Sustainable Futures 5 (2023) 100104

Contents lists available at ScienceDirect

Sustainable Futures

journal homepage: www.sciencedirect.com/journal/sustainable-futures

Stochastic financial evaluation: The case of an intermodal terminal

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ARTICLE INFO

Keywords:
Intermodal transportation
Intermodal terminal
Stochastic analysis
Net present value
Internal rate of return
Benefit-cost ratio

ABSTRACT

Intermodal terminals (IMTs) have significant importance in logistics networks whose development enables the implementation of intermodal transportation technologies and participation in international goods flows. Developing IMT contributes to the greater use of intermodal transportation thus contributing to sustainability. To stimulate stakeholders to participate in such projects, they need to be proven economically sustainable as well. This article analyzes the financial risks of investing into an IMT in Belgrade (Republic of Serbia). The scientific contribution of the article is in being the first to use a stochastic financial evaluation model for assessing the development of an IMT. The article analyzes the financial risk probability over real-world data, considering the stochastic nature of container flow volumes and the prices of logistics services. The risk probability, as an output result of the used simulation model, is derived from the probability distribution of three distinct financial parameters – net present value (NPV), internal rate of return (IRR), and the benefit-cost ratio (B/C). The results of the analysis indicate that the development of the IMT is financially justified, with relatively low investment risk.

1. Introduction

The development of logistics systems is the key to achieving regional competitiveness, economic prosperity, and sustainable development [1]. The growth of living standards and the individualization of customer demands caused the need for developing and managing efficient logistics systems. Furthermore, the ongoing global trend is to strive towards the reduction of road transportation involvement in the overall freight transport by a modal shift towards more eco-friendly transportation modes – such as rail and inland waterway transportation modes. Obviously, intermodal transportation stands out as a sustainable development direction of regional, European, and global logistics networks [2].

To ensure the sustainability of intermodal systems, it is necessary to develop appropriate infrastructure, whose key elements are intermodal terminals (IMTs) [3]. Determining the location, subsystem structure, and the role of IMTs represent some fundamental problems that require attention while modeling intermodal networks [4] and their solving should be executed in the context of financial and economic assessment. Despite the fact that developing IMTs contributes to all three sustainability pillars (economic, environmental, and social), proving their economic sustainability is still the main driving force for public and private investors to engage in such projects. The existing literature in the domain of assessing the sustainability of intermodal transportation projects fails to incorporate the stochastic nature of supply chains, especially in the domain of economic assessment.

This article uses a stochastic financial evaluation model for assessing the development of an IMT and fulfills the existing literature gap in the domain. For the first time, a thorough financial analysis is performed through three different financial parameters – net present value (NPV), internal rate of return (IRR), and the benefit-cost ratio. A case study for an IMT in Belgrade (Serbia) is performed to demonstrate the approach. By applying the simulation-analytical model the probability distributions of observed parameters are derived. Based on those distributions, the investment risk of the IMT is determined. Having all this in mind, the main contribution of this article is in being the first one to financially assess IMT development in a stochastic environment for real-world terminal development data.

The article is organized into seven sections. The next section presents a short literature review of intermodal transportation, the funding of intermodal transportation projects, modeling IMTs and the stochastic approach to solving problems in that area. Section 3 explains the stochastic approach used for the analysis. Section 4 presents the case study for which the financial assessment is performed. Section 5 presents the

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https://doi.org/10.1016/j.sftr.2022.100104
Received 27 June 2022; Received in revised form 28 November 2022; Accepted 13 December 2022
Available online 14 December 2022
2666-1888/

result analysis while Section 6 contains the discussion of the obtained results. In the end, the concluding section is presented.

2. Literature review

"Intermodal transportation represents the movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes" [5]. Intermodal transportation stands out as one of the key factors for achieving sustainable development due to the numerous positive effects that follow its application [6]. Some of the most visible effects of its application are the reduction of energy use, time, costs and negative environmental effects of transport.

The developed countries of the European Union (EU) have institutionalized intermodal transportation and have established appropriate funding models for the projects of intermodal transportation [7]. In contrast to the western and northern parts of Europe, southern and southeastern Europe falls back greatly in terms of the development stage of intermodal transportation [1]. The integration of countries into the European logistics and transportation system and sustainable realization of international (regional and intercontinental) goods flows is not possible without the application of intermodal technologies.

IMTs, as one of the main subsystems of intermodal transportation, represent facilities where intermodal units' storage and transshipment between different transportation modes takes place [8]. IMTs are vital nodes of every intermodal network and they stand out as important catalysts of regional sustainable development. This means that the efficiency, and so the sustainability, of the whole intermodal network depends on the efficiency of IMTs.

Logistics networks are systems in which the network nodes, together with links between nodes, form the physical and organizational structure. The links between nodes are established through various transportation modes. In general, the nodes of a logistics network represent the origins and final destinations of goods flows, and they can be facilities, warehouses, logistics centers, IMTs, ports, etc. [9]. The links between network nodes are established with road or rail infrastructure, or via inland waterways. IMTs are the main elements of intermodal networks and they can differ in their function, role, subsystems, users, applied technologies, etc. [8].

Regions that do not possess appropriate logistics infrastructure and which are not included in an intermodal network become uncompetitive in the logistics service market. The trade of these regions is penalized, which leads to the dislocation of goods and services into better-serviced regions [10]. Infrastructural investments are of vital importance for the development of logistics infrastructure and so for the economic activity of a state/country/region as well.

