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Re-Thinking Detroit: A Multicriteria-Based Approach for Adaptive Reuse for the Corktown District

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Abstract: The paper addresses the paradigm of adaptive reuse with a specific focus on issues related to the evaluation and the decision-making processes in this context. In more detail, this paper aims at recognising the main gaps that concern the evaluation process associated with adaptive reuse and providing some points of reflection and a preliminary methodological proposal to evaluate transformation scenarios related to adaptive reuse, through a multidimensional and multi-objective perspective. According to these purposes, this paper describes the implementation of the pillars of adaptive reuse to re-think the Corktown District of the city of Detroit, underlying through a real case study the complexity, the multidimensionality, and the multi-objective challenges of this concept, when implemented in urban planning and the revitalization of historic buildings. According to this scenario, the present paper focuses on issues related to managing the complexity and the multidimensionality of the decision process, under the analysis and evaluation of alternative adaptive-reuse strategies. This research, thus, proposes the application of the Multi-Criteria Analysis (MCA) technique, based on the Multi-Attribute Value Theory (MAVT), to evaluate and compare different strategic scenarios to re-think the Corktown District of the city of Detroit, according to the principles of adaptive reuse. The final result is a multidimensional evaluation that provides a final ranking of the different proposed alternatives, in order to support the decision-making to select the most suitable transformative scenario, according to the initial purposes of the project.

Keywords: adaptive-reuse; urban regeneration; multi-criteria analysis (MCA); Decision Support tool; Multi-Attribute Value Theory (MAVT)

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1. Introduction

The concept of adaptive reuse was introduced in the architectural field during the 1960s and 1970s, due to the growing attention to environmental aspects. Furthermore, this paradigm has attracted more attention during the last decade to requalify historic buildings and urban areas [1]. It can be considered as a challenging approach for architecture and urban design [2]. In more detail, the paradigm of adaptive reuse addresses the promotion of sustainable development, with a specific focus on the adaptation of the existing built environment [3] as well as the promotion of the circular-economy model, with specific attempts to improve local economies, environments, and social conditions [4,5], plus the transfer of the identity to future generations [6]. In this sense, the paradigm of adaptive reuse is also inserted in the debate related to the balance between social, cultural, functional, environmental, and economic goals. Moreover, when applied to revitalizing historic buildings or urban areas, adaptive reuse aims to answer communities' needs, maintaining their historical significance and cultural value [7,8]. Therefore, interventions based on the paradigm of adaptive reuse have to be managed and evaluated according to these multidimensional and multi-objective pillars, related both to the paradigm of sustainable

development and the circular economy [6]. Therefore, considering the adaptive-reuse paradigm with sustainable development, adaptive reuse is grounded in an integrated framework. It, thus, needs a macro perspective, including consideration of economic development, environmental protection, social justice, and equity [9]. Secondly, for its perspective on implementing the circular-economy paradigm, finding the most suitable function is the most critical issue, since preserving the heritage building's cultural relevance is related to the inner context. Therefore, all variables should be considered in the adaptive-reuse decision-making process, considering the many dimensions of adaptive reuse to determine the most appropriate role for buildings [6]. Thus, adaptive reuse concerns different and multidimensional aspects, from sustainable development to the circular economy and the transmission of values and knowledge to future generations, as well as a complex set of other considerations that concern location, heritage, architectural assets, and market trends [10]. In this sense, when dealing with the decision process regarding adaptive reuse, different issues and challenges are faced, thus providing complex and multidimensional problems. In more detail, the decision-process related to adaptive reuse is a complex process that requires stakeholders' engagement in the evaluation and decision process, to address the most appropriate future for a building in a particular location and time [11].

It is necessary to address that the renovation actions promoted by the paradigm of adaptive reuse ensure multifaced and multidimensional impacts, which engage the environment, economy, society, and cultural dimensions, thus affecting communities with several impacts. According to these definitions, adaptive-reuse strategies represent a complex decision-making process, in which different dimensions, objectives, and stakeholders' preferences must be considered and managed simultaneously [6,12]. However, behind the great attention in proposing adaptive-reuse strategies according to their cultural, economic, environmental, and cultural benefits to urban community, the research field that concerns the evaluation of adaptive reuse is still less explored and fragmented. This paper aims at addressing this gap, examining the existing literature and proposing an evaluation model that is inclusive, transparent, and capable of taking into account the different points of view of the actors involved in the decision-making process [13]. According to this purpose, this paper briefly illustrates the state of the art of adaptive-reuse assessment, to describe its features, lacks, and challenges. Furthermore, it also proposes the application of Multi-Attribute Value Theory (MAVT) to assess three different adaptive-reuse strategies for the requalification of Corktown district, located in the city of Detroit, in order to address the one of the main challenges of the adaptive-reuse paradigm, or rather the definition of the more appropriate function of a historic building, according to the sustainable-development perspective within its multidimensionality and multi-perspective.

2. Adaptive-Reuse Assessment: State of the Art

The evaluation of adaptive reuse for architectural heritage is a multi-interest process that includes the preservation of the historical, economic, scientific, and aesthetic worth and medium- to long-term development visions, combined with planning actions [9]. The adaptive-reuse process needs to be based on a comprehensive assessment of values, histories, visions, and communities. In the literature, different scholars have explored the application of different evaluation tools to support the definition and the assessment of adaptive-reuse strategies. The different methods proposed by the literature can be divided into different categories: the mixed method, the Multi-Criteria Analysis (MCA), and the preference-measurement model (PMM). For the mixed methods, they are often employed in the evaluation of adaptive-reuse alternatives, due to its capacity to interpret both qualitative and quantitative data [9]. Furthermore, this integrative approach allows for constructing a holistic framework that can then be utilized for adaptive-reuse assessment and an analysis of architectural heritage [14]. However, research that applies mixed methods to investigate adaptive reuse is still limited in many aspects, as underlined by the critical analysis provided in the literature [9].

On the other hand, the application of the MCA in adaptive-reuse assessment tries to embrace the interdisciplinary nature of adaptive-reuse projects, which need to be assessed comprehensively and in detail [15]. MCA techniques are grounded in expert opinion. In addition, they are able to consider a set of possible decision-making alternatives with their defined characteristics. Thus, these models can also process data describing heritage buildings' attributes and indicator values, ranking them to obtain an optimal solution. In general, the wide application of MCA within research on the adaptive reuse of heritage buildings proves the necessity of decision-making, when considering the reuse and changing functions of a heritage building. According to this fact, the MCA can be considered as the most-used evaluation approach in this field. As an example, the work proposed by Ferretti and colleagues can be cited, in which a multi-criteria approach based on MAVT has been proposed to decide the best use and select the best function [16]. Moreover, Centis and Micelli propose developing interviews supported by specific questionnaires to assess the effects of different adaptive-reuse strategies, referred to as different case studies [17]. Cerreta and colleagues provide a collaborative decision-making process to identify the complex values' changes generated by adaptive reuse [18]. Furthermore, Dell'Ovo and colleagues developed a NAIADE application to define the most suitable function for the adaptive reuse of the Castello Visconteo in Cusago [19]. Ribera et al. (2020) chose the monumental Palazzo Genovese in Italy and used an AHP model to analyze the social, cultural, and economic value of the reuse function of this architectural heritage through multiple dimensions, to obtain the highest valuation and best use [20]. Furthermore, Salerno proposes the application of MCA to evaluate different strategies of adaptive reuse for cultural-heritage assets [21]. Moreover, Dezio and colleagues also provide a combination of MCA with a Geographic Information System to identify the most suitable buildings for the adaptive-reuse approach [22].

