Reuse strategy and management models for abandoned industrial areas. A case study in Yerevan

Astghik Grigoryan¹, Zara Manvelyan¹, and Emilya Sargsyan²

¹NUACA, Chair of Economics, Law and Management, 105 Teryan str., Yerevan 0009, Armenia
²NUACA, Chair of Architecture and Design of Architectural Environment, 105 Teryan str., Yerevan 0009, Armenia

Abstract. In the conditions of ever growing urbanization and increasing prominence of the sustainability agenda the issue of urban quality is subject to prior consideration worldwide. In this context the revitalization of abandoned industrial areas entails the reconstruction of buildings, structures and spaces with significant functional potential. This paper explores the methodologies proposed for the reconstruction of abandoned industrial areas in Yerevan, focusing on elaboration of the environmental-economic criteria. This approach aligns with the principles of sustainable economic and urban development, considering comprehensive impact on environmental, social, and economic aspects throughout the entire reconstruction process. The developed methodology offers an inclusive analysis of existing environmental-economic conditions of the abandoned industrial areas of Yerevan, ensuring compliance with current legal norms and standards. The applied calculation method uses an innovative analytical formula that enables investors to estimate the projected costs more accurately and precisely. It is proposed to apply a new application developed using BIM technologies which provides an opportunity to carry out a systematic assessment and analysis of abandoned industrial areas based on formula averaged values of environmental-economic parameters. The tool also facilitates development of a management model that will allow evaluation of the feasibility of abandoned industrial area reuse. The conclusions derived from this study offer an exceptional opportunity to identify practical and optimal solutions for regeneration of the urban built environment, guided by the principles of sustainable urban development and by careful consideration of potential risks.

1 Introduction

In the recent years, the challenges associated with the redevelopment of abandoned industrial areas have become much more actual stemming from the transition of "industrial" society towards "information" society. Due to closure of industrial units or their relocation to suburban areas the decline of entire cities and neighborhoods constantly progresses thus...
precipitating a concomitant erosion of the social and cultural fabric. Furthermore, industrial zones cover considerable urban land areas and, owing to their advantageous locations, provide significant potential for urban development [1].

The reorganization of abandoned industrial areas requires not only economic but also architectural solutions. The industrial unit as a structural element has its significant impact on the architectural image of the city [2]. The effective reuse of industrial sites offers a significant enhancement to the quality of land use resulting in its turn to the quality of urban space and quality of life [3]. The adaptive reuse model is a sustainable strategy that promotes the strengthening of urban development and gives life to revitalization processes of abandoned areas, with a view to creating a resilient architecture [4]. With regard to polluted abandoned sites, under specific conditions and through defined procedures, the need for remediation of these areas can be transformed into an important opportunity for local sustainable development [5]. Further in their paper Del Giudice et al. illustrate the phases and results of an evaluation model applied to abandoned industrial sites. They further explore the evaluation of the impacts of environmental pollution on the market value of these sites considering their further requalification and amendment of main function [5]. Another research provides a multi-methodological approach which was defined to support the choice about the highest and best adaptive reuse of abandoned listed castles in Northern Italy based on choice experiments and social multicriteria evaluation. The proposed evaluation process allows the decision maker (DM) to consider both socio-economic and technical dimensions within the same evaluation framework [6]. This is quite important illustration for future investors and other stakeholders of revitalization projects where certain indicators and parameters can be further elaborated to be used in practical software tools.

While comprehensive research of various authors represents discussion on strategies and management models for transformation of derelict industrial sites to new cultural, environmental and commercial uses [4-6], we have noticed certain gap regarding introduction of software tools for implementation of developed strategies and models. These tools are essential to visualize the developed strategies and models, thus supporting key role-players in making investment decisions related to reuse of abandoned industrial sites.