The development of IMTs is followed by high investments and long construction periods, as well as a low return rate of the investments. Having this in mind, it is obvious that individual engagement of the private sector in this area is rare. During the development of intermodal systems, large amounts of funding and subsidies are required before any profits begin to happen. Therefore state intervention is required when developing intermodal networks [11]. High investments and potential investment risks stimulate public-private partnerships (PPP) in funding the projects of intermodal transportation.

PPP refers to different collaboration forms of public authorities and the private sector with the goal of funding, construction, restoration, management, and maintenance of infrastructure or providing services [12]. The forming of PPP is a result of recognizing the gains from joining financial assets, knowledge, and skills with the goal of improving certain activities or services. Through PPP, the public and private sectors share costs, risks, responsibilities, and benefits [13]. The main motive for the private sector for joining a PPP for the projects of intermodal transportation is better opportunities for offering a wider set of logistics services and a larger profit, while the state gains modal shift (from road to rail/inland waterway modes) and stimulates regional sustainable development.

Defining an appropriate PPP model is a complex task when developing IMTs. The public sector has to define the partnership model in a way to minimize uncertainties and risks, but at the same time, to make it attractive for the private sector [14]. Defining a PPP represents a serious challenge for developing countries because they lack collaboration experience between the public and private sectors in the projects of intermodal transportation.

Many scientific articles are trying to prove justified the broader application of intermodal transportation. Many of them focus on the operational benefits and thus conduct various financially-oriented analyses. In the paper [15], the problem of selecting the appropriate scenario for revitalizing an obsolete IMT is solved. The article considers various economic criteria and uses the TOPSIS method to rank the scenarios. The article [16] analyzes the impact of different government policies on the competitiveness of intermodal transportation in Belgium. Other articles, such as [17,18] analyze how operational costs, internalization of externalities, and fuel prices impact the attractiveness of intermodal transportation. Wiegmanns and Behdani, in their article [11], analyze the investment costs and their structure for IMTs.

The literature regarding modeling IMT is scarce and it is mostly focused on modeling intermodal networks. The article [19] proposes a methodology for prioritization of IMT development features. The developed design procedure considered the needs of various stakeholders and the principles of sustainable development. The article [20] combines different structural elements in defining typical inland IMT types and the selection of the most efficient. A stochastic simulation approach was used in [21] to evaluate and select the main parameters that would lead to a sustainable state of the investigated IMT. The article has taken into account the environmental factors and the impact intensity between the considered parameters. A simulation approach was used in the article [22] to investigate the impact of IMT layout on its economic and environmental performance.

A large number of external factors that influence the realization of intermodal chains and their complexity give the problems of intermodal transportation stochastic traits. Several articles incorporate stochastic variables in solving problems of intermodal transportation, for example [23,24,25]. Simulation stands out as an appropriate tool for solving problems of intermodal transportation in such, stochastic conditions [26]. In the existing literature, simulation has been used for solving various problems in the field of intermodal transportation, such as locating IMTs [27], modeling intermodal networks [28], allocating resources in intermodal systems [29], container flow volumes prediction [30], terminal capacity dimensioning [31], etc.

The article [32] conducts a financial analysis of developing an IMT in Belgrade but in a deterministic environment. It is concluded that the development of an IMT is financially justified, but the authors point out that analysis in a stochastic environment is necessary in order to determine the investment risks in such a project. The article has shown that the financial justification of developing an IMT is more sensitive to the changes in container flow volumes than to the changes in terminal service charges. The article [33] analyzes different development scenarios of an IMT in Bucharest, where the scenarios differ in the terminal services. There is no article that conducts a thorough financial analysis of an IMT in a stochastic environment that considers multiple financial parameters.

This article uses a simulation model to determine the investment risks of an IMT in Belgrade from the aspect of three different financial parameters – NPV, IRR, and B/C. The analysis is inspired by some of the existing ideas of stochastic financial analysis in the literature counducted for case studies outside the field of logistics [34,35]. In contrast with the article [33] where only terminal service prices are a variable, this article considers also variable container flow volumes. Based on the container flow volumes and terminal service prices, the financial flows of the terminal are determined and so are the probability distributions of the observed parameters as well.

3. Stochastic approach in the financial analysis of an IMT development

When designing logistics systems, stochastic factors that mostly have an impact on the system are demand characteristics which refer to the type, assortment, and the quantity of goods, demanded delivery time, the service itself, etc. It is not unusual for a logistics system to be unable to serve all the demands because of the lack of capacities or to have wasted capital due to underutilized capacities. These situations are mostly the consequence of inadequate understanding of factors that impact the development and exploitation of a logistics system.

In the context of intermodal transportation, container flows volume on a certain relation is a probabilistic variable. Despite that a trend line for container throughput could be identified and predicted, it is common for the volumes to deviate significantly from the predicted values. Considering the complexity of all the factors that influence these deviations, there is no model that could precisely determine the container flow nature over a longer time period. Furthermore, logistics service prices are also a variable category. Service prices of an IMT are tightly bound to the global and local state of the economy, and political circumstances, but also to the competition in the logistics services market.