On the other hand, the PMM is more related to the evaluation performed through the bottom-up processes. In this context, Sokolowicz and Przygodzki (2020) provide a good example of these bottom-up methods. They introduce interdisciplinary research methods to supplement the decision-making process related to the adaptive reuse of heritage building from an economic perspective. Visitors' Willingness to Pay (WTP) can be measured and used to maximize the value of heritage buildings. In more detail, a three-stage-assessment method to understand residents' and visitors' views of these heritages have been organized.

In conclusion, it is possible to state that no common and shared methodology is accepted by the scientific community to assess the adaptive-reuse strategy. As well, the main challenge of this research topic is providing an evaluation framework that is able to address the complexity, multidimensionality, and multi-objective nature of the adaptive-reuse strategy.

3. Methodology

This paper proposes the application of MAVT [23] to evaluate different scenarios for the requalification of the Corktown District (Detroit). MAVT belongs to the broader group of MCA techniques [24]. They are employed in real-world decision problems to manage complexity and multidimensionality, including the stakeholders' perspectives. In the context of territorial transformation, MCA is employed to provide an ex-ante evaluation to identify the preferable transformation alternatives [25].

In detail, MAVT is applied to analyze problems characterized by a finite and discrete set of alternatives. It can deal with both qualitative and quantitative data. Moreover, MAVT is based on the assumption that real-value functions exist to represent the preference of Decision Makers (DMs) for every decision problem [26]. These functions are employed to translate the evaluation of each alternative option into one single value. Following the methodology, there are five fundamental steps to construct the MAVT [23,27]:

1. Definition of the basic evaluation objective and related attributes;
2. Identification of the alternative options;
3. Assessment of the scores for each alternative for each criterion;

4. Modeling preferences and value trade-offs, which concern the elicitation of the value functions associated with objectives and attributes and the assessment of their weights;
5. Ranking of the alternatives.

The first step concerns the identification of a decision objective, as well as for all real-decision problems. In detail, the evaluation objectives directly depend on the problem to be analyzed and on the stakeholders involved in the decision process. Following the MAVT procedure, the second step consists of identifying alternative options. Once the alternative options have been identified, it is necessary to assign scores for each alternative in terms of each attribute. This step is fundamental because it represents the perceived values of the impact that the strategy should have. These preferences are obtained through value functions [27]. Value functions are mathematical representations of human judgment. They can translate the performance of each alternative into a value score. These functions have non-dimensional values that are included, between 0 and 1. The value 1 stands for the best performance available, while the value 0 means the worst performance [28].

Moreover, these value functions are developed by experts through the support of specific interviewing processes, designed to organize judgments and represent them analytically [28]. Furthermore, the value functions are defined independently from the alternatives and are only according to stakeholders' preferences. The third phase also concerns the weighting of criteria, to set a specific score for each criterion [29].

For the MAVT method, the most-used techniques for weighting criteria are [24,28]:

- Swing method. It uses a reference state in which all attributes are at their worst level and asks the interviewee to assign points to states in which one attribute at a time moves to the best state. The weights are then proportional to these points.
- Rating. The stakeholder evaluates the importance of each attribute, considering their ranges. This procedure is developed into different steps. Firstly, they are divided into classes of importance and afterward numerical rating are assigned to each attribute.
- Pairwise comparison. This technique establishes the comparison of each pair of attributes. Moreover, this method permits to calculate the inconsistency of the assigned weights [30,31].
- Trade-off. In this case, the DM compares two alternatives that are different in only two attributes.
- Qualitative translation. This method provides numerical weights from ordinal weights.

The final step of MAVT concerns the calculation of the final score for each alternative. Different methodologies are provided in the literature for this task [32]. However, the easier and most-used technique is the additive model, which is described by Equation (1):

$$V_{(a)} = w_i \cdot v_i(a_i) \quad (1)$$

where:

$V_{(a)}$ is the overall score of the alternative a;
w_i is the weight of the attribute i;
$v_i(a_i)$ represents the performance of alternative a, according to the attribute i.

Finally, the sensitivity analysis is recommended to validate and test the robustness of the model and the obtained results.

In more detail, MAVT has been selected in this application for its simplicity to be performed and its consumes less time to perform the evaluation when compared with other techniques, such as DELPHI, among others [33]. Furthermore, MAVT has also been selected for the value function's efficiency to normalize the considered indicators [28] and for the trade-off methodology to perform the weighting process, as discussed in depth in the following section.

4. Detroit's Historic Corktown District

During the twentieth century, there has been an exponential growth of the whole country, but in an unequal way. In the 1940s, in fact, the United States concentrated, in its core, 68% of the production and employment for more than 90% of the value generated by the five-hundred largest industrial companies of the country [34,35]. This labor supply generated by the flourishing economy of the nucleus created a massive migratory flow from the marginal states (south–west). The core (north–east) represented the status quo of the American dream, not only for the work boom, as these states were able to guarantee higher salaries, prestigious universities, and a better quality of life, while producing what they consumed. However, starting from the post-war period, there is an inversion of the phenomenon in favor of the marginal states, which brought the core states of the Great Lakes region to a progressive decline, connoting them with a new term: "Rust Belt". This dynamic, linked to policies of shift out of industries towards the southern states and the arrival in the US market of Japanese automotive companies, represents a serious lack of ability by the Rust Belt to re-invent itself as a new economy to support the abandonment of their cities.

In the past, Detroit set itself as a reference point for the Rust Belt economy, becoming the natural development ground for a new economy. From the beginning of the twentieth century, Henry Ford founded the Ford Motor Company in 1903; after that, other automotive founders followed [36]. This resulted in population growth, from 285,700 to 1.8 million inhabitants (between 1900 and 1950), an expansion of the city motivated by the working demand, and even the boundaries of Detroit expanded (between 1900 and 1930, Detroit's total land area grew from 121 km^2 to its current size, 370 km^2). This demand for expansion allowed the planners of Detroit to think of a way of growth based on the Taylorism approach: the "city as machine", when the Fordism philosophy was a winning aspect of the city: a model that consumes the products of its work, and at the same time creates a surplus of requests, ensuring a nomadic model that is operational and continually repeated. The cities of the "Rust Belt economy", where abandoned buildings and brownfields bear witness to the recent past, are attempting to re-ignite interest and re-inject appeal into their cities. Overall, Detroit is still in a state of disrepair, and the empty plots attest to the astronomical number of people who fled the city; however, there has been some positive change over the past few years [37].