A significant proportion of abandoned industrial structures, amounting to approximately 12 percent of the total urban area (2700 ha, as per the 2005-2020 master plan) are located in the city of Yerevan. These structures have remained unused for an extended period, negatively impacting the urban environment. Additionally, there are numerous semi-built buildings that have been left unfinished and abandoned due to various circumstances. The survey results indicate that a significant majority, accounting for 88.3 percent, of the abandoned industrial areas in Yerevan are privately owned, while the remaining 11.7 percent fall under state ownership (Fig. 1 & Fig. 2). The current physical state of abandoned industrial areas and buildings, along with their architectural and aesthetic features, negatively affect the urban quality of Yerevan and lead to continuous urban decay. Implementation of restructuring of those industrial units offers potential to enhance economic efficiency of these buildings, in the meantime by addressing ecological and transportation issues as well as protecting architectural integrity of the urban environment. The challenge of urban development requires immediate attention and a proactive approach to find solutions.
2 Conceptual framework

2.1 Revitalization of architectural structures

The reclamation of abandoned industrial areas entails the revitalization of structures and surrounding areas, unlocking their significant functional potential. This concept, internationally known as "Loft", has served as a basis for new architectural style, often associated with the adaptive reuse of buildings for residential or public purposes [9]. The revitalization of former industrial sites and buildings has become a global phenomenon, extending beyond North American and Western European cities. Over the past two decades, this movement has expanded to the countries such as Germany, Russia, China, as well as throughout the South America. This kind of spaces have evolved into enclaves of creative expression being reimagined and reclassified for various functional purposes, including residential and public use [10].

Reuse strategy have given new life to various former industrial sites and buildings, despite their numerous differences based on diversity of shareholders, users, residents, investors, developments and future plans. This diversity has been clearly illustrated in the principles of reuse strategy, in particular - release, growth and development [11].

The revitalization of contaminated industrial zones constitutes a key aspect of the concept of sustainable urban economic development, often encompassing a range of socio-economic and environmental criteria. Research indicates that "transformation zones" or "brownfields" are valuable assets for promoting sustainable urban development, serving as crucial spaces for the advancement of knowledge-intensive and innovative industries, as well as the establishment of residential communities [12].

Among various strategies employed, the transformation of abandoned industrial buildings has emerged as a prevalent and effective tool for fostering urban revitalization.
2.2 Urban development versus urban quality

Historically, in British planning debate the discussion of the impacts of development has been closely linked to the question of betterment, or in other words to the improvement of urban quality [13].

On the other hand, over the decades, in many cities of the world the requirements for urban planning were influenced by administrative systems that centrally financed the development and construction of cities. Moreover, social and quality issues were overshadowed by other pressing priorities such as advancing industrialization which was considered as enhancing the state's material and technical infrastructure and fortifying the defense system [14].

If considering the quality of urban space with regard to urban design and architectural issues the definition of the concept is provided through more specific features within the framework of the Bristol Accord. Among these features are included: (1) “Sense of place – a place with a positive ‘feeling’ for people and local distinctiveness” (2) “Appropriate size, scale, density, design and layout, including mixed-use development, that complement the distinctive local character of the community” (3) “High quality, mixed-use, durable, flexible and adaptable buildings, using materials which minimise negative environmental impacts”. The Commission for Architecture and Built Environment CABE (established in 1999 by the first mandate of Tony Blair’s Labour Government) has provided a broad range of publications to clarify what is meant by a Well Designed and Built city or project. The assessment tool used by the CABE is the Design Review, based on the principle that “Good design is fit for purpose, sustainable, efficient, coherent, flexible, responsive to context, good-looking and a clear expression of the requirements of the brief” [13]. A valuable attempt has been made in UK to combine expert assessments with the opinions of stakeholders (end users, investors, developers, building managers, neighbourhood associations, etc.), which is the Design Quality Indicators (DQI) - “a method of evaluating the design and construction of new buildings and the refurbishment of existing buildings” [14].

Some indicators of the quality of urban space are considered as an important factor also for attracting future investments. According to Sarău, in order to be a strong competitor in attracting investments, a place must demonstrate convincingly that their city residents enjoy a higher level of well-being and satisfaction than the competitive places [15].