The traditional approach to calculating financial parameters does not take into account the stochastic nature of all the factors that impact their value. Therefore, a simulation is recognized as a suitable method for calculating the financial parameters' value in a stochastic environment. The stochastic approach to determining financial parameter value enables the decision-maker better insights into the investment risks of a project [30]. In stochastic approaches for determining financial parameters, with probability distributions as input data, the output results (financial parameters) are also in the form of probability distributions [31]. Three different financial parameters are considered in this article – NPV, IRR, and B/C.

NPV takes into consideration the time value of assets. Its calculation includes the discount of all future asset inflows and outflows. A positive NPV indicates that a project should be accepted, or refused in the case when NPV is negative. The NPV is calculated according to [36]:

$$NSV = \sum_{t=0}^{n} \frac{NT_t}{(1+i)^t} \tag{1}$$

where NT_t represents the asset flow on the end of the period *t*, *i* represent the discount rate of the project, while *n* represents the time period for which the analysis is performed.

IRR represents the discount rate for which the NPV of the project equals zero. Projects are financially acceptable when the value of IRR is greater than the actual interest rate. IRR is calculated according to [36]:

$$\sum_{t=0}^{n} \frac{NT_t}{(1+IRR)} - I_o = 0 \tag{2}$$

where NT_t represents the asset flow on the end of the period *t*, *n* represents the time period for which the analysis is performed, and I_0 represents the initial investments in the project.

B/C is determined by comparing the discounted values of benefits and costs so it represents the relation of present values of benefits and costs. An investment project is accepted if the value of B/C is equal or greater than 1. B/C can be determined by the following formula [36]:

$$B \Big/ C = \frac{DV_{benefits}}{DV_{costs}} \tag{3}$$

where $DV_{benefits}$ represents the discounted value of benefits, and DV_{costs} represents the discounted value of costs.

Stochastic approaches in the analysis of financial parameters of projects are already acknowledged in the existing literature [37,38,39]. There is no research that conducted stochastic financial analysis of an IMT. Considering the stochastic nature of all the factors that influence the costs and profits of an IMT, the input parameters and data are probability functions and therefore NPV, IRR, and B/C, as output parameters, are in the shape of probability distributions as well. Based on the probability distributions of the output parameters, the financial risks of the project can be easily determined.

For the financial evaluation of the IMT development a simulation model, based on the article [40], is developed. The model simulates the stochastic nature of all input parameters and determines the probability distributions for NSV, IRR, and B/C (Fig. 1). The model is run through a large number of iterations (100,000 times in this case). In all iterations, the asset flows for every individual year are estimated according to the simulated values of all the parameters that influence the incomes and costs of terminals. Based on the asset flows for all the years, the NPV, IRR and B/C are determined for every individual iteration. After completing all the iterations, the individual values of NPV, IRR and B/C are collected and statistically analyzed. The statistical analysis provides, as the end result, the probability distributions of those parameters. From these probability distributions, IMT development investment risks can be determined. From the aspect of NPV, the risk is represented as the probability that the project NPV value would be negative or equal to zero, while from the aspect of IRR, the risk is represented as the probability that the IRR value would be lesser than the project discount rate. According to B/C, the risk is represented as the probability that the B/C would take values below 1.

4. IMT in Belgrade and input data

The IMT in Belgrade (Batajnica, 15 km away from the city center) is the focus of this article analysis. The analysis is performed in the context of the data from [32,41] but in a stochastic environment. The data required for the analysis are expected yearly container throughput volumes and the predicted prices of terminal services. The predicted terminal container flow throughput volumes are presented in Table 1.

When designing any logistics center, a wrong assumption regarding the goods flows throughput volumes can lead to catastrophic consequences. The acceptance of any logistics-related project has to be accompanied by appropriate risk and sensitivity analyses. Considering the stochastic nature of goods flows through time, project financial analysis should also include possible parameter deviations from the predicted values. In this article, it is assumed that the expert predictions of container flow volumes would vary between −50% and +50%. Three container flow volumes deviation scenarios are considered: pessimistic, realistic, and optimistic (Fig. 2). For every scenario, a probability distribution of the flow volume deviation is defined. The occurrence probability for the realistic scenario is 0.4, while the occurrence probability for the other two scenarios is 0.3 for both. The probability distributions are experimentally defined because the lack of such data in the existing literature.

The development of the IMT in Belgrade is planned to be executed through two operational phases [41]. Both phases refer to specific type of construction works and require specific investments. Since the construction and development expenses of an IMT are extremely high, it is assumed that the private investor would take loans. All the data regarding the development phases, their dynamics, required investments, loan repayment, and other assumptions are taken from [41] and are explained in detail in the article [32].

Terminal service prices directly impact the amount of profits during its exploitation cycle. Having in mind that all the factors that dictate terminal service prices are variable, it is assumed that the prices may vary over time as well. Basic terminal service prices are shown in Table 2. Inadequate assumption of future terminal service prices might form an unrealistic picture of expected profits. In this article, the terminal service prices might vary from the basic values in a predefined range. The probability distribution of terminal service prices deviation is experimentally defined and presented in Fig. 3.

