

Improving the management of highway construction projects using BOT system for heavy vehicles: A case study in Diyala

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Abstract

Due to population growth, introduction of new technologies in the construction industry, political turmoil and mismanagement that have plagued all countries of the world, especially developing countries like Iraq, the demand for infrastructure development in developing countries has witnessed a sharp increase in recent times. Governments are no longer able to keep up with the pace of society development and meet its demands. As a result, it has become imperative for private sector partners to join the public sector in financing infrastructure projects and sharing the associated risks. Both BOT and PPP are two distinct financing models that have shown strong progress and great potential for growth in the infrastructure industry, in terms of project financing. This paper discusses the concept, content, functions, advantages and disadvantages of financing, applicability and evolution of the two financing models in our nation from the perspective of investment and government financing. In this study, the Khalis-Baghdad road was chosen as a case study, as this road witnessed heavy traffic and stops because it is one of the most important commercial roads entering the capital, Baghdad, from its northern entrance, which works as a commercial link and transports goods and commodities from northern Iraq and outside the capital or passes through the capital on its way to southern Iraq. Also, due to the lack of periodic maintenance of the road as a result of the heavy loads placed on it for long periods, which led to significant deterioration of the road, a proposed investment road was established that includes heavy vehicles and was analyzed economically. After applying the BOT system, the net present value reached 59,119,395,765 dinars and a B/C ratio of 2 after operating for 10 years. The results were very good, indicating the possibility of applying and implementing such projects with this contract system in Iraq.

Introduction:

Infrastructure development has a significant impact on the growth of urban sustainability as industrialization and urbanization continue to accelerate. However, funding and investment in urban development constitute a critical issue impeding our nation's progress. The administration has worked very hard in recent years to borrow money in order

to finish building infrastructure, which has left the city with a massive debt load. It is needed to expedite the reform of government financing of investment projects, enhance investment efficiency, draw social capital into the field of building urban infrastructure, and resolve the supply and demand paradoxically of capital during the phase of large-scale centralized construction, which must be a crucial concern in the government investment methods of construction. The government funding issue led to the development of the project finance model, which is represented by BOT and PPP. In contrast to the conventional finance approach, project financing has gained global acceptance and use. The project finance model is still in its early stages of exploration in developing countries, while it is well matured in advanced countries. [1].

BOT projects are by their very nature major financial commitments with complex organizational structures. The political, social, commercial, and legislative environment may all drastically change throughout the period of these projects. This is particularly true in emerging nations where social, political, and economic circumstances are uncertain [2].

Large projects often take place for infrastructural purposes, either by the government or with assistance from the private sector. One way to incorporate the private sector into infrastructure projects is through the Build-Operate-Transfer (BOT) plan. BOT, in which the private sector finances, designs, builds, operates, and maintains the project before handing it back to the government at the end of the concession period, has become more and more common, particularly in developing nations[3]. B.O.T. contracts are a crucial contractual tool for carrying out infrastructure projects because they are regarded as one of the most effective ways for developing nations to advance and offer public services without using up the enormous amounts of resources required for these initiatives, allowing governments to allocate those funds to other parties [4]. An infrastructure project classified as a BOT is based on a concession given to a consortium known as the concessionaire, which is typically from the private sector, by a client that is typically a public organization. The concessionaire arranges financial terms to "build" the project's facilities, "operate" them during the concession period to generate revenue for debt repayment and investment recovery with a certain level of profit, and "transfer" the project's operational facilities to the client at the end of the concession period, usually without incurring any additional costs. The concessionaire is in charge of project finance, construction, and operation in a BOT project. Typically, the customer covers the cost of the service rather than funding the infrastructure, even in cases where they are also the service user [5].

The main objective of implementing BOT is to lower government budget expenditures by obtaining funding from outside sources, particularly for large-scale projects. Governments may therefore construct more infrastructure services without utilizing extra public funds thanks to the BOT contractual arrangement, which offers a vehicle for utilizing private finance [6]. Governments may benefit from the best of both worlds under the BOT system: more infrastructure projects can be built without adding to the burden of public borrowing. In addition, the BOT system gives contractors the chance to enter the growing market for developing and managing infrastructure projects with less interference from the government and more potential for financial gain. BOT works well for projects that are both financially feasible and able to provide investors with a respectable rate of return [7].

