

Paulina Badura

University of Economics in Katowice

Department of Economics

paulina.badura@uekat.pl,  <https://orcid.org/0000-0002-6562-8363>

Land use decision modeling with opportunity costs

Abstract: The purpose of this paper is to propose a model approach to the land development decision-making process that formally incorporates opportunity costs. Drawing on the experiences of municipalities in the Silesian Voivodeship regarding the analysis of post-industrial land development, the study used content analysis of project documents and the BPMN (Business Process Model and Notation) notation to develop an innovative decision process model. The research identified key required stages, including socio-economic analysis, social participation, financial efficiency analysis, and comprehensive economic and environmental analyses that quantify both costs and benefits. Crucially, the model mandates a systematic analysis of alternative options and introduces a formal decision gateway based on the acceptable level of quantified opportunity costs, including their often-neglected social and ecological dimensions. This framework offers a practical tool for decision-makers at the local government level, enabling a more holistic, sustainable, and economically optimal approach to land use planning by directly addressing the trade-offs inherent in resource allocation.

Keywords: opportunity costs, land management, decision-making modelling, social costs, environmental costs

Introduction

The problem of limited resources is widespread today, and researchers from many scientific disciplines are involved in the search for the right way to use them, but also to preserve them. Acemoglu (2016) argues that economics is the science of society's choices regarding the allocation of its resources and how these choices affect society (Acemoglu et al. 2016). The issue of limited resources is linked to the concept of scarcity, understood as a shortage of what is needed. Scarcity is characterized by its ubiquity and diversity, it is inevitable and found in almost every area of human life (Sun, Teichert 2024). In economic terms, scarcity is most often related to existing constraints that occur in economic transactions. These constraints are usually the result of the difference between the availability of

resources and the needs reported by individuals (Cannon et al. 2019). The phenomenon of scarcity and the necessity to choose to raise the problem of how to allocate resources most effectively, which poses challenges for decision-makers, expecting optimal choices in conditions of limited resources (Shi et al. 2020). In view of the necessity to choose in the face of scarcity, it can be concluded that scarcity implies the existence of alternatives and the possibility of loss, while optimization, as one of the basic principles of economics, not only forces us to choose, but also imposes the need to compromise and give up one thing in favor of another. The existence of optimization and the phenomenon of scarcity leads directly to the emergence of the category of opportunity cost.

A choice is the selection of a preferred option from the sum of all possible alternatives and consists of the selected option and the rejected options. The opportunity cost, described by Buchanan (1999), is the relationship between scarcity and choice. Every decision has its opportunity cost, even when there are no restrictions on the number of other available resources, because the choice made by an individual inevitably results in the elimination of all other possible actions. The opportunity cost is a measure of the value of the most valuable and advantageous of the rejected alternatives. It is the value sacrificed to realise the higher value of the chosen option (Buchanan 1999).

In the context of land use, the issue of resource allocation takes on particular importance. Post-industrial areas are generally understood as spaces where industrial activity has ceased or which have lost their auxiliary functions related to industrial production (Domański 2000). In a broader sense, this category also includes areas degraded as a result of industrial activity, such as contaminated land, waste disposal sites or post-mining areas (Domański 2000). These areas are most often located within urban structures and constitute an important element of reurbanization processes. In the international literature, post-industrial areas are often referred to as brownfields, typically defined as previously used industrial or commercial sites that may be affected by contamination. It should be noted, however, that not all such areas can be classified as degraded, as the concept of degradation is defined in various ways in legal and planning contexts (Domanowska 2010). The emergence of post-industrial areas is closely linked to the industrial crisis that began in Western Europe in the second half of the 20th century, leading to the decline of large industrial plants and the creation of extensive unused urban spaces. In Poland, this process occurred later due to the specific conditions of the centrally planned economy, which allowed industrial enterprises to retain large land reserves within cities (Ślodziak 2003). The economic transformation of the 1990s resulted in the closure of many industrial facilities and, consequently, in a significant concentration of post-industrial areas, particularly in regions such as Upper Silesia (Gasidło 1998). From the perspective of urban development, post-industrial areas represent both a challenge and an opportunity. On the one hand, they may pose environmental and social risks; on the other hand, due to their location and existing infrastructure, they constitute valuable development potential (Pancewicz 2012). Their transformation is therefore a key element of urban policy, often involving complex decision-mak-