Annual IMT expenses can be divided into fixed and variable expenses

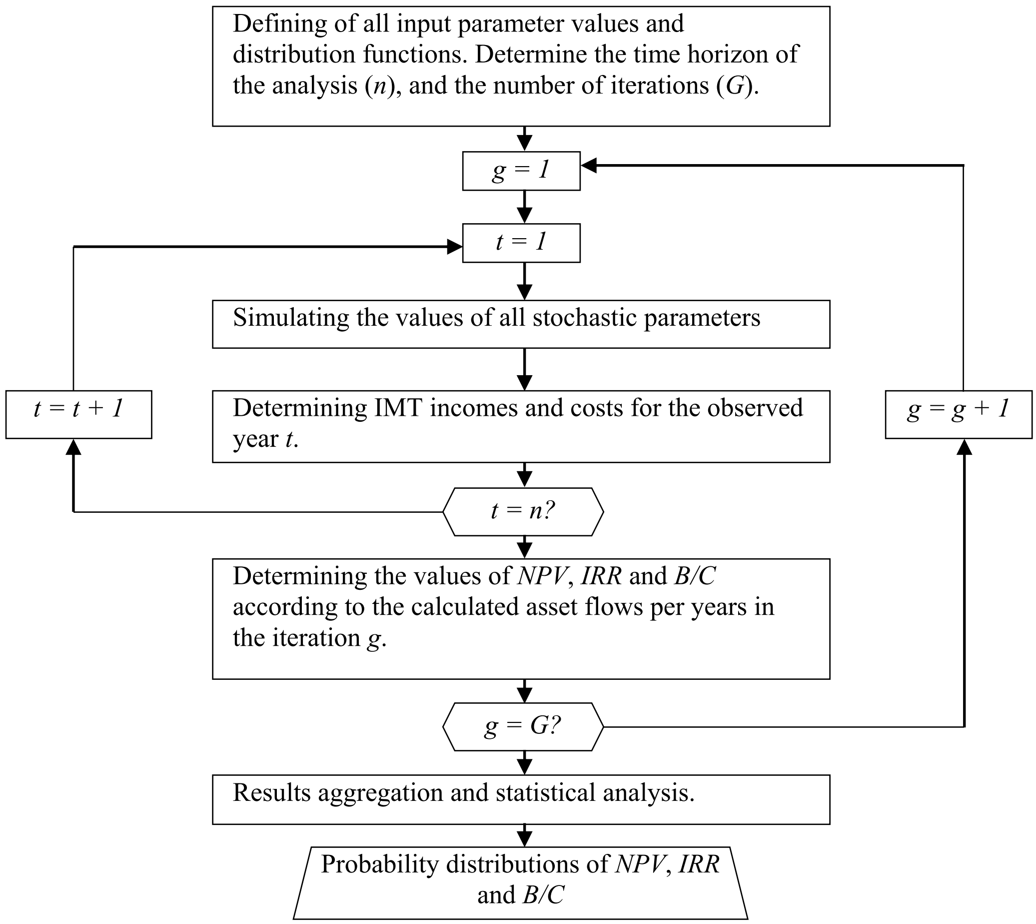

Fig. 1. Conceptual representation of the simulation model.

Table 1
Predicted container flow volume over time [32,41].

Year	Container throughput (TEUs)	Growth (%)	Year	Container throughput (TEUs)	Growth (%)
2013	0	0	*2028*	54,880	2.3
2014	3200	0	*2029*	61,040	11.2
2015	15,960	398.8	*2030*	65,520	7.3
2016	21,000	31.6	*2031*	70,611	7.8
2017	27,300	30	*2032*	74,055	4.9
2018	30,660	12.3	*2033*	77,499	4.7
2019	33,460	9.1	*2034*	80,943	4.4
2020	34,580	3.3	*2035*	84,387	4.3
2021	38,080	10.1	*2036*	87,831	4.1
2022	44,240	16.2	*2037*	91,275	3.9
2023	46,480	5.1	*2038*	94,719	3.8
2024	47,320	1.8	*2039*	98,163	3.6
2025	51,100	8	*2040*	101,607	3.5
2026	53,620	4.9	*2041*	105,051	3.4
2027	53,620	0	*2042*	108,495	3.3

(Table 3). All terminal exploitation profits and expenses are evaluated according to real-life and the [41] project data. It is assumed that the values of all costs that are not in any relation to container flow volumes and terminal services do not change over time.

5. Results

According to the simulation model, the NPV values range between −7 and 18 million € for a period of 30 years (Fig. 4). The most probable NPV (with a probability of 0.12) is 5 million €. The investment risk according to NPV is 11.3%. This risk is calculated as the sum of probabilities of all negative NPV values.

According to IRR, the results differ from those of NPV, but from the perspective of investment risks, they are the same since IRR and NPV are mathematically complementary parameters. The values of IRR are in the range between 1% and 18%, where the most probable value is 8% (with a probability of 0.22). As is the case with NPV, the investment risk is 11.3% (Fig. 5), which is the sum of all the probabilites of values lesser than 5% for the IRR.

The values of B/C are in the range between 0.9 and 1.3, while the most probable value is 1.1 (with a probability of 0.39). According to the probability distribution of B/C, the investment risk is 6.81% (Fig. 6). This is derived from the sum of probabilities where B/C had the value bellow 1.

The results indicate that the investment risks in the IMT in Belgrade are relatively low for all three financial parameters. The investment risk according to NPV and IRR is 11.3% and 6.81% according to B/C. This implies that the development of such an intermodal terminal is financially justified in the case of Belgrade.

