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Adaptive transformations of tram depots for museums and exhibition spaces

Abstract

The article analyzes the adaptive potential of former tram depots in the context of contemporary revitalization processes in post-industrial cities. Based on the study of eight cases – covering both compact 19th-century complexes and dispersed campus-like layouts – the authors assessed the suitability of these facilities for museum and exhibition functions. The research enabled the identification of characteristic adaptation strategies and types of architectural transformations, as well as the determination of their consequences for heritage preservation and the implementation of sustainable design principles. The results provide a practical tool supporting designers in selecting optimal solutions for adapting tram depots for cultural purposes, combining the protection of historic fabric with the requirements of contemporary museum institutions.

Key words: historic tram depots, cultural heritage, adaptive reuse, museum, exhibition gallery, sustainable development

Introduction

Since the 1950s, transport infrastructure facilities – including tram depots – have been gradually abandoned as a result of changes in public transport systems, the reduction of tram lines in favour of other modes of transport (metro and bus), or their modernisation combined with the construction of new depots in different locations. The reuse of transport infrastructure buildings is an established heritage-preservation strategy. Introducing new activities into existing building also has a positive impact on the urban context and can initiate processes of revitalisation and socio-economic activation. These effects can be further strengthened when adaptive reuse is treated as a city-wide development strategy, extending beyond a single building to encompass a network of similar facilities.

The adaptive potential of transport infrastructure buildings is closely linked to their spatial characteristics, which allow them to be transformed for a wide range of functions

– particularly those requiring large, open volumes. This potential is reinforced by their favourable locations within the urban fabric. These qualities are increasingly utilised in the adaptation of decommissioned tram depots into multifunctional centres (commercial, service-oriented, gastronomic, educational) as well as cultural institutions, including museums and exhibition galleries.

Aim and scope of the study

The research focused on analysing cases of tram depots adapted into museums – cultural institutions dedicated to collecting, studying, and preserving architectural objects of historical or artistic value – and exhibition galleries, understood as spaces intended for the temporary presentation of artworks, artist promotion, lectures, and related activities. In both categories, the analysis covered the extent of interventions in the historic fabric of the buildings and the feasibility of meeting the spatial requirements of exhibition functions. This enabled the identification of strategies and typologies of transformations, as well as model solutions for adapting tram depots for the above functions.

Completed projects and ongoing adaptive reuse schemes were also examined in relation to sustainable design objectives, such as heritage preservation, environmental protec-

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tion, resource efficiency, social activation, and the mitigation of economic and social decline.

The study encompassed eight facilities, six of which currently operate as museums and/or exhibition spaces in former tram depots (MultipleXity in Timișoara, Classic Remise in Berlin, The Museum of Engineering and Technology in Kraków, The Depot History Centre in Wrocław, Tramway – the Social Centre for Culture in Glasgow, and the Academic Culture and Local Initiatives Centre *Czasoprzeźrenie* in Wrocław). Two additional projects are under development (the Centre for Contemporary Art in Tashkent and the Dundee Museum of Transport in Dundee). The selection criterion was typological diversity within a spectrum of adaptive strategies.

Sources and materials

The primary sources for analysing the transformations of tram depots into new functions include archival materials from local municipal archives and transport institutions, as well as heritage inventory records prepared by relevant conservation authorities. These include, among others: Dundee City Archives and Dundee Museum of Transport Archives (Dundee), Arhivele Naționale ale României – Direcția Județeană Timiș (Timișoara), Landesarchiv Berlin and Berliner Verkehrsbetriebe – BVG Archiv (Berlin), the National Heritage Board of Poland (Kraków and Wrocław), the Academic Culture and Local Initiatives Centre (Wrocław), and Historic Environment Scotland. The literature review also incorporated publications by institutions specialising in industrial and transport heritage (e.g., *Industrial Archaeology Review*, *The Journal of Transport History*).

An important source of information was the websites of the architectural studios responsible for the adaptive reuse projects, including Andrew Black Design (Dundee), DFZ Architekten (Berlin), Gołębek Daleczko Architekci (Wrocław – *Czasoprzeźrenie*) and Studio KO (2026), the authors of the concept for the Centre for Contemporary Art Tashkent.

Supplementary materials included professional portals and project databases such as ArchDaily and Dezeen, which publish both project documentation and – after completion – photographic studies enabling the analysis of spatial, material, and functional solutions.

State of research

The adaptation of tram depots forms part of a broader field of research on the revitalisation of industrial heritage, where concepts of sustainable design, circular economy, and adaptive architecture play a central role. The literature emphasises that reusing existing structures reduces emissions associated with the production of new materials (Plevoets, Van Cleempoel 2019) while preserving cultural and identity-forming values (Bullen, Love 2011). Tram depots, due to their scale, flexible interior spaces, and robust construction, are particularly suitable for transformation into cultural institutions.

Contemporary approaches to adaptive reuse highlight the importance of functional flexibility (Schmidt III et al. 2010), which enables long-term programmatic adaptability,

as well as social integration, which strengthens the durability of revitalisation projects (Evans 2005). For cultural institutions, the concept of *creative reuse* is also significant, as it combines heritage preservation with innovative forms of art and education (Douglas 2006).

The adaptive transformation of historic tram depots into museums and exhibition spaces remains a relatively under-researched topic. Existing studies focus primarily on the history of urban transport, the evolution of tram infrastructure, or the vehicles themselves. Comparatively few analyses address the transformed spaces of former depots or the potential of unadapted depots for museum functions. The available materials include local studies, historical monographs, and isolated academic articles describing the specific heritage of individual cities.