ing processes related to redevelopment, functional change and the integration of these areas into the urban structure. Land is a non-renewable and immovable resource, which makes decisions about its use (e.g. for housing, infrastructure or nature conservation) difficult to reverse and long-term. This is a paradigmatic field of conflict between different, mutually exclusive functions – economic, social and environmental. Each decision on land use therefore generates a high opportunity cost, which often goes beyond the purely monetary aspect to include social losses (e.g. loss of access to recreation) and environmental losses (e.g. loss of biodiversity, deterioration of water retention) – i.e. external and immeasurable costs. Although opportunity cost is fundamental, its formal and systematic inclusion in models supporting land use decisions remains a challenge. In the context of land use, the issue of resource allocation takes on particular importance. Land is a non-renewable and immovable resource, which makes decisions about its use (e.g. for housing, infrastructure or nature conservation) difficult to reverse and long-term. This is a paradigmatic field of conflict between different, mutually exclusive functions – economic, social and environmental. Each decision on land use therefore generates a high opportunity cost, which often goes beyond the purely monetary aspect to include social losses (e.g. loss of access to recreation) and environmental losses (e.g. loss of biodiversity, deterioration of water retention) – i.e. external and immeasurable costs. Although opportunity cost is fundamental, its formal and systematic inclusion in models supporting land use decisions remains a challenge. Despite the extensive body of literature on opportunity costs and economic efficiency, there is a noticeable lack of studies addressing these concepts in the context of post-industrial land redevelopment. In particular, existing research does not sufficiently consider how opportunity costs can be incorporated into decision-making processes related to the transformation of such areas. This gap is especially relevant given the complexity and long-term consequences of investment decisions concerning post-industrial sites. Therefore, the main objective of this article is to propose a decision-making framework for post-industrial land redevelopment that explicitly incorporates opportunity costs. Traditional analysis methods, such as classic cost-benefit analysis, often focus on the present value of the selected option, neglecting the systematic quantification and comparison of the value of sacrificed alternatives. Furthermore, the multi-criteria complexity of spatial decisions (MCDM – Multi-Criteria Decision Making) requires tools capable of simultaneously weighing multiple conflicting objectives and measuring the loss resulting from the choice. In light of the above, the aim of this article is to design and validate an innovative decision-making model which, by integrating multi-criteria analysis methods, will enable the proper estimation and formal consideration of the full spectrum of alternative costs at each stage of the land allocation and planning process. The contribution of this article to the scientific discussion lies in proposing a structured approach to the decision-making process for post-industrial land redevelopment, in which opportunity costs are not treated solely as a theoretical concept but are formally incorporated as a factor conditioning the selection of investment options. The article offers a novel perspective by combining an economic approach (oppor-

tunity costs), analytical tools (multi-criteria analysis and non-market valuation methods), and process modelling (BPMN). The development of such a tool is intended to support decision-makers in their efforts to achieve a more sustainable and optimal use of land resources.

The next part of the article is structured as follows: Section 2 presents a literature review on decision models in spatial planning and a theoretical approach to opportunity cost. Section 3 describes in detail the methodology and construction of the proposed model, including the definition of criteria and the method of quantifying opportunity costs. Section 4 presents the results of simulations demonstrating the application of the model. Section 5 presents a discussion of the results obtained and their contribution to research in this field. Finally, Section 6 summarizes the key conclusions and indicates directions for further research.

Literature review

In microeconomic terms, opportunity cost is the value that must be sacrificed to achieve a goal. Opportunity cost determines the amount of a good that must be sacrificed to produce or deliver an additional unit of another good. Based on the definition of accounting cost, economic cost accounting also considers the costs of lost (unused) opportunities. It is the result of a situation in which limited resources force a choice to be made and alternative options to be automatically rejected. Opportunity cost is not included in accounting because it is not related in any way to expenditure or consumption of production factors. As Musiał (2010) notes, it is a type of 'cost' that cannot be expressed solely in monetary terms, as it does not only affect the financial aspect. It therefore remains an unmeasurable, unused opportunity (Musiał 2010). According to the assumptions of subjective value theory, the value of an economic good is determined by the subjective point of view of the economic agent (Menger 2013). This theory proposes an approach according to which the value of a good is not determined by any inherent property of the good or by the amount of labor required to produce it. Instead, it is the meaning that a person attributes to a good when they realize that only that good can satisfy their needs (Janik 2014). This perspective contrasts with the labor theory of value associated with classical economists such as Ricardo, which links value to the amount of labor embodied in a good and therefore does not fully capture the subjective and context-dependent nature of value relevant to decision-making processes. An individual assesses the value of goods by assigning them weight according to the hierarchy of their own needs. This demonstrates their awareness of the relationship between a given good and the extent to which it satisfies their needs. At the same time, by ranking goods in this way, they are aware of the value they will lose by deciding to satisfy their needs with another good that will do so most fully (Appelt 2018). As Haghpour (2022) points out, the subject of opportunity cost is so specific that the number of studies in this area is still limited, which significantly hinders the search for

the most appropriate definition of opportunity cost (Haghpour et al. 2022). To this day, there is ongoing debate as to whether, in light of contemporary research, opportunity cost should be treated as a physical entity with the highest value (Hubbard, O'Brien 2012, McConnell et al. 2012, Krugman, Wells 2020, Mankiw 2021), or expressed in terms of willingness to pay (Samuelson, Nordhaus 2010, Frank, Bernanke 2012, Colander 2014). However, despite the multitude of different definitions, most of them are based on a similar concept and boil down to the claim that the opportunity cost is the best alternative use of a resource (Parkin 2016). Unlike other types of costs in economics, opportunity cost does not have to be expressed in monetary terms, as it is an option, choice or possibility that has been foregone in favor of another choice. Opportunity cost arises when the use of resources in a planned project prevents their alternative allocation in another available way. This perspective is also consistent with Robbins' understanding of economics as a science of choice under conditions of scarcity, where costs reflect the valuation of alternative options resulting from individual decision-making (Księżyk 2012). This results in the creation of opportunity costs of resources, which are expressed as the value of goods or services that could be produced from the resources in their most optimal alternative use (Ligus 2010). In the classical approach, the main criterion for assessing project effectiveness is the Hicks-Kaldor criterion, which assumes that a project can be effective if the sum of the benefits achieved is higher than the sum of the costs incurred for its implementation. However, this approach has its limitations and does not consider projects that show significant benefits in the social, economic, environmental or infrastructural spheres. The explanation for why the economic and financial effectiveness of investment projects may differ lies in market imperfections, especially in the market where public projects operate, where externalities arise (Ligus 2010). To obtain a complete picture of the costs and benefits of the investment being evaluated, the scope of the evaluation should be broadened to include the measurement of effects not only from a financial perspective, but also from an economic perspective, considering the non-market perspective. In this case, the value of the expenditure is expressed in terms of the opportunity costs of its use, and the assessment of the results is measured by one of the elements of the contingent valuation method, namely willingness to pay (WTP) (Boardman et al. 2001). Social opportunity cost can be said to exist when a project or product excludes the implementation of another solution (project, product or service) in each place (or at a given time) that would better meet the expected social benefits (would serve society). In the context of public projects, social opportunity costs can therefore take the form of public objectives not directly related to financial efficiency, such as: modernization of buildings and improvement of their aesthetics, change of the urban landscape, development of culture, tourism and recreation in connection with a new investment, development of new economic activities or economic revitalization of the area (Drobniak 2001).

