing of the Digital Models

After the architectural modelling of Volumes A–D was completed in Revit, the digital models were prepared for use in a mobile augmented reality environment. The aim of this stage was to place the models near their estimated former locations and view them together with the present-day urban context of Tophane. The prototype was developed as part of the research to test model transfer, interaction, placement, and on-site visualisation. It was not intended for public use.

Unity was selected as the real-time development environment because it allowed the digital models, live camera view, AR functions, and user controls to operate within the same scene. It also made it possible to develop and revise the placement and interaction controls without changing the original Revit models.

The former positions identified through the historical map analysis in Chapter 4 were approximate. The prototype did not use geographical coordinates, so the placement method depended on references that could be recognised on the site. Once a horizontal surface was detected, the first reference point established the position of the model, while the line between the first and second points defined its direction. The model could then be moved, rotated, and scaled before being locked in place. Surviving architectural elements and present road lines provided further visual references. These included Nusretiye Mosque, Tophane Fountain, and Tophane Pavilion.

On-site tests were carried out for Volumes A, B, C, and D. Each model was placed and adjusted at its selected location, and its alignment and visibility were observed during use. Practical conditions affecting placement and visibility included trees, fences, pedestrian circulation, road traffic, and the large dimensions of Volumes C and D. Observations made during the tests led to revisions in the placement controls, lighting, materials, and interface of the prototype.

This chapter first explains the preparation and transfer of the models from Revit to Unity. It then describes the AR environment, scene organisation, interaction tools, and reference-based placement method. The final sections present the on-site tests of the four volumes and the technical observations made during use. The wider spatial and interpretive implications of these results are discussed in Chapter 7.

6.1 Model Preparation and Transfer to Unity

From the beginning, the digital workflow was divided into two stages. Revit was used for architectural modelling, while AR visualisation and interaction were developed in a separate real-time environment. After Volumes A–D had been completed and checked in Revit, the digital models were prepared for transfer to a platform where they could be viewed together with the live camera image and controlled in real time. This transfer connected the architectural modelling process to the on-site AR application.

6.1.1 Unity as the Real-Time Development Environment

The prototype was developed in Unity 6 using AR Foundation 6.4.3 and the Google ARCore XR Plugin 6.4.3. Unity provided the real-time environment in which the transferred architectural models could be combined with the device camera, AR tracking functions, and interface controls. It also allowed the placement and interaction systems to be developed and revised without changing the original models prepared in Revit.

Within Unity, the project was organised through Scenes, GameObjects, and Components. Each object in the Scene was represented as a GameObject, while its functions and settings were assigned through Components. Position, rotation, and scale were controlled through the Transform component. This structure was used to organise the transferred models, AR camera, lighting, calibration system, and user interface within the same project.

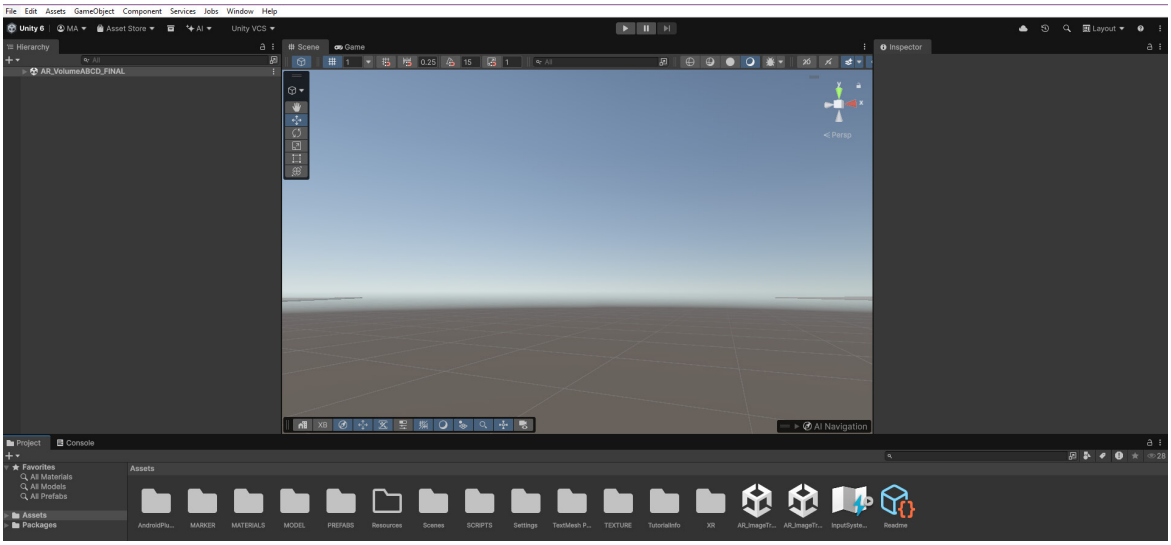
Several Unity Editor windows were used together throughout the project. The Hierarchy lists the GameObjects in the active Scene and shows their parent–child relationships (Unity Technologies, n.d.-g). In this study, it was used to organise the AR Session, XR Origin, model roots, calibration objects, and user interface groups. The Scene view was the main workspace for positioning and visually checking the imported volumes (Unity Technologies, n.d.-i).

Selecting an object in the Hierarchy displayed its components and Transform settings in the Inspector, where they could be reviewed and modified (Unity Technologies, n.d.-f). The Project window provided access to the models, materials, textures, prefabs, Scene files, and scripts used in the application (Unity Technologies, n.d.-h). Errors, warnings, and script messages were monitored through the Console (Unity Technologies, n.d.-c). Figure 6.1 shows the Unity Editor workspace used during this stage.

Figure 6.1

Unity Editor workspace used to organise the AR project, showing the Scene, Hierarchy, Inspector, and Project windows.

Source: Screenshot taken by the author in Unity, 2026.



6.1.2 Model Transfer from Revit through 3ds Max

The completed models were first exported from Revit in FBX format. This format allowed the model geometry prepared in Revit to be transferred to 3ds Max and other three-dimensional environments (Autodesk, 2025c). The first transfer test was carried out by importing the Revit FBX file directly into Unity. Although the model geometry was transferred, the separation between some materials and architectural components was not preserved as expected.

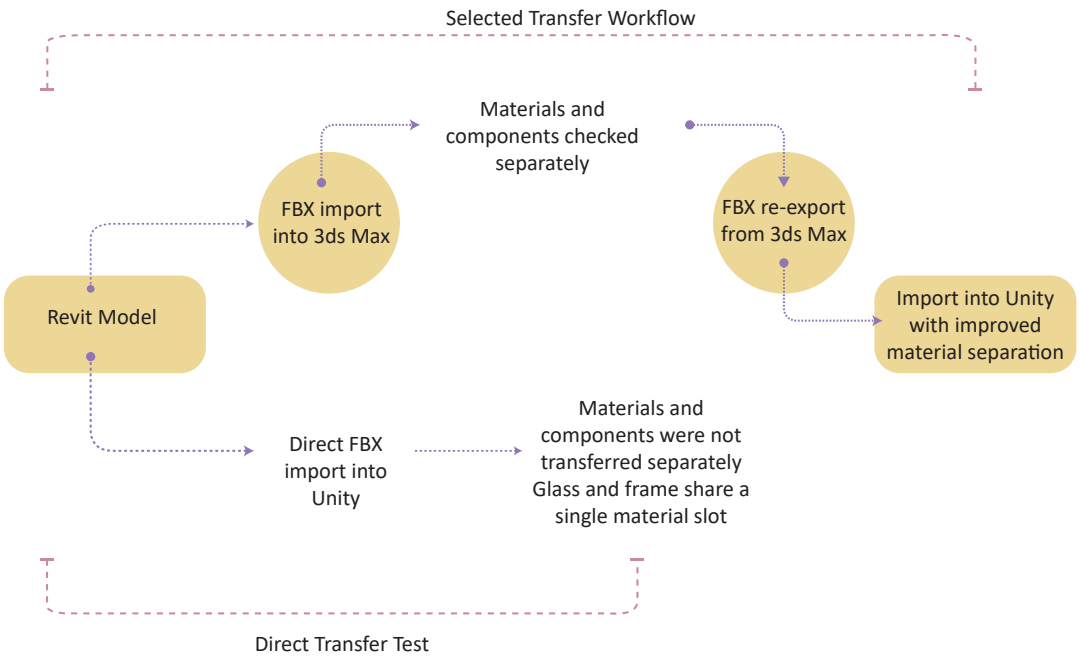
This problem was clearly visible in the window components. The glass and frame had separate materials in Revit. After the direct Unity import, however, the window appeared as a single object with only one material slot, displayed as Element 0. As a result, the glass and frame could not be controlled separately in Unity. A different transfer method was tested.

The FBX file exported from Revit was imported into 3ds Max. Revit FBX files can be opened in 3ds Max, where imported objects and materials can be reviewed before being exported to another environment (Autodesk, 2025c). After the file was imported, the material groups and related components could be viewed separately. The imported model was then exported again in FBX format and transferred to Unity. With this workflow, elements such as window glass and frames were transferred with a more controlled structure.

Some materials still required individual adjustments after the Unity import. However, the main separation between materials and components was better preserved. 3ds Max was not used as an additional architectural modelling environment. It served as an intermediate preparation and transfer stage between Revit and Unity. Figure 6.2 summarises the problem observed during the direct transfer and the workflow selected after this test.

The same transfer workflow was followed for Volumes A, B, C, and D. The following section explains the material adjustments and the organisation of the models within the AR interaction and placement system.

Figure 6.2
Comparison of the tested FBX transfer workflows: direct import from Revit to Unity and the selected workflow through 3ds Max.
Source: Diagram prepared by the author, 2026.



6.2 Development of the AR Prototype and Interaction System

6.2.1 AR Environment and Material Preparation

After the transferred models had been checked in Unity, the AR environment was prepared using AR Foundation. AR Foundation provides a common framework for developing AR applications in Unity and connects the project to the AR capabilities of the target mobile platform (Unity Technologies, n.d.-a). An AR Session and an XR Origin were added to the Unity Scene to enable device tracking and link the AR camera to the movement of the mobile device. The live camera view, reconstructed volumes, and interaction tools could then be managed within the same Scene.

First, materials were created in Unity for the different surfaces of the imported models. The material groups retained during the transfer through 3ds Max allowed the main surfaces to be selected and edited separately. The new materials were assigned to walls, roofs, window frames, glass surfaces, and other architectural elements.

