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RESEARCH ARTICLE

Feasibility Study for the Establishment of a Multi-Story Car Park, A Case Study

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Abstract:

Background:

Cars cruising to search out a parking zone represent a key component of the traffic on urban university campuses.

Objective:

The research aims to prepare a feasibility study for a multi-story car park for Engineering College /Mustansiriayah University through public-private partnership as a solution for parking problems which consumes a lot of time and effort.

Methods:

At first, theoretical information was collected about the subject of the research; a field survey was conducted to estimate parking demand and supply. A feasibility study was prepared for a proposed four-story car park.

Results:

The field survey showed that the current car park accommodates only 48% of the peak demand, so the rest of the cars are parked in an irregular manner. The proposed multi-story car park was estimated to have a maximum capacity of 560 cars and an investment cost of (4,140,875$).

Conclusion:

The economic indicators of the project showed that it would achieve a Simple Rate of Return 5.49% of the investment cost. It has a positive net present value at 5% rate of discount, which means it is feasible, and has an internal rate of return 8.1%, also the payback period is 10 years, which means that the investor will have his investment back after 10 years of operating the project. This research contributes to the body of information by including community participation in the procurement of infrastructure.

Keywords: BOT, Construction management, Economic indicators, Feasibility study, Financial analysis, Multi-story car park.

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1. INTRODUCTION

The never-ending search for free places in a car park is a burden for any driver nowadays since vehicles are a predominant method of transportation [1]. Well organized car parking system makes maximum use of available space. Two types of parking systems were identified: Traditional car parking systems and multistoried car parking system [2].

"A multi-story car park is a building (or part thereof) which is designed specifically to be for car parking and where there are a number of floors or levels on which parking takes place [3].

A multistoried car parking system will help in parking a large number of vehicles in an exceedingly smaller area. This Automatic Car Parking System enables the parking of vehicles, floor after floor, and thus reducing the space used [4].

Parking facilities are a noteworthy expense to society, and parking conflicts are among the most common problems facing designers, operators, planners and other officials. Such problems can be often defined either in terms of supply (too few spaces are available, somebody must build more) or in terms of management "available facilities are used inefficiently and should be better managed" [5].

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Parking studies recognize the importance of planning for a sufficient 'cushion' in excess of the necessary spaces [6]. Nowadays, due to a shortage of parking facilities, vertical parking is preferred instead of horizontal parking which accommodates more number of vehicles in less space available [7]. In determining the requirements of parking space for universities, the specific characteristics and needs must be understood. Tertiary educational institutions are students' major gathering place and also serve as a place of employment [8].

2. RESEARCH AIM AND OBJECTIVES

The research aims to evaluate and solve the problem of parking in the park of the Faculty of Engineering as a case study where it became urgent to find a solution, as it consumes a lot of time and effort in the process of entry and exit of the cars. The following objectives were identified to achieve this aim:

1. Evaluate the current situation of the car park of the staff of the Faculty of Engineering.

2. Evaluate parking demand and supply.

3. Prepare a feasibility study to propose a multi-story car park.

3. METHODOLOGY

In order to achieve the research objectives, the following scientific methodology has been followed:

1. Collecting information from the literary sources related to the research topic

2. Conduct a field survey to evaluate the situation of the current park and estimate the current parking demand and supply.

3. Prepare a feasibility study for a proposed multi-story car park.

4. RESULTS AND DISCUSSION

4.1. Analyzing Parking Demand and Supply

In order to evaluate the current situation of the faculty of the engineering car park, it is necessary to analyze the parking demand and parking supply. Parking demand is represented by the number of cars parked in a parking place at a certain time on a busy day. In this study, the park is used by the staff of engineering college and their visitors. The parking demand of the mentioned park is estimated through a field survey within five official working days (Sunday through Thursday) of December 2018 at Engineering College /Mustansiriya University. It was found that peak hours of parking demand through the day are (from 8 AM to 12 PM), as presented in Table **1**. It can be noticed that the peak number of cars reached 315 on Monday.