Neoclassical analysis of corporate equilibrium primarily considers own costs and opportunity costs. The costs of corporate impact on the environment, which may also constitute an opportunity cost, are rarely or almost never considered.

Ecosystems and their services are essential for creating an optimal living environment for humans. Although each successive generation is becoming more aware of the need to respect ecosystems, they are still too often viewed in terms of what they can offer, e.g. free space for development, without considering the long-term consequences of decisions. The complexity of land use decisions, resulting from the need to reconcile conflicting economic, social and environmental interests, has necessitated the development of advanced analytical tools. Multi-criteria decision-making (MCDM) methods play a key role here. These methods, such as the Analytic Hierarchy Process (AHP), PROMETHEE and ELECTRE, enable the hierarchization and evaluation of alternative land use options by combining multiple criteria (Malczewski 1999). The use of MCDM allows for the inclusion of both quantitative criteria (e.g. investment cost, distance from infrastructure) and qualitative criteria (e.g. impact on landscape aesthetics, social acceptance), assigning them different weights based on the preferences of decision-makers. In the context of spatial planning, MCDM is often integrated with Geographic Information Systems (GIS-MCDM) for the visualization and spatial analysis of results, which is particularly important in the case of land resources. These methods allow for the modelling of trade-offs between conflicting objectives, supporting the selection of the most optimal option. However, despite their versatility, classic MCDM implementations focus on optimizing the selection and ranking of options, without offering a formal mechanism for quantifying and integrating opportunity costs, i.e. the loss of value resulting from rejecting the best unselected options (Belton, Stewart 2002). In face of the postulate of considering external effects and non-market value, it becomes crucial to apply methods enabling the transformation of intangible assets into measurable cost categories. According to the environmental economics literature, contingent valuation methods (CVM), based on the concept of willingness to pay (WTP), are the primary tool for estimating the value of public and environmental goods (Mitchell, Carson 1989, Boardman et al. 2001). Through surveys or market simulations, CVM allows for the estimation of the value that society assigns to a given resource (e.g. a city park or recreational area) before it is lost to alternative uses.

In spatial planning, this quantification is essential for correctly determining the social and environmental opportunity cost, enabling its formal inclusion in the decision-making matrix. Other methods, such as the hedonic price method (HPM) or the travel cost method (TCM), also provide indirect measures of non-market values, allowing the discussion to move from a purely descriptive to a quantitative level (Freeman 2003). This quantitative approach to lost value is a prerequisite for developing a decision-making model capable of holistically assessing the effectiveness of land development projects, in accordance with the accepted definition of opportunity cost. In the literature, it is emphasized that decision-making processes in spatial planning within the public sector, including at the level of local government units, are inherently multi-criteria in nature and require the integration of economic, social and environmental aspects (Malczewski 1999, Belton, Stewart 2002). In practice, these decisions are based on spatial analyses and planning documents, the preparation of which is determined

both by formal requirements and by the availability of data and analytical tools. Studies focusing on local government practice indicate, however, that the scope of analyses applied in decision-making processes remains limited, which may affect both the decision-making process and the quality of the decisions taken.

Methods

The literature review highlighted the complexity of the concept of opportunity cost and the difficulties associated with its unambiguous interpretation, while at the same time confirming its potential usefulness in the analysis of investment processes, including those in the public sector. In order to verify this usefulness in the decision-making practice of municipalities, a qualitative study was conducted based on semi-structured in-depth interviews and document analysis. The subject of the study was investment decisions related to the redevelopment of post-industrial areas undertaken by municipalities in the Silesian Voivodeship. A purposive sampling approach was applied, with the following selection criteria: location within the Silesian Voivodeship, the status of an urban or urban-rural municipality, and ownership or co-ownership of post-industrial land subject to or planned for investment. The study covered 10 municipalities located in the Silesian Voivodeship, all of which were urban units with experience in managing post-industrial areas. The Silesian region is characterized by a high concentration of such areas due to its industrial heritage, which makes it a particularly relevant context for the analysis of redevelopment processes. The municipalities were selected purposively based on their ownership or co-ownership of post-industrial land and their involvement in investment processes related to its redevelopment. A total of 10 in-depth interviews were conducted with representatives of municipalities directly involved in investment decision-making processes. The study was carried out between September and December 2022, based on a previously prepared interview scenario. In qualitative research, it is generally assumed that a sample size of several to a dozen interviews is sufficient to reach data saturation (Guest et al. 2006, Creswell 2007, Mason 2010) and increasing the sample size does not necessarily lead to a significant improvement in analytical outcomes (Adler 2012). The collected material was transcribed and analyzed using qualitative coding. An open coding approach was applied, involving the identification of categories directly from the respondents' statements (Charmaz 2009). This process allowed for the identification of recurring elements of the decision-making process, key determinants of investment decisions, and barriers related to the redevelopment of post-industrial areas. The study was complemented by an analysis of investment documentation provided by selected municipalities. Only projects implemented within the last five years were included in the analysis, and the examined materials consisted primarily of feasibility studies and conceptual project documentation. Ultimately, documents from 6 municipalities were analyzed. The document analysis enabled the identification of key stages of the decision-making process and an assessment of the scope of analyses applied in