The larger a city grows, the more transportation services and associated facilities are needed, and the cost of providing these services rises accordingly [8]. The options open to

decision-makers in the planning stages of construction projects, such as constructing a new road, are frequently governed by the feasibility study. The project's economic feasibility is determined by comparing the costs of constructing a new road with the savings from a drop in road user tolls as a consequence of the new road's enhanced smoothness and shorter travel times compared to the existing roadways [9]. A cost estimate for building a roadway is essential to creating an appropriate feasibility study. Much effort was devoted to refining the assessment procedure in order to get a better analysis [10]. Cost-benefit analysis, which divides the net present value of all benefits by the net present value of all costs, has long been used in economic feasibility assessments. It is regarded as one of the best tools available for use in the evaluation processes for investments in transportation infrastructure [11]. Net present value (NPV) is the difference between the cost of the investment and the estimated value of future benefits throughout the project's duration, discounted to the present at a certain rate. A project is considered financially viable if its net present value is positive. Feasibility studies also frequently employ this strategy [12]. Giving a precise estimate of the road user cost is essential to creating an effective economic analysis. The phrase "road user cost" refers to the rise in travel costs resulting from road development projects. It is the total of operational costs. for the vehicle, costs associated with passenger delays, and, occasionally, unintended costs [13].

The PPP model's functions and salient characteristics. The PPP model, which embodies public-private partnerships in their broadest sense, is founded on the cooperative idea of "win-win" for all parties involved. Additionally, it covers institutions of public service, public infrastructure, and the privatization of firms held by the government. These are some of its attributes:

1. In the PPP model, the public and private sectors have similar goals.
2. Both the public and private sectors possess appropriate risk-sharing.
3. The market's competitive mechanism will be added to the infrastructure project in order to improve social services [14].

Objectives of the Research

The main objectives of this study are to use the Build-Operate-Transfer (BOT) model and assess its applicability to enhance future highway projects in Iraq and to evaluate the economic feasibility of constructing a new road (Khalis-Baghdad Road). The following is a list of secondary objectives:

- a. Quantifying the traffic volume at specific locations.
- b. Estimating the volume of traffic that will be created in the present and the future.
- c. Doing an economic study to see whether this delivery technique is applicable such as net present value (NPV), benefit cost ratio (B/C), and internal rate of return (IRR).
- d. Performing an economic study to see if this delivery method is applicable.

Advantages & Disadvantages of B.O.T Contracts

Several researchers have documented an abundance of advantages associated with B.O.T. contracts, motivated by their implementation across various projects and nations. According to these researchers [15], these contracts can have many good consequences if government institutions are sufficiently flexible and they are implemented effectively. In addition, those findings [16].

- (1) The government is not required to look for funding in order to construct or update infrastructure.
- (2) Since private investors administer and maintain the infrastructure, revenue reductions are minimal throughout the concession period.
- (3) Reducing routine and bureaucracy since it has the power to oversee construction and oversee the project through to completion.
- (4) Infrastructure projects are implemented more quickly when the private sector is driven primarily by profit.
- (5) B.O.T. projects are the most convenient means of disseminating new technology and managerial expertise.
- (6) Even if these initiatives are fraught with dangers, the private sector is better equipped and more seasoned than the public administration to handle them.

While B.O.T. contracts provide numerous benefits, there are drawbacks as well that have an immediate impact on national economies.

The following are the most notable disadvantages that ACAR (2009) identified for these contracts [17].

- a. Needing a Long and Complicated Process: The B.O.T. model is distinguished by a very intricate and sophisticated contract structure.
- b. High Costs: The second critique aimed at B.O.T. is that any project carried out using this model would come at a greater cost than any other project carried out in a different manner.
- c. Extreme Sensitivity to Political and Economic Stability: Foreign investors are very sensitive to the political and economic stability of the nation where their capital is to be invested, and they are constantly wary of it.
- d. Eddy/Tornado Effect: When a choice is authorized and it has a bad impact on one party's decision at some point, that party also has an impact on the decisions of the other parties. The negative impacts then build up over time and may even stop the project from being implemented.