6. Discussion

This article is the first in the literature to address the financial analysis of an IMT under a stochastic environment, through three different financial parameters. The approach used in this article can help decision-makers in performing stochastic financial analyses, not only for IMTs but also for any kind of logistics project that involves stochastic input parameters (which is almost always the case in logistics). Furthermore, the application of such models could help the decision-makers to identify and define sustainable PPPs, where the risk of

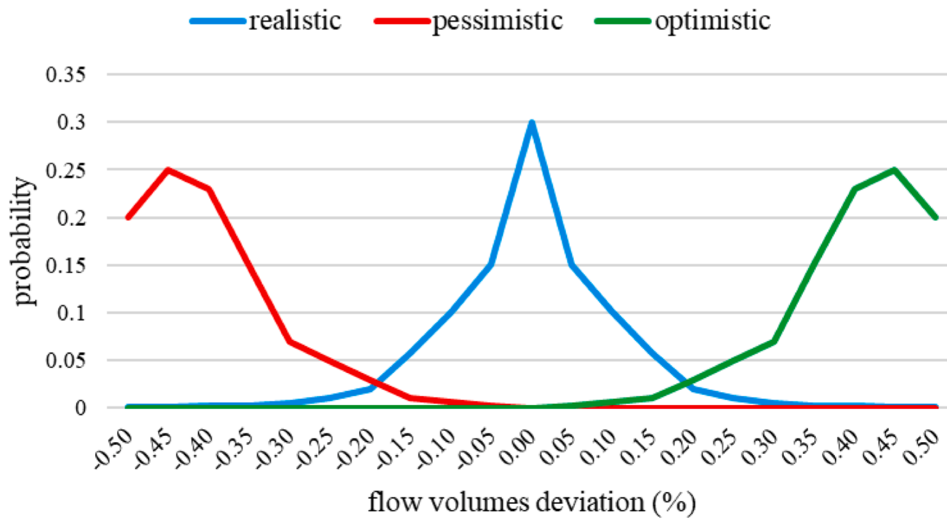

Fig. 2. Container flow volumes deviation scenarios.

Table 2
IMT services prices [32,41].

Service *Manipulation with ITUs*	*Price* 39 €/manipulation			*Service* *Road transportation planning*	*Price* In the boundaries of the logistics zone	On the territory of Belgrade	Outside of Belgrade
ITU storage	First three days for importing containers and one day for exporting containers is this service free of charge	For containers	For EITUs	*Road transportation planning*	80 €	144 €	190 €
	Storage for the next 5 days	16 €/day	29 €/day	*Parking*	First two hours	After the first two hours	
	Storage for the next 2 days	34 €/day	68 €/day		Free of charge	7.5 €/h	
	Storage for the next 2 days	57 €/day	99 €/day	*Cancelling fees*	85 €/cancelation		
Specialized ITU storage	Additional 30% on the prices for standard ITUs			*Container inspection fees*	17 €/container		

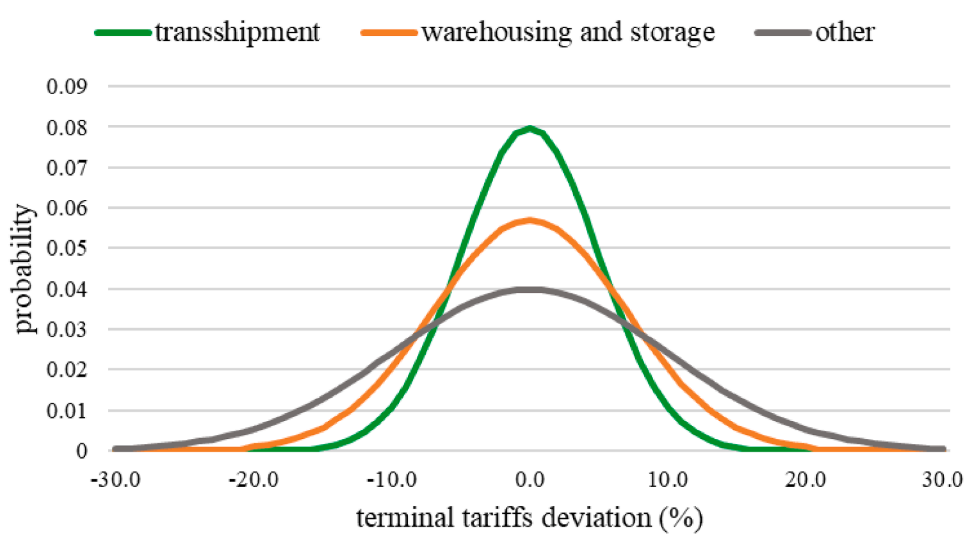

Fig. 3. Probability distribution of possible terminal service prices deviation.

investment is minimized for all participants. By defining multiple different scenarios of project development timeline, structure, and involved stakeholders, using such models could help determine the development direction with minimal investment risks.

Every terminal subsistem generates costs (investment and exploitation costs) as well as revenues. This means that the outcome of every financial analysis firstly depends on the structure of IMT services. A stochastic financial evaluation approach can also help determine the best structure of IMT services. The outcome of such analysis would give managerial insights into modeling the structure of IMT terminals under

Table 3
IMT fixed and variable expenses [32,41].