practice. The combination of interview results and document analysis formed the basis for the development of a decision-making process model using BPMN notation, reflecting the actual practices observed in the analyzed local government units. At the same time, the proposed model is not a tool that offers accurate, quantified calculations of the alternative cost of land development. In this case, the model is understood as a simplified representation of reality (Czakon 2021) or a representation of reality and serves to identify 'components and their characteristics that are relevant to the analysis' (Ciszewski, Nowakowski 2017). The developed model focuses primarily on the chronological order of activities that should follow one another during an investment planning. BPMN notation – business process modelling notation – was used to build the model. The key innovation of the proprietary BPMN model is the formal integration of alternative costs as an element that is mandatory for the decision.

The model divides the decision-making process into two main, interdependent analytical paths: variant analysis (assessment of financial, social and environmental costs and benefits) and alternative cost assessment. The model uses basic elements of BPMN notation, such as Tasks, Events, Pools/Lanes to distinguish roles, and Exclusive Gateways. The process includes an 'alternative cost valuation' stage. This valuation concerns the lost value of the best rejected alternative and is based on environmental economics methods (e.g. contingent valuation – CVM, based on WTP), which allows for a quantitative assessment of intangible social and environmental costs. The quantified alternative cost, divided into three dimensions, is assessed at the Decision Gateway. In accordance with the adopted methodology, this gate acts as a qualifying filter, as an acceptable level of quantified opportunity costs is a prerequisite for moving on to the project implementation stage. This means that the model forces decision-makers to formally compare the benefits of the selected option with the loss of value resulting from rejecting the best alternative. Business process modelling is a typical software engineering activity in which processes occurring in companies are represented and visualized in such a way that each process can be analyzed and improved (Żytniewski, Zadora 2013). Business Process Modelling and Notation, more commonly referred to in English literature as BPMN, is most often used for business process modelling. BPMN is a standard used primarily to describe business processes in a way that is understandable to both professionals and average users (Rizun 2021). BPMN notation is also defined as a standard that combines the documentation of business process flows and visual interaction techniques (Polak 2019). In this case, the use of BPMN notation allowed for the visualization of a complex decision-making process concerning the development of post-industrial areas. It allowed for the analysis of alternative costs in this process to be considered.

Several limitations of the study should be acknowledged. The first one results from the voluntary nature of participation, which limited access to investment documentation and consequently reduced the number of analyzed cases to 6. The second limitation concerns the diversity of the collected documentation, both in terms of its type (e.g. feasibility studies, conceptual designs) and the level of

detail. This affected the comparability of the materials and the identification of common elements. The third limitation relates to the application of a time criterion (projects not older than five years), which further narrowed the research sample. At the same time, this criterion was intentional and aimed at capturing current decision-making practices in local government units.

Findings

Based on the documentation review, the elements appearing in the project documentation for investments implemented in selected municipalities of the Silesian Province were identified. The following common elements of the process were identified:

- Analysis of the socio-economic environment – diagnosis of the investment environment, which includes, among other things, a detailed description of the demographics, economy, society, institutional environment in the region and an analysis of its potential in terms of planned investments. The aim is to establish the boundary conditions and the macro- and meso-social context of the project. This diagnosis forms the basis for determining the absorption potential of the region (e.g. availability of labour, infrastructure) and identifying existing risks and opportunities related to the environment. This is a key step before defining the effectiveness criteria.
- Analysis of demand and investment needs – a study to identify the target stakeholder group and current demand for investment to verify the needs of the local community. This study is essential to ensure the usefulness of the project. It includes market segmentation and analysis of the gap between current development and the actual needs of residents and potential investors. Verification of community needs is closely linked to the concept of public good and influences the assessment of the social benefits of the project.
- Social participation is understood not only as a form of consultation with residents, but as a series of activities undertaken by local government units in the process of adopting spatial planning documents. It is a two-way process aimed at increasing the legitimacy and social acceptance of decisions (social licence to operate), including both information techniques and consultation and decision-making methods that allow the preferences of various stakeholders to be incorporated into the decision-making matrix. It should also be noted that, despite the formal inclusion of social participation in decision-making processes, the role of local communities may in practice remain limited. This creates a risk of government paternalism, where decisions are taken primarily from the perspective of public authorities, without fully incorporating the preferences and perceptions of residents. Given that the consequences of investment decisions, including non-financial opportunity costs, are borne by the local community, insufficient involvement of residents may lead to suboptimal allocation of resources and reduced social acceptance of implemented projects. Full participation is therefore key to reducing social opportunity costs.