The current Parking supply is about 150 spaces, which means about 48% of the actual peak number of cars that are supposed to occupy the park while 52% of cars are parking in an irregular manner which causes congestion and waste a lot of time and effort and sometimes damage to cars due to space constraints as it can be noticed from Fig. (**1**).

Table 1. Parking demand.

The Day	Peak Parking Demand
Sunday	250
Monday	315
Tuesday	200
Wednesday	270
Thursday	200

4.2. Multi-Story Car Park

Multi-story car parks can be one of the main facilities that assist in increasing the ease and efficiency of parking [9]. The evaluation of the Current Park situation indicates the need to find a radical solution, and since it is not possible to expand the park site horizontally, the researchers suggest the establishment of a multi-story park. It can give ideal usage of the region by expanding the quantity of cars that can be stopped in an accessible space by utilizing various floors.

Through the following, the researchers prepared a feasibility study for the proposed multi-story car park.

4.3. Technical Study

Conducting a technical feasibility study leads to the clarity of the technical aspects of the project, thus forming a clear vision of the project technically from the project owner perspective [10].

The project site is located in Baghdad / Al-Rusafa/ Bab Al Moatham to the right of the Faculty of Engineering, as explained in Fig. (**2**). The project will serve the staff of the Faculty of Engineering. The area of the project site is about (4875) m^2. As it was mentioned previously, the current park can accommodate 48% of the peak demand, so the researchers suggested converting the existing park into a multi-story car park to overcome the problem of the current park.

4.4. The Proposed Multi-Story Car Park Description

Based on maximum parking demand, which was previously estimated through a field survey of the current park, and depending on the standard parking design criteria [11], the researchers proposed the establishment of a multi-story car park with four floors and a maximum capacity of 560 cars. Table **2** shows the optimal distribution of cars on the proposed park floors as well as the location of the Engineering Consulting Office Facilities on the ground floor. Fig. (**3**) explains the proposed landscape of the ground floor, which will contain 128 cars with allocating 200 m^2 to construct the Engineering Consulting Office Facilities, while Fig. (**4**) explains the landscape of 1st floor, which is the same as 2nd, 3rd, and 4th floor.