For the Dundee Museum of Transport (Scotland), the main sources are historical studies on the development of public transport (Burt 2014; Waller 2019). A similar focus is found in publications on Tashkent (Kupaysinov 2022; Akimov, Banister 2011), which discuss the evolution of tram and bus networks, providing context for later adaptive reuse efforts. More extensive historical material exists for the depot in Timișoara, now MultipleXity (Directuinea 1929; Întreprinderea 1969), and for the Tramway Social Centre for Culture in Glasgow (Mitchell 2022). In the context of Berlin, studies describe the development of the tram network and the operations of the municipal transport company, offering insight into the functional evolution of transport facilities (Bennewitz, Demps and Winkler 2002; Die Berliner Verkehrs 2019). Information on Wrocław is largely historical (Sielicki 2010; Kołodziejczyk 2016; Głowacki 2017), covering both the development of the tram network and the contemporary transformation of depots into cultural and tourist facilities, including the adaptation of the Dąbie depot into the *Czasoprzeźrenie* cultural centre. Wdowiarz-Bilska (2022) analysed the revitalisation of the depot on Św. Wawrzyńca Street in Kraków, highlighting its role in shaping public space and its significance for local identity.

The literature review reveals a lack of comparative and systematising studies. Existing research focuses mainly on transport history or individual revitalisation processes, without attempting to classify transformation types or assess their relevance to sustainable design. Consequently, there is a clear research gap concerning a comprehensive analysis of adaptive strategies for transforming tram depots into museums and exhibition galleries.

Methods

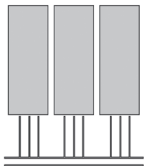
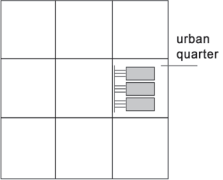

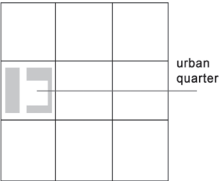
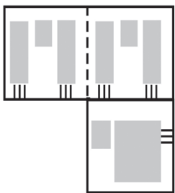
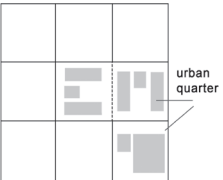

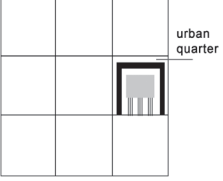

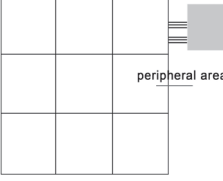
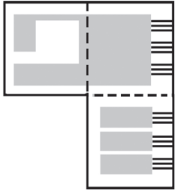
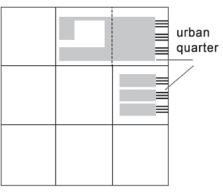




The study was conducted in two stages. The first stage consisted of a comprehensive literature review aimed at gathering relevant data, theoretical frameworks, and best practices – beginning with publications on strategies for preserving broadly defined post-industrial heritage (Pieczka, Wórzeczka 2021) and concluding with works directly addressing historic tram depots in the context of their adaptive reuse (Wdowiarz-Bilska 2022).

The second stage involved analysing all source materials collected for the examined facilities. Based on these materials, case studies were carried out for eight former

tram depots adapted into museums or exhibition galleries. The selection was guided by the diversity of operational profiles, the variety of adopted adaptive methods, the originality of solutions, and the availability of documentation enabling in-depth analysis.

Adaptive strategies for historic post-industrial buildings and the typological diversity of former tram depot complexes – along with their relationships to the urban fabric – were used as reference points (Table 1). The collected material underwent both qualitative and quantitative analysis,

Table 1. Spatial typologies of tram depot layouts in urban structure (elaborated by B. Wowrzeczka, A. Czajczyńska-Mieszala)
Tabela 1. Typy układów przestrzennych zajezdni tramwajowych w urbanistyce miasta (oprac. B. Wowrzeczka, A. Czajczyńska-Mieszala)

| Urban layout type | Plot level scheme | Urban scale scheme | Examples |
|---|---|---|--|
| Linear (row) layout |  |  | <ul style="list-style-type: none"> – Dundee Museum of Transport (Dundee, Scotland); – Tramway (Glasgow, Scotland) |
| Courtyard layout |  |  | <ul style="list-style-type: none"> – Centre for Contemporary Art (Tashkent, Uzbekistan) |
| Campus layout |  |  | <ul style="list-style-type: none"> – MultipleXity (Timișoara, Romania) |
| Block integrated layout |  |  | <ul style="list-style-type: none"> – Classic Remise (Berlin, Germany) |
| Peripheral layout |  |  | <ul style="list-style-type: none"> – The Depot History Centre (Wrocław, Poland) – <i>Czasoprzestrzeń</i> (Wrocław, Poland) |
| Hybrid layout |  |  | <ul style="list-style-type: none"> – The Museum of Engineering and Technology (Kraków, Poland) |
| <p>LEGEND:</p> <ul style="list-style-type: none">  tram depot  existing buildings of the quarter  urban grid  tram tracks | | | |

resulting in a classification of individual cases, a discussion of the advantages and limitations of such facilities, their technical requirements, the factors determining the success of adaptive reuse, and an assessment of their significance in the context of sustainable design and the revitalisation of post-industrial areas.

Case studies

Eight former tram depots adapted into museums or exhibition galleries were selected for analysis. The sampling was purposive and based on four criteria:

1. Functional diversity – the selected facilities represent different models of adaptation (technical museums, city museums, art galleries, cultural centres), allowing the study to capture a broad spectrum of possible transformations (case descriptions).

2. Originality and representativeness of solutions – the facilities were chosen to reflect different conservation traditions, management models, and urban contexts (Table 1).

3. Diversity of adaptive methods – the sample includes both conservative interventions and projects involving a high degree of transformation, enabling a comparison of design strategies.