- Financial efficiency analysis – focuses on the perspective of the entity implementing the project (municipality or investor) and assesses the project's ability to generate profits or cover costs. It includes standard indicators such as net present value (NPV), internal rate of return (IRR) and payback period (PP), and its purpose is to assess the financial profitability and liquidity of the development option.
- Economic analysis (considering social costs and benefits) – this is a broader analysis conducted from the perspective of society (the state or region). It uses shadow prices instead of market prices to take externalities into account. Taking social costs and benefits into account (e.g. impact on employment, health, accessibility of public services) is fundamental to meeting the criterion of allocative efficiency (Hicks-Kaldor criterion) in public projects.
- Environmental impact assessment (considering environmental costs and benefits). This is a mandatory part of the process in the context of sustainable development. In addition to traditional environmental impact assessment (e.g. emissions, resource consumption), it requires the quantification of environmental costs and benefits (e.g. value of ecosystem services, remediation costs), often using environmental valuation methods. This is a direct preparation for estimating the environmental opportunity cost.
- Analysis of alternative options – this is a systematic comparison of possible land use scenarios that differ in function (e.g. industrial park, residential area, green zone). Identifying alternative options is a prerequisite for multi-criteria modelling and, most importantly, enables the identification of the best unselected option, the value of which forms the basis for calculating the alternative cost. It should be noted that the scope and type of analyses carried out in the decision-making process may vary depending on the characteristics of the investment and the specific conditions of the area concerned. In particular, factors such as the level of environmental degradation, the intended function of the site, and the scale of the project influence the selection and depth of the applied analyses. The proposed model should therefore be understood as a general framework indicating key analytical components, rather than a rigid procedure applicable uniformly to all cases.

The model was developed presenting the decision-making process for land development, considering alternative costs. It is not purely conceptual but is grounded in empirical research. Its individual components reflect recurring patterns identified in both in-depth interviews and the analysis of investment documentation. In particular, the stages of the decision-making process and the types of analyses included in the model correspond to actual practices observed in the analyzed municipalities (Table 1).

The first stage in the decision-making process for land development is to identify vacant land and decide about its development. An important element is to conduct a socio-economic analysis and an analysis of demand and investment needs. As a result of these analyses, it is usually possible to choose several equally relevant and feasible scenarios for the development of vacant land. When considering the effectiveness of land development from the perspective of local

Table 1. Empirical basis of the decision-making process model

Element of the decision-making process	Empirical basis
Socio-economic analysis	Present in the majority of analysed documents
Analysis of investment needs	Identified in both documents and interviews as a recurring element of the process
Analysis of alternative options (financial, social and environmental costs and benefits)	Rarely observed in practice; present in the literature and introduced in the model as a recommended element (identified gap)
Social participation	Indicated in selected interviews as part of the decision-making process
Opportunity cost analysis	Not observed in practice; introduced in the model as a key component (identified gap)
Identification and implementation of compensation mechanisms	Not observed in practice; proposed in the model as an extension of opportunity cost analysis (identified gap)

Source: own elaboration.

government units, it is important to conduct an in-depth analysis of the costs and benefits incurred by both the municipal authorities and its residents.

To make the most optimal choice, each of these scenarios should first be analyzed in terms of costs and benefits, both financial and non-financial (social and environmental). The results obtained will serve as a basis for comparing all possible options and selecting the one that appears to be the most advantageous in terms of economic efficiency. The model adopts a qualification criterion for the project, which is represented by the first decision gate in the diagram and according to which a variant could be selected if it showed at least two positive analyses out of the three performed (financial, social and environmental analysis). This assumption limits the possibility of selecting a project that risks generating more costs than benefits at later stages. After the project has been positively verified by a cost-benefit analysis, the selected option is subjected to an alternative cost assessment. This is performed through a comparative analysis with the other possible options that were not selected and which, at this stage, represent the 'next best possibilities'. The alternative costs will therefore be assessed for each of the non-selected options in terms of: financial (e.g. using elements of Cost Benefit Analysis – financial analysis), social (e.g. based on the contingent valuation method) and environmental (e.g. using the opportunity cost of conservation method).

After the valuation, a second key verification takes place in the model, represented by a decision gate that checks the acceptable level of opportunity costs. This gate acts as a formal filter in the process, as its condition for passage is an acceptable level of opportunity cost. This level means that the investor is willing to accept the compensation associated with the planned project and is willing to pay it. The selected option is then subject to public consultation, during which the planned investment is widely discussed, also in the context of measures that could compensate for the losses that may be incurred by the environment. This process is supervised by a third decision gate, which requires consensus to be