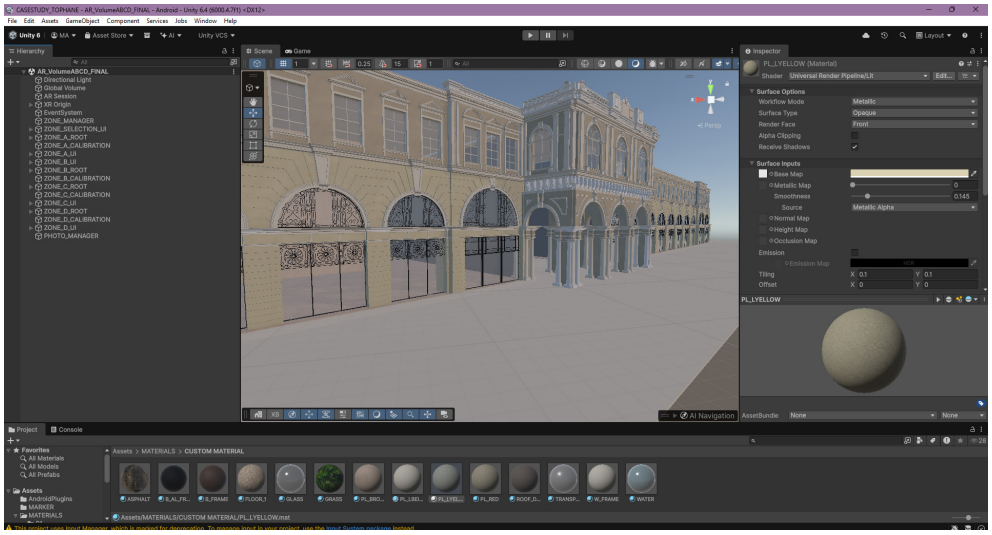


Figure 6.3

Creation, assignment, and visual inspection of the model materials in Unity.

Source: Screenshot taken by the author in Unity, 2026.

6.2.2 Model Organisation and Volume Selection

The digital volumes were organised in the Unity Hierarchy according to the requirements of the interaction system. A parent GameObject called Zone Root was created for each volume, and the corresponding model was placed under it. Each complete volume could then be moved, rotated, or scaled through its Zone Root without changing the relative positions of its architectural components.

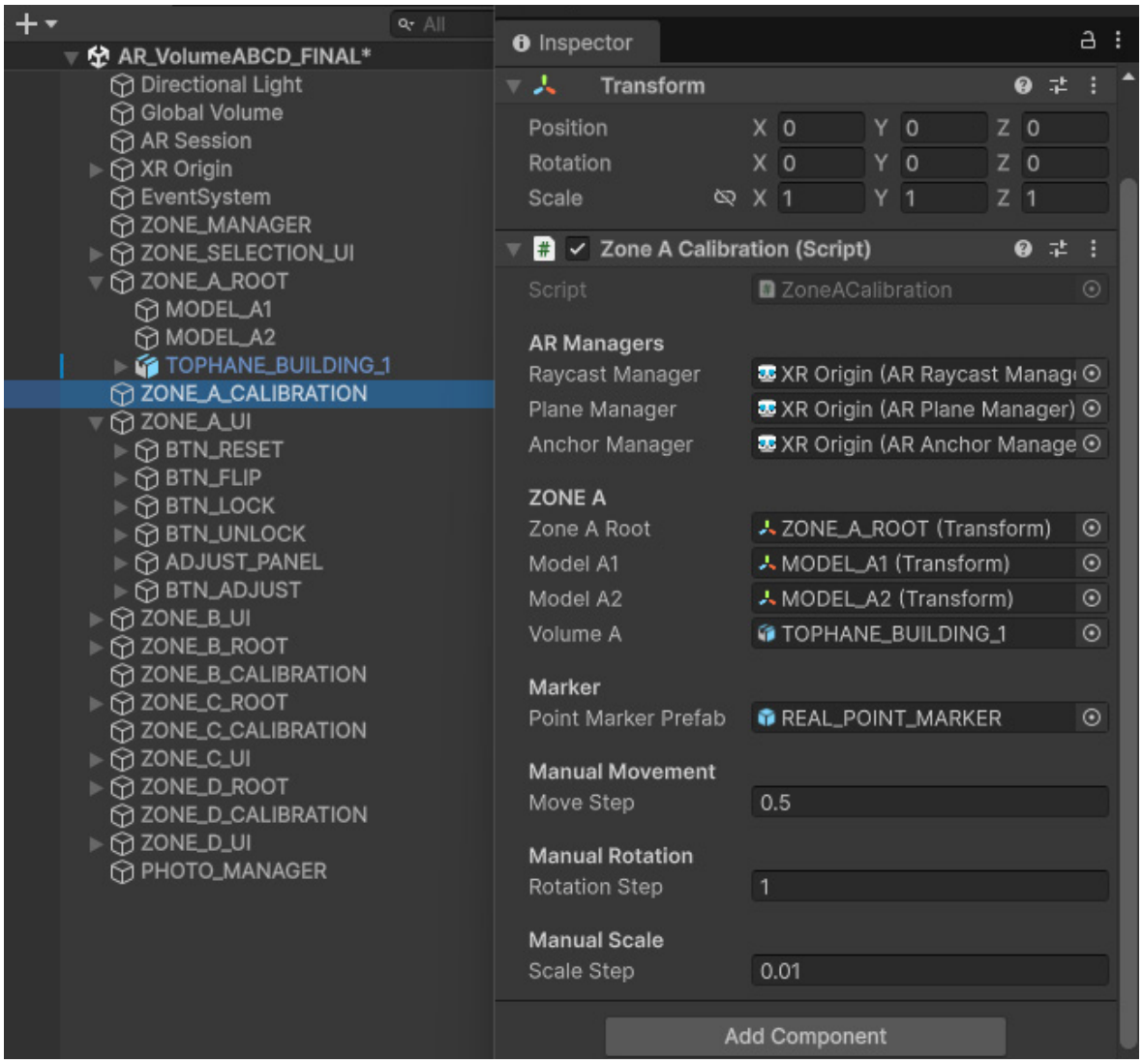
A separate Calibration GameObject was created next to each Zone Root. It did not contain any architectural geometry. Instead, it held the script used to position the volume on site. The two model-side reference points were placed under the corresponding Zone Root and assigned to the calibration script through the Inspector. Their positions were defined individually because each volume had a different relationship with the selected site references.

Each volume also had its own UI group containing the controls used during calibration and placement. Only the UI group linked to the active volume was displayed. The same Zone Root–Calibration–UI arrangement was used for Volumes A, B, C, and D, allowing each volume to be managed independently within the same Unity Scene.

Unity supports the use of C# scripts that can be attached to GameObjects and used to control their response to input (Unity Technologies, n.d.-d). In this project, separate scripts connected the calibration functions, digital volumes, and interface controls. The interface was organised in stages so that only the controls needed at each stage appeared on the mobile screen. The following description presents the final organisation of the interface. The changes introduced after the field tests are discussed in Section 6.3.

When the application was opened, the initial interface displayed the selection buttons for Volumes A, B, C, and D. After a volume was selected, the Reset, Flip, Lock, Adjust, and Photo controls became available. These controls affected only the selected model, allowing each volume to be placed independently. The Unlock control became available after the volume was locked so that further corrections could be made without repeating the complete calibration process.

Figure 6.4
Organisation of the Volume A model, calibration, and UI groups in the Unity Hierarchy and the references assigned to the Zone A Calibration script in the Inspector.
Source: Screenshot taken by the author in Unity, 2026.



6.2.3 Reference-Based Calibration

The size of the digital volumes affected how they could be placed in the AR environment. Unlike small AR objects that can be viewed and controlled on a mobile screen, these buildings covered large parts of the site. Only part of a building could be seen from one viewpoint, making it difficult to understand its full position and orientation through the camera view alone. Moving the models with the screen controls was not enough to align them accurately with the site.

For this reason, a reference-based calibration method was developed. The method matched reference points defined on the digital models with corresponding points marked on the site. This established the initial position and orientation of each volume before the detailed adjustment controls were used.

The placement references were identified through the map comparisons and spatial analyses presented in the earlier chapters before the on-site tests began. The selection focused on surviving architectural elements and present-day road alignments that could be recognised in both the documentary sources and the current site. These references did not change the geometry of the digital models. They were used only to establish their initial position and direction during AR placement.

For Volume A, the side wall of the Nusretiye Mosque formed the primary reference because the former building began directly beside it, without an intervening space. Volume B was positioned in relation to the Tophane Fountain. For Volumes C and D, the road alignment identified through the earlier map comparisons formed the primary reference. The relationship with the Nusretiye Mosque provided a secondary visual check for Volume C, while the Tophane Pavilion served the same purpose for Volume D.

After these site references were selected, corresponding calibration points were defined for each digital volume in Unity. Two model-side points were used for every volume. Their locations were set separately because Volumes A–D had different positions and directions. These points formed the digital component of the calibration system and were later matched with P1 and P2 placed in the physical environment.

Horizontal plane detection was enabled through the AR Plane Manager so that the corresponding reference points could be positioned on site. As the mobile device was moved, AR Foundation analysed the camera view and identified suitable horizontal surfaces. Each detected plane appeared on the screen as a semi-transparent orange surface. This surface was used only as a temporary placement guide and did not form part of the architectural model.

The AR Raycast Manager converted touch input on the detected plane into a position within the AR environment. After the relevant volume and the first point command were selected, touching the orange surface placed a visible sphere marker at the chosen location. This marker was identified as P1 and corresponded to the first model-side reference point.

The second point, P2, was placed in the same way. Both points were located on the same horizontal plane, keeping them at a consistent elevation. The line from P1 to P2 defined the required direction on the site.

During alignment, the system matched P1 with the first model-side reference object and compared the P1–P2 direction with the direction of the model-side reference pair. The corresponding Zone Root was moved to the position defined by P1 and rotated to align the two directions. Applying these changes to the Zone Root moved all model components grouped under it. The orange plane and sphere markers remained visible while the initial placement was checked.