4. Availability of source materials – only depots with sufficient archival, design, and descriptive documentation were included, ensuring the reliability of the analysis.

This selection made it possible to identify patterns, differences, and relationships relevant to future adaptive reuse processes for transport infrastructure buildings.

Linear layout

The linear layout is represented by two examples: the Tramway Social Centre for Culture in Glasgow (Fig. 1) and the Dundee Museum of Transport in Dundee (Fig. 2), both located in Scotland.

The former Tramway depot in Glasgow, built in the late 19th century as a linear, row-type arrangement of storage halls (Browning 1965), is one of the most successful examples of transport infrastructure adapted into a cultural institution in Europe. After its closure in the 1960s, the building served as a storage facility for some time; however, its large scale, rhythmic structural grid, and raw spatial character created ideal conditions for transformation into a contemporary arts centre (Jenkins, Price 2022).

The adaptation introduced theatre black boxes, rehearsal rooms, performance spaces, and flexible exhibition halls. The original hall layout was preserved, with steel trusses, brick walls, and traces of former track infrastructure left exposed. The industrial aesthetic became a deliberate narrative element – a backdrop for artistic activities that benefit from the neutrality and scale of the space. The interiors were designed to allow rapid reconfiguration, supporting experimental art forms.

Over time, the Tramway complex was expanded with a new function – the Scottish Ballet Centre, located adjacent to the former depot halls. The project completed the linear building layout, creating a cohesive ensemble that links historical spaces with contemporary architecture. The new building houses rehearsal rooms, dance studios, technical facilities, and educational spaces, while its transparent, lightweight form contrasts with the solid, industrial structure of the former depot.

Tramway has become one of the most important centres for contemporary art in Scotland, known for producing performances, hosting artist residencies, and collaborating with local communities. The facility functions as a hybrid institution – combining a theatre, gallery, educational centre, and venue for performative events.

The second example is the Maryfield depot – the Dundee Museum of Transport in Dundee. It is characterised by a row-type arrangement of halls and tracks, typical of depots located on narrow, elongated plots. The facility is cur-

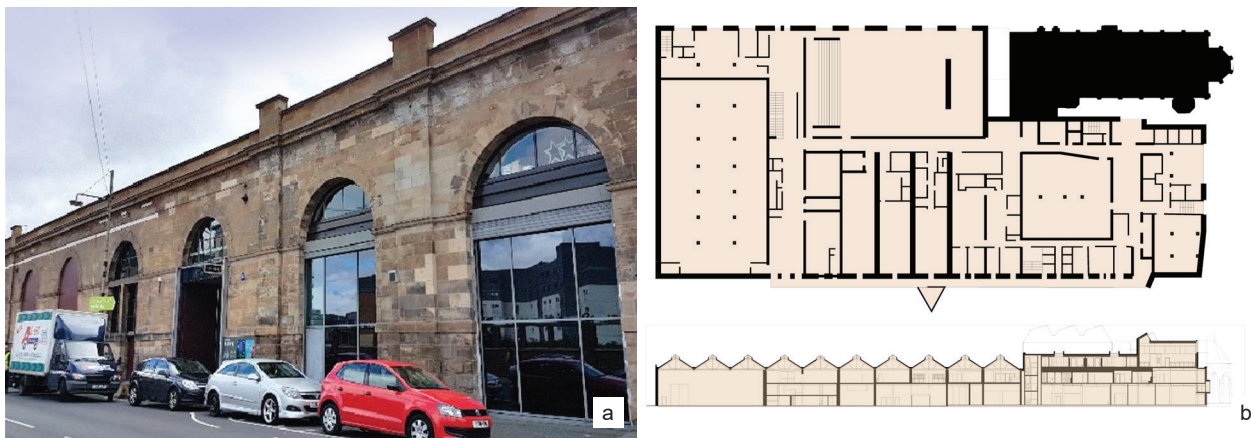


Fig. 1. Linear (row) depot layout adapted into the Tramway Social Centre for Culture, Glasgow:

a) north façade from Albert Drive (photo by Stinglehammer, 2017,

source: https://en.wikipedia.org/wiki/Tramway_%28arts_centre%29#, accessed: 15.03.2026),

b) plan and longitudinal section of the building (after Glasgow Life elaborated A. Czajczyńska-Mieszala)

Il. 1. Zajezdnia o układzie liniowym (szeregowym) adaptowana na Społeczne Centrum Kultury Tramway w Glasgow: a) elewacja północna od strony ul. Albert Drive (fot. Stinglehammer, 2017, źródło: https://en.wikipedia.org/wiki/Tramway_%28arts_centre%29#, dostęp: 15.03.2026), b) rzut oraz przekrój podłużny budynku (oprac. A. Czajczyńska-Mieszala na podstawie Glasgow Life)



Fig. 2. Linear (row) depot layout adapted into a transport museum – Dundee Museum of Transport: a) visualisation of the front façade from Forfar Road (proj. Andrew Black Design, “Dundee Museum of Transport Project”, andrewblackdesign.com, accessed: February 15, 2026), b) building plan (elaborated by A. Czajczyńska-Mieszala)

II. 2. Zajeżdźnia o układzie liniowym (szeregowym) adaptowana na Dundee Museum of Transport: a) wizualizacja elewacji frontowej od strony Forfar Road, aut. Andrew Black Design, „Dundee Museum of Transport Project”, andrewblackdesign.com, dostęp: 15.02.2026), b) rzut budynku (oprac. A. Czajczyńska-Mieszala)

rently undergoing an advanced adaptation aimed at creating a transport museum with a strong educational and community-oriented profile. The architecture will be preserved with minimal alterations and subjected to conservation works. The collection will include historic vehicles, archival materials, oral histories, and documentation of technological change. Particular emphasis will be placed on presenting the modernisation processes that shaped the city’s development and on illustrating the role of public transport in the social and economic transformations of Dundee. The adaptation of the depot is intended to contribute to the social and economic revitalisation of the surrounding area, strengthening local identity and creating a new cultural public space.