Detroit, known for its once-bustling car industry, is the poster city for abandonment. It is universally recognized as an empty nest, where more than 85% of the remaining inhabitants are African-American [38]. Sprawl began to change the city's physical structure in the mid-1950s, leading to the displacement of a large, predominantly white part of the population. Detroit is a city suited to reuse and remix that is within everybody's reach. This can be seen in Detroit's historic Corktown District.

A potential area has been chosen for future developments among Michigan Avenue (Figure 1). The district shows a morphological break dictated by the old railway system between north and south, and a strong deterioration situation defined by the abandonment of the buildings built in a medium/large size (Michigan Central Station, Roosevelt Post Office, and 1448 Wabash St. Warehouse), which separate the eastern part of the district from the west side. The disposal, thus, offers a way to re-think the area: the program that re-establishes the continuity of the district through the railway axis and the reconnection of the city with its waterfront via the north–south union of the 14th-street axis. Both programmatic lines define the base of work for urban development, removing the urban centrality of Michigan Avenue—where most of the commercial activities are concentrated to date—and moving it to the interior of the Corktown district, becoming a new urban reference.

The diversification of the current scenario leads to a topic to create a new socio-cultural mixture through spaces dedicated not only to work use but also through new areas of aggregation that promote the action made by the user (bike parks, playgrounds, basketball

courts, etc.), and new residential spaces that aim to invite a new, secure urban center through a mixed and complex urban structure.

The design of the new green plant shapes a new identity of the territory that creates a series of buffers within the scenario, breaking the unscheduled green screen; urban agriculture also develops through the creation of urban gardens and greenhouses for community use. The densification process takes place through the adaptive reuse of the three project buildings (Michigan Central Station, Roosevelt Post Office, and 1448 Wabash St. Warehouse), becoming new catalysts for working and social life and the creation of types of new construction and recovered multi-tenants.

The city, therefore, abandons individuality in favor of a new shared space where the experience takes place: public space is, therefore, the main theme of the new urban reflection of Detroit; the alternation of specific programs and informal spaces give rise to always diversified and collective scenarios, where life and work meet continuously, giving rise to new relationships.

Adaptive-reuse strategies, or additions and radical transformations of the existing, are acknowledged as design approaches that are often more appealing in demanding circumstances, which seek a particular characterization and specificity, one which does not always find convincing answers in the new homologated transformation projects, despite enhanced services, common spaces, and super-flexible investment or rental arrangements. Detroit is experiencing an alternation between new residential districts, mainly consisting of multiple-unit buildings, and disused buildings being reused for housing, with formulas capable of diversifying the supply and redefining the traditional-housing mode [39].

Figure 1. Corktown functional program (Reprinted with permission from Ref. [40]; Ingaramo Tutor).

As mentioned in the introduction, this paper illustrates the evaluation of different adaptive-reuse strategies for the Corktown district. This case study has been selected according to the multifaceted and multidimensional challenges that its adaptive reuse should address. In addition, this case study embodies several principles and pillars of the adaptive-reuse paradigm, from the choice of the most suitable function for the transformation to the integration of sustainable development in the broadest sense, thus also considering the social, economic, and environmental aspects, and the intention to pass on to future generations the knowledge and culture of the past.

Adative-Reuse Strategies

Figure 2 represents the three different adaptive-reuse strategies. In detail, the proposed scenarios are: and RE-THINKING (Figures 3–5), a New Economic Approach [40], RE-LEARNING (Figures 6–8) Urban Manufacturing [41], RE-MAKE(R) Urban Manufacturing (Figures 9–11) [42]. All these strategies aim to renovate this area by reusing empty buildings and building new constructions, to provide the area with new housing, working places, public spaces, incubators, and startups [43]. In detail, they can be described as follows:

Figure 2. Masterplan of different adaptive-reuse strategies (Reprinted with permission from Ref. [40]; Ingaramo Tutor).

Figure 3. RE-THINKING DETROIT, Michigan Central Station, railway view (Reprinted with permission from Ref. [40]; Ingaramo Tutor).

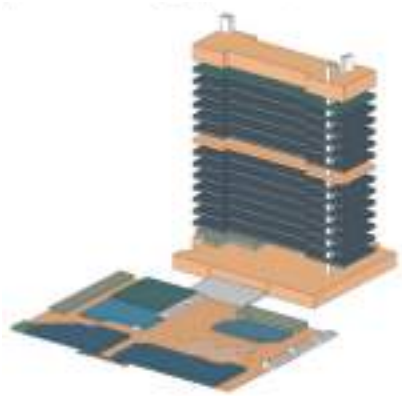

Figure 4. RE-THINKING DETROIT, Michigan Central Station, programmatic axonometry (Reprinted with permission from Ref. [40]; Ingaramo Tutor).

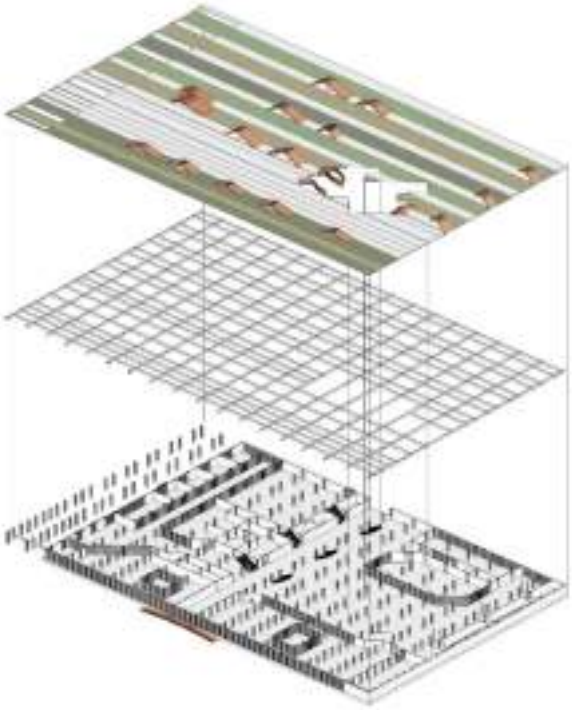

Figure 5. RE-THINKING DETROIT, Michigan Central Station, basement axonometry (Reprinted with permission from Ref. [40]; Ingaramo Tutor).

Figure 6. RE-LEARNING DETROIT, Roosevelt Post Office, exterior view (Reprinted with permission from Ref. [41]; Ingaramo Tutor).