A Comparison of the Advantages and Disadvantages of the Two Financing Models

1. (A) The advantages of BOT are as follows:

- a) The government and business sectors may easily negotiate because of simple organization.
- b) There are less conflicts of interest between the public and commercial sectors, and the project's return on investment is correct.
- c) BOT can increase the variety of financing sources to reduce the financial strain on the government.

(B) Disadvantages are:

- a) Due to the lengthy investigations and negotiations that the public and private sectors often engage in, the tender cost is very expensive.
- b) Financing is tough since there is a large risk for lenders and investors.
- c) Project management may leave the government's hands during the concession period.
- d) The introduction of advanced methods and private sector management is detrimental.

2. (A) Advantages of PPP are as follows:

- a) To reduce the project cost and shorten the work cycle, early participation in the preliminary research by the public and private sectors.
- b) To negotiate with others who have diverse ideas about the desired outcome, form a strategic coalition.
- c) The private sectors can introduced advanced technology and management experience in the initial stage.
- d) The government holds control of the project.

(B) Disadvantages

- a) How to guarantee that the government assumes responsibility for cooperation's challenges, increasing the risk responsibility
- b) The organization has a very complex organizational structure, and management is getting harder.
- c) It might become debatable how to calculate a project's return rate [18].

Case Study

The road chosen for data collection is the Khalis-Baghdad road, which connects the northern, central and southern regions of Diyala Governorate and is considered a major expressway. This important commercial road ends at the Baghdad Gate and begins at Khalis. Due to the large volume of trade within the country and with its neighbours, especially from the north, heavy vehicles use the road frequently. It is 7.5 meters width include two lanes and 36 kilometers long. As seen in Figure 1, it travels through a number of the governorate's communities. The enormous weights carried by the road necessitate routine repair for a variety of reasons, including increased accident rates, vehicle operating expenses, and travel times, where heavy vehicles require around an hour to cross the road when carrying products.



Fig. 1. *A case study of Al-Khalis – Baghdad Road*

Methodology

The research methodology was achieved using the following:

- (1) This includes reading theses, references, locally and internationally published papers and international publications that discuss the idea of BOT in order to provide theoretical background and context for the research.
- (2) Field work: An approach that involves choosing a case study and gathering data from the Diyala Governorate's directorates will be employed in order to meet the goals of the study. With

the use of computer tools like Microsoft Excel, data analysis (benefits and costs) will be carried out using economic analysis methodologies (net present value and benefit-cost ratio), as explained below.

Data collection

To achieve the intended results of this manifestation, data collection is essential. This instance emphasizes how crucial it is to collect and categorize data on the amount of traffic produced by various kinds of heavy trucks. To estimate projected traffic volumes and future user benefits, the average daily and yearly traffic is recorded.

1. Traffic data

Traffic data is any information or statistics on the movement of vehicles and people on roads, highways, and other transportation networks. Traffic data is frequently used by engineers and planners of transportation systems to create and enhance networks. By comprehending the features of traffic volume, they also utilize it to measure and compute the numbers of vehicles, time, and route size distribution for each place [19]. This time frame might be anywhere from 15 minutes to a year, depending on how the data is going to be used [20]. The road traffic statistics were conducted by placing a digital camera to facilitate the counting process of vehicles using the road for seven days from 7:00 am to 7:00 pm, which greatly accelerated the counting process. Moreover, Figure 2 shows the highest traffic volume for the highest quarter of an hour, and the traffic flow data summary shows that the evening peak is the highest.