The adaptation of linear-layout facilities supports the organisation of exhibitions as a narrative sequence guiding visitors through successive thematic sections. In the case of Dundee, the linear layout enabled the creation of a clear visitor route and facilitated the integration of museum functions with workshop and educational spaces.

The main characteristics of this layout type include the dominance of an axial hall arrangement, which translates into the linear movement of visitors. Its advantages include clarity and intuitive narrative flow, while its limitations involve restricted possibilities for lateral expansion.

Courtyard layout

The courtyard layout is based on a central internal space that plays an integrative role, with halls and auxiliary buildings arranged around it. It is represented by the depot in Tashkent (Fig. 3), whose historic layout has been transformed into a multifunctional complex with a courtyard

servicing as a public space, event venue, and zone of social interaction.

The historic depot from 1912 is currently being transformed (according to a design by Studio KO, 2026) into the Centre for Contemporary Art (CCA), combining exhibition, research, and educational functions. The CCA is intended to serve as a platform supporting the development of local artists, curators, and researchers, offering workshops, seminars, and creative workspaces.

The adaptation strategy involves using the building’s authentic architectural structure as a carrier of memory of Tashkent’s industrialisation in the 20th century, while adding new built elements that complement the form. The core of the CCA will be the exhibition hall, characterised by its considerable height, open structure, and flexible arrangement enabled by modular display systems, as well as the preservation of a raw post-industrial aesthetic that forms an integral part of the artistic narrative.

The defining feature of the courtyard layout is its central square, which functions as a social space – often highly flexible and suitable for outdoor events. This layout also generates strong integration between buildings, facilitating circulation and multiple spatial connections.

Campus layout

The campus layout consists of several buildings distributed across a larger site, often with diverse functions and origins. In MultipleXity in Timișoara (Fig. 4), former tram halls and workshops built in 1927 have been transformed into a dispersed complex combining the Corneliu Mikloși Museum, technology laboratories, workshop spaces, and exhibition halls. Since 2020, they have formed a centre for



Fig. 3. Courtyard-layout depot adapted into a contemporary art centre – Centre for Contemporary Art, Tashkent:
 a) model of the complex viewed from the courtyard (photo: O'zbekiston Respublikasi Madaniyat va San'atni Rivojlantirish Jamg'armasi, source: <https://pr.uz/uzbekistan-vystavka-design-miami-basel/>, accessed: March 20, 2026),
 b) building plan (elaborated by A. Czajczyńska-Mieszala)

II. 3. Zajezdnia o układzie dziedzińcowym adaptowana na centrum sztuki współczesnej – Centre for Contemporary Art w Taszkencie:
 a) makietka kompleksu z widokiem od strony dziedzińca (fot. Fundacja Rozwoju Kultury i Sztuki Republiki Uzbekistanu, źródło: <https://pr.uz/uzbekistan-vystavka-design-miami-basel/>, dostęp 20 marca 2026), b) rzut budynku (oprac. A. Czajczyńska-Mieszala)



Fig. 4. Former tram halls and workshops transformed into the MultipleXity campus in Timișoara
 – a centre for art, technology, and experimentation:

a) competition-project visualisation of the front façade from Bulevardul Take Ionescu (design by Parasite Studio, source: parasitestudio.com, accessed: March 15, 2026),
 b) campus building plans (elaborated by A. Czajczyńska-Mieszala)

II. 4. Dawne hale tramwajowe i warsztaty przekształcone w kampus MultipleXity w Timișoarze – centrum sztuki, technologii i eksperymentu:
 a) wizualizacja z projektu konkursowego elewacji frontowej od strony ul. Bulevardul Take Ionescu (proj. Parasite Studio, źródło: parasitestudio.com, dostęp: 15.03.2026),
 b) rzuty budynków kampusu (oprac. A. Czajczyńska-Mieszala)



Fig. 5. Tram depot on Wiebestraße in Berlin, embedded within a city block and transformed into the multifunctional automotive centre Classic Remise:
 a) front façade from the interior of the block, Wiebestraße (photo by A. Czajczyńska-Mieszala),
 b) building plan (elaborated by A. Czajczyńska-Mieszala)

Il. 5. Zajezdnia tramwajowa przy Wiebestraße w Berlinie wtopiona w kwartał zabudowy miejskiej, przekształcona na wielofunkcyjne centrum motoryzacyjne z dominującą funkcją ekspozycyjną Classic Remise:

a) elewacja frontowa od strony wnętrza kwartału przy ul. Wiebestraße (fot. A. Czajczyńska-Mieszala),
 b) rzut budynku (oprac. A. Czajczyńska-Mieszala)

art, technology, and experimentation, with a strong emphasis on innovation and cross-sector collaboration.

The adaptation strategy is based on dividing the site into several complementary zones that together create a complex institutional ecosystem. The most important areas are the exhibition spaces designed for multimedia installations, generative and interactive art, and VR/AR projects. The post-industrial halls retain their raw character, and their considerable height and open layout allow for projects with high technical requirements. In addition, the complex includes studios for artists and designers, prototyping and experimentation spaces, as well as educational and research zones. Between the buildings, a vibrant public space has been created, with courtyards and plazas used for outdoor events, as well as gastronomic, coworking, and recreational spaces. A defining feature of this layout is its multi-building structure, which offers significant potential for future development. New architectural elements have been integrated into the preserved historic structures (Ordinul Arhitectilor din România 2020).