Figure 7. RE-LEARNING DETROIT, Roosevelt Post Office, programmatic axonometry (Reprinted with permission from Ref. [41]; Ingaramo Tutor).

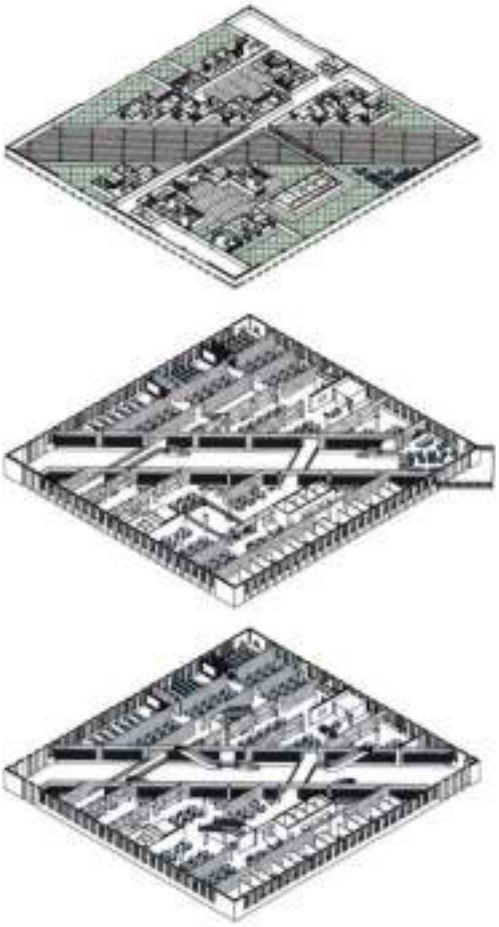

Figure 8. RE-LEARNING DETROIT, Roosevelt Post Office, building axonometry (Reprinted with permission from Ref. [41]; Ingaramo Tutor).

Figure 9. RE-MAKER DETROIT, 1448 Wabash St. Warehouse, exterior view (Reprinted with permission from Ref. [42]; Ingaramo Tutor).

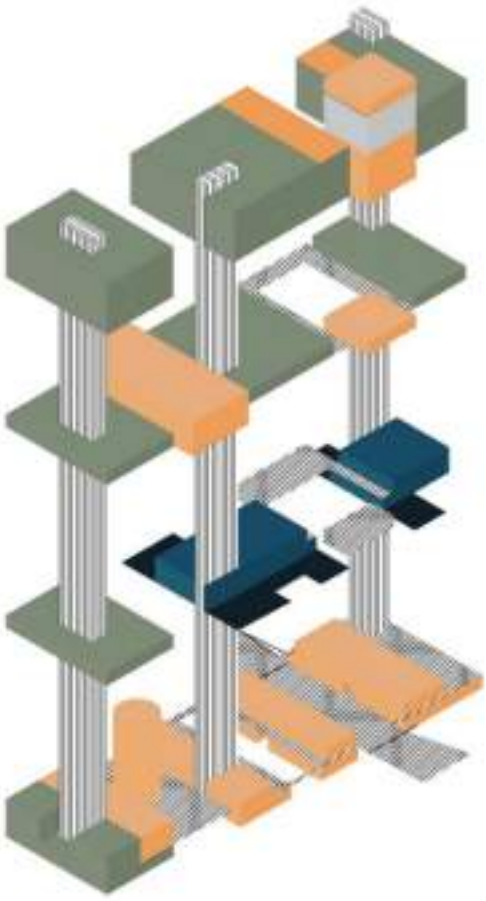

Figure 10. RE-MAKER DETROIT, 1448 Wabash St. Warehouse, programmatic axonometry (Reprinted with permission from Ref. [42]; Ingaramo Tutor).

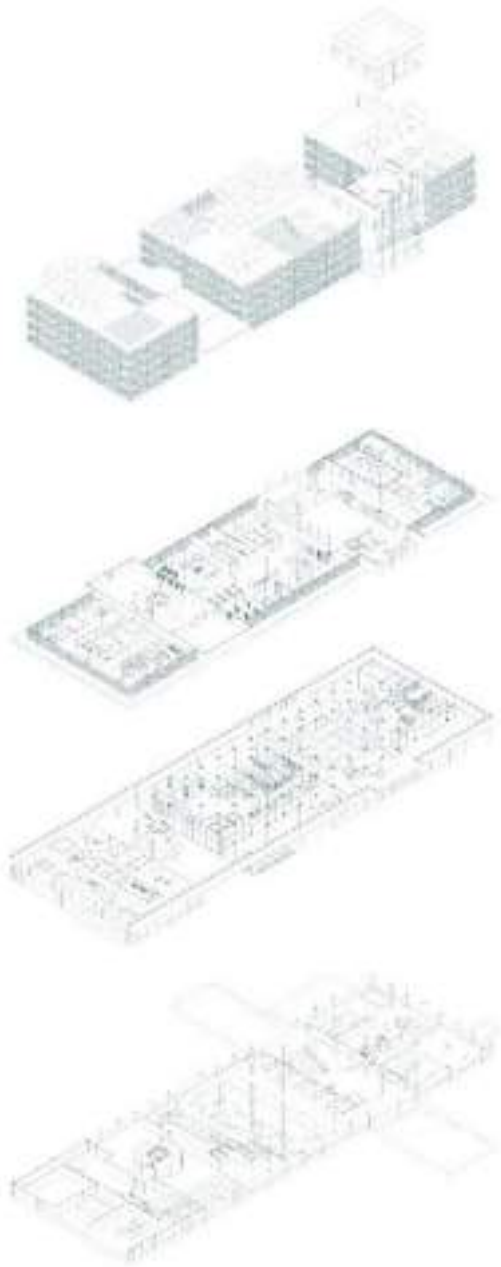

Figure 11. RE-MAKER DETROIT, 1448 Wabash St. Warehouse, building axonometry (Reprinted with permission from Ref. [42]; Ingaramo Tutor).

1. Initial scenario: This scenario concerns the current state, without any intervention in the redevelopment and adaptation of existing buildings for new functions, such as working activities.
2. The Michigan Central Station Scenario (MCS): This strategy focuses on the requalification of the abandoned Michigan Central Station of Corktown. This scenario aims at creating a new focal point for work activities and two new public spaces for the community. For example, it proposes the adaptation of the first public floor of the MCS into an ample, mixed-use public space. The central programmatic axis that runs the entire length of the MCS takes on a new meaning as a semi-public space covered through the opening that directly faces Newark St., presenting itself as a new space for relations between the north–south part of the district. Moreover, in this case, the project again assumes a dichotomy between the intervention of the ground floor of the MCS and the railway level underground. The MCS program has already been

extensively studied and structured. Therefore, the type of intervention within it will be mainly conservative, unlike the basement level, where interventions will be more oriented towards adaptive reuse of space. However, the separation between the two elements is mitigated by the presence of the programmatic axis, which becomes the direct contact with the public space, transforming the passage into an urban spectacle for those who cross it.