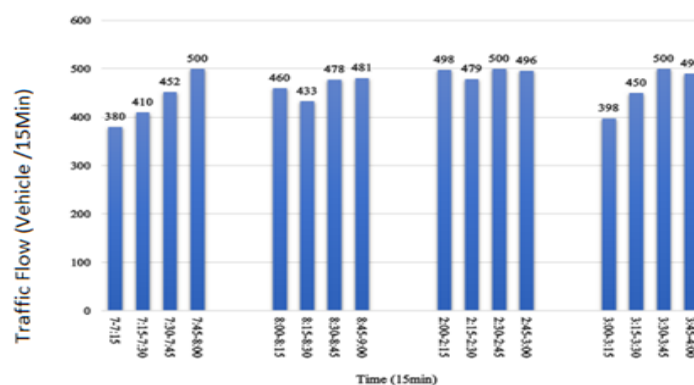


Fig. 2. Traffic flow 15 minutes to all vehicles

2. Projections for future traffic

Any road project is required to include economic analysis based on future traffic. Therefore, accurately predicting future traffic is crucial for this evaluation. Traffic forecast or forecast volume is defined as "the current traffic volume multiplied by the ratio of future traffic volume to current traffic volume" by SCRB (2005) [21]. This straightforward approach is useful for giving quick estimates, but it may not always be accurate because there are a number of factors that might cause changes in traffic patterns, such as changes in land use, population growth, or the introduction of new transportation choices. In some cases, more sophisticated forecasting methods could be needed to generate more accurate estimates. When it comes to the planned road, traffic projections must be given for the whole length of the road using the current traffic levels displayed in Table 2, which are regarded as the hourly design volumes [22] A 3% annual

traffic increase rate is considered Equation (1) is then used to estimate the yearly traffic volumes from this data. Since the road in this equation is a highway, the proportion of AADT that happens during peak hour, or K value is 30th hour factor and can be assumed as 11.5% for urban roads [23] As we previously stated, the project will last for 10 years in addition to the two years that construction services will be provided. The annual average daily traffic (AADT) is determined according to Eq. (3.1)

$$\text{AADT} = \text{DHV} / K \quad \dots\dots\dots (1)$$

where AADT is the annual average daily traffic, K is the percentage of AADT that occurs during peak hours, and DHV is the hourly design volume. Equation (2) is used to determine the current annual traffic on each road. Equation (3) is used to estimate the annual traffic volume on each road in the future.

$$\text{Annual Traffic Volume} = \text{AADT} * 365 \quad \dots\dots\dots (2)$$

$$F = P(1+r)^n \quad \dots\dots\dots (3)$$

The traffic study indicates that the traffic volumes for the peak hour (Hour Peak Volume) is (940 Veh \hr.) taking into account the diverted and attracted traffic and the growth rate of vehicles which was calculated on the basis of (3%). Assuming that the traffic volume at the peak hour constitutes (11.5%) of the average daily traffic volume (Average AADT Traffic Daily Annual (Thus the value of K = 0.115)

$$\text{AADT} = 940 / 0.115 = 8,173 \text{ Veh./day}$$

$$\text{ADT} = \text{AADT} * 365 = 2,983,145 \text{ Veh/y}$$

The traffic volumes for heavy vehicle each section are computed and projected for the next 10 years, as indicated in Table 1.

Table 1. Traffic volumes for heavy vehicles

No	years	Future Annual Traffic (v/y)
0	2021	2,983,145
1	2022	3,072,639
2	2023	3,164,819
3	2024	3,259,763
4	2025	3,357,556
5	2026	3,458,283
6	2027	4,129,370
7	2028	3,668,892
8	2029	3,778,959
9	2030	3,892,328
10	2031	4,009,097
11	2032	4,129,370

Feasibility Analysis

The benefits of the project and the expenses incurred for comparable work, including the cost of yearly road maintenance, must be computed in order to determine the project's financial viability. It is possible to ascertain the possible advantages of this route by carrying out this study to assess its effects on the road.

1. Costs: Costs are divided into construction costs, road use fees, and annual maintenance.

1.1. Construction costs: To determine the cost of building the road, the relevant departments, namely, the Directorate of Roads and Bridges in Diyala Governorate were consulted and the

statements of similar works in the governorate were reviewed. In order to determine the final cost of road construction over two years, the expected costs of road construction activities were obtained, which is 52,554,000,000 Iraqi dinars.

- 1.2. Maintenance costs:** These are necessary to maintain the project's infrastructure, vehicles, and other assets in excellent operational condition. Decisions about maintenance budgets affect the lifespan of assets and, in general, how well they operate. These are essential during the course of the project to maintain the functionality of infrastructure, vehicles, and other assets. Decisions regarding maintenance expenditures affect the life of assets and their overall operating conditions. The route percentages (2.5%, 5%, 10%, and 20%) were determined through personal discussions with expert engineers. Each percentage is allowed to be depreciated over five years of the construction cost.