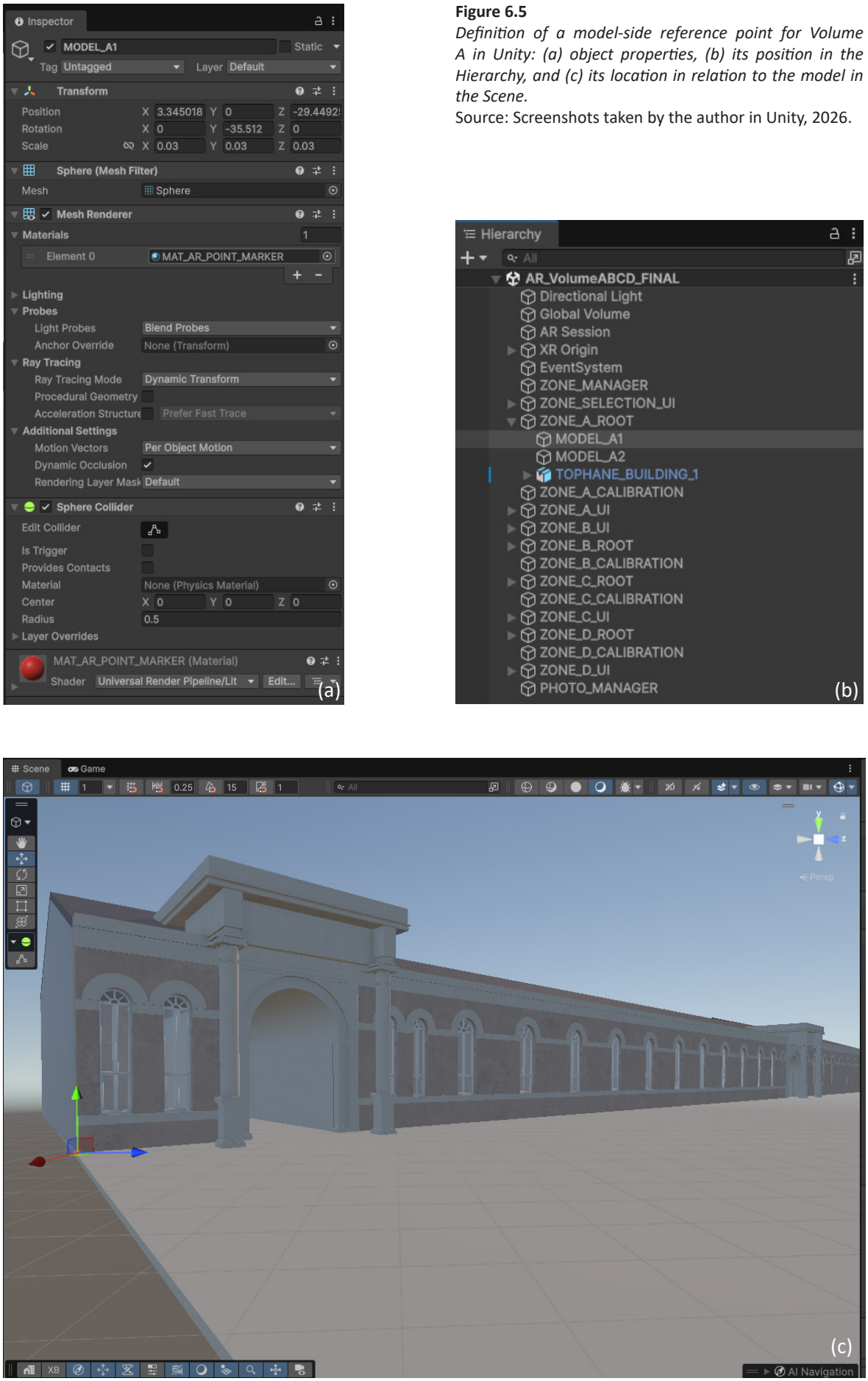


Figure 6.5
Definition of a model-side reference point for Volume A in Unity: (a) object properties, (b) its position in the Hierarchy, and (c) its location in relation to the model in the Scene.
Source: Screenshots taken by the author in Unity, 2026.

6.2.4 Adjustment and Placement Controls

The reference-point system completed the initial alignment, but small corrections were still needed because of the size of the models, the viewing distance, and the physical conditions of the site. The main interface provided the Reset, Flip, Lock, Adjust, and Photo controls for these corrections. Unlock became available after the volume was locked. Each command applied only to the active volume.

The Adjust button opened a secondary panel containing the detailed positioning tools. The volume could be moved upward or downward, left or right, and forward or backward. The same panel also contained rotation and scale controls. Each command changed the model in small steps, allowing the large volumes to be adjusted incrementally. Selecting Adjust a second time closed the panel while the main controls remained visible.

Flip remained outside the Adjust panel because it served a different purpose: correcting the model when it faced the opposite direction. Reset cleared the physical reference points and restarted the calibration process for that volume. The positions of the other volumes remained unchanged.

Once the volume's position had been checked, Lock prevented further manual adjustments. It also hid the orange plane and sphere markers, leaving a clearer view of the digital model within its present-day surroundings. Unlock made the volume editable again without changing its position. After the necessary corrections, it could be locked again.

The Photo button captured the combined view of the digital volume and the live camera image through the mobile interface. The resulting images documented the model in relation to the present-day setting.

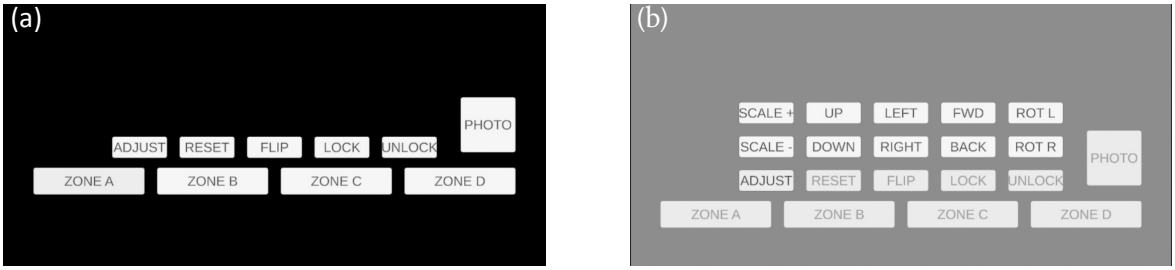
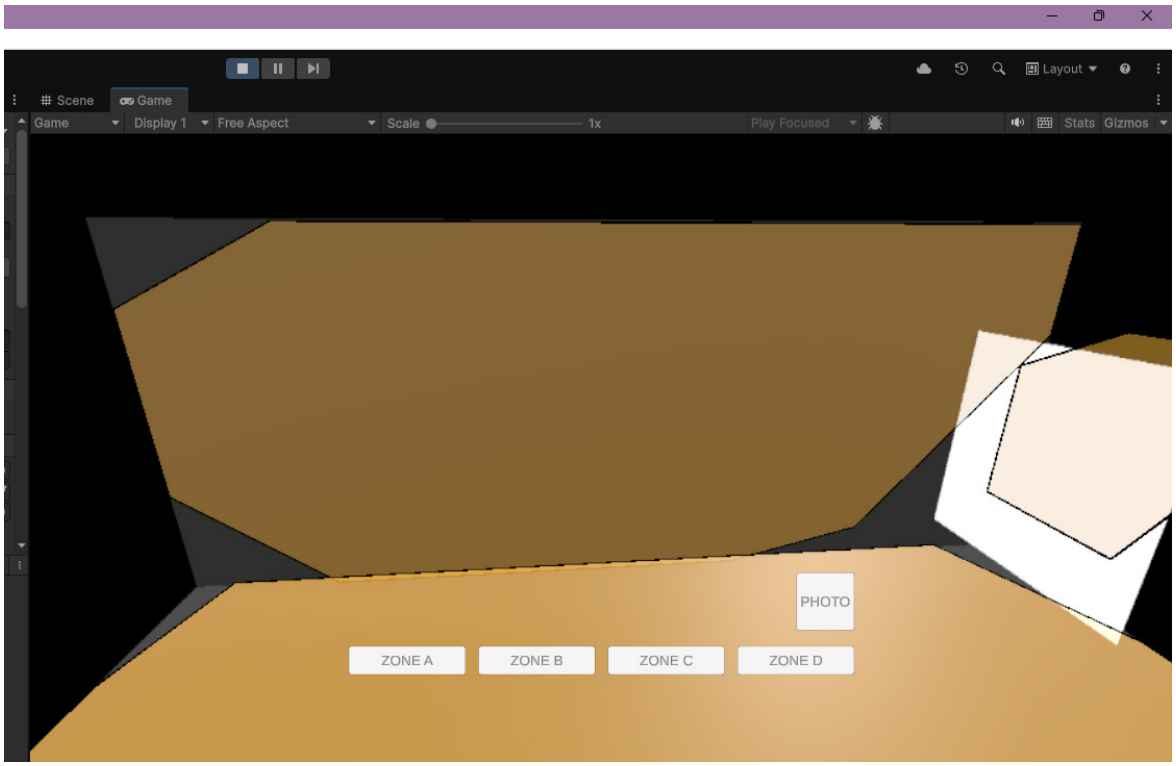


Figure 6.6
Model-placement interface: (a) main controls displayed after volume selection and (b) movement, rotation, and scale controls opened through the Adjust panel.
Source: Screenshots taken by the author during Unity Play Mode testing, 2026.