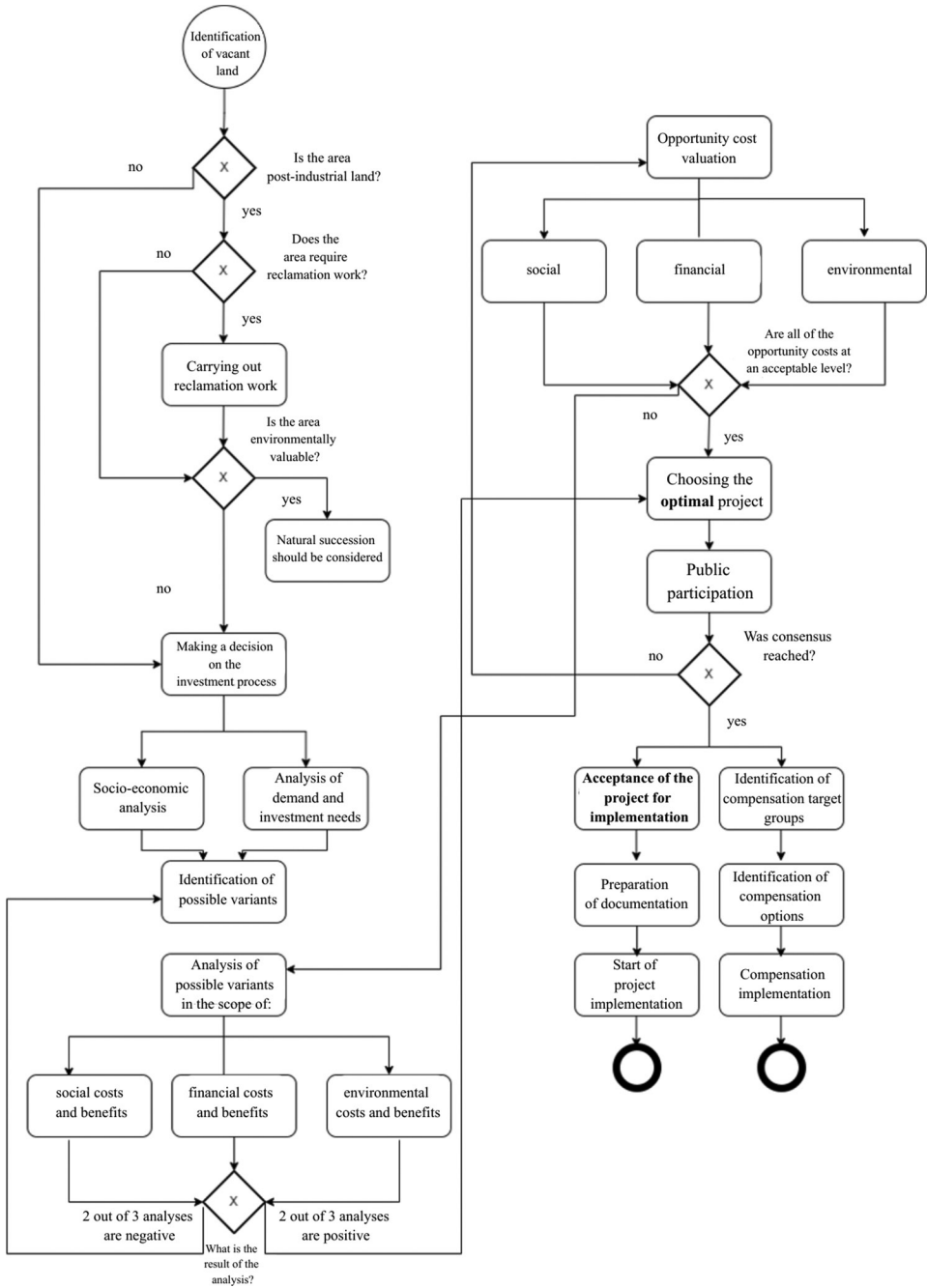


Fig. 1. The decision-making process concerning land use – a model procedure
Source: own elaboration.

reached to proceed to the project acceptance stage. A situation where the local community categorically refuses to consent to such measures should prompt a reassessment of alternative costs to verify whether there is a variant with compensation that is more acceptable to residents. The procedure is repeated until a consensus is reached. Then, when the project is handed over for implementation, followed by the preparation of documentation and its commencement, the process of paying compensation should be started simultaneously. At this stage, it is crucial to identify the stakeholder groups that should receive compensation and to define the forms of compensation.

According to the assumptions of the presented model, the project will be fully economically effective if, at the time of its commencement, its alternative cost is zero. However, this situation is impossible to achieve, as there is an alternative for every choice. Considering the possibility of compensation payments for determining and valuing the alternative cost significantly completes the picture of the planned investments, thus providing an opportunity to make decisions in the light of striving for economically optimal choices. The presented model shows a model of actions in the decision-making process regarding land development in a new light – not as a condition for obtaining external funding and a necessity to be presented in the project documentation, but as a tool enabling the most optimal and economically effective decision to be made. The proposed approach, which involves conducting a cost-benefit analysis for all the options under consideration and evaluating the alternative costs of the selected option in relation to the others, is something of a novelty. Currently, cost-benefit analysis is only carried out for the option that will ultimately be implemented. According to the interviews conducted, it is usually carried out due to formal requirements when attempting to obtain external funding for a project.