3. The Roosevelt Post Office Scenario: This scenario proposes a functional re-thinking of the spaces inside the old post office. In detail, the post office promotes a new network to make the spaces focused on a learning approach (a philosophy of what to do and how to do). On the roof, a new construction for residential use is proposed. In particular, attention is focused on the city of Detroit and on the development of the maker movement, a worldwide community of DIY producers (a do-it-yourself philosophy) that has been imposing itself on the manufacturing environment of the city for many years. In particular, one of the main points of the manifesto of this movement is the sharing of their knowledge, in this case to help the precarious situations of the K–12 schools (students from 6 to 17 years of age) in Detroit. The design part begins with the elaboration of a project masterplan for the new manufacturing area, which collects the three large and abandoned buildings in the area of the railway connecting Canada and the USA. Next, the reuse project, in which it is proposed to intervene in order to create a space that accommodates both a vertical factory, with all its characteristics, and a part of informal education that develops throughout the building, so as to create a prototype of school–factory that can then be applied to other abandoned buildings, recovered for the same purpose. The large and flat volume of the Roosevelt Warehouse is included in this urban project, which presents the recovery of the decommissioned railway area. It represents a fulcrum of manufacturing production and education. The old warehouse structures are maintained and modified for the needs of the new functions. The building has a dimension of an isolated medium and, as a consequence, an internal micro-environment is created; the project is divided, therefore, for the most part inside the old existing brick walls. The type of the Roosevelt Warehouse has changed, starting from the old post office and the storage and sorting building, resulting in a vertical and social factory, an integral part of the district of Corktown and the city of Detroit, and becoming a container for activities and events, as a stage of industrial rebirth.
4. The 1448 Wabash St. scenario. This strategy proposes mixed use inside the warehouse, subject to industrial recovery, a possible and partial solution to the problems of urban segregation, unemployment, lack of attractiveness, and lack of quality of the urban space that nowadays affects the city of Detroit. By analyzing the type of industrial building, its relationship with the city, and the consequent effects generated on the territory, it is proposed to recreate a local and urban production system that occupies part of the city's industrial areas. The factory is redesigned as an urban key, creating a proposal that, considering the examples of American vertical factories and the principles on which their relationship with the city is based, generates a typological complexity to create a greater dialogue with the context. The scenario is research that proposes to understand the relationship that exists in the history of the city of Detroit, between the typology of the factory and the city's development. At 1448 Wabash St., Corktown, Detroit, there is located an old and abandoned 1920s warehouse. An impressive eight-story structure stands out in the neighborhood's skyline, second only to Michigan Central Station and the residential towers along the river front. Therefore, the typological change of the building reflects the urban thought, which proposes to be adopted for the design of this object. A building completely detached from the urban and social space, a consequence of the "Motor City", is transformed with the idea of creating a city made for people. The elements of the city, generating the segregation of this, must be transformed to become part of the creation of a new type of city, inclusive and measured for humans.

5. Evaluation of Alternative Scenarios

5.1. Identification of Criteria

After identifying the evaluation objective, it is necessary to define the evaluation criteria to perform the analysis through MAVT. For this application, a multidimensional set of criteria is defined in order to address the complexity, the multidimensionality, and the conflicting nature of the analyzed decision process.

In detail, the criteria are referred to as multidimensional aspects, or rather:

- Environmental aspects. They focus the attention on the environmental elements of the proposed strategies. As an example, they concern the decontamination of brownfield areas or the creation of new green areas.
- Project aspects. They concern the pillars and the different functions proposed by different strategies (e.g., workspaces, residential spaces, etc.).
- Economic aspects. This category includes the economic and financial aspects related to the proposed adaptive strategies, such as project costs, economic benefits, and investment risks.
- Social aspects. This variable group mainly addresses community engagement and the possible social impacts of the interventions.

Table 1 lists the criteria considered for the performed evaluation. This set of multidimensional indicators is the result of an in-depth literature review about the indicators, referred to as sustainable development and urban sustainability [44–46], as well as the analysis of some case studies from the purpose-indicator-based model, to evaluate the adaptive-reuse strategy [47]. In more detail, an effort to fit and adapt the founded indicators to the specific case study has been developed. Thus, Table 1 represents the results of these research processes.

Table 1. List of criteria ([42]; Ingaramo Tutor).

Dimension	Criteria	Description	Unit
Environmental	ENV.1: Regenerated area	The regenerated area inside the project masterplan	sqm
	ENV.2: Requalified green areas	Green areas requalified inside the project masterplan	sqm
	ENV.3: Requalified brownfields	Brownfields requalified inside the project masterplan	sqm
	ENV.4: Public playgrounds	New playgrounds developed inside the project masterplan	sqm
	ENV.5: Territorial index	Building index referring to the lot	-
Project	PR.1: Public spaces	Public spaces developed inside the project masterplan	sqm
	PR.2: Public/private ratio	Ratio between public and private spaces	-
	PR.3: Working space	Working spaces developed for each scenario inside the project masterplan	sqm
	PR.4: Commercial–exhibit areas	Commercial and exhibit areas developed for each scenario inside the project masterplan	sqm
	PR.5: Time construction	Time construction for each scenario inside the project masterplan	months
	PR.6: Learning/educational spaces	Learning and educational spaces developed for each scenario inside the project masterplan	sqm
	PR.7: New residential spaces	New homes developed for each scenario inside the project masterplan	sqm

Table 1. *Cont.*

Dimension	Criteria	Description	Unit
Economic	EC.1: Economic benefits delivered by the project	Return of investment delivered by each scenario inside the project masterplan	qualitative
	EC.2: Project cost	Cost of each project scenario	$
	EC.3: Investment risk	Investment risk of each project scenario	qualitative
Social	S.1: New jobs	New number of workers engaged for each scenario	number
	S.2: Gentrification	Urban changes implemented by population growth within each scenario	-
	S.3: Functional mixed-use index	Uses developed for each scenario (compared to residential, commercial, productive, sport, cultural/educational, service industry, healthcare)	-
	S.4: Community spaces	Spaces reserved for social/community initiatives	sqm
	S.5: Inhabitants' increase	Increase in inhabitants for each scenario inside the masterplan	number

5.2. Elicitation of the Value Functions

The following step concerns the definition of the value function for each of the considered criteria, in order to normalize them. Figure 12 illustrates some examples of the developed-value functions, related to (1) functional mixed-use, (2) project cost, (3) requalified buildings, and (4) working spaces. In more detail, the function used for the functional mixed-use, the project cost, and the working spaces is referred to as the linear-value function. Whereas, for the requalified buildings, a V-shape function has been chosen. Thus, it was possible to develop the performance matrix of the considered strategies (for the performance matrix, please see Appendix A). Moreover, to perform these value functions, the decomposed-scaling method has been applied. This method establishes that the elicitation of the value function and the weighting process are performed separately, thus dividing the evaluation process into different sub-tasks [48]. As well, a reference range have been established, in order to define the monotonicity, as suggested by the methodology [28].