Block-integrated layout

Facilities of this type form an integral part of the compact urban fabric, embedded within a city block, often using a gate-type access system. Adaptation in such contexts requires particular conservation sensitivity and careful integration of new functions with the existing built environment. An example of this layout is the former tram depot on Wiebestraße in Berlin – now Classic Remise (Fig. 5).

The building, erected at the beginning of the 20th century (Classic Remise Berlin 2026), has been transformed into a multifunctional automotive centre combining exhi-

bition, service, retail, and event functions (Denkmaldatenbank 2026). It is an interesting example of historic transport infrastructure repurposed into a contemporary service-oriented space while retaining its industrial character and architectural value.

The exhibition area, which showcases classic cars from private collectors, preserves the open character of the halls, with their considerable height and exposed steel structure. The display is organised using modular glazed frames from which vehicles can be driven out at any time. This solution merges functional and museological roles, creating a unique model for presenting automotive heritage. The former depot also houses restaurants, cafés, conference rooms, and event spaces (Classic Remise Berlin 2026).

A key characteristic of this layout type is its direct relationship with the street, which often results in a strong emphasis on architectural quality.

Peripheral layout

The peripheral layout refers to facilities located outside the compact urban fabric. It is represented by two examples from Wrocław: the Depot History Centre (Fig. 6) and the Academic Culture and Local Initiatives Centre *Czasoprze-strzeń* (former Dąbie depot) (Fig. 7).

The Depot History Centre – the former tram depot in Grabiszyńska Street, built in 1893 as one of the first in the city – served as a technical base for public transport for over a century. It was here, in August 1980, that the first “Solidarity” strike committee in Lower Silesia was formed. The adaptation of the depot into a cultural institution therefore had a dual purpose: preserving transport heritage and commemorating key social events.



Fig. 6. Former tram depot in Grabiszyńska Street in Wrocław, located outside the compact urban fabric and adapted into the Depot History Centre: a) front façade from Grabiszyńska Street, b) building plan, c) exhibition area inside the museum, d) entrance and gastronomic zone (photos and elaborated by A. Czajczyńska-Mieszala)

II. 6. Dawna zajezdnia tramwajowa przy ul. Grabiszyńskiej we Wrocławiu zlokalizowana poza ścisłą zabudową miejską, adaptowana na Centrum Historii Zajezdnia: a) widok elewacji frontowej od strony ul. Grabiszyńskiej, b) rzut budynku, c) część ekspozycyjna we wnętrzu muzeum, d) strefa wejściowa i gastronomiczna (fot. i oprac. A. Czajczyńska-Mieszala)

The transformation process included comprehensive structural modernisation, restoration of the brick façade, and complete replacement of installations. The characteristic hall-type structure was preserved, with its height and openness used to create a contemporary exhibition space. The interior was fully adapted to its new function and divided into narrative zones combining multimedia, archival materials, and scenographic elements.

Additional functions were introduced, including educational rooms, a conference space, a reading room, and a café, enabling broader community use. The peripheral location made it possible to create a public space around the depot – a recreational, event-oriented plaza.

The second example is the Dąbie depot in Wrocław, which underwent conservation work and was transformed

into the Academic Culture and Local Initiatives Centre *Czasoprzestrzeń*. The complex, built in 1913, consists of several halls and auxiliary buildings that have been adapted into functionally diverse spaces, such as concert and event halls, as well as exhibition and market areas. The courtyard is also used for outdoor events.

A defining feature of this layout is the greater availability and expansiveness of the site, offering higher recreational and landscape potential and typically facing lower conservation pressure.

Hybrid layout

The hybrid layout combines features of several types, usually as a result of multistage transformations or a complex



Fig. 7. Dąbie depot in Wrocław, located peripherally and transformed into the Academic Culture and Local Initiatives Centre *Czasoprzestrzeń*: a) front façade from the manoeuvring yard, b) building plan, c) interior of the main hall – event space, d) interior of the concert space of Klub Łącznik (photos and elaborated by A. Czajczyńska-Mieszkała)

II. 7. Zajezdnia Dąbie we Wrocławiu zlokalizowana peryferyjnie, przekształcona w Centrum Kultury Akademickiej i Inicjatyw Lokalnych *Czasoprzestrzeń*:

- a) elewacja frontowa od strony placu manewrowego, b) rzut budynku, c) wnętrze hali głównej – przestrzeni eventowej, d) wnętrze przestrzeni koncertowej Klubu Łącznik (fot. i oprac. A. Czajczyńska-Mieszkała)

historical structure. An example of such a complex, hybrid arrangement is the depot complex located within the dense urban fabric on Św. Wawrzyńca Street in Kraków (Fig. 8).

This depot was built at the end of the 19th century as one of the oldest in Poland (Dyba 2014). After its closure and subsequent modernization, it was divided into two separate yet functionally complementary parts: the Old Depot, serving gastronomic and event functions, and the Museum of Engineering and Technology (MET), which continues the tradition of documenting the history of urban transport and technology. The ensemble, composed of both courtyard and linear layouts and expanded with underground exhibition halls and connecting passages – elements that integrate the entire built structure – represents an example of historically layered development embedded within the dense urban fabric. The spatial organisation of MET is based on preserving the original halls and tracks, which constitute an important component of the museum's narrative. The com-

plex includes exhibition halls with historic rolling stock, interactive zones, educational workshops, an archive and documentation centre, as well as conservation workshops where restoration work on historic vehicles is carried out.

Hybrid layouts are characterised by high adaptive potential but require an advanced design strategy that functionally and spatially integrates all components of the built structure.

Results

Based on the conducted analysis, clear patterns can be identified in the transformation of former tram depots, encompassing both characteristic spatial layout types and applied adaptive strategies. The study also makes it possible to define key technical requirements that determine the feasibility of assigning museum and exhibition functions to these facilities.