Discussion

The local government units avoid conducting more complex analyses, limiting themselves to the minimum necessary, which is a conceptual design. Any additional analyses are carried out only if they are a prerequisite for the implementation of an investment or obtaining external financing. An important reason for this may be a lack of knowledge about how to carry out such analyses or a lack of awareness of their importance and benefits. An analysis of the documents shows that comprehensive analyses are carried out relatively rarely, almost exclusively in the case of large projects where they are a prerequisite. This situation leads to decisions being made based on fragmentary knowledge, which in the long term increases the risk of allocational inefficiency and contributes to high, unidentified external costs. Based on the analysis of the documents, it was found that all municipalities had analyzed the socio-economic environment, and almost all had taken into account public participation and analyzed investment demand and needs. Half of the respondents conducted a financial efficiency analysis, and only two municipalities enriched their documentation with analyses considering

social and environmental costs and benefits. This lack of analysis in non-market costs and benefits (social and environmental) is consistent with the classic problem of not considering external economic effects (Ligus 2010). It is crucial that only one municipality considered other scenarios alternative to the investment in its project. The practical lack of analysis of alternative options means that local government units are de facto unable to estimate or manage the opportunity cost, i.e. the value they are giving up in favor of the selected investment. Without a formal analysis of alternatives, these choices may be suboptimal, even if the selected projects are financially profitable. The above conclusions prove that the innovative approach proposed in this paper is not only theoretically justified (through the concept of opportunity cost) but is also urgently required by spatial planning practice in Poland. The BPMN model formalizes and enforces two missing elements: systematic analysis of all possible scenarios (alternative options) and integration of a decision gate based on verification of an acceptable level of opportunity cost, which translates economic theory into a decision-making procedure. As a result, the decision-making process moves from the level of minimum compliance with formal requirements to the level of striving for full economic efficiency in social and environmental terms.

Conclusions

The aim of this study was to design and justify a model for the decision-making process in land development that formally considers opportunity cost. The literature review confirmed that the traditional approach to analyzing the economic efficiency of investment projects, especially in the public sector, often suffers from a lack of systematic quantification of non-market values and neglects lost value (Mitchell, Carson 1989, Boardman et al. 2001). Empirical research conducted among local government units in the Silesian Province clearly showed that practice rarely goes beyond the formal minimum, focusing on the analyses required to obtain financing, with minimal consideration of social and environmental costs and benefits. A crucial empirical gap was found to be the fact that only one of the municipalities surveyed considered other, alternative investment scenarios. The findings indicate that current decision-making processes do not systematically incorporate the estimation and management of opportunity costs. In response to this gap, the proprietary model developed, visualized using BPMN notation, brings key elements to the decision-making process. The basic one is the formalization of the opportunity cost as a decision-making criterion, which integrates it not as a theoretical postulate, but as an obligatory decision gate (Exclusive Gateway), conditioning the transition of the project to implementation and requiring the quantification of the lost value of the best alternative (social, financial and environmental) using environmental economics methods (e.g. CVM). The model also introduces multidimensional verification, including qualification based on cost-benefit analysis (2/3 positive analyses), qualification based on an acceptable level of alternative cost, and qualification based on social

consensus (social participation). As a result, the model shifts the focus from striving for financial profitability to striving for full economic efficiency, understood as minimizing losses (opportunity costs) to society and the environment. The model assumes that a project is fully effective when compensation for the accepted opportunity cost is included in the implementation cost. The proposed model provides valuable methodological guidance for local government units, offering them a more transparent and holistic tool for making decisions on land allocation. The conclusions should be interpreted in the context of the qualitative and exploratory nature of the study. Further research should focus on validating the model through a detailed case study in which the model is applied to a real project, and on simplifying the valuation tools to facilitate preliminary, rapid estimation of opportunity costs and economic efficiency by decision-makers.

Conflict of interest

The author declares no conflicts of interest and assures that the work is the result of her own creation.

Literatura / References

- Acemoglu D., Robinson J.A., Laibson D. 2016. *Macroeconomics (Global Edition)*. Pearson, p. 36–38.
- Adler P.A., Adler P. 2012. How many qualitative interviews is enough? [In:] S.E. Baker, R. Edwards (eds.), *How many qualitative interviews is enough? Expert voices and early career reflections on sampling and cases in qualitative research*. ESRC National Centre for Research Methods, University of Southampton, p. 8–11.
- Appelt K. 2018. *Aequalitas Valorisin Menger's Theory of the Commodity Exchange*. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H, Oeconomia*, 52(1): 9–12.
- Belton V., Stewart T.J. 2002. *Multiple Criteria Decision Analysis: An Integrated Approach*. Kluwer Academic Publishers.
- Boardman A.E., Greenberg D.H., Vining A.R., Weimer D.L. 2001. *Cost-benefit Analysis: Concepts and Practice*. Prentice Hall, p. 29.
- Buchanan J.M. 1999. *The Collected Works of James M. Buchanan: An Inquiry in Economic Theory*. Liberty Fund.
- Cannon C., Goldsmith K., Roux C. 2019. A self-regulatory model of resource scarcity. *Journal of Consumer Psychology*, 29(1): 104–127.
- Charmaz K. 2009. *Teoria ugruntowana. Praktyczny przewodnik po analizie jakościowej*. Wydawnictwo Naukowe PWN, p. 60–79.
- Ciszewski T., Nowakowski W. 2017. Analysis of the cost of existence using the example of a railway crossing security system. *TTS Technika Transportu Szybowego*, 24(12): 149–154.
- Colander D. 2014. *Economics*. 10th ed. McGraw-Hill/Irwin.
- Creswell J.W. 2007. *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications, p. 12.
- Czakon W., Glinka B. 2021. *Foundations of Qualitative Research*. Polskie Wydawnictwo Ekonomiczne, p. 57–62.
- Drobniak A. 2001. Evaluation of public projects with cost-benefit analysis. *Gospodarka Narodowa*, 172(11–12): 52–68.
- Domanowska M. 2010. Problematyka definiowania przestrzeni zdegradowanych. *Problemy Rozwoju Miast*, 2: 81–87.