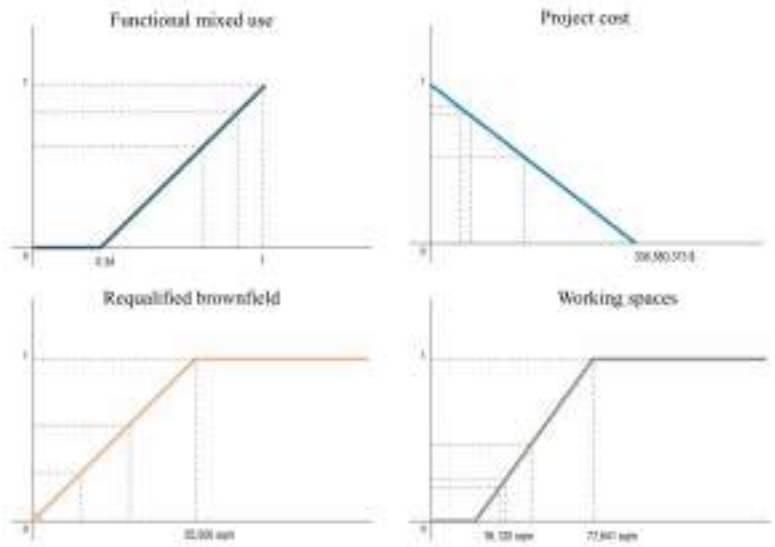

Figure 12. Example of the performed-value functions (authors' elaboration).

5.3. Weighting Process

Once the value functions have been defined, the criteria have been weighed using the swing weights technique. This technique considers the variation of the attributes. More in detail, the method works by optimizing the attributes from the worst to the best level. These levels are evaluated, using the reference level when the attributes are at the worst level. Thus, DMs are asked to assign a score (0–100) based on their interest in improving the level of performance of the attribute. Specifically, the swing method has been selected here in order to give the possibility to experts to perform an evaluation, while having a general overview about the entire set of dimensions and indicators, and to give the possibility to them to address the relative importance of each indicator according to its increase or decrease.

For this application, the weighting process has been developed by a sample of experts who have an in-depth knowledge of the complexities and dynamics of Detroit and the Corktown area. This sample is, thus, composed Dr. Jaqueline Taylor (Specialist of Cultural Landscape and General and Strategic Planning at the City of Detroit) for the assessment of environmental aspects, Dr. Scott Shall (Associate Dean and Associate Professor of the Architecture and Design College at Lawrence Tech University of Southfield) for the design aspects, Mr. Noah Elliott Morrison (Director of the Ponyride Incubator) for the economic aspects, and Dr. Joongsub Kim (Professor and Director of the Master of Urban Design Program Architecture at Lawrence Tech University) for the social aspects.

After completing the questionnaire, the criteria have been weighted by the obtained scores. The values have been obtained for the environmental, design, economic, and social aspects.

Figure 13 represents the weights of the different aspects, given by the different involved experts. As is possible to notice, the experts have assigned values according to the different aspects. Only the expert in the environment field assesses the environment aspects as much more important than the others.

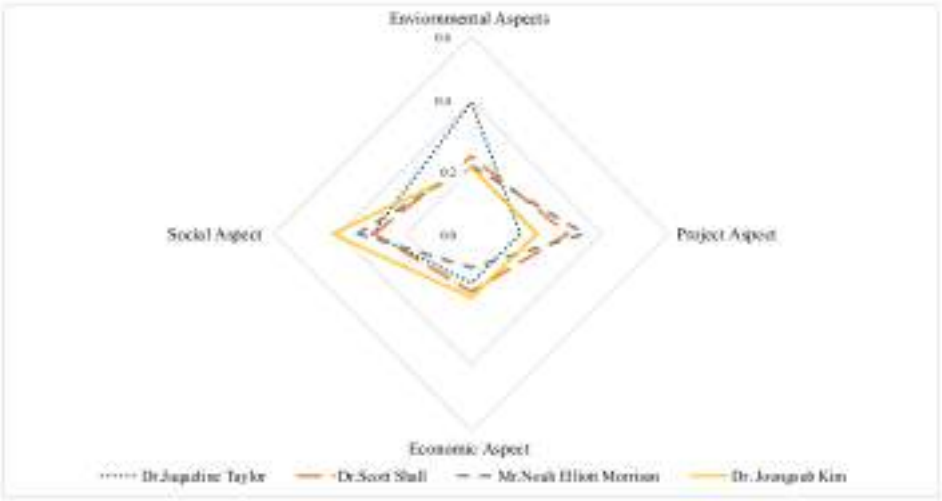

Figure 13. Weights of aspects, radar graph (authors' elaboration).

Figure 14 shows the weights of different attributes. It is possible to notice that the considered most important criteria are Ec.1, the economic benefits by the projects, Ec.2, the project cost, S.5, the inhabitants' increase, S.4, the community spaces, Env.1, the regenerated area, and Env.5, the territorial index. Whereas, the less important criteria are Pr.2, the public/private ratio and S.1, new jobs.

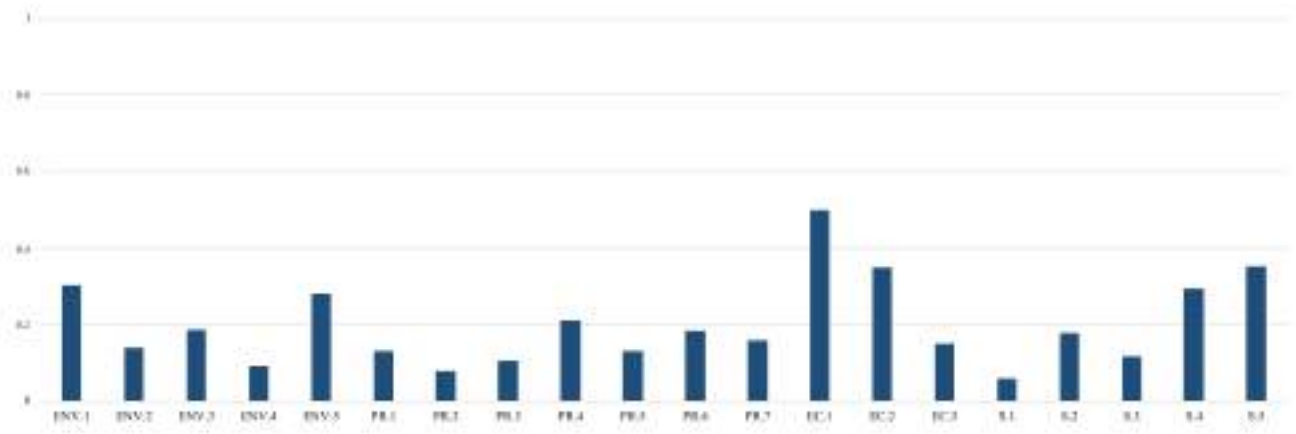

Figure 14. Weights of attributes (authors' elaboration).