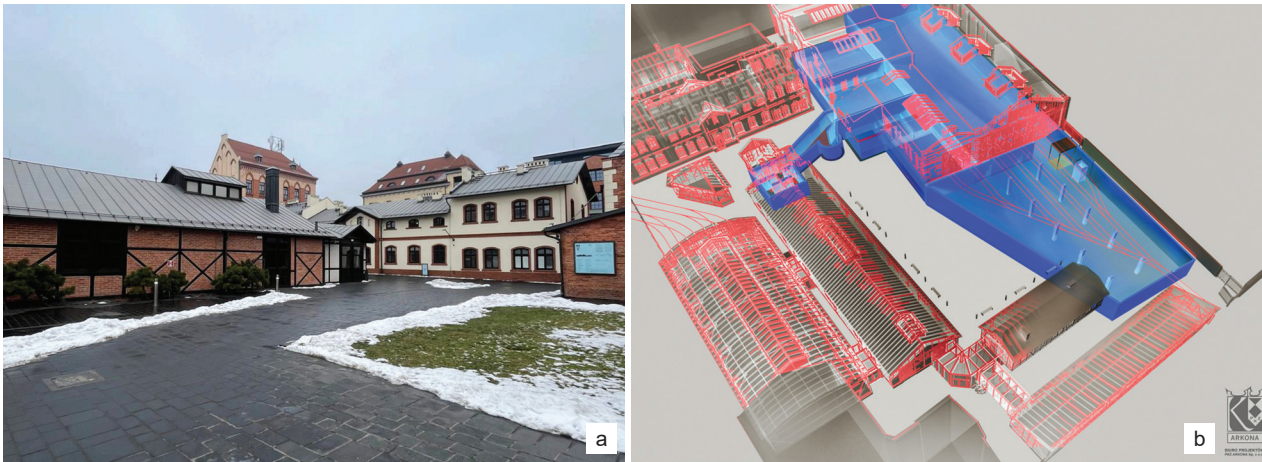


Fig. 8. Depot complex in Św. Wawrzyńca Street in Kraków, embedded in the compact urban fabric, featuring a hybrid spatial layout (courtyard + linear) after revitalisation and expansion with an underground section, transformed into the Museum of Engineering and Technology: a) side façades from within the block, b) 3D visualisation of the building complex (photos and elaborated by A. Czajczyńska-Mieszala)

Il. 8. Wpisany w zwartą tkankę miejską zespół zajezdni przy ul. Św. Wawrzyńca w Krakowie, o hybrydowym układzie przestrzennym (układ dziedzińcowy i liniowy) po rewitalizacji i powiększeniu o część podziemną, przekształcony w Muzeum Inżynierii i Techniki: a) elewacje boczne od strony wnętrza kwartału, b) wizualizacja 3D kwartału budynków (fot. i oprac. A. Czajczyńska-Mieszala)

Typology of spatial structures of former tram depots adapted for museum/exhibition purposes

The adaptation of former tram depots for museum and exhibition functions reveals a wide spectrum of spatial solutions resulting from original technical conditions, urban location, and the degree of preservation of historic fabric. A comparative analysis of eight selected cases allows the identification of six recurring models of spatial organisation, which form the basis of the typology presented in Table 2. These types

are not rigid categories – in many cases, intermediate or hybrid forms occur – but distinguishing them helps capture key relationships between spatial structure, adaptive potential, and the range of possible museum functions.

Strategies and types of transformations

Each analysed case of tram depot adaptation represents a specific type of intervention in the architectural and urban structure of the facility. The process operates on two parallel levels:

Table 2. Spatial layouts of tram depots and their characteristics (elaborated by A. Czajczyńska-Mieszala)
Tabela 2. Układy przestrzenne zajezdni i ich charakterystyka (oprac. A. Czajczyńska-Mieszala)

| Layout type | Characteristic features | Examples |
|--------------------------|--|--|
| Linear layout (row type) | Classical and most common; multi nave (2–6) halls arranged in parallel, with tracks running perpendicular to the street; manoeuvring yard in front of the halls; administrative building at the front; high adaptive potential due to large, tall hall spaces | Dundee Museum of Transport (Dundee), Tramway (Glasgow) |
| Courtyard layout | Depot enclosed within a city block; buildings form a perimeter around an internal courtyard used for manoeuvring and storage; often linked with residential or industrial buildings; high adaptive potential, especially due to the courtyard's suitability as an exhibition space | Centre for Contemporary Art (CCA), Tashkent |
| Campus layout | Ensemble of several buildings (halls, warehouses, administration) dispersed across a large site; presence of open yards, sidings, and technical spaces; very high functional flexibility and strong potential for phased adaptation | MultipleXity, Timișoara |
| Embedded block layout | Depot forming part of compact, usually 19 th century urban fabric; administrative building facing the street, halls located deeper within the block; advantage: central location; limitations: spatial and conservation constraints; medium adaptive potential | Classic Remise, Berlin |
| Peripheral layout | Depots located on the outskirts of cities, on large plots without spatial constraints; halls arranged in parallel or fan shaped; often connected with railway or technical roads; medium high adaptive potential: broad functional possibilities but lower social attractiveness | <i>Czasoprzestrzeń</i> (Wrocław); The Depot History Centre (Wrocław) |
| Hybrid layout | Complex structure resulting from multi stage development; parallel halls preceded by a fan shaped entrance; presence of a courtyard linked to a campus type layout; high adaptive potential but requiring an advanced design strategy | The Museum of Engineering and Technology (Kraków) |

1) adopting a conservation strategy appropriate to the historical and heritage value of the complex, and

2) adapting the building to contemporary functional requirements resulting from its new museum or exhibition role.