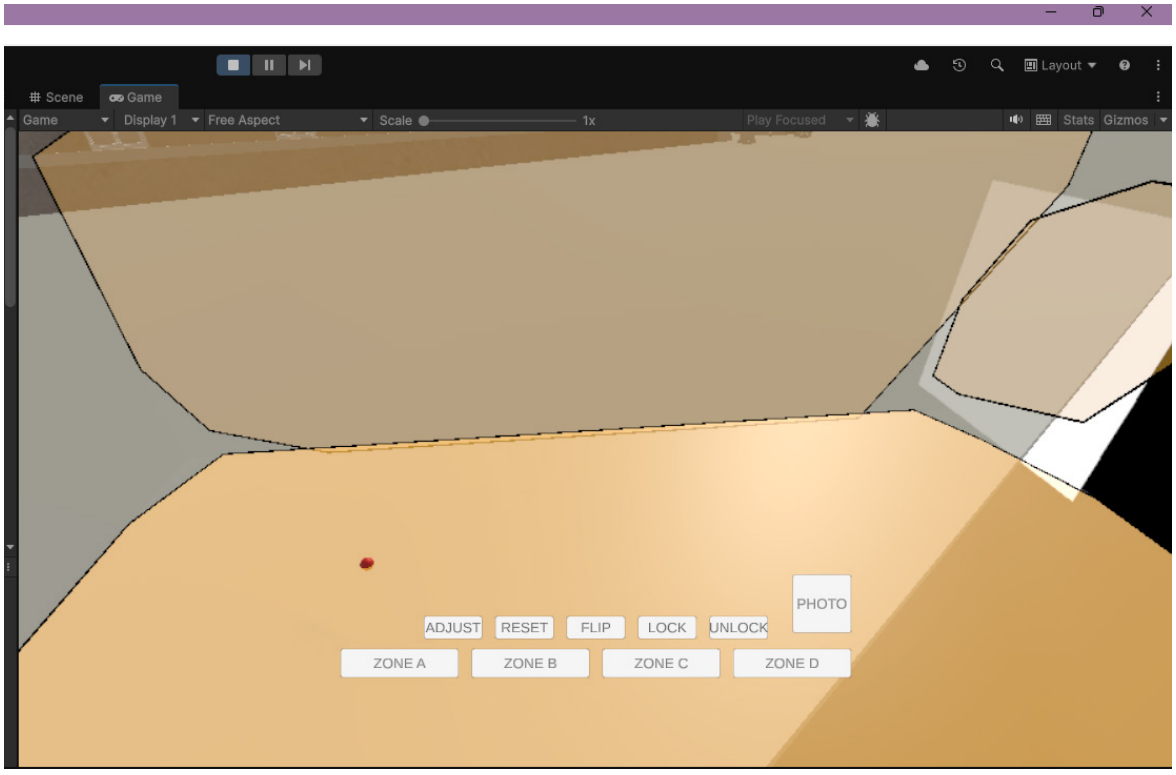
6.2.5 Play Mode Testing and Android Build

Before the first Android build was produced, the main functions were tested on a PC using Play Mode in the Unity Editor (Figure 6.6). Unity's Play Mode runs a Scene directly within the Editor (Unity Technologies, n.d.-b). In this study, it provided an initial view of how the scripts and interface responded to user input. The review covered model visibility, material appearance, volume selection, and the opening and closing of the UI panels.

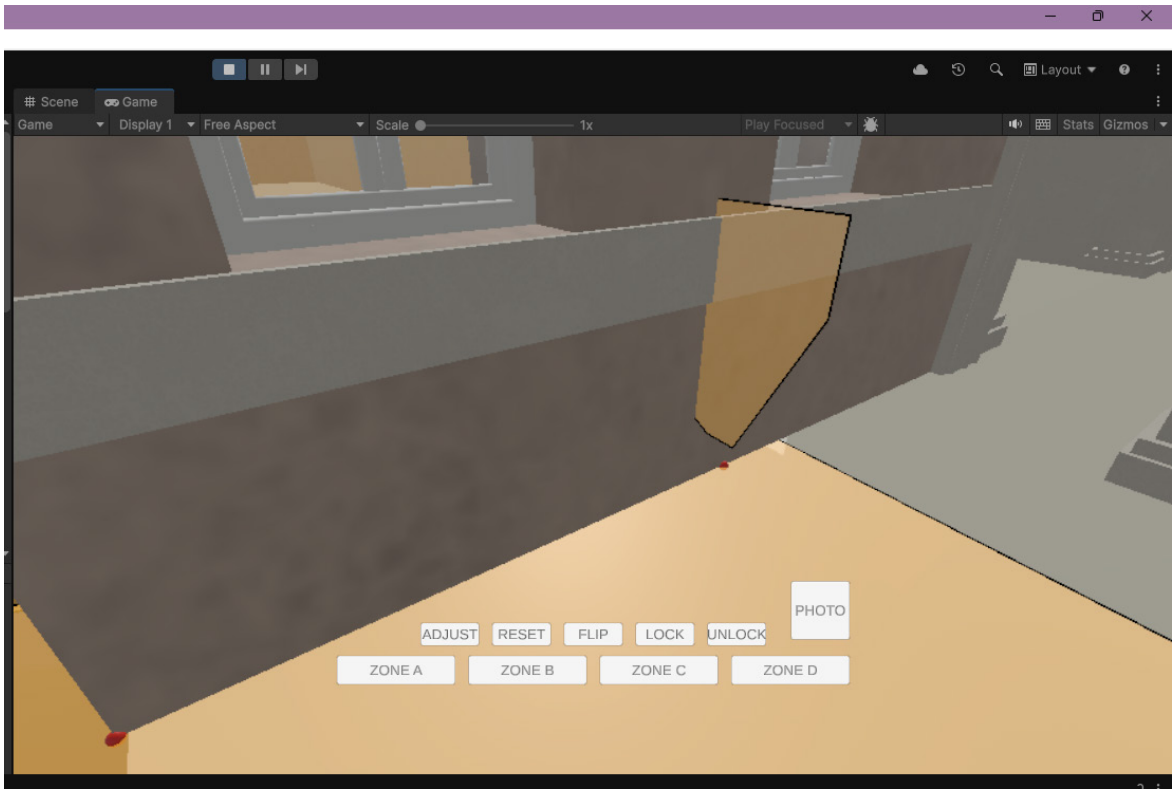
The controls were tested in the same order in which they would be used on the mobile device (Figure 6.7). The initial screen displayed only the volume-selection buttons. After a volume was selected, P1 and P2 were placed and the model appeared in its initial position. The Adjust panel was then opened to test the movement, rotation, and scale commands, followed by the Lock and Unlock functions. Script errors, missing object references, and unexpected responses were identified through the Inspector and Console before device testing began.



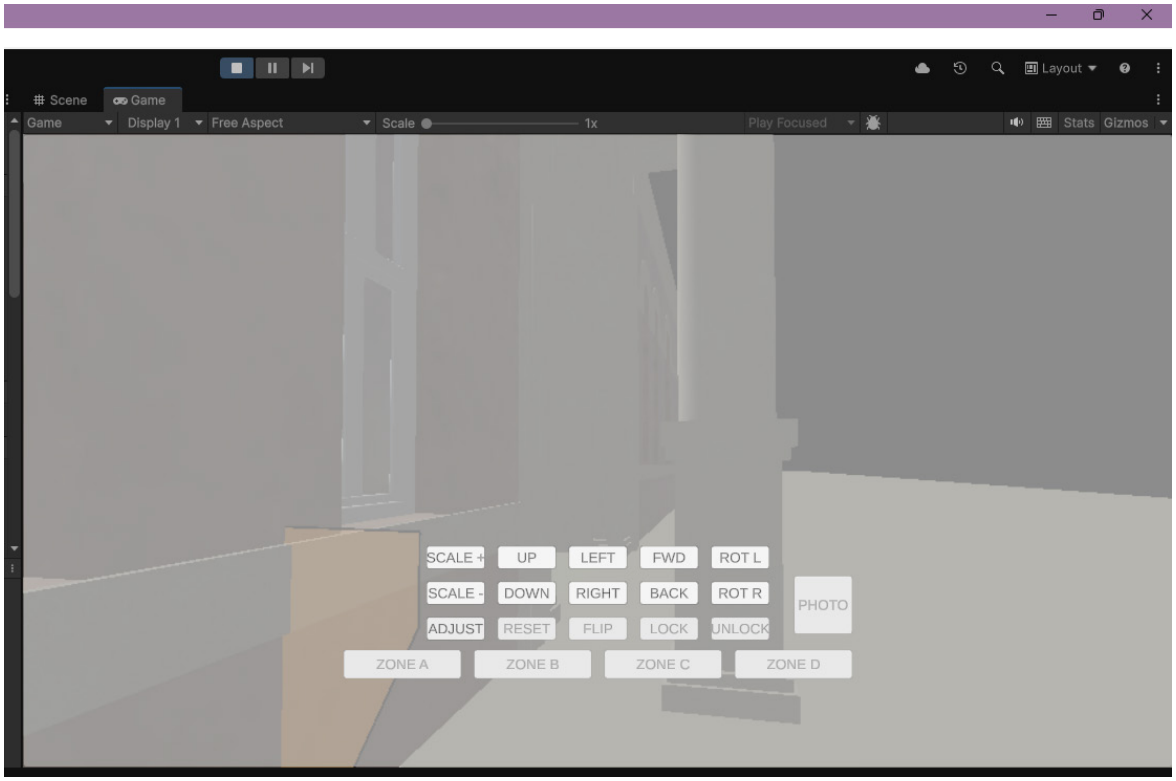
(a) Initial volume selection. The first interface displayed the buttons for Volumes A–D before the placement controls were activated.



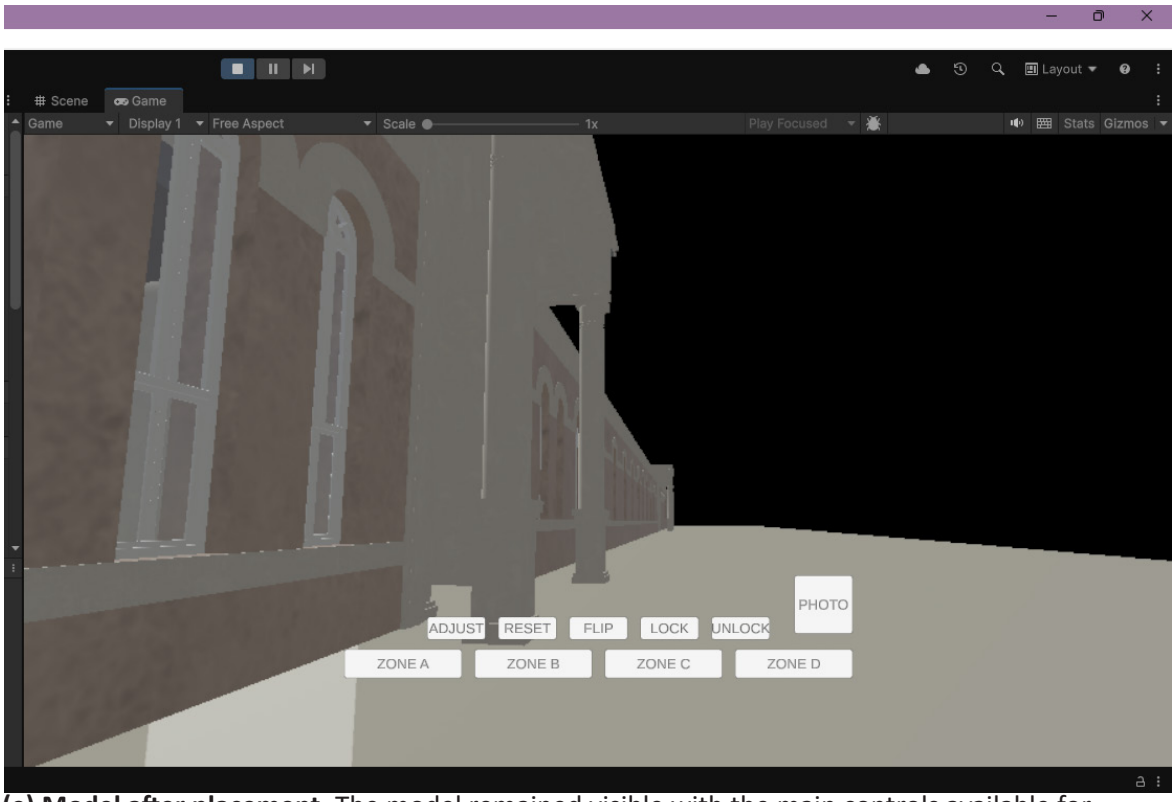
(b) Placement of P1. After a volume was selected, the main controls appeared and the first reference point was placed.