2. Benefits calculations

The tolls collected from each vehicle carrying goods must be calculated in order to determine the benefits that road users get. In this research, the tolls taken from road users for owners of heavy vehicles in general were assumed to be 5000 ID (Iraqi Dinars). This amount was determined in the study based on personal interviews with the owners of these vehicles as well as the assistance of some specialized parties including stakeholders and road engineers. The benefits that these vehicles get can be roughly calculated by multiplying the daily traffic volume for each type of heavy vehicles by the relevant tolls. We show that a BOT contract with a price regulation during the concession period and a license extension after the concession period is capable of achieving full efficiency. Both license extension and price control are observed in many real-world BOT projects. We also investigate the efficiency in such contracts by considering other factors, including time consistency, price ceiling, foreign ownership, and the lack of price regulation [24].

Economic Analysis

The road's benefits for the base year are compared to its total discounted cost once the discount rate is applied in the economic evaluation. To determine the project's financial viability, a few economic metrics need to be obtained. The benefit-cost ratio (BCR) and net present value (NPV) are two examples of these measures [25].

$$p = F [1 (1+i)^{-n}] \dots\dots\dots(4)$$

Where:- P: Present value of benefits or costs.

F: benefits value in the future.

n: number of future years for the project.

i: discount rate

$$\frac{B}{C} = \frac{\sum_{t=0}^n ((B/(1+r)^t))}{\sum_{t=0}^n ((C/(1+r)^t))} \dots\dots\dots(5)$$

If BCR>1 then the project's benefits exceed its costs.

Where: Bt, Ct: Benefit and Cost in year t for any project.

n: the total number of years for the project duration/lifespan

i: discount rate.

$$npv = \sum_{t=0}^n \frac{Bt-Ct}{(1+i)^t} \dots\dots\dots(6)$$

If NPV> 0, the project is economically viable.

If NPV= 0, remain indifferent to the investment.

If NPV < 0, the project is not economically viable.

Where: Bt, Ct, t, n, i: As was mentioned previously

The study's usage of various discount rates, which account for time worth of money, shows the project's long-term financial viability. Economic analysis evaluates costs and benefits using economic metrics such as net present value (NPV), interest rate ratio (BCR), and a predetermined discount rate (5%, 8%, or 10%) [26].

Results and discussion

It is anticipated that the road takes two years to construct. Subsequently, the discounted present values of future benefits and costs were computed at various discount rates by using equation (4), as presented in Tables 2 and 3. The time value of money and the many appropriate discount rates are thought to be represented by the discount rate. The long-term financial viability of the project is demonstrated by the research [27]. Economic criteria like the interest rate ratio (BCR) and net present value (NPV) are applied, together with a particular discount rate (5%, 8%, or 10%, for example), to assess costs and benefits. According to the findings, the net present value is positive for the two criteria (79,360,571,883, 59,119,395,765, and 48,432,320,255) ID. There is a positive net present value. The BCR scores were all over the 1.0 criteria (4, 3, and 2 correspondingly). The results reflect a relatively high long-term internal rate of return of approximately 26% showing that the outcomes were extremely favorable and that the costs and benefits have an association.

Table 2. Discounted benefits with different discount rates

No	years	Construction and Maintenance costs	D.R 5%	D.R 8%	D.R 10%
0	2021	26,277,000,000	26,277,000,000	26,277,000,000	26,277,000,000
1	2022	26,277,000,000	25,025,714,286	24,330,555,556	23,888,181,818
2	2023	262,770,000	238,340,136	225,282,922	217,165,289
3	2024	262,770,000	226,990,606	208,595,298	197,422,990
4	2025	262,770,000	216,181,529	193,143,794	179,475,446
5	2026	262,770,000	205,887,171	178,836,847	163,159,496
6	2027	525,540,000	392,166,040	331,179,346	296,653,629
7	2028	525,540,000	373,491,466	306,647,542	269,685,117
8	2029	525,540,000	355,706,158	283,932,910	245,168,289
9	2030	525,540,000	338,767,770	262,900,842	222,880,262
10	2031	525,540,000	322,635,971	243,426,706	202,618,420
11	2032	1,051,080,000	614,544,707	450,790,196	368,397,128
TOTAL			55,172,706,513	53,709,690,287	52,862,714,365