Song and Knaap offer a quantitative classification of neighbourhood type, through identifying relevant attributes of physical form and computing indicators of those attributes, such as street pattern, plot density, land-use mix, accessibility, transportation infrastructure and open spaces. Factor analysis is then used to derive generalized dimensions of neighbourhood character based on the raw attribute data [16].

3 Proposed methodology

The revitalization of industrial zones is a significant effort within the global real estate markets and urban economic management. It is obvious that in urban management projects, the primary objective shall not be focused on short-term profit maximization. The rapidly changing economy, which involves the use of flexible factors of production at various levels of cooperation, requires the implementation of a comprehensive and complex urban planning framework that embraces diversity, compactness and sustainable development. Such an approach is crucial for effectively revitalizing and reimagining abandoned or deteriorating industrial areas within the city, enabling their transformation into vibrant and thriving spaces aligned with the evolving needs of the economy. With this regard, considering the issue of valuation of abandoned industrial areas for further business projects, we have selected certain parameters which along with others shall provide necessary information to the investor.
These parameters are the Financial Stability Coefficient and the Land Tax based on the period of ownership. These parameters are selected to solely illustrate the algorithm of proposed tool. The tool may be used for any other parameters which will be determined to evaluate the revitalization project. Moreover, each rating criterion of the methodology can be applied separately or in combination with others, based on certain condition.

3.1 Financial stability factor

The Financial Stability Ratio is a widely recognized metric that quantifies an organization's reliance on external financing and provides insights into its long-term solvency. Calculated based on the balance sheet, this ratio serves as a predictive tool for evaluating financial health. In the context of assessing abandoned industrial areas as potential investment opportunities, the optimal value of the Financial Stability Ratio falls within the range of 0.8 to 0.9 [17].

Analyzing the coefficient of financial stability, the formula of which is presented below, we can say that the closer is its value to 1, the more stable are the company's positions since the share of long-term funding sources is much greater than of the short-term. When the coefficient of financial stability reaches a value of 1, it indicates that the company does not rely on short-term funding sources.

However, it is essential to note that this scenario may not always be economically optimal. The general formula, for calculating the financial stability the coefficient supposes consideration of various economic indicators and their respective weightings. This comprehensive approach provides a more accurate assessment of an organization's financial stability (FS) and helps to guide competent decision-making [18].

\[
FS = \frac{(\text{Equity Capital} + \text{Long-Term Loans and Borrowings})}{\text{Total Balance}}
\]

whereas:
Equity Capital + Long Term Loans must not exceed 100%, therefore:
Equity Capital is within 30-70% limit,
Long-term Loans are within 30-70% limit,
Total Balance must be equal to 100%.

Based on the financial stability factor, we can conclude that:
1. A value ratio higher than 0.95 may be an indicator showing that the organization inefficiently uses part of the available financial opportunities in the form of short-term loans during its activities (including for business expansion).
2. If the value of the coefficient varies between 0.8 and 0.9, and there is an upward trend, then the organization's financial condition is stable.
3. If the value of the coefficient is not less than 0.75, then it gives cause for concern in terms of the stability of the company.

The purpose of financial stability analysis is to consider the following three issues:
- To find out how dependent the company is on borrower/lender sources;
- To understand whether it can carry such a debt burden;
- To determine what prospects await the company if nothing changes in the capital structure.

3.2 Land Tax based on the ownership period

Land transactions can occur at any time during the taxation year, requiring the calculation of land tax for the specific period during which the ownership rights to the land are defined. The formula for determining the land tax amount is as follows [19]:

\[\text{Land Tax} = \text{Land Value} \times \text{Tax Rate}\]
LTA = RNO \times LTR \times Cv

whereas:
LTA - land tax amount,
RNO - the period of use of the given land by a private person (the ratio of the months of ownership up to 12 months),
LTR - the land tax rate in the given area according to the level of land classification,
Cv – the cadastral value defined for specified area by the RA Law on Property Tax.
The values of the coefficients used in the formula are included in the current legal regulations of the Republic of Armenia.