(c) Placement of P2 and initial alignment. The second reference point established the required direction and brought the selected model into its preliminary position.



(d) Detailed adjustment. The Adjust panel provided the movement, rotation, and scale controls used for finer corrections.



(e) Model after placement. The model remained visible with the main controls available for locking, unlocking, or further adjustment.

Figure 6.7
PC-based interaction sequence tested in Unity Play Mode.
Source: Screenshots taken by the author during Unity Play Mode testing, 2026.

The PC-based testing could not reproduce all AR functions. Device tracking, the live camera view, horizontal plane detection, and the placement of P1 and P2 in the physical environment depended on the camera and sensors of a mobile device. The spatial relationship between the digital volumes and the site could only be assessed on site using the device.

The project was then configured for Android. The application Scene was added to the build settings, the required AR provider was enabled, and the camera permissions were set. An APK file was created and installed on the mobile device. This build was used to run the full sequence of surface detection, reference-point placement, initial alignment, adjustment, locking, unlocking, and image capture.

The application was developed as an adjustable prototype rather than a system that placed the models automatically at fixed locations. The configuration presented above reflects the changes made during several mobile and on-site tests. The next section describes this process and the resulting revisions in response to the conditions encountered at the Tophane site.

6.3 On-Site Placement and Testing

After the Android build was prepared, the prototype was tested during five visits to Tophane. The earlier Play Mode tests had checked the interface and scripts on the computer. On site, the live camera view showed the digital volumes together with the existing environment. Their position at ground level, direction, scale, and relationship with nearby buildings could then be examined. After each visit, the application was revised to address the problems observed on site.

The models were imported into Unity at full scale. However, the application was developed as a basic prototype and did not include a georeferenced positioning system. Adding such a system would have required further technical infrastructure to connect the Unity scene with geographical coordinates and location-tracking data, which was beyond the scope of this study. Reference locations were instead identified from the maps and spatial analyses presented in the earlier chapters, and their corresponding positions were selected visually on site. The placement method was informed by map analysis and visible site features rather than exact measured coordinates.

Because of their size, the buildings could not be seen completely from the points where P1 and P2 were placed. The device had to be moved farther away to obtain a wider view. As the distance from the calibration point increased, small tracking errors became more noticeable, and the model could appear to shift in relation to the site. The wider view also changed the apparent proportions of the model, making its displayed scale difficult to judge from a single viewpoint. Historical photographs and surviving architectural elements provided a basis for checking its proportions and direction. When needed, the model's Transform scale in Unity was adjusted to improve its visual relationship with the surrounding buildings. This adjustment changed only the displayed scale in Unity and did not alter the full-scale geometry developed in Revit. The resulting AR views were visually calibrated and should not be considered metric records.

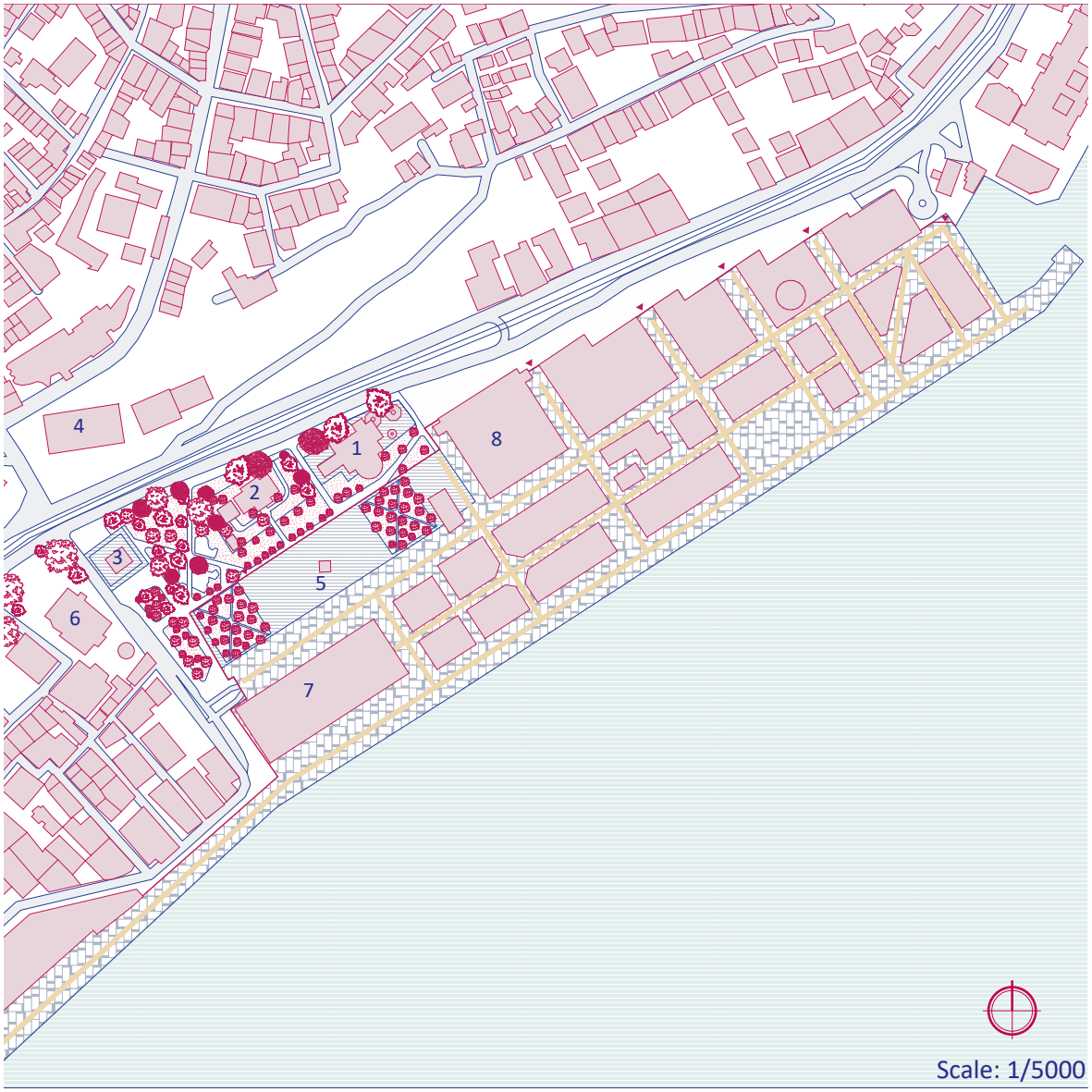
The first version tested on site allowed P1 and P2 to be placed on either vertical or horizontal surfaces. At that stage, the interface included only the Reset, Lock, and Flip controls. In practice, the mobile device did not detect building façades consistently, whereas the ground was recognised more successfully. P1 and P2 were consequently moved to the same horizontal plane in the next version. While the points were being selected, the detected ground appeared as a semi-transparent orange surface.

P1 and P2 established the basic position and direction of a volume. For buildings of this size, however, a small difference between the visually selected points could create a noticeable change across the complete model. The Adjust panel was added to allow corrections to position, rotation, and displayed scale without restarting the calibration. Once a model had been locked, it was checked from other viewpoints around the site. These checks often showed that further corrections were needed. The Unlock control was added so that the model could be adjusted again without replacing P1 and P2. Lock and Unlock could be used several times while the placement was examined from different positions.

The final version also included a Photo button. When selected, it temporarily hid the calibration markers and interface controls. The digital model and live camera view could then be recorded without the adjustment tools covering the image. The complete field sequence now began with ground detection and volume selection, followed by the placement of P1 and P2, initial positioning, detailed adjustment, locking or unlocking when needed, and image capture.

The daylight tests revealed another problem in the Unity lighting settings. Some model surfaces appeared excessively bright in the camera view. Since this problem came from the application rather than the physical conditions of the site, the lighting settings were revised between visits to improve the visibility of the models.

Conditions within the present-day site also affected the testing process. Roads, pedestrian areas, planting, trees, parked vehicles, and urban furniture now occupy parts of the former building locations. In the camera view, these elements sometimes overlapped with the digital façades or blocked the architectural landmarks used for comparison. The effect differed for each volume, and several viewing positions were usually tested before the final images were recorded.