5.4. Evaluation Results

As stated in the general introduction (Section 1), one of the main challenges of adaptive reuse is the definition of a new and appropriate function for the heritage building. In this sense, this paper aims at supporting the definition of the most suitable adaptive-reuse strategy for the Corktown District of Detroit. Therefore, this paper reports and evaluates three different adaptive-reuse strategies, with the aim of a new interpretation of the city of Detroit. In more detail, this section describes and discussed the results obtained by the comparative evaluation of the three proposed strategies: (1) Re-thinking Detroit, (2) Re-learning Detroit, and (3) Re-making Detroit.

Figure 15 shows the results obtained by the MAVT evaluation. The best scenario is the Michigan Central Station, with a total score of 0.69. The second-best scenario is the Roosevelt Post Office, with a score of 0.48, and the least-preferable scenario is the 1448 Wabash St., with a score of 0.35. The best performance of the Michigan Central Station scenario is due to its good performances in all of the aspects and criteria considered (see Appendix A). In fact, it shows good performance for the environmental aspects, especially according to requalified areas, requalified green areas, and brownfields. For the social dimension, it also provides good performance in education spaces. For the concerns of the economic aspects, it presents the best performance for the investment risk and for the economic benefits. Thus, its score is due to its capability to satisfy the multidimensional aspects of the transformation process. Whereas, the Wabash St. score is due to the low performance for the criteria related to the requalified green areas and brownfields as well as the bad performance in commercial areas, education spaces, and the ratio between public and private spaces.

Moreover, sensitivity analysis has been performed to verify the obtained results' validity and robustness. This sensitivity analysis has been performed by maximizing one aspect and minimizing the others. As an example, when the environmental aspects are maximized, they have the weight equal to 0.4, and the other aspects have 0.2 as their importance. This passage has been repeated for all the considered aspects. Figure 16 shows the results of the sensitivity analysis. As is possible to see, the evaluation model is robust. In fact, no significant changes have been observed in the final ranking through this analysis. Figure 16 shows the result of the sensitivity analysis. As observed, the valuation model is robust. Indeed, this analysis observed no significant changes in the final ranking. The Michigan Central Station is the best scenario, according to the maximization of the environmental, design, and economic aspects. However, given the size of the project lot, there is a global deterioration in the performance of the economic aspects, where the high cost of the project negatively affects EC.2 and the investment risk, EC.3. It changes position only in the function of the maximization of the social aspects. This behavior is due to the better performance of the Roosevelt Post Office scenario for the criteria of gentrification (S.2)

and the functional mixed index (S.3), faced with a lower project lot cost and lower cost than the MCS scenario, thus becoming, the Roosevelt scenario the best in terms of cost/benefits compared to the shortest construction time of the project (PR.5).

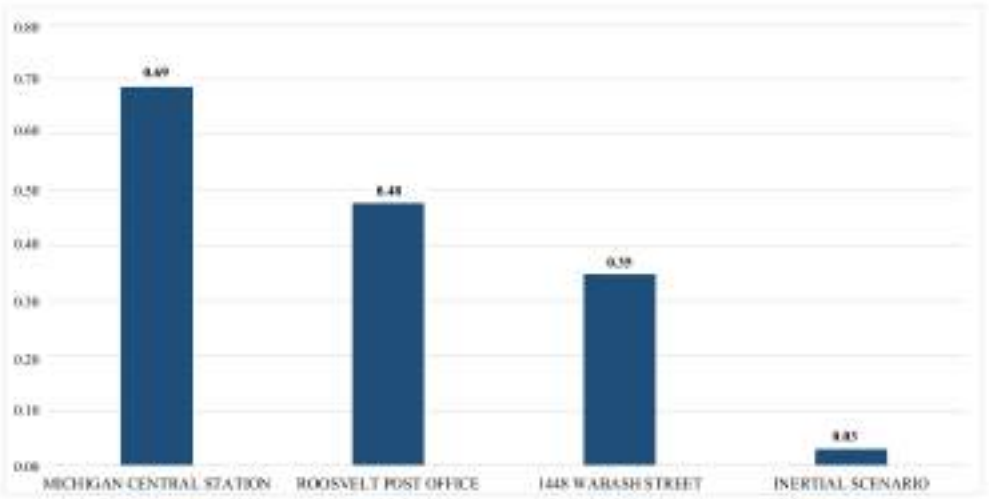

Figure 15. Final strategies' priorities (authors' elaboration).

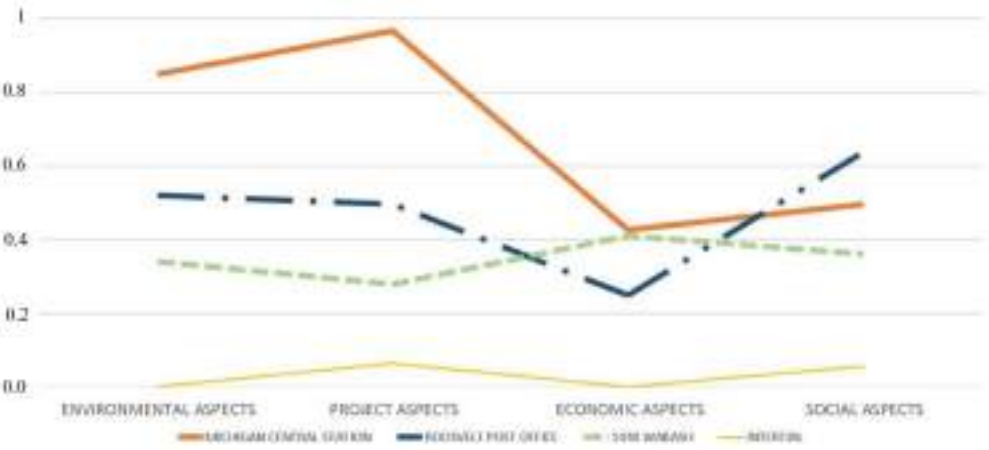

Figure 16. Sensitivity analysis (authors' elaboration).

6. Discussion and Conclusions

This paper addresses the adaptive-reuse paradigm, with a specific focus on its issues and challenges according to its connection with the sustainability development. In this sense, this paper underlines the necessity of thinking of a restoration of urban manufacture in the city within the consideration of the last century's failure and the new forms of strategy. Therefore, this paper explores and analyses the challenges and issues concerning adaptive-reuse assessment, according to its complexity, multidimensionality, and multiple perspectives. The paper provides a brief overview of the state-of-the-art adaptive-reuse assessment, thus highlighting that the most visible lack is the absence of a clear and defined methodology to support the evaluation of adaptive-reuse strategies. In fact, many of the proposed methodologies are focused on the environmental, physical, and functional aspects, leaving the social-cultural aspects under-analyzed.