The adaptation strategy defines the overarching goal and direction of transformation: the extent of historic fabric preservation, the degree of permissible intervention, and the overall functional-spatial concept (e.g., conservation-based revitalisation, total revitalisation, adaptation with reconstruction elements).

The type of adaptation, understood in terms of building structure, classifies specific technical interventions in the fabric – such as superstructures, extensions, interior remodelling, insertion of new structures into existing halls, or changes of use without altering the external form.

For historic tram depots adapted for museum and exhibition purposes, six basic types of architectural transformations can be identified:

1. Preservation without alteration – conservation work only.

2. Preservation of the existing layout – minimal intervention, retaining the original hall structure and track layout, introducing only essential installations and auxiliary functions.

3. Insertion of new internal elements – adaptation through adding new structures (e.g., mezzanines, exhibition cubes, platforms, circulation cores) that do not alter the external form but modify spatial use.

4. Addition of a new structure interwoven with the historic one – integrating heritage fabric with a new volume, often formally contrasting but functionally linked to the depot halls.

5. Construction of a new complementary building – creating additional facilities (entrance pavilions, storage buildings, laboratories, educational rooms) adjacent to the historic structure without altering its form.

6. Mixed layout – a complex combination of the above strategies, typical for multi-stage, heterogeneous complexes with diverse functional requirements.

This typology is presented in Table 3 and serves as a tool for comparing different models of adaptation, as well as assessing their impact on the preservation of heritage values and on the programmatic possibilities of contemporary museum institutions.

Technical requirements for tram depots adapted for museum and exhibition use

The adaptation of former tram depots into museum and exhibition facilities requires a wide range of technical interventions. These requirements are listed in Table 4.

Summary

The adaptation of tram depots into museums is a global practice that enables the preservation of historic industrial architecture while showcasing large-scale collections associated with it – primarily tram rolling stock (whose unique character is thus retained) and other vehicles, such as his-

toric cars. Among adapted depot buildings, one now finds not only transport museums but also history museums (e.g., the Depot History Centre in Wrocław) and exhibition galleries, where the emphasis is placed on creating a neutral backdrop (e.g., white-cube interiors) for artworks while maintaining stable environmental parameters for delicate exhibits (Charkowska 2016).

Heritage preservation, historical identity, and interaction with the city

The adaptation of former tram depots transforms abandoned industrial sites into cultural institutions, giving new identity to historic urban areas. This process combines the preservation of transport heritage with the needs of contemporary cultural institutions. It involves revitalisation that retains the industrial character of interiors (such as multi-bay halls, steel or reinforced-concrete structural elements), tram tracks (serving both as exhibition elements and historical remnants), and façades, while introducing new functions.

Notably, contemporary projects for adapting former depots into museums increasingly move away from static displays toward immersive experiences, combining preserved artefacts with VR and AR technologies, multimedia (such as 3D mapping, binaural sound, touchscreens, AI-based systems), and simulators that allow visitors to sit in the driver's cabin of a historic tram and take a virtual journey along routes that no longer exist.

These transformations maintain the original industrial aesthetic, and in some cases include reconstructions based on historical documentation. Preserved tracks also enable the movement of exhibits, while maintaining an active connection to the city network allows for the operation of tourist tram lines directly from exhibition halls (“open museum”).

It should also be emphasised that the adaptation of former depots should be integrated into broader revitalisation programmes for neglected urban areas. Particularly effective is the strategy of creating a network of several adapted depots with mutually complementary functions.

Sustainable design in tram depot adaptations

The analysis of eight tram depot adaptations demonstrates that sustainable design constitutes a shared foundation across all projects, regardless of their scale, programme, or urban context. A key element is the preservation and reuse of the existing building fabric, which significantly reduces the project's carbon footprint. Facilities such as Dundee, MIT in Kraków, or Classic Remise in Berlin retain original structures, tracks, and architectural details, minimising the scope of new interventions. Larger-scale projects – Tramway Glasgow, MultipleXity, or CCA Tashkent – combine conservation with advanced energy-efficiency upgrades, introducing HVAC systems, insulation, and low-emission technologies.

Adaptive transformations of historic tram depots into museums and exhibition galleries make use of expansive,

Table 3. Types of transformations of tram depots for museum and exhibition functions (elaborated by B. Wowrzeczka, A. Czajczyńska-Mieszala)
 Tabela 3. Typy przekształceń zajezdni tramwajowych na funkcje muzealne i wystawiennicze (oprac. B. Wowrzeczka, A. Czajczyńska-Mieszala)

| Type of intervention | Diagram | Example | |
|--|--------------------------------|---|--------------|
| Building preserved without changes – conservation works only | | – Dundee Museum of Transport, Dundee, Scotland – <i>Czasoprzestrzeń</i> , Wrocław, Poland The Depot History Centre, Wrocław, Poland | |
| Building preserved with interior adapted to a new function | | – MultipleXity, Timișoara, Romania | |
| New elements inserted into the existing preserved structure | | – Classic Remise, Berlin, Germany | |
| New structure interwoven with the historic building | | – The Museum of Engineering and Technology, Kraków, Poland | |
| New structure as an extension of the existing building | | – Tramway, Glasgow, Scotland | |
| Mixed type / combination of three intervention types: façadism, new structure, and preserved historic building | | Centre for Contemporary Art, Tashkent, Uzbekistan | |
| LEGEND: | | | |
| | existing building | | new building |
| | building with adapted interior | | façadism |

industrial, and modular spaces, enabling creative and flexible use as well as adaptation to changing exhibitions or multifunctional arrangements. These modernisations preserve industrial heritage while creating unique venues for large-scale displays. Parallel nave structures – often characterised by open interiors, natural lighting, and reinforced

construction – are ideally suited for storing, exhibiting, and maintaining large vehicles, such as transport artefacts showcased at MET in Kraków or the Dundee Museum of Transport in Scotland.