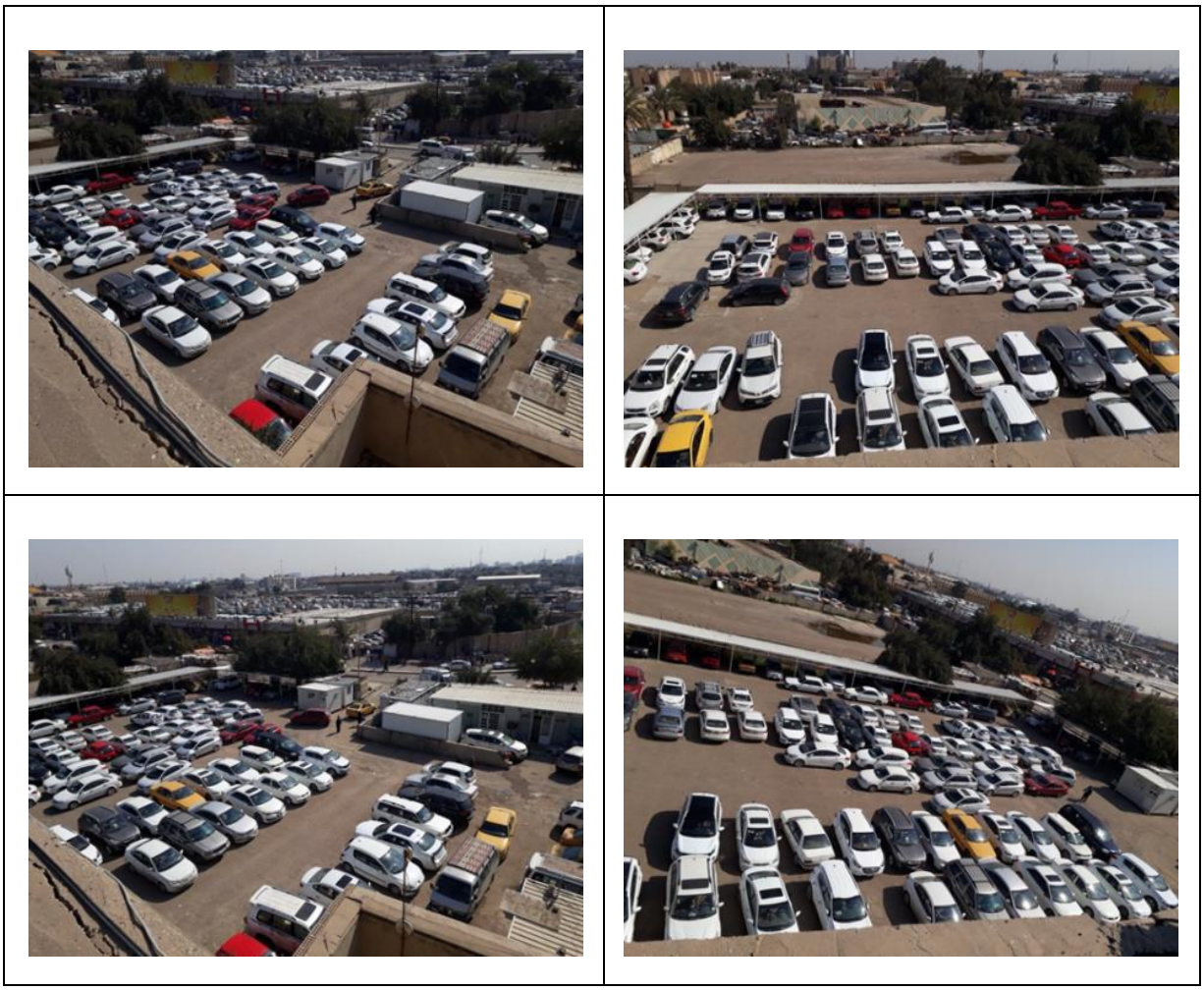

Fig. (1). The current park situation.

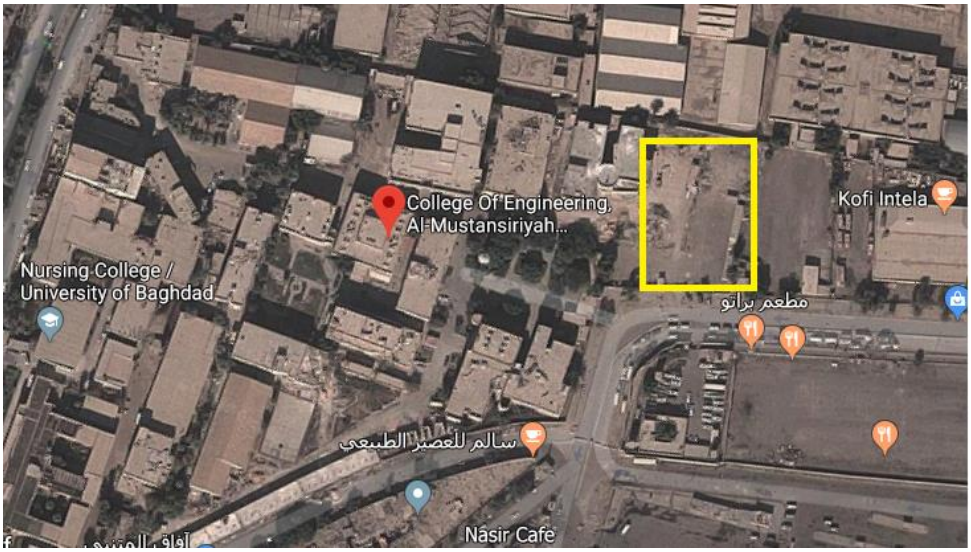

Fig. (2). Location of the proposed project site.