1- Nusretiye Mosque
2- Tophane Pavilion
3- Tophane Fountain
4- Tophane-i Âmire Culture and Art Centre
5- Tophane Clock Tower
6- Kılıç Ali Pasa Mosque
7- Istanbul Modern
8- Istanbul Museum of Painting and Sculpture (MSGSÜ)

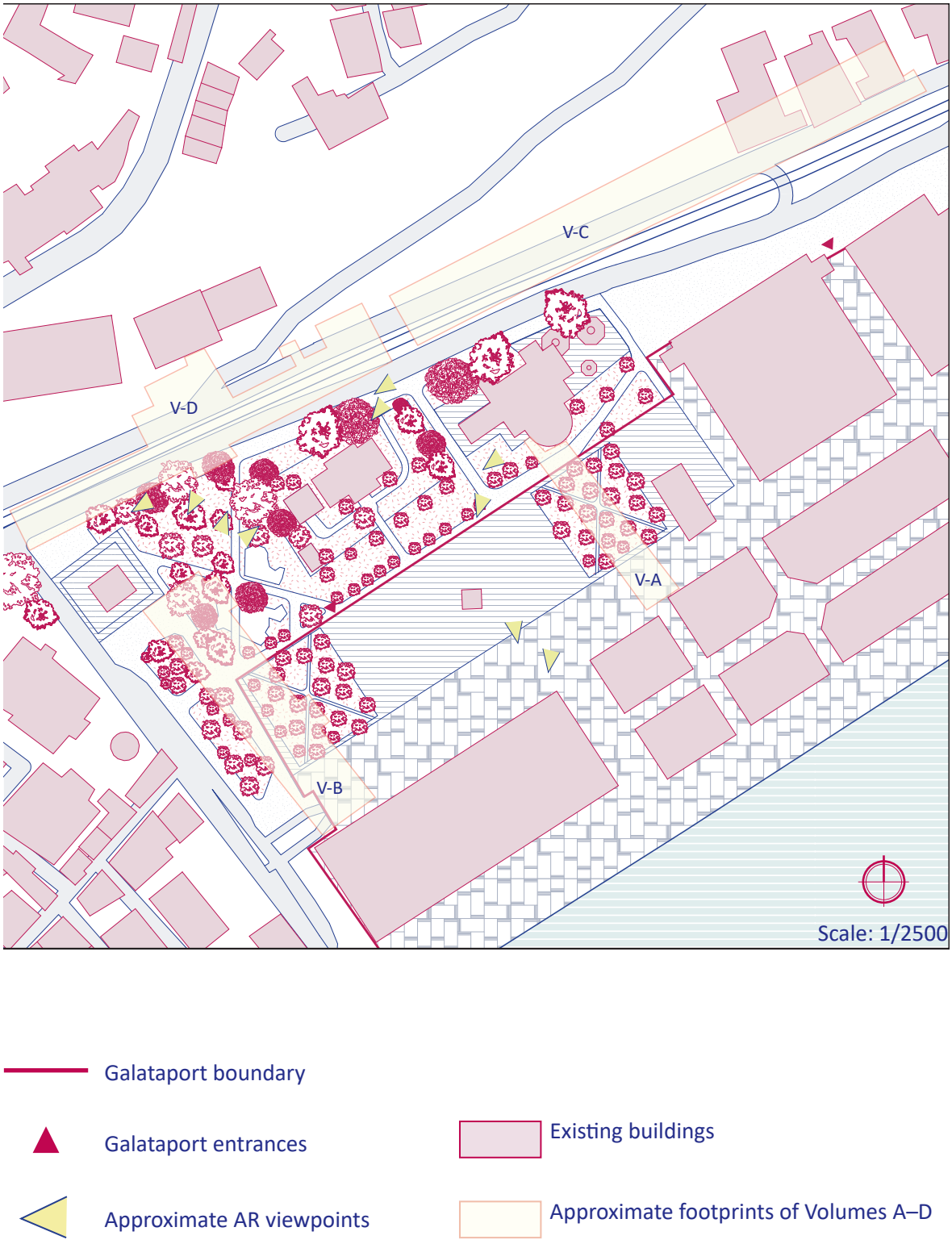
Galataport boundary

Galataport entrances

Pedestrian routes

Figure 6.8
Present-day context of the Tophane study area, showing key buildings, the Galataport boundary and entrances, and pedestrian routes.
Source: Map prepared and annotated by the author, 2026. Base map: © OpenStreetMap contributors.

Figure 6.9
Site plan of the Tophane test area, showing Volumes A–D and approximate AR viewpoints in relation to the existing buildings and open spaces.
Source: Map prepared and annotated by the author, 2026. Base map: © OpenStreetMap contributors.



6.3.1 Placement and Testing of Volume A

The map comparison indicated that Volume A began immediately beside the side wall of the Nusretiye Mosque. There was no space between the two structures. The line where the volume met the mosque wall provided the main reference for its initial position and direction.

For the first placement, P1 and P2 were positioned directly beside the mosque, where Volume A began. Rotation and forward–backward controls were used to align the model with the side wall. Its base was then moved vertically to meet the present ground level. This close position made the connection with the mosque easier to check. However, the viewing angle was narrow, and the complete volume could not be seen together with its wider surroundings. Trees around the mosque restricted the view further.

A second placement was made from a more distant viewpoint, where the complete building could be seen together with the surrounding structures. The required viewpoint was inside Galataport. A fence separated this area from the mosque side, and the entrance was located at the opposite end. It was not possible to reach the reference beside the mosque directly from this position. P1 and P2 were instead placed from a greater distance, while the visible relationship between Volume A and the mosque guided the alignment.

From this position, Volume A, the Nusretiye Mosque, and the Tophane Clock Tower could be viewed together. The viewpoint was chosen to approximate the direction of a historical photograph. The relative proportions of the three structures also helped check the displayed scale of the model. This comparison remained visual rather than metric.

Figure 6.10

Wider AR views of Volume A from Galataport, showing its relationship with Nusretiye Mosque, Tophane Clock Tower, and the surrounding site.

Source: Screenshots captured by the author during on-site AR testing, 2026.







Figure 6.11
Close-range AR views of Volume A beside the side wall of Nusretiye Mosque, showing its initial alignment and ground-level adjustment.
Source: Screenshots captured by the author during on-site AR testing, 2026

6.3.2 Placement and Testing of Volume B

The position of Volume B was identified from its relationship with the Tophane Fountain in the earlier map analysis. The prototype did not carry an exact measured coordinate for this location, so the corresponding point on the ground was selected visually. The fountain remained the main on-site reference throughout the placement.

After the model appeared, rotation and horizontal movement controls corrected its direction and position in relation to the fountain. Vertical movement brought its base to the present ground level. Since the building covered a large area, the device had to be moved farther away to see more of the volume. At this distance, changes in tracking sometimes shifted its apparent alignment and scale. When this occurred, the model was unlocked and adjusted again.

Historical photographs analysed in the previous chapter provided a wider basis for comparison. In these images, the Tophane Fountain and the Kılıç Ali Paşa Mosque were visible together with the former building represented by Volume B. Their relative proportions were compared with the AR view from the selected viewpoint. If the digital model appeared too large or too small in relation to the two surviving structures, its displayed scale was adjusted.

Trees and park furniture occupied parts of the viewing area and sometimes overlapped with the digital façade. This reduced the clarity and realism of some views. Several positions were tested before the model was aligned and the images were recorded.

Figure 6.12

Initial AR placement views of Volume B in relation to Tophane Fountain, showing the model from two positions around the fountain.

Source: Screenshots captured by the author during on-site AR testing, 2026.







Figure 6.13
Additional AR views of Volume B used to check its direction and displayed scale in relation to Tophane Fountain and Kılıç Ali Paşa Mosque.
Source: Screenshots captured by the author during on-site AR testing, 2026.

6.3.3 Placement and Testing of Volume C

The road alignment identified in the map analysis formed the main reference for Volume C. P1 and P2 were placed on the detected ground plane so that the direction between them followed this line. This established the initial position and axis of the model.

The position of Volume C in relation to the Nusretiye Mosque was then used as a second visual check. The mosque did not form a separate calibration reference. It provided an additional reference for checking whether the position and direction of the model matched the spatial relationship identified in the maps.

Volume C was placed as a single model. Movement, rotation, ground-level, and displayed scale corrections affected the complete building. After being locked, the model was examined from several positions and unlocked when further adjustment was needed. The available historical photographs were also compared with these views to check its general proportions, façade direction, and relationship with the mosque.

Trees and cars frequently crossed the selected views and obscured parts of the digital façades. They also reduced the realism of the combined camera image. Different viewpoints were tested before the final images were recorded.

Figure 6.14
Initial AR placement and adjustment views of Volume C along the road alignment beside Nusretiye Mosque.
Source: Screenshots captured by the author during on-site AR testing, 2026.









Figure 6.15
Wider AR views of Volume C showing its façade direction and the overlap of the digital model with trees, parked vehicles, and the present street.
Source: Screenshots captured by the author during on-site AR testing, 2026.

6.3.4 Placement and Testing of Volume D

During the first tests of Volume D, the calibration reference was positioned close to one end of the building. This location proved unsuitable for such a long model. Viewing the central and opposite sections required moving too far from the original reference. As the distance increased, tracking became less stable and the alignment began to shift. The perspective of the complete volume was consequently difficult to judge.

The reference was later moved closer to the centre of the model. Volume D remained a single model, but the new location reduced the distance needed to reach its different sections. Both ends of the building could then be examined while the device remained within a more stable tracking area.

Following this change, the road alignment provided the main basis for positioning P1 and P2 and setting the direction of the volume. Its relationship with the Tophane Pavilion was used as a second visual check. This helped determine whether the road-based placement corresponded with the spatial arrangement identified in the maps.

Movement, rotation, ground-level, and displayed scale corrections were applied to the complete model. Historical photographs provided further guidance when comparing its proportions and alignment. Volume D was locked and viewed from several positions, then unlocked when additional corrections were needed.

Trees, cars, signs, and other elements in the present-day setting often crossed the camera view. They obscured sections of the digital façade and reduced the realism of some images. Despite these difficulties, moving the reference closer to the centre made the model easier to observe and adjust.



Figure 6.16
Close-range AR views of Volume D after the calibration reference was moved towards the centre of the model, showing the ground-floor arcade from within the former building line.
Source: Screenshots captured by the author during on-site AR testing, 2026.



Figure 6.17
AR views of Volume D from several positions, showing the central section of the model and its relationship with the present pedestrian route and planted area.
Source: Screenshots captured by the author during on-site AR testing, 2026.

6.3.5 Overall Evaluation of the Placement Tests

The field tests showed that the same reference strategy could not be applied to every volume. Volumes A and B were positioned mainly in relation to surviving architectural elements. For Volumes C and D, the road alignment provided the primary reference. In the case of Volume D, moving the calibration reference closer to the centre made the different sections of the long model easier to view.

