# A Decision Support System for Plot Pricing of BOT Projects in the State of Kuwait

Hameed Al-Qaheri

Department of Quantitative Methods and Information Systems College of Business Administration, Kuwait University alqaheri@cba.edu.kw

### Abbas Al-Mejren

Department of Economics College of Business Administration, Kuwait University mejren@cba.edu.kw

## Abstract

Build-Operate-Transfer (BOT) projects in Kuwait have increased in number, size and type over the last couple of decades. The usage of an inflexible annual rental rate as a plot pricing system which disregard social gain, environmental considerations, general economic conditions, etc. has led to a sub-optimum level of public revenue and inadequate protection of the public fund. And over a number of years, the magnitude of the losses in public revenue from these projects has led to the accusation of public fund mishandling, cancelation of many BOT contracts by the government and the call by the National Assembly to the enactment of a legislation that would regulate the BOT projects, and establish a fair, transparent and justified pricing system for public plots of land offered to these projects. In response to this critical national problem<sup>1</sup>, this paper presents a decision support system for the Plot Pricing of BOT Projects in the State of Kuwait. The decision support system includes a multidimensional plot pricing model specified in [1]. The objective of the decision support system is to create an environment that would directly enable the maximization of public revenue and indirectly provide the necessary protection of the public fund.

## **1. Introduction**

Build-Operate-Transfer (BOT) projects in Kuwait have increased in number, size and type over the last couple of decades. The usage of an inflexible annual rental rate as a plot pricing system which disregard social gain, environmental considerations, general economic conditions, etc. has led to a sub-optimum level of public revenue and inadequate protection of the public fund. And over a number of years, the magnitude of the losses in public revenue from these projects has led to the accusation of public fund mishandling, cancelation of many BOT contracts by the government and the call by the National Assembly to the enactment of a legislation that would regulate the BOT projects, and establish a fair, transparent and justified pricing system for public plots of land offered to these projects.[1]

this paper presents a decision support system for Plot Pricing of BOT Projects in the State of Kuwait. The decision support system includes a multidimensional plot pricing model specified in [1]. This multi-dimensional plot pricing model, the cornerstone of this DSS, and as shown in Figure 1, covers several key issues such as Location Allowance, Strategic National Objectives Allowance, National Labor Allowance, Return on Investment, Investment Expenditure, Commercial-Noncommercial Ratio, Energy Consumption Coefficient and Environment Protection. The model as implemented in this dss, should eliminate the deficiencies in the unidimensional plot pricing system currently in practice in the State of Kuwait. The utilization of such DSS in turn should fulfill the demand and requirement for optimum revenue generation, protection of public properties and a transparent and just system, and when executed in an iterative manner, should provide an environment that directly enable the maximization of public revenue and indirectly enable the necessary protection required for the public fund.

# 2. BOT Background

For BOT background including BOT approach, leasing of public land, see [2], [3], [4],[5], [6,[7],[8],[9],[10],[11]. For Land Lease for BOT Projects in Kuwait see [12],[13] and [14] and for the present leasing system see [15]. Since 1994, nearly 100 BOT projects with an approximate cost of 1.5 billion US dollars ranging from

<sup>&</sup>lt;sup>1</sup> This project was partially funded by a contract from the Ministry of Finance, State of Kuwait.

large utility schemes to commercial malls, schools, universities, health and other enterprises have been allocated plots of public land under discretionary and ad hoc rules and on a case-by-case basis However, in 2006 the government of Kuwait decided to halt new BOT plans after the detection of financial and administrative violations in some of build-operate- transfer (BOT) projects by Kuwait's Public Audit Bureau, [1].

Topping the list of these project is the \$390 million Sulaibiya Waste Water Plant, the largest facility of its kind in the world that uses reverse osmosis and ultrafiltration membrane-based procedures. Other major projects include the free trade zone at Shuwaikh port, the \$162 million fifth waterfront development project comprising of Marina Mall, Marina Crescent and Hotel, the \$44.5 million sixth waterfront development project comprising of Alkout Mall, the \$132 million Sharq Mall, the \$73.2 million Heritage Village project, the \$35.7 international golf stadium and club, the \$23.2 million Hawally amusement park, the \$21.5 million Friday market development project, the \$10.7 million plant for the recycling of construction waste, and the \$8.2 million KFAS scientific center [13].

The allocation of plots of public land for such dissimilar and diverse projects and the establishment of annual leasing rate for such plots are based upon a parallel simple pricing procedure that disregards social gains, environmental considerations, general economic conditions, and a host of other relevant aspects, on one hand, and have led to the sub-optimum level of public revenues and inadequate protection of public fund. Plot lease rates for key BOT projects are usually established by the State Property Department at the Ministry of finance or the Public Authority of Industry. Such rates are worked out by merely the chosen location and the proposed project's internal rate of return (IRR). whereas lease rates for schools, health services, car parks and alike projects are already assigned by government resolutions which also disregard dissimilarity between these projects. Yet, bidder's influence, and bargaining skills play a role in this process [15].

Only as recent as 2008, Law No 7 (amending Law No 105 of 1980 regarding state-owned properties) was issued to re-regulate the BOT and similar techniques. Nevertheless, the new law does not deal with the significant issue of pricing of public land [16].

# **3.** Multi-Dimensional Plot Pricing Model (MDPPM)

The cornerstone of the decision support system is the Multi-Dimensional Plot Pricing Model(MDPPM) the dimensions of which are shown Figure 1 [1].



Figure 1. MDPPM dimensions

The formula shown below represents the main MDPPM formula which incorporates all the equations representing the dimensions shown in Figure 1 except for the Environment Protection. The Environment Protectionwhich requires some technical criteria that currently lack and are to be set by Kuwait Public Authority for Environment(PAE) [1].

$$\sum_{i=1}^{n} MDPP_{i} = PL_{i} + (LWA + ARI + CNR)$$

$$-(AME + IE + ACNO + ECC + NLA)$$

The appendix which is taken from [1] contains the mathematical equations representing MDPPM dimensions and their justifications. The appendix also shows, in a progressive manner, the impact of the addition of each dimension's measurement on the initial formula.

In the MDPPM formula PL stands for Plot Leasing, LWA for the Location Weight Adjustment, ARI for Adjusted Return on Investment, CNR for Commercial- Noncommercial Ratio, AME for Adjustment for Maintenance Expenditure, IEfor Investment Expenditure, ACNO stands for Adjustment for Contributions to National Objectives, ECC for Energy Consumption Coefficient, NLAstands for national labor adjustment, and i stands for time periods where i = 1, ..., n. Also to account for the

future values of fund, given the multi-period nature of the BOT contracts, these values are discounted and the MDPP variables, as shown in the formula, are multiplied by the appropriate Discount Rate(r). However, to balance the effect of each dimension in