Table 2. Optimal distribution of cars on the park floors.

Floor	Floor Area (m^2)	Num. of Cars	Notes
Ground	4875	128	200 m^2 for Engineering Consulting Office facilities
1st	4875	144	-
2nd	4875	144	-
3rd	4875	144	-
Park Maximum capacity		560	-

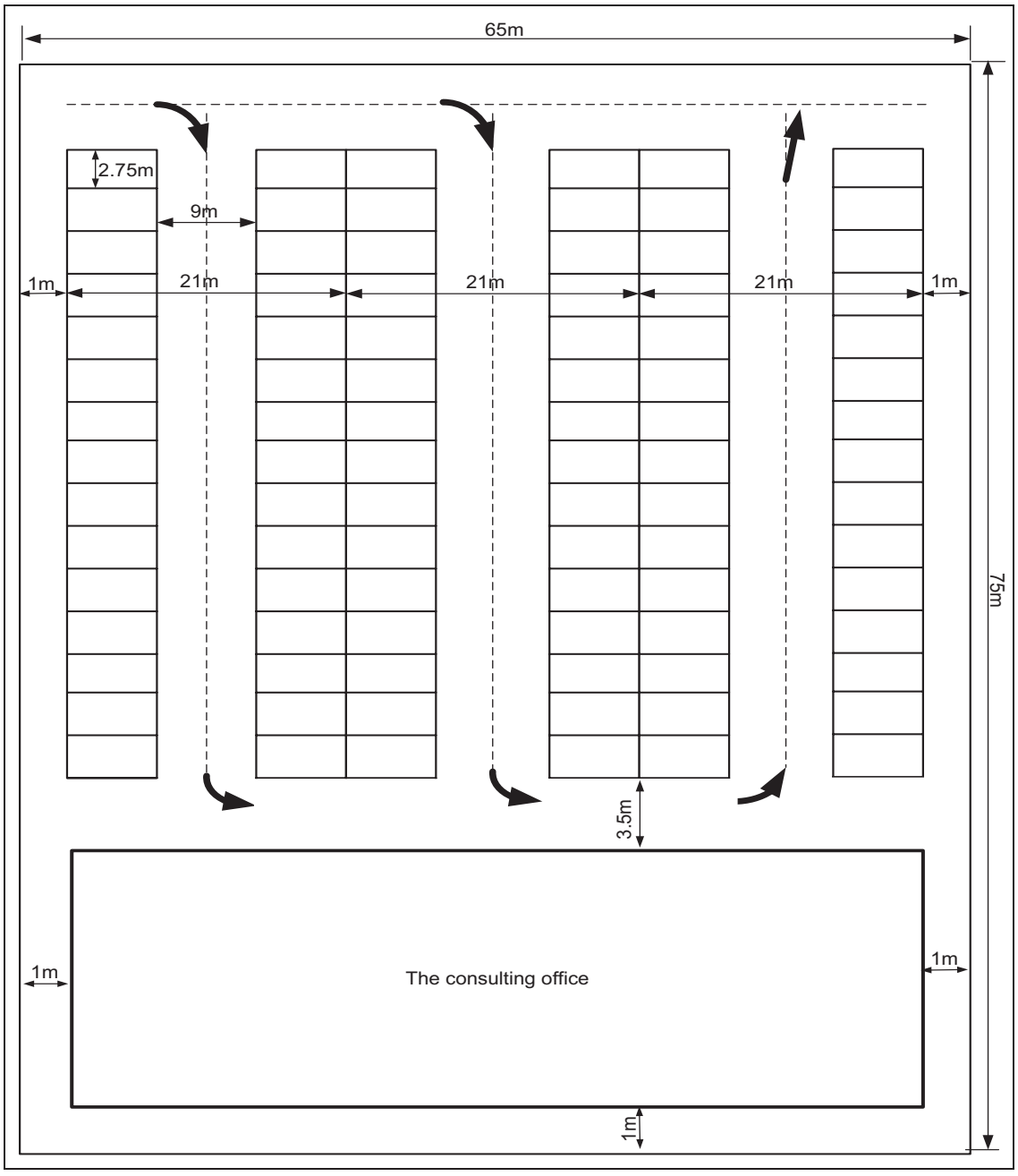

Fig. (3). Ground floor landscape.

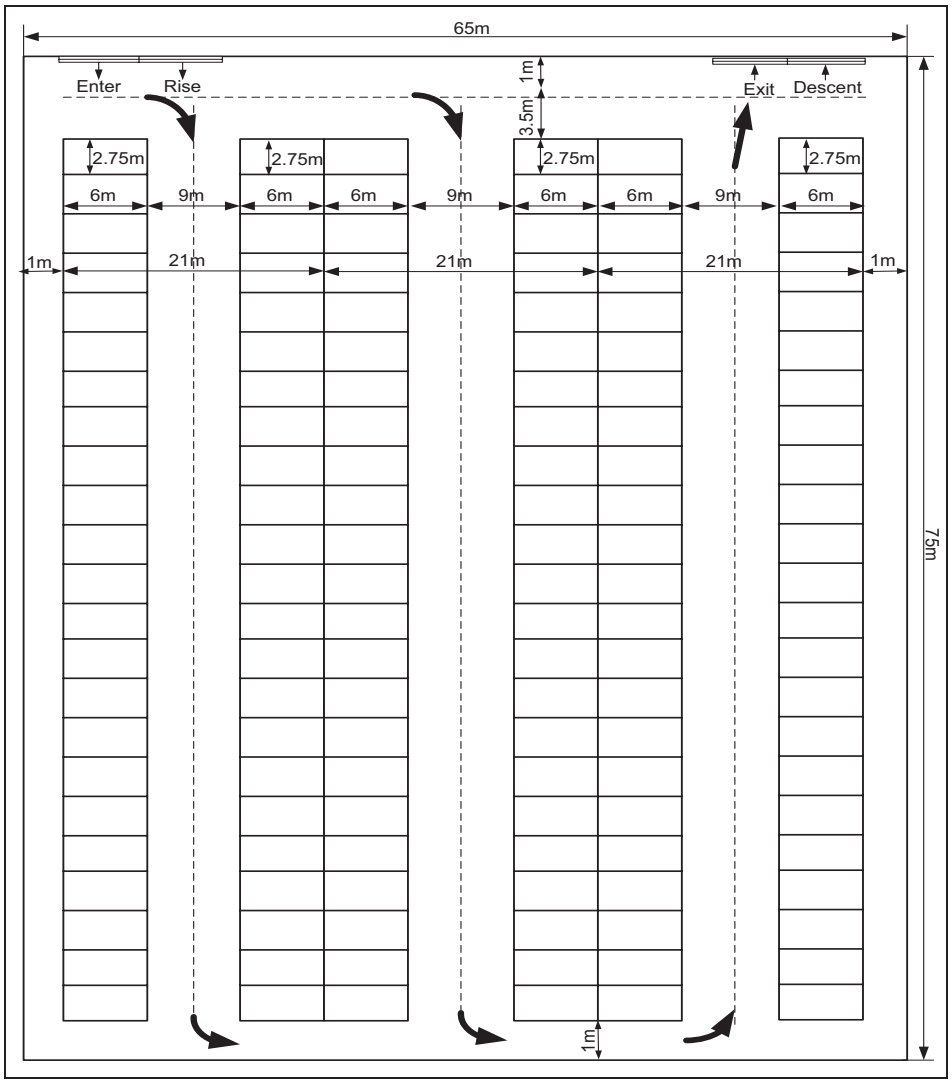

Fig. (4). 1st – 4th-floor landscape.