Fixed expenses	*Expenses*	*Variable expenses*	*Expenses*
Energy, telecommunications, Internet	30,000 €/year	*Personnel salaries and expenses*	17,155 €/employee
Office equipment	22,500 €/year	*Manager salaries and expenses*	32,740 €/employee
Service insurance and taxes	57,500 €/year	*Annual training, control and inspection costs*	10% of employee costs
Fixed maintenance costs	333,000 €/year	*ITU manipulation electricity expenses*	1.45 €/ITU
Freight village developer fees	160,000 €/year	*Road transportation planning expenses*	100 €/truck

uncertainty and help them in making appropriate decisions which are necessary when developing sustainable IMT systems.

The direction of future research is in incorporating such models in the processes of logistics networks modeling, to ensure maximal profitability of all developed network elements, with minimized competitive disadvantages and risks. Models that also incorporate other sustainability criteria (environmental and social) should be developed to make the decision-making processes in logistics aligned with all three pillars of sustainability.

The probability distributions of container throughput deviation and terminal service prices deviation are experimentally defined because the lack of such data in the scientific literature but also due the uncertainties from the aspects of globalization, global trade flows and disrupting events (political crises, global pandemics, etc.). More efforts should be focused on a long-term analysis of all stochastic factors that influence the development of logistics projects because their understanding is vital for conducting analysis such as the one presented in this work. Case studies of real-life examples should be studied and examined to determine all scenarios and their probability distributions more accurately.

7. Conclusion

This article presented a stochastic financial analysis of an IMT in Belgrade. The analysis is performed in the context of three different

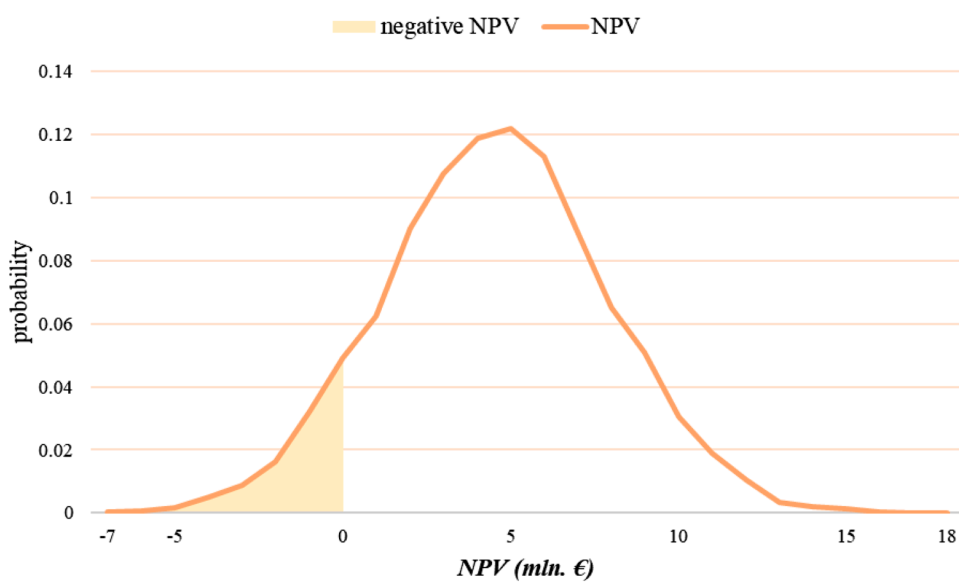

Fig. 4. NPV probability distribution.

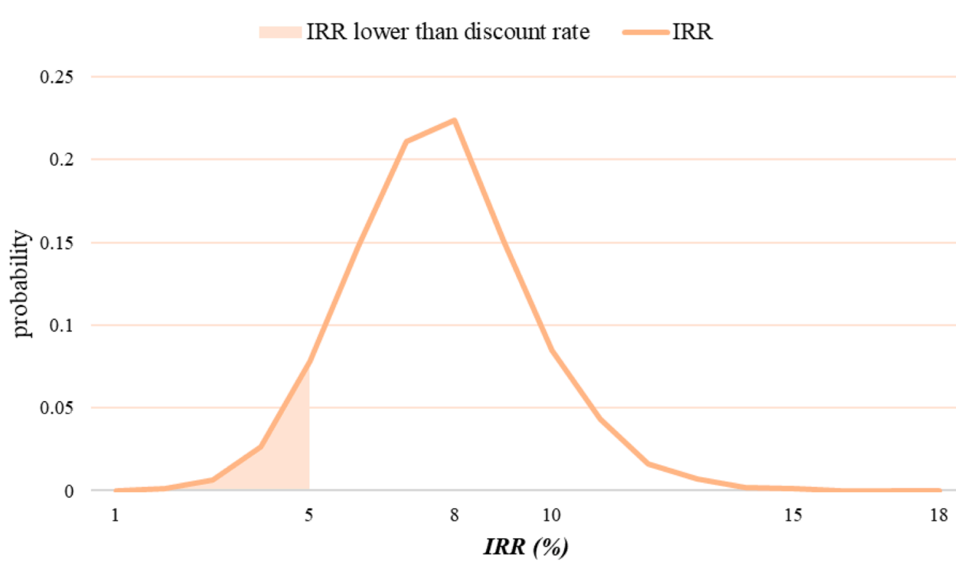

Fig. 5. IRR probability distribution.