Table 3: Discounted benefits with different discount rates

No	years	Future Annual Traffic (v/y)	Benefits	D.R 5%	D.R 8%	D.R 10%
0	2021	2,983,145	0	0	0	0
1	2022	3,072,639	0	0	0	0
2	2023	3,164,819	15,824,092,653	14,352,918,506	13,566,608,927	13,077,762,523
3	2024	3,259,763	16,298,815,432	14,079,529,582	12,938,525,180	12,245,541,271
4	2025	3,357,556	16,787,779,895	13,811,348,066	12,339,519,385	11,466,279,554

5	2026	3,458,283	17,291,413,292	13,548,274,769	11,768,245,339	10,736,607,219
6	2027	3,562,031	17,810,155,691	13,290,212,393	11,223,419,166	10,053,368,578
7	2028	3,668,892	18,344,460,361	13,037,065,490	10,703,816,427	9,413,608,759
8	2029	3,778,959	18,894,794,172	12,788,740,433	10,208,269,370	8,814,560,929
9	2030	3,892,328	19,461,637,997	12,545,145,377	9,735,664,307	8,253,634,324
10	2031	4,009,097	20,045,487,137	12,306,190,227	9,284,939,107	7,728,403,049
11	2032	4,129,370	20,646,851,751	12,071,786,604	8,855,080,815	7,236,595,582
		TOTAL		131,831,211,447	110,624,088,025	99,026,361,788
		NPV		79,360,571,883	59,119,395,765	48,432,320,255
		B/C		2	2	1

Conclusions

Interest in build-operate-transfer (BOT) models is rising as a result of the financial resources required to participate in large-scale infrastructure projects. Due to their substantial influence on the construction sector, mega transportation projects, for which BOT is frequently employed as a financial model, are viewed as potentially significant and are a method that many nations employ to accomplish their objectives. Iraq would reap great benefits from using this BOT management approach.

1. The main obstacle for the applicability of BOT in Iraq is the lack of adequate awareness among decision maker in higher authorities and the public, and regard investment environment
2. PPP should be carefully planned and presented based upon simple, transparent and strategic principles. The role of a legal and regulatory framework for PPPs is vital to its success. PPP policies are important as a starting point for the PPP process. Consequently, governments need to be the driving force behind the creation and implementations of PPP policies. Trust alone is not sufficient for the success of PPPs
3. Because it promotes trade and commerce, reduces transaction costs, and enhances access to markets and services, good road infrastructure has a direct impact on economic growth and development.
4. The economic evaluation of the fees shows strong results in terms of economic criteria such as cost-benefit ratio (B/C), internal rate of return (IRR), and net present value (NPV). The results are 159,119,395,765 dinars, 2 for NPV and B/C at a discount rate of 8%. Furthermore, the results reflect the high value in the long-term internal rate of return, reaching about 26%.
5. The results showed how financially feasible the project was under various conditions and how resilient it was to variations in these variables.
6. Using vehicle tolls in order to fund the construction of roads and bridges in Diyala and the use of the bot system in Iraq proved to be very profitable and economically and financially feasible.