4.5. Social Study

The beneficiaries of the proposed project are the staff of the Faculty of Engineering and visitors to the College. The following benefits can be achieved from the implementation of the project:

1. Solve the problem of parking in the current park allocated to the staff of the Faculty of Engineering, where consumes a lot of time in the process of stopping and taking out cars due to the small space of the park and the increased number of cars.

2. Provision of suitable space for Engineering Consulting Office Facilities

3. The application of scientific research for faculty professors and postgraduate students, which aims to use modern engineering techniques in the implementation of the project, such as the use of solar energy in the provision of electricity, the use of green architecture techniques, the use of environmentally friendly building materials, and the use of alternatives to reduce the cost of implementation of the project.

4.6. Environmental Assessment

For the purpose of environmental assessment, the following points may be indicated:

1. The project site is basically a car park currently, and therefore it does not include overtaking green spaces or cutting down trees.

2. The project will provide a suitable systematic place for parking during peak periods, which will reduce irregular parking spaces in the project area and thus reduce the negative effects of them.

3. Disposal of construction waste (failed concrete mixtures and residues of construction materials left over from work) in an environmentally sound manner.

4. The preliminary design of the project was proposed according to the design requirements that provide comfort and safety for car owners during parking or taking them out from the garage.

4.7. Financial Analysis

In general, any project uses resources (capital, land, labor). These resources are limited or scarce, so it is important to use these resources in the best way to maximize the benefit of these resources.

The researchers propose to implement the project in the form of investment in accordance with BOT contracts to ensure appropriate funding for the project with the possibility of placing the requirement to involve the engineering cadres of the College within the stages of design and implementation. The investor shall finance the project, execute and operate it for a nominal fee and then return the project to the Faculty of Engineering after the end of the investment contract.

4.7.1. Expected Costs

The cost of establishing the project is estimated at (4,140,875 $). It will be executed within two years. The service life of the project is proposed to be 30 years. The cost of maintenance is considered to be 3% of the construction cost starting after the fifth year of operating the project taking into consideration an inflation rate 5% every five years of project operational life [12].

4.7.2. Revenues

The project aims to solve the problem of parking for the staff of the Faculty of Engineering, and provide regular parking suitable for visitors to the College in the case of holding scientific seminars and conferences; however, some financial returns can be achieved. The maximum capacity of the proposed park is 560 cars, and the park will be used in the morning shift and afternoon shift, so the maximum number of cars occupied the park will be 1120/ day. 315 of them are allocated for the use of Engineering College Staff and the remaining number will be used for Non-Staff cars such as students with nominal fees. Table **3** explains the estimated annual revenues, while Table **4** explains the annual net profit through the operational life of the project, taking into account that the duration of establishing the project is two years. Fig. (**5**) shows estimated cash flow.

4.8. Economic Indicators

For the purpose of the economic evaluation of the project, some economic indicators have been adopted, such as a simple rate of return, net present value, internal rate of return, and payback period [13].

Table 3. Estimated annual revenues ID.

Park Users	Num. of Cars Per Day	Car Parking Fees Per Day (ID)	Annual Revenues (ID)
College staff	315	1000	75600000
Non-college staff	805	2000	386400000
Sum. Per day	1120	3000	462000000

Annual Revenue =385000 $
*consider the dollar exchange rate =1200ID

4.8.1. Simple Rate of Return

The project achieves a simple rate of return (5.49%), which represents the percentage of the net profit of the proposed project compared to its estimated cost as shown in Equation (**1**) [13]:

$$SRR = \frac{annual\ net\ profit}{initial\ cost} \quad (1)$$

$$SRR = \frac{6{,}820{,}867/30}{4140875} * 100 = 5.49\%.$$

4.8.2. Net Present Value (NPV)

The net present value of costs and returns is calculated during the life of the project at a discount rate of 5% and a discount rate of 10%. It calculated using equation (**2**) [13].

$$\text{NPV} = \sum \frac{\text{net cash flow}}{(1+\text{r})^{\text{t}}} - \text{initial investment} \quad (2)$$

It can be noticed from Table **5** that a 5% discount rate gives positive (NPV), which means the project is economically feasible at this discount rate.