The resulting placements were visual rather than metric. Maps established the initial spatial relationships, while surviving buildings and road alignments helped check position and direction. Historical photographs provided an additional basis for comparing scale and perspective. Although mobile tracking and physical obstructions limited some views, the application made it possible to observe the digital models of the demolished buildings in relation to their present-day setting. The implications and limitations of these results are discussed in Chapter 7.

7. Discussion

The previous chapters followed the research process from the historical and spatial analysis of Tophane to the development of the digital models and their on-site visualisation through mobile AR. This chapter brings these stages together and discusses what the findings mean in relation to the research questions and the theoretical framework of the thesis. The evaluation goes beyond the technical production and display of digital models of the demolished buildings. It also considers what can be learned from working with incomplete historical evidence, how the former spatial organisation of Tophane can be interpreted, and what mobile AR makes possible when lost architecture is viewed within the present city.

The discussion begins with the development of the source-based digital models. It then examines how the models were related to the site through AR and what became visible when they were placed near the surviving monuments and current urban spaces. The following sections interpret these findings through the fragmented urban Wunderkammer, the performing museum, and the tourist gaze. Methodological and technical limitations are considered alongside each stage because they affect how the results can be understood.

7.1 From Fragmented Historical Evidence to Digital Models

The first research question asked how the lost architectural layers of Tophane could be interpreted and digitally represented through the available historical sources. Measured drawings, original architectural plans, and other detailed project documents for the selected buildings could not be located. The Pervititch insurance map established the main planimetric reference for their approximate footprints and positions. Historical photographs informed the interpretation of massing, façade rhythms, openings, and architectural details. Written sources helped identify the functions and historical development of the buildings, while surviving structures offered additional references for scale and spatial relationships. The digital models were developed by combining these different forms of evidence rather than by reproducing a complete architectural record.

Each source also had its own limitations. The Pervititch map showed the building outlines and their relationship with the surrounding urban fabric, but it did not contain measured architectural plans or detailed elevations. Historical photographs recorded the buildings from particular viewpoints. Perspective, viewing distance, obstructions, and image quality affected how their dimensions and details could be read. Written records explained their uses and transformations but did not always contain sufficient information about architectural form. Surviving monuments offered useful proportional references, although they could not resolve every missing dimension.

Comparing the sources helped clarify information that could not be obtained from any single document. The QGIS overlay connected the historical footprints with the present-day road network and surviving buildings, providing the spatial basis for the modelling process. Historical photographs and surviving reference structures were then examined within this framework to interpret vertical dimensions and façade arrangements. The architectural information obtained through these comparisons guided the development of the models.

The four volumes required different types of interpretation. For Volume A, the direct connection with the side wall of the Nusretiye Mosque provided an important reference for location and scale. Historical photographs made the rhythm and proportions of the repeated windows visible, although none showed the complete building. Volume B was examined through its relationship with the Tophane Fountain and photographs recording parts of its external and courtyard façades. The long forms of Volumes C and D presented a different problem. Strong perspective and their extended dimensions prevented the complete façades from being read in a single photograph. Repeated openings, façade groups, and horizontal alignments were compared with their footprints on the Pervititch map to develop the wider compositions.

These differences show why source-based modelling cannot follow one fixed procedure for every demolished building. The available evidence determined which architectural features could be interpreted more directly and which required wider comparison. Clearly visible façade elements provided information about form and proportion. Where evidence was missing, repeated façade rhythms and relationships between visible elements offered a basis for completing the composition. Such decisions were necessary to create continuous architectural models, but they also introduced interpretation into the process.

The resulting models should not be considered exact copies of the demolished buildings. Their value lies in organising the available evidence within coordinated architectural forms. Approximate footprints, massing, façade composition, and repeated architectural elements were brought together to convey the scale and spatial character that these buildings once created within Tophane. Interior layouts, construction systems, original materials, and details that could not be identified from the sources were not developed to the same level. These gaps kept the limits of the historical evidence visible within the research. This distinction matters because the visual completeness of a three-dimensional model can suggest a degree of historical certainty that the sources do not support.
Revit provided a structured way to translate the interpreted architectural information into editable digital models. Repeated elements were developed as families and modular components controlled by reference planes, constraints, and parameters rather than being fixed within a single façade object. More complex windows, columns, arches, and central façade elements were divided into simpler geometric parts and assembled through combinations of solid and void operations, sweeps, and nested components. This approach made the elements manageable while preserving the ability to revise their dimensions and proportions as the sources were reconsidered.

The parametric structure did not reduce the uncertainty in the historical evidence. Its contribution was to keep the resulting interpretation coordinated, testable, and open to revision. When assembled, the families and modular components formed complete volumes through which façade organisation, overall scale, and relationships between the demolished buildings could be examined together. Revit supported the incomplete and revisable nature of the research rather than concealing it behind fixed geometry. The completed models then provided the basis for on-site visualisation through mobile AR.

7.2 Reconnecting Lost Spatial Relationships through AR

The second research question considered how mobile AR could reconnect the demolished buildings with their former locations and the present urban environment. The on-site tests showed that the main value of AR lay in viewing the digital models in direct relation to the surviving monuments, streets, and open spaces. Past and present conditions could be compared from the same location. This comparison clarified how the demolished buildings had once defined the scale, boundaries, and spatial organisation of the area.

The placement process also showed that a single site-reference strategy could not be applied to every volume. Volumes A and B were positioned through their direct relationships with the Nusretiye Mosque and the Tophane Fountain. The longer forms of Volumes C and D relied more on road alignments and their relationships with nearby monuments. The application did not identify these historical relationships automatically. They were established through the earlier comparison of maps, photographs, and surviving structures and then used to guide the placement of each model. The AR stage continued the historical and spatial interpretation developed during the earlier parts of the research.

On-site AR offered a different form of spatial understanding from historical photographs and computer-based models. Historical photographs recorded the buildings from fixed viewpoints, while a model viewed on a computer remained separate from the physical scale of the site. Once the digital volumes were placed near their former locations, their approximate heights, footprints,

and distances from the surviving monuments could be examined within the present environment. The long façades of Volumes C and D extended beyond a single field of view and had to be followed through movement across the site. This gradual reading made their length and the scale of the former complex more apparent. The loss could then be examined as the disappearance of the buildings together with the boundaries, enclosed spaces, and architectural relationships that had once organised this part of Tophane.

The present city did not function as a neutral background to the digital models. The volumes appeared across roads, pedestrian routes, planted areas, fences, and open ground created by later interventions. These overlaps sometimes made the models more difficult to view, but their significance was not limited to a technical obstruction. They showed how spaces once occupied by military-industrial buildings had been reorganised around circulation, cultural and commercial uses, and waterfront development. The former building lines also helped explain why the surviving monuments are now experienced as separate objects rather than as parts of a wider architectural setting. The open character of the present site could be understood as a result of the removal of these boundaries, followed by road construction and later redevelopment. AR kept the interpreted historical layer and the contemporary city visible at the same time, allowing their spatial differences and conflicts to be examined together.

The field tests also clarified the limits of the positioning method used in the study. In the prototype, P1 established the position of the model, while the line between P1 and P2 defined its direction. Scale was adjusted separately. This local calibration allowed the volumes to be aligned visually with surviving monuments and road lines, but it did not connect them to geographical coordinates. Placement had to be carried out manually, and changes in horizontal-plane detection or tracking could affect the alignment during use.

The local positioning method used in the prototype does not represent the full range of tools available for Unity-based AR development. Through ARCore Extensions for AR Foundation and Google's Geospatial API, digital content can be placed at geographical coordinates using WGS84, Terrain, and Rooftop anchors (Google for Developers, 2026b). These features were not included because their integration and validation were beyond the technical scope of this architectural study. A later version could use geospatial anchors and the Visual Positioning System (VPS) to reduce manual calibration and provide more consistent placement across different site visits. Even with these tools, exact alignment could not be assumed. Under typical VPS conditions, the expected accuracy is approximately five metres for position and five degrees for orientation (Google for Developers, 2026a). Differences of this scale could become clearly visible along the long façades of the larger volumes.

More stable positioning would not remove the uncertainty within the historical data. The building locations used in the study were obtained by georeferencing the Pervititch map in relation to the present urban fabric and should still be considered approximate. A geospatial anchor could place a model more consistently at the selected coordinates, but it could not confirm that these coordinates represented the exact former position of the building. Technical stability and historical reliability remain separate issues: improving one would not resolve the limitations of the other.

Developing and testing a more reliable system at this scale would require collaboration between architects, software developers, and GIS or geomatics specialists. Architectural expertise is needed to interpret the sources, identify meaningful site references, and prepare the digital models. Software and geospatial expertise would be required to integrate coordinate-based anchors and evaluate their accuracy across different devices and site conditions. Within the scope of this study, the application was developed as a research prototype. It supports an on-site comparison between lost architecture and the present environment, but it does not claim to provide verified geographical placement.

7.3 From a Fragmented Urban Wunderkammer to a Performing Museum

As discussed in Chapter 3, the Ottoman identity and spatial development of Tophane were closely connected to Tophane-i Âmire. The production buildings, military structures, square, waterfront, and surrounding monuments formed a larger spatial system around the imperial foundry. Demolitions and later urban interventions weakened this organisation. Tophane-i Âmire and several monuments remain, but the relationships that once connected them are no longer easy to recognise. Understanding these buildings requires attention to the architectural setting that has disappeared as well as to what has survived.

This fragmented condition supports the interpretation of Tophane as an urban Wunderkammer. Layered cities such as Istanbul contain traces from many periods, but these traces are rarely encountered as a complete historical sequence. A surviving wall, a change in the street line, an old photograph, or the name of a place may provide one clue to an earlier urban condition. Each clue forms part of a wider spatial history and gains meaning through its relationship with the others. The digital models added one of the missing layers to this reading. They did not complete the historical image of Tophane, but they provided a way to connect selected traces that are difficult to understand when viewed separately.

The role of AR in this process extends beyond the display of demolished buildings on a mobile screen. The application was developed to direct attention towards the historical depth of the present environment. A monument that might otherwise be encountered briefly or used mainly as a photographic background could be considered in relation to the buildings that once stood beside it. Its position, scale, and role within the former square could then be examined more closely. The digital image does not replace a detailed historical account. It provides an accessible starting point for recognising the relationship between what remains visible and what has disappeared from the site. This approach distinguishes looking at a building from identifying the historical layers that its present appearance leaves unseen.