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References

- [1] Huang, W. (2016, April). Comparative analysis on BOT, PPP and ABS project financing models. In 6th international conference on electronic, mechanical, information and management society (pp. 1077-1082). Atlantis Press.
- [2] McCowan, A. K., & Mohamed, S. (2002, November). Evaluation of build-operate-transfer (BOT) project opportunities in developing countries. In Proc. of the 1st Int. Conf. on Creating a Sustainable Construction Industry in Developing Countries, November, South Africa (pp. 377-386).
- [3] Zayed T M and Chang L 2002 Prototype model for build-operate-transfer risk assessment ASCE - Journal of Construction Engineering and Management 7–16.
- [4] Using Build-Operate-Transfer Contracts In Iraqi Infrastructure Projects, Suhail Faisal Mohammed, College Of Engineering – University Of Baghdad, 2022.
- [5] Delmon, J. 2000. BOO/BOT projects: A commercial and contractual guide, Sweet & Maxwell, London.
- [6] Shen, L. Y., and Wu, Y. Z. 2005. "Risk concession model for build/ operate/transfer contract projects." J. Constr. Eng. Manage., 1312, 211–220.
- [7] Ngee, L., Tiong, R. L. K., and Alum, J. 1997. "Automated approach to negotiation of BOT contracts." J. Comput. Civ. Eng., 112, 121–128.
- [8] Newman, P. and J. Kenworthy (1999) Sustainability and Cities: Overcoming Automobile Dependence, Washington, DC: Island Press.
- [9] C. Gago, M. Serrano, and F. J. Anton, "Repercusiones de las ´ carreteras orbitales de la Comunidad de Madrid en los cambios de usos del suelo," Anales de Geograf´ia, vol. 24, pp. 145–167, 2004.
- [10] R. Anas, R. S. Suyono, M. S. Surbakti, and I. Puji Hastuty, "Unit cost analysis for road construction sustainability: a case study of national road in West Java Province, Indonesia," IOP Conference Series: Materials Science and Engineering, vol. 1122, no. 1, Article ID 012008, 2021.
- [11] S. Damart and B. Roy, "+e uses of cost-benefit analysis in public transportation decision-making in France," Transport Policy, vol. 16, no. 4, pp. 200–212, 2009.
- [12] S. Ehsan Zahed, S. Mohsen Shahandasht, and M. Najafi, "Investment valuation of an underground freight transportation (UFT) system in Texas," in Proceedings of the Pipelines 2017, Phoenix, Arizona, 2017.
- [13] X. Qin and C. E. Cutler, "Review of road user costs and methods," 2013, <http://library.nd.gov/statedocs/MPC/MPC13-25420130827>.
- [14] L. Li: The South of China Today, (2013) No.5, p121. (In Chinese).

- [15] Vassileva, A. and Ignjatijević, S. (2020) : BOT (Build-Operate-Transfer) Projects As A Successful Model Of Public-Private Partnership. Pregledni Rad, UDK: 658.114.5, 005.56:005.81. DOI:10.5937/Rev2092023V.
- [16] Zhang, W., Liu, Y., Liu, Y., Liang, B., Zhou, H., Li, Y., ... & Chen, K. (2018). An assessment of dietary exposure to cadmium in residents of Guangzhou, China. *International journal of environmental research and public health*, 15(3), 556.
- [17] ACAR, M. (2009): The Build-Operate-Transfer Model For Aerodrome Terminal Buildings. Publications of Directorate General of Civil Aviation, Publication No.: HAD/A-02, pp. 48-56.
- [18] Ignjatijević, S., Vassileva, A., Tasić, S., Avakumović, J., & Feruh, M. B. (2020). Challenges of development of the processed food industry of Bulgaria in the context of European integration. *Ekonomija-teorija i praksa*, 13(4).
- [19] F. (Federal H. Administration), "Traffic data computation method pocket guide." US Department of Transportation, 2018.
- [20] F. S. Derea, "Economic and Environmental Assessment of Improved Roads and Their Impact on Traffic Generation: A Case Study," B.Sc. thesis, College of Engineering, University of Mustansiriyah, Baghdad, Iraq, 2020.
- [21] SCRB. (2005), Highway design manual, 2nd edition. State Corporation for Roads and Bridges, Ministry of Construction and Housing, Republic of Iraq.
- [22] Alam, Ridwan Bin. 2013. "Traffic Volume Study Report Submitted By." (August). doi: 10.13140/RG.2.1.3063.7521.
- [23] Garber, Nicholas J., and Lester A. Hoel. 2019. *Traffic and Highway Engineering*. Cengage Learning.
- [24] Qiu, L. D., & Wang, S. (2011). BOT projects: Incentives and efficiency. *Journal of development economics*, 94(1), 127-138.
- [25] T. Officials, A Policy on Geometric Design of Highways and Streets, AASHTO, Washington, DC, USA, 2011.
- [26] Economic Impacts of effective road management case study, Husam Jaffer Salim College of Engineering, Diyala University, Baqubah, Iraq, 2024.
- [27] Transport and Main Roads, "Theoretical guide," 2011.