All analysed depots exhibit high functional flexibility, enabling long-term adaptability and reduced operational

Table 4. Technical requirements for adapting tram depots for museum and exhibition purposes (elaborated by A. Czajczyńska-Mieszala)
 Tabela 4. Wymagania techniczne dla adaptacji zajezdni tramwajowych na cele muzealne i wystawiennicze (oprac. A. Czajczyńska-Mieszala)

| Technical area | Scope of requirements/actions |
|---|--|
| Load bearing capacity and floor structure | <ul style="list-style-type: none"> – analysis and potential reinforcement of the floor due to point loads generated by rolling stock – decision on how to use inspection pits (e.g., as exhibition elements) – possibility of securing pits with tempered glass |
| Track and overhead line infrastructure | <ul style="list-style-type: none"> – maintaining tracks and overhead lines to preserve the operability of selected vehicles – possibility of occasional tourist rides through connection to the city network – promotional function of the museum through the movement of historic vehicles |
| Microclimatic conditions | <ul style="list-style-type: none"> – humidity control (45–50%) and temperature control (19–22°C), especially for artworks and documents – challenges resulting from the large volume of depot halls <ul style="list-style-type: none"> – climate zoning through sealed display cases – protection of metal and wooden vehicle components – appropriate ventilation and heating using concealed systems that do not interfere with the historic structure |
| Safety (OHS, fire protection) | <ul style="list-style-type: none"> – zoning using smoke extraction systems and fire curtains adapted to high hall roofs <ul style="list-style-type: none"> – ensuring safe pedestrian circulation – separation of functional areas: ticketing, cloakrooms, restrooms – possibility of adding modular units or adapting auxiliary buildings (e.g., gatehouses) |
| Lighting | <ul style="list-style-type: none"> – UV protection (filters in skylights, blackout systems) – flexible lighting systems (track lighting on suspended structures) – ability to quickly reconfigure lighting without interfering with historic fabric |
| Acoustic adaptation | <ul style="list-style-type: none"> – reducing reverberation typical of brick, raw industrial halls <ul style="list-style-type: none"> – use of sound absorbing materials – ensuring visitor comfort and suitable conditions for events (e.g., exhibition openings) |
| Accessibility requirements | <ul style="list-style-type: none"> – ensuring accessibility for people with disabilities in spaces with significant level differences – integrating ramps, platforms, and lifts in a way that does not conflict with the historic structure |
| Logistical requirements | <ul style="list-style-type: none"> – designating a delivery and exhibition assembly zone that meets operational needs |

costs. These adaptations show that sustainability in such post-industrial facilities combines heritage preservation, energy efficiency, and programmatic durability, creating cultural models of high environmental value.

Social activation and counteracting economic and social degradation

An important aspect is the involvement of local communities, particularly evident in Space-time and the Depot History Centre, where revitalisation plays an integrative role. The adaptation of disused tram depots into museums fosters community interaction, enabling educational and social programmes, collaboration with universities, schools, and technical organisations, as well as integration with municipal tourism initiatives.

The analysis of eight adaptations shows that the type of location determines the dominant benefits, while the type of intervention shows the scale and character of sustainability. The location-related benefits are as follows:

- In city centres, adaptations strengthen social and cultural life (Tramway Glasgow, Classic Remise).

- In historic districts, they protect heritage and build educational narratives (Museum of Engineering and Technology; Centre for Contemporary Art, Tashkent).

- In peripheral zones, they become tools for revitalisation and reducing development pressure (Dundee Museum of Transport, *Czasoprzestrzeń*, MultipleXity, Depot History Centre).

Meanwhile, the degree of intervention – from preservation to expansion – translates into different forms of sustainability, ranging from minimising the carbon footprint to creating new, innovative cultural models. All cases confirm that tram depots are exceptionally effective assets for sustainable urban transformation.

In the analysed depots, the suitability of new museum and exhibition functions is highest where the institution's programme makes full use of the scale, openness, and industrial character of the halls – both in technical museums (Museum of Engineering and Technology, Dundee Museum of Transport) and contemporary art institutions (Tramway Glasgow, MultipleXity, CCA Tashkent). The weakest outcomes are observed in projects with dispersed or unstable programmatic profiles (Classic Remise, Space-time).

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Streszczenie

Adaptacyjne przekształcenia zajezdni tramwajowych na funkcje muzealne i galerie wystawiennicze

W artykule przedstawiono analizę potencjału adaptacyjnego dawnych zajezdni tramwajowych w kontekście współczesnych procesów rewitalizacji miast postindustrialnych. Na podstawie studiów ośmiu przypadków – obejmujących zarówno zwarte XIX-wieczne zespoły, jak i rozproszone układy kampusowe – oceniono przydatność tych obiektów do pełnienia funkcji muzealnych i wystawienniczych. Badania pozwoliły ich autorom na wyodrębnienie charakterystycznych strategii adaptacji oraz typów przekształceń architektonicznych, a także na określenie ich konsekwencji dla zachowania dziedzictwa i wdrażania zasad zrównoważonego projektowania. Wyniki stanowią praktyczne narzędzie wspierające projektantów w wyborze optymalnych rozwiązań dla adaptacji zajezdni na cele kultury, łącząc ochronę substancji zabytkowej z wymaganiami współczesnych instytucji muzealnych.

Słowa kluczowe: zabytkowe zajezdnie, dziedzictwo kulturowe, adaptacja, muzeum, galeria wystawowa, zrównoważony rozwój