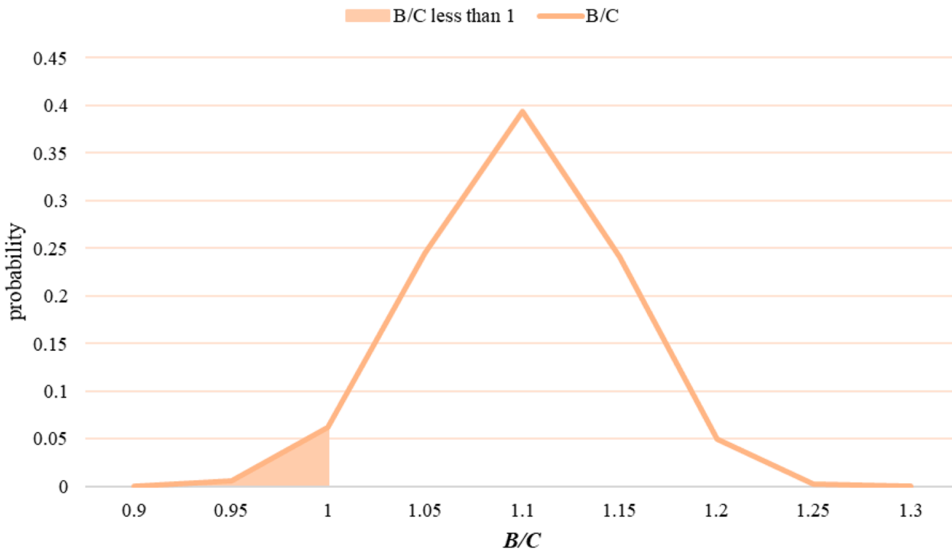

Fig. 6. B/C probability distribution.

parameters – NPV, IRR, and B/C. A stochastic approach is applied in determining the values of the parameters. Considering the dynamic and stochastic nature of the input parameters and data, the output results are in the shape of probability distributions.

The analysis of the results shows that the development of an IMT in Belgrade is financially justified. The investment risk, according to NPV and IRR is 11.3%, while according to B/C the investment risk is 6.81%. The most probable NPV is 5 million €, while the most probable IRR is 8%. The value of B/C with the greatest probability is 1.1.

Considering the results, it can be stated that the development of an IMT in Belgrade is financially justified, with relatively low investment risk. The direction of future research could be in the analysis of the effects that the development of an intermodal system would result in, especially on the economic growth of a country/region. Of course, that should be preceded by a more detailed analysis of the required number of terminals, their location, structure, etc. One of the directions could also be in the analysis of intermodal technologies that justify its system development and application in developing countries and regions.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

[1] S. Tadić, M. Kovač, M. Krstić, V. Roso, N. Brnjac, The selection of intermodal transport system scenarios in the function of Southeastern Europe regional development, Sustainability 13 (10) (2021) 5590.
[2] E. Göçmen, R. Erol, The problem of sustainable intermodal transportation: a case study of an international logistics company, Turkey. Sustainability 10 (11) (2018) 4268.
[3] J. Ližbetin, Methodology for determining the location of intermodal transport terminals for the development of sustainable transport systems: a case study from Slovakia, Sustainability 11 (5) (2019) 1230.
[4] A. Caris, C. Macharis, G.K. Janssens, Planning problems in intermodal freight transport: accomplishments and prospects, Transp. Plann. Techol. 31 (3) (2008) 277–302.
[5] ECMT - European Conference of Ministers of Transport. Terminology on combined transport, http://www.unece.org/fileadmin/DAM/trans/wp24/documents/term.pdf; 2001 [accessed 11 February 2022].
[6] P. Kelle, J. Song, M. Jin, H. Schneider, C Claypool, Evaluation of operational and environmental sustainability tradeoffs in multimodal freight transportation planning, Int. J. Prod. Econ. 209 (2019) 411–420.
[7] S. Tadić, S. Zečević, D. Milenković, Intermodal transport treatment in developed and developing countries, Tehnika 67 (6) (2017) 897–902.
[8] M. Krstić, Modelling the Structure of Intermodal Terminals, University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia, 2019. Doctoral dissertation.
[9] M. Janic, Modelling the full costs of an intermodal and road freight transport network, Transp. Res. Part D 12 (2007) 33–44.
[10] J. Monios, Intermodal transport as a regional development strategy: the case of Italian freight villages, Growth Change 47 (3) (2015) 363–377.
[11] B. Wiegmans, B. Behdani, A review and analysis of the investment in, and cost structure of intermodal rail terminals, Transp. Rev. 38 (1) (2017) 1–19.
[12] E.C .- European Commission. A cleaner, greener Europe. LIFE and the European Union waste policy. Publications Office of the European Union, Luxembourg; 2004.
[13] W. Ittmann, Private-public partnerships: a mechanism for freight transport infrastructure delivery, J. Transp. Supply Chain Manag. 11 (2017) 1–13.
[14] L. Nguyen, T. Notteboom, Public-private partnership model selection for dry port development: an application to Vietnam, World Rev. Intermodal Transp. Res. 6 (3) (2017) 229–250.
[15] J. Ližbetin, O. Stopka, Application of specific mathematical methods in the context of revitalization of defunct intermodal transport terminal: a case study, Sustainability 12 (6) (2020) 2295.
[16] B.F. Santos, S. Limbourg, J.S. Carreira, The impact of transport policies on railroad intermodal freight competitiveness – The case of Belgium, Transp. Res. Part D 34 (2015) 230–244.
[17] C. Macharis, E. Van Hoeck, E. Pekin, T Van Lier, A decision analysis framework for intermodal transport: comparing fuel price increases and the internalisation of external costs, Transp. Res. Part A 44 (7) (2010) 550–561.
[18] M. Mostert, A. Caris, S. Limbourg, Road and intermodal transport performance: the impact of operational costs and air pollution external costs, Res. Transp. Bus. Manag. 23 (2017) 75–85.
[19] S. Tadić, M. Krstić, V. Roso, N. Brnjac, Planning an intermodal terminal for the sustainable transport networks, Sustainability 11 (15) (2019) 4102.
[20] S. Tadić, M. Krstić, N. Brnjac, Selection of efficient types of inland intermodal terminals, J. Transp. Geo. 78 (2019) 170–180.
[21] D. Muvarev, H. Hu, A. Rakhmangulov, P. Mishurkov, Multi-agent optimization of the intermodal terminal main parameters by using AnyLogic simulation platform: case study on the Ningbo-Zhoushan port, Int. J. Inf. Manag. 57 (2020), 102133.
[22] T. Abu-Aisha, M. Ouhimmou, M. Paquet, A simulation approach towards a sustainable and efficient container terminal layout design, J. Int. Marit. Safety 5 (4) (2021) 147–160.
[23] R. Wang, K. Yang, L. Yang, Z. Gao, Modeling and optimization of a road-rail intermodal transport system under uncertain information, Eng. Appl. Artificial Intell. 72 (2018) 423–436.
[24] W. Wang, X. Xu, Y. Jiang, Y. Xu, Z. Cao, S. Liu, Integrated scheduling of intermodal transportation with seaborne arrival uncertainty and carbon emission, Transp. Res. Part D 88 (2020), 102571.
[25] E. Demir, W. Burgholzer, M. Hrušovský, E. Arikan, W. Jammernegg, T Van Woensel, A green intermodal service network design problem with travel time uncertainty, Transp. Res. Part B 93 (2016) 789–807.
[26] T.G. Crainic, G. Perboli, M. Rosano, Simulation of intermodal freight transportation systems: a taxonomy, Eur. J. Operat. Res. 270 (2) (2018) 401–418.