4.8.3. Internal Rate of Return (IRR)

The discount rate, which is often used in investment budgeting, causes the present value of all cash flows from a given project to be zero [14]. IRR represents the discount rate, at which the investment value is equal to the present value of the net cash flow throughout the life of the project. Depending on Table **5**, the project can achieve (IRR= 8.1), as explained in equation (**3**).

$$IRR = 5 + (10 - 5) * \frac{1314762}{1314762-(-813169)} = 8.1\% \quad (3)$$

Table 4. Annual net profit $.

-	Year	Construction Cost $	Maintenance Cost $	Revenues $	Annual Net Profit $
0	2020	2070438	0	-	-2070438
1	2021	2070438	0	-	-2070438
2	2022	0	0	385000	385000
3	2023	0	0	385000	385000
4	2024	0	0	385000	385000
5	2025	0	0	385000	385000
6	2026	0	0	385000	385000

-	Year	Construction Cost $	Maintenance Cost $	Revenues $	Annual Net Profit $
7	2027	0	62,113	404250	342,137
8	2028	0	62,113	404250	342137
9	2029	0	62,113	404250	342137
10	2030	0	62,113	404250	342137
11	2031	0	62,113	404250	342137
12	2032	0	65,219	424463	359244
13	2033	0	65,219	424463	359244
14	2034	0	65,219	424463	359244
15	2035	0	65,219	424463	359244
16	2036	0	65,219	424463	359244
17	2037	0	68,480	445686	377206
18	2038	0	68,480	445686	377206
19	2039	0	68,480	445686	377206
20	2040	0	68,480	445686	377206
21	2041	0	68,480	445686	377206
22	2042	0	71,904	467970	396066
23	2043	0	71,904	467970	396066
24	2044	0	71,904	467970	396066
25	2045	0	71,904	467970	396066
26	2046	0	71,904	467970	396066
27	2047	0	75,499	491368	415870
28	2048	0	75,499	491368	415870
29	2049	0	75,499	491368	415870
30	2050	0	75,499	491368	415870
-	Sum.	4,140,875	-	12,602,314	6,820,867