3.3 Use of BIM technologies for assessment and analysis of abandoned industrial sites and buildings

On the basis of above described methodology there has been developed an Autodesk Revit Application (a software tool) to be used by the students of National University of Architecture and Construction of Armenia (this is the reason why the tool interface is developed in Armenia language). The application may facilitate to make a systematic evaluation and analysis of abandoned industrial areas, based on formula averaged values of environmental-economic parameters.

Main objective of the tool is visualization of the revitalization project idea for investor to estimate proposed investments at planning stage. Practically, the digital tool provides about 80% precision in estimation of proposed investment amounts and their feasibility at the planning stage.

The investor is given an opportunity to choose the purpose of use for the area subject to revitalization, as well as to enter the data of equity capital and credit funds, which will become the basis for assessment of financial stability factor and, based on the period of ownership, the payment of land tax.

Since the implementation of this digital tool has been considered for the initial stage of planning, thus the data to be used in the tool also was taken at minimal required level. The tool can be further developed with various parameters, criteria and calculation methods.

To construct the simple model of proposed revitalization area the following data should be inputted in the tool:
- Location and boundaries of the land plot
- The external dimensions of the buildings located within the boundaries of the land plot
- The external dimensions of refurbishment or demolition of the buildings or the new builds (in case of new construction) within the boundaries of the land plot
- Average price estimates of construction works per 1 sq. m

Afterwards the model of the target area with all the information required for estimation of the area is created (Fig. 3.).

![Fig. 3. The model of abandoned industrial area.](image-url)
Further, by entering the following data in the tool we can push the “calculate” button and see the derived financial stability coefficient and conclusion on feasibility of the project in terms of use of investor’s resources (Fig. 4):

- Purpose for use of abandoned industrial area
- Cumulative profit
- Invested equity capital
- Invested loan funds

Fig. 4. Illustration of calculation methodology.

Based on derived financial stability coefficient the conclusion on feasibility of the project in terms of use of investor’s resources may be different. For example, if the calculated value of the coefficient is equal to 0.59, the value will be marked in red and an alarm message shall appear on the screen in the conclusion field by alerting on incorrect inputs of parameter values.

While different research papers provide thorough analysis of evaluation impacts resulting from reuse of abandoned industrial areas as well as develop effective reuse strategies and management models, the approach proposed by the authors of this paper allows assessment of efficiency of proposed investment for reuse of abandoned industrial site by using the evaluation impacts and various parameters of adaptive reuse models.

4 Conclusions

Many cities are trying to overcome their past and build a new identity for themselves. They are trying to replace the traditional basis of the declining industry with a service sector. This model of revitalization is typical for almost all cities that have developed more or less during the successful years of industrial development in the 20th century. The city of Yerevan also
has undergone a transformative phase of resurgence and is currently immersed in a process of revitalization and renewal. With this regard the above demonstrated smart solutions by using BIM technologies may contribute to development and implementation of sustainable urban revitalization projects which will definitely improve the quality of urban environment at reasonable cost.

Abandoned industrial buildings, becoming witnesses of the past and a part of the identity of each place, equally represent a public value. If the transformation is done correctly, they may remain an active part of the urban fabric with relative value.

In contrast to buildings that have no identity and are part of the urban landscape, abandoned industrial buildings have a unique character that can become places with great potential in the future.

It is obvious that the presence of abandoned industrial areas is due to another factor, namely the development of innovative technologies in the world. The recommendations for the realization of the abandoned industrial areas of the city of Yerevan are aimed at improving the urban situation, which can be implemented by the following principal actions: 1) saving the old fabric from isolation and decay, 2) realizing it in a new functional zone, 3) connecting it with the social requirements of the development of the urban environment.

The results of this research, as well as the methodological approaches proposed in it, can be applied not only in Yerevan, but also in a number of cities with abandoned industrial areas.

References

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