[27] M. Vidović, S. Zečević, M. Kilibarda, J. Vlajić, N. Bjelić, S. Tadić, The p-hub model with hub-catchment areas, existing hubs, and simulation: a case study of Serbian intermodal terminals, Netw. Spat. Econom. 11 (2) (2011) 295–314.
[28] K. Yang, L. Yang, Z Gao, Planning and optimization of intermodal hub-and-spoke network under mixed uncertainty, Transp. Res. Part E 95 (2017) 248–266.
[29] H. Wang, X. Wang, X. Zhang, Dynamic resource allocation for intermodal freight transportation with network effects: approximation and algorithms, Transp. Res. Part B 99 (2017) 83–112.
[30] Q. Meng, S. Wang, Intermodal container flow simulation model and its applications, Transp. Res. Rec. 2224 (1) (2011) 35–41.
[31] E.D. Özkan, D. Nas, N. Güler, Capacity analysis of Ro-Ro terminals by using simulation modeling method, Asian J. Shipping Logist. 32 (3) (2016) 139–147.
[32] S. Tadić, J. Petrović-Vujačić, M. Kovač, Financial analysis of the intermodal terminal in Belgrade, Tehnika 70 (6) (2020) 782–789.
[33] R. Raicu, S. Raicu, M. Popa, D. Costescu, On the evaluation of urban logistics intermodal terminal projects, Procedia – Soc. Behav. Sci. 39 (2012) 726–738.
[34] S.S. Shaffie, S.H. Jaaman, Monte Carlo on net present value for capital investment in Malaysia, Procedia – Soc Behav Sci 219 (2016) 688–693.
[35] G. Tziralis, K. Kirytopoulos, A. Rentizelas, I.P. Tatsiopoulos, Holistic investment assessment: optimization, risk appraisal and decision making, Manag. Decis. Econom. 30 (6) (2009) 393–403.
[36] J. Petrović-Vujačić, S. Kaplanović, M. Miljković, Engineering Economy in Transport and Telecommunications (In Serbian), University of Belgrade, Faculty of Transport and Traffic Engineering, Belgrade, Serbia, 2019.
[37] F. Rezaei, A.A. Najafi, R. Ramezanian, E. Demeulemeester, Simulation-based priority rules for the stochastic resource-constrained net present value and risk problem, Comp. Ind. Eng. 160 (2021), 107607.
[38] A. Maravas, J.P. Pantouvakis, A new approach to studying net present value and the internal rate of return of engineering projects under uncertainty with three-dimensional graphs, Adv. Manag. Civ. Eng. Proj. (2018), 6108680.
[39] M. Nosrtapour, A. Nazerib, H. Meftahi, Fuzzy net present value for engineering analysis, Manag. Sci. Lett. 2 (6) (2012) 2153–2158.
[40] M.B. Zaman, D. Priyanta, F. Trisilo, Risk assessment in financial feasibility of tanker project using Monte Carlo simulation, Int. J. Marine Eng. Innov. Res. 1 (4) (2017) 303–316.
[41] EC Delegation to the Republic of Serbia. Facilitating intermodal transport in Serbia, Republic of Serbia (2012), 2010-2012.