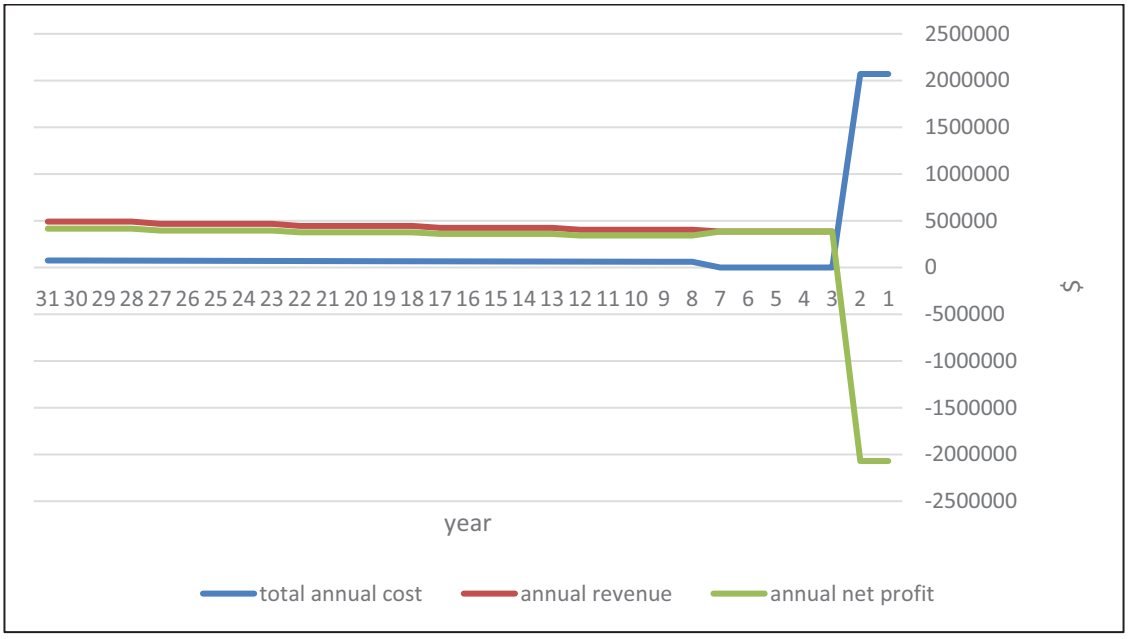

Fig. (5). Estimated cash flow.

Table 5. Discounted net present value.

No.	Year	Net Present Value	NPV at 5% Discount Rate	NPV at 10% Discount Rate
0	2020	-2070438	-2070438	-2070438
1	2021	-2070438	-1971845	-1882216
2	2022	385000	349206	318182
3	2023	385000	332577	289256
4	2024	385000	316740	262960
5	2025	385000	301658	239055
6	2026	385000	287293	217322
7	2027	342,137	243150	175570
8	2028	342137	231572	159609
9	2029	342137	220544	145099
10	2030	342137	210042	131909
11	2031	342137	200040	119917
12	2032	359244	200040	114466
13	2033	359244	190515	104060
14	2034	359244	181442	94600
15	2035	359244	149273	64613
16	2036	359244	164574	78182
17	2037	377206	164574	74628
18	2038	377206	156737	67844
19	2039	377206	149273	61676
20	2040	377206	142165	56069
21	2041	377206	135395	50972
22	2042	396066	135395	48655
23	2043	396066	128948	44232
24	2044	396066	122807	40211
25	2045	396066	116959	36555
26	2046	396066	111390	33232
27	2047	415870	111390	31722
28	2048	415870	106086	28838
29	2049	415870	101034	26216
30	2050	415870	96223	23833
-	Sum.	6,820,867	1,314,762	-813,169

4.8.4. Payback Period

The period required to recover the capital invested in the project is ten years and is calculated from equation (**4**) [14]

$$payback\ period = \frac{initial\ cost}{annual\ revenue} = \quad \textbf{(4)}$$

$$payback\ period = 10\ \text{Years}$$

Which means that the investor will have his investment back after 10 years of operating the project

CONCLUSION

This research aims to solve the problem of parking for employees of the College of Engineering as a case study. It was found that the peak parking demand is determined by (315 car), while the current parking supply can accommodate only 48% of parking demand. A multi-story car park will be a good solution. Socially, the proposed multi-story car park will have service benefits. Technically, the project has a maximum capacity of 560 cars, which will cover the need of the College with an opportunity to achieve some financial returns. The implementation of the project in the manner of investment in accordance with BOT contracts will provide a suitable source of funding for the project as well as ensure the quality of implementation and operating efficiency. Economic indicators indicate that the project is economically feasible as it will have a Simple Rate of Return 5.49% of the initial investment. It has positive NPV at 5% rate of discount, which means it is feasible and has an internal rate of return 8.1%. Also, the payback period is 10 years, which means that the investor will have his investment back after 10 years of operating the project. As the project is sensitive to inflation, incomes are expected to increase by 5% or more in five years. This paper can contribute to the body of knowledge through including the participation of the community in the procurement of infrastructure.

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

None

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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