Furthermore, this paper proposes the application of MAVT for the evaluation of three different adaptive-reuse strategies. In this sense, this research is within the field of research that is supporting evaluations of complex, multidimensional adaptive-reuse processes, with the goal of overcoming some of the critical issues found in the literature [9,14–16]. In fact,

the decision process has been analyzed according to its complexity and different objectives by using different criteria (qualitative, quantitative, monetary, and non-monetary). In more detail, this technique has been selected according to its simplicity in performing the evaluation, as well as the easy, understandable results to be shared with the DMs. Therefore, this application has been based on the engagement of a multidimensional panel of experts, to support the evaluation in a rigorous way. According to its multidimensional impacts, the final result is a ranking that permits defining the most preferable strategy. Therefore, this application has underlined the suitability of applying MCA to support the decision-making process in urban and territorial transformation [49].

As well, through the proposed use of MCA, it was possible to analyze and address a new socio-economic approach in this American city, which promotes a new form of urban manufacture spread throughout the quarter; the historical neighborhood is deprived of its antisocial character that has been so widespread in the past, rising to a new urban pole that promotes new types of aggregation instead of segregation, sharing rather than continuing the individuality inherited from the past. The scenario of a future Corktown, therefore, presents itself as the perfect test bench that summarizes the philosophy of this approach, shifting the attention from the urbanized center that is optimized for work activities towards a new system that makes adaptive reuse a strong point, giving life to urban spaces in favor of new forms of aggregation and slow mobility.

Therefore, this application has underlined the strength of MAVT, to be applied for adaptive-reuse assessment. As an example, its main strength is represented by the value functions that permit to translate the performances of the alternatives, considering only the assessment of the experts. However, at the same time, it is possible to discuss the necessary implementation, to reduce the main weaknesses of the methodology and discuss the possible future implementation. Firstly, one of the main weakness concerns that MAVT and the weighted sum refer to compensatory evaluation methods. This category of evaluation technique does not underline the main weakness and criticality of the analyzed alternative, according to the possibility to compensate a lesser performance of one criterion with a higher performance of another criterion. In this sense, for the future implementation and perspective of the proposed research, it should be valuable and interesting to apply and test other more formal methods, to process the sensitivity analysis to better verify the robustness of the model and the statistical significance of the obtained results [50–52].

Another weighting method can be tested as well. In fact, the swing method cannot consider the consistency of the experts' evaluation. Therefore, pairwise comparison can also be performed in order to compare the results of weight elicitation, as well as to verify the consistency of the weights.

Moreover, the integration of the discount cash-flow analysis and the GIS [53] can be proposed, to take into account both the spatial dimension of the intervention and its economic feasibility, according to its complexity.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Performance Matrix.

Dimension	Criteria	Description	Unit	MCS Scenario	Roosevelt Post Office	1448 Wabash St.	Inertial Scenario
Environmental	ENV.1: Regenerated area	Regenerated area inside the project masterplan	sqm	159,379 (0.582)	56,815 (0.207)	57,883 (0.211)	0 (0.00)
	ENV.2: Requalified green areas	Green areas requalified inside the project masterplan	sqm	56,057 (0.65)	14,887 (0.17)	15,849 (0.18)	0 (0.00)
	ENV.3: Requalified brownfields	Brownfields requalified inside the project masterplan	sqm	42,773 (0.65)	20,535 (0.31)	2192 (0.03)	0 (0.00)
	ENV.4: Public playgrounds	New playgrounds developed inside the project masterplan	sqm	855 (0.21)	2480 (0.62)	687 (0.17)	0 (0.00)
	ENV.5: Territorial index	Building index referring to the lot	-	1.32 (0.31)	1.53 (1.36)	1.31 (0.17)	1.06 (0.00)
Project	PR.1: Public spaces	Public spaces developed inside the project masterplan	sqm	124,950 (0.52)	47,928 (0.20)	49,690 (0.21)	15,603 (0.07)
	PR.2: Public/ private ratio	Ratio between public and private spaces	-	2.4 (0.118)	1.6 (0.135)	2.8 (0.135)	1 (0.047)
	PR.3: Working space	Working spaces developed for each scenario inside the project masterplan	sqm	37,355 (0.48)	12,025 (0.15)	12,141 (0.16)	16,120 (0.21)
	PR.4: Commercial–exhibit areas	Commercial and exhibit areas developed for each scenario inside the project masterplan	sqm	4830 (0.73)	1496 (0.22)	329 (0.16)	0 (0.00)
	PR.5: Time construction	Time construction for each scenario inside the project masterplan	months	36 (0.44)	26 (0.32)	20 (0.24)	0 (0.00)
	PR.6: Learning/ educational spaces	Learning and educational spaces developed for each scenario inside the project masterplan	sqm	2100 (0.79)	324 (0.12)	242 (0.09)	0 (0.00)
	PR.7: New residential spaces	New homes developed for each scenario inside the project masterplan	sqm	3500 (0.15)	14,468 (0.64)	4704 (0.21)	0 (0.00)

Table A1. *Cont.*

Dimension	Criteria	Description	Unit	MCS Scenario	Roosevelt Post Office	1448 Wabash St.	Inertial Scenario
Economic	EC.1: Economic benefits delivered by the project	Return of investment delivered by each scenario inside the project masterplan	qualitative	High (0.75)	Medium (0.50)	Very High (1.00)	Very Low (0.00)
	EC.2: Project cost	Cost of each project scenario	$	179,765,297 (0.53)	86,233,984 (0.26)	70,581,093 (0.21)	0 (0.00)
	EC.3: Investment risk	Investment risk of each project scenario	qualitative	Very High (1.00)	Medium (0.50)	High (0.75)	Very Low (0.00)
Social	S.1: New jobs	New number of workers engaged for each scenario	number	2200 (0.36)	770 (0.13)	3100 (0.51)	0 (0.00)
	S.2: Gentrification	Urban changes implemented by population growth within each scenario	-	Medium (0.50)	Very High (1.00)	High (0.75)	Very Low (0.00)
	S.3: Functional mixed-use index	Uses developed for each scenario (compared to residential, commercial, productive, sport, cultural/educational, service industry, healthcare)	-	0.9 (0.86)	0.7 (0.71)	0.6 (0.57)	0.4 (0.43)
	S.4: Community spaces	Spaces reserved for social/community initiatives	sqm	3955 (0.63)	1800 (0.29)	522 (0.08)	0 (0.00)
	S.5: Inhabitants' increase	Increase in inhabitants for each scenario inside the masterplan	number	70 (0.15)	289 (0.64)	94 (0.21)	0 (0.00)

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