- Domański B. 2000. Restrukturyzacja terenów przemysłowych w miastach. [In:] Z. Ziobrowski et al. (eds.), *Odnowa miast. Rewitalizacja, rehabilitacja, restrukturyzacja*. Instytut Gospodarki Przemysłowej i Komunalnej, Wydawnictwo Politechniki Śląskiej, p. 107–140.
- Frank R.H., Bernanke B.S. 2012. *Principles of Economics*. 5th ed. McGraw-Hill/Irwin.
- Freeman A.M. 2003. *The Measurement of Environmental and Resource Values: Theory and Methods*. 2nd ed. Resources for the Future.
- Gasidło K. 1998. *Problemy przekształceń terenów przemysłowych*. Wydawnictwo Politechniki Śląskiej.
- Guest G., Bunce A., Johnson L. 2006. How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, 18(1): 59–82.
- Haghpour B., Donnelly G.E., Bettman J.R., Luce M.F. 2022. Opportunity cost in consumer behavior: Definitions, operationalizations, and ambiguities. *International Journal of Consumer Studies*, 46(5): 1942–1959.
- Hubbard R.G., O'Brien A.P. 2012. *Economics*. 4th ed. Pearson Education.
- Janik M. 2014. The Austrian School of Economics and its representatives. *Roczniki Ekonomii i Zarządzania*, 6(2): 43–75.
- Krugman P., Wells R. 2020. *Microeconomics*. Wydawnictwo Naukowe PWN, p. 414–415.
- Księżyk M. 2012. *Ekonomia: podejście historyczne i perspektywne*. Krakowskie Towarzystwo Edukacyjne – Oficyna Wydawnicza AFM, p. 57–60, 95–99.
- Ligus M. 2010. Social costs and benefits in assessing the economic efficiency of energy management at the local level. [In:] *Efficiency – considerations on essence and measurement*. Scientific Papers of the University of Economics in Wrocław, 144: 268–288.
- Malczewski J. 1999. *GIS and Multicriteria Decision Analysis*. John Wiley & Sons.
- Mankiw G., Taylor M. 2021. *Microeconomics*. 2nd ed. Polskie Wydawnictwo Ekonomiczne, p. 342–353.
- Mason M. 2010. Sample size and saturation in PhD studies using qualitative interviews. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 11.
- McConnell C.R., Brue S.L., Flynn S.M. 2012. *Economics*. 19th ed. McGraw-Hill/Irwin.
- Menger C. 2013. *Principles of Economics*. Fijorr Publishing Company, p. 113–141.
- Mitchell R.C., Carson R.T. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future.
- Musiał G. 2010. *Foundations of Microeconomic Science*. Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, p. 43.
- Pancewicz A. 2012. *Przyrodnicza rewitalizacja terenów przemysłowych*. *Architektura – Czasopismo Techniczne*, 12: 313–317.
- Parkin M. 2016. Opportunity cost: A reexamination. *The Journal of Economic Education*, 47(1): 12–22.
- Polak P. 2019. Use of BPMN diagrams to describe relations between citizens and public administration institutions. *Zeszyty Naukowe Politechniki Częstochowskiej*, 33: 201–213.
- Rizun M. 2021. *Knowledge modelling for shaping an individual study profile*. Thesis.
- Samuelson P., Nordhaus W. 2012. *Economics*. Dom Wydawniczy Rebis, p. 782–804.
- Shi X., Li F., Chumnumpan P. 2020. The use of product scarcity in marketing. *European Journal of Marketing*, 54(2): 380–418.
- Słodczyk J. 2003. *Przestrzeń miasta i jej przeobrażenia*. Studia i Monografie Uniwersytetu Opolskiego.
- Sun H., Teichert T. 2024. Scarcity in today's consumer markets: Scoping the research landscape by author keywords. *Management Review Quarterly*, 74: 93–120.
- Żytniewski M., Zadora M. 2013. Business process modelling using BPMN notation. *Studia Ekonomiczne/Uniwersytet Ekonomiczny w Katowicach*, 128: 195–210.

Modelowanie procesu decyzyjnego zagospodarowania terenów z uwzględnieniem kosztów alternatywnych

Zarys treści: Celem artykułu jest zaproponowanie modelowego podejścia w procesie decyzyjnym dotyczącym zagospodarowania terenów, które formalnie uwzględnia koszty alternatywne. W badaniu

wykorzystano analizę dokumentów i notację BPMN do opracowania innowacyjnego modelu, bazując na doświadczeniach gmin województwa śląskiego. Określono kluczowe etapy, w tym analizę efektywności finansowej, ekonomicznej (koszty/korzyści społeczne) oraz środowiskowej (koszty/korzyści ekologiczne), a także systematyczną analizę opcji alternatywnych. Model wprowadza bramkę decyzyjną opartą na akceptowalnym poziomie skwantyfikowanych kosztów alternatywnych. Badanie dostarcza decydom praktycznego frameworku dla bardziej optymalnego i zrównoważonego planowania przestrzennego.

Słowa kluczowe: koszty alternatywne, zarządzanie gruntami, modelowanie podejmowania decyzji, koszty społeczne, koszty środowiskowe

Data przekazania tekstu: 24.11.2025; data zaakceptowania tekstu: 12.05.2026.

Article submitted: 24.11.2025; article accepted: 12.05.2026.