Casey's performing museum provides a useful framework for interpreting this relationship. In the performing museum, meaning is shaped through the connection between the object, its setting, the form of display, and the actions of the viewer (Casey, 2003). In Tophane, the wider urban area can be read as the display space. The surviving monuments, digital models, streets, and open spaces form parts of the same interpretive setting, while the mobile screen creates a temporary frame between the visible city and its missing architectural layers. Meaning develops as the user selects a volume, approaches its former location, changes viewpoint, and compares the model with the surrounding structures. The museum is performed through these actions rather than contained within a single building.

Using a mobile device provides a practical way to bring this interpretive experience into public space. It does not require a separate exhibition room or specialist viewing equipment, although device compatibility and digital access still need to be considered. Historical information is encountered where its spatial relationships can be compared directly with the present city. Mobile AR could extend the cultural role of Tophane-i Âmire beyond the walls of the Culture and Art Centre and reconnect it with the square, surrounding monuments, and waterfront.

The current prototype should be understood as an initial step towards this wider interpretation. It established a basic relationship between the digital models, the physical site, and the actions of the viewer. It does not constitute a complete museum experience or a final interpretive system. Its contribution lies in defining a spatial and technical basis through which the lost layers of Tophane can be explored as connected parts of the present urban environment.

7.4 Redirecting the Tourist Gaze towards Lost Urban Layers

The interpretation developed in the previous section also relates to Urry's concept of the tourist gaze.

Urry argues that the tourist gaze is not an entirely personal or spontaneous way of seeing. It is shaped by images, expectations, cultural narratives, and established ways of representing a place (Urry, 2002, pp. 1–3). Visitors are more likely to notice features that have already been presented as significant, distinctive, or worth photographing. In present-day Tophane, this attention is directed mainly towards the surviving monuments, the waterfront, and the area's cultural and commercial settings. The demolished military-industrial buildings have little physical presence and usually remain outside the immediate experience of the site.

The AR application offers a way to bring this missing layer into the visitor's field of attention. When the digital volumes are viewed beside the Nusretiye Mosque, the Tophane Fountain, or the surviving Tophane-i Âmire buildings, these monuments can be considered as parts of an earlier spatial organisation rather than only as separate historical objects. Empty ground can be read in relation to a former building footprint, while a present road or pedestrian route can be compared with an earlier building line. Attention is directed from the appearance of the individual monument towards the wider setting that once gave it spatial meaning.

Through AR, successive views of the site can be connected within the same interpretive process. Tourist images often isolate a monument within a recognisable and photographable frame. The AR experience instead links views of buildings, open spaces, roads, and missing boundaries to one another. The mobile screen can guide attention towards distances, alignments, and relationships that a single photograph may leave outside its frame. The tourist gaze could then take on a more relational form, in which the significance of a monument is considered through its position within the wider urban setting.

The use of a mobile phone works with an already familiar part of the tourist experience. Visitors commonly use their phones to navigate, photograph buildings, and obtain information about a place. The application uses the same device to introduce material that is no longer physically visible. A visitor approaching the Nusretiye Mosque, for example, could photograph the monument while also comparing it with the former buildings that once stood beside it. The scale and placement of the digital volumes can also suggest aspects of the area's former spatial atmosphere, particularly the density and enclosure that are no longer present. At its current level, the prototype cannot represent the wider sensory and social conditions of the historical setting. With further historical research, a more developed version could combine the models with archival images, short narratives, and information about former uses to offer a richer sense of how the area may once have been experienced. Rather than rejecting photography or screen-based viewing, the application uses these familiar practices to widen what can enter the visitor's attention and direct it towards the historical relationships behind the present image.

The public and accessible character of this experience also relates to Han's discussion of homo digitalis, who participates in the production, consumption, and circulation of visual information (Han, 2017). An AR encounter may continue beyond its on-site use when screenshots or photographs are shared through digital platforms. Visible use of the application in public space could also attract the attention of other visitors and create informal interest in the site. Although these forms of circulation were not examined through visitor testing, they suggest how the lost architectural layers might gain a visual presence beyond the immediate use of the application. The same visibility also carries a risk. Without clear historical context, the experience could become another visually striking image detached from the evidence behind it. The visual appeal of AR can attract initial attention, but its interpretive value depends on its connection to the sources, spatial evidence, and uncertainties behind the models.

The study did not include interviews, questionnaires, or observations of visitor behaviour. It cannot determine whether the prototype changed tourists' understanding of Tophane, influenced their patterns of looking, or extended their engagement with the site. The field tests addressed a more

limited question: whether the digital models could be placed within the present environment in a way that supported direct spatial comparison. Within this scope, the prototype provides a basis for examining how mobile AR might direct attention from isolated monuments towards the relationships, absences, and transformations around them. Further development and visitor research would be required to assess how this potential operates in practice.

8. Conclusion

This thesis examined how the lost architectural layers of Tophane could be interpreted through fragmented historical evidence and related to the present city through mobile augmented reality. The research focused on four demolished building volumes that once formed part of the military-industrial environment surrounding Tophane-i Âmire. Historical maps, photographs, written records, and surviving monuments were brought together to develop source-based digital models. These models were then placed near their former locations and tested on site. The study approached the demolished buildings as parts of a wider spatial system rather than as isolated architectural objects.

The first research question concerned the interpretation and digital representation of the lost buildings. The modelling process confirmed that none of the available sources could provide a complete architectural record on its own. The Pervititch map established the approximate footprints and spatial relationships, while photographs informed the interpretation of massing, façade rhythms, openings, and architectural details. Written sources provided information about the functions and transformations of the buildings, and the surviving monuments offered proportional and spatial references. Comparing these materials made it possible to develop coordinated architectural volumes while keeping the differences between documented, interpreted, and missing information clear.

QGIS and Revit supported different parts of this process. The georeferenced map overlay connected historical footprints with the present urban fabric and provided the spatial framework for the models. Revit allowed the interpreted information to be organised through parametric families and modular components. Dimensions, proportions, and repeated elements could be revised as the sources were reconsidered. The resulting models remain approximate because the available evidence does not support complete architectural certainty. Their contribution lies in gathering fragmented information into a consistent and editable form through which the former scale, façade organisation, and spatial relationships of the buildings can be examined.

The second research question addressed the relationship between the digital models, their former locations, and the present environment. The field tests showed that mobile AR could support a direct comparison between lost architecture and the existing city. When the models were viewed beside the Nusretiye Mosque, the Tophane Fountain, Tophane-i Âmire, and other surviving structures, the former building lines and spatial boundaries became easier to examine. The long façades of Volumes C and D also showed that the scale of the former complex could not be understood from a single viewpoint. Their length became more apparent as the models were followed through the site. The experience presented architectural loss as the disappearance of a wider spatial organisation that had connected buildings, streets, courtyards, monuments, and the waterfront.

The contemporary city remained part of this comparison. Roads, pedestrian routes, planted areas, fences, and open spaces intersected with the digital volumes. These overlaps sometimes affected visual clarity, but they also made the transformation of Tophane more legible. Areas that now appear open or are used for circulation were once defined by the military-industrial buildings. The digital models helped explain why the surviving monuments are currently experienced as separate objects and how demolition, road construction, and later redevelopment changed the former density and boundaries of the area. The value of AR came from keeping the interpreted historical layer and the present urban condition visible together rather than creating a complete scene separated from contemporary Tophane.

The findings also support the theoretical reading of Tophane as a fragmented urban Wunderkammer. The surviving monuments, lost buildings, altered street lines, historical photographs, and later developments form traces from different periods. These traces gain meaning when their relationships are examined together. Mobile AR provided a way to reconnect selected fragments within the physical

setting where they had once existed. In relation to Casey's performing museum, the urban area could be approached as an interpretive space in which the site, the digital display, and the actions of the viewer work together. The mobile screen acted as a temporary frame, while changes in position and viewpoint connected the digital volumes with the surrounding architecture.

The project also explored how familiar tourist practices could be directed towards the less visible history of the site. Mobile phones are already used for navigation, photography, and access to information. The same device can introduce architectural layers that have disappeared from the present view. This offers a possible way to shift attention from isolated and photographable monuments towards their former surroundings and spatial relationships. Digital images produced through the application could also circulate beyond the immediate experience or attract the attention of other people in the area. These effects were not evaluated through visitor research, so the study cannot claim that the application changed the tourist gaze or increased historical awareness. It established the spatial and technical conditions through which such forms of engagement could be studied in the future.

Several limitations define the scope of the results. The historical locations and dimensions were derived from incomplete sources and from a georeferenced historical map. They cannot be treated as verified measurements. The models also do not represent unknown interior layouts, construction systems, materials, or architectural details to the same level. In the AR prototype, position and direction were established locally through P1 and P2, while scale was adjusted separately. Manual calibration, horizontal-plane detection, and tracking variations could affect alignment during use. The prototype did not include coordinate-based geospatial anchors, and the field tests were carried out by the researcher rather than through a structured visitor study. The results describe the interpretive and technical potential of the method within these limits.

A more advanced version would require collaboration between architects, software developers, and GIS or geomatics specialists. Geospatial anchors and VPS could provide more consistent positioning, while more detailed surveying and geospatial analysis could improve the relationship between historical footprints and present coordinates. These improvements would increase technical stability, although they could not remove uncertainty from the historical evidence. The application could also be developed with clearer narratives, guided routes, multilingual information, and visual indications showing which parts of the models are directly documented and which are more interpretive. Extending the system to other lost buildings or historical periods could create a wider digital route through the layered development of Tophane.

Future testing should examine the application across different mobile devices, lighting conditions, site conditions, and levels of VPS coverage. Visitor studies would be needed to understand how people navigate the experience, which forms of information they use, and whether the digital models support a more attentive reading of the site. These studies could also assess accessibility, ease of use, the clarity of uncertainty indicators, and the relationship between screen-based interaction and observation of the physical environment.

The project developed in this research represents the first stage of a wider heritage interpretation system. It establishes a method that connects historical research, source-based digital modelling, spatial analysis, and on-site AR visualisation. Its main contribution is to make the absence of the demolished buildings and aspects of their former spatial atmosphere perceptible while keeping the present city and the limits of the evidence visible. In a layered city such as Istanbul, this approach can support an understanding of surviving monuments as parts of longer and more complex urban histories. Digital modelling cannot restore the lost buildings, but it can return their spatial relationships to the contemporary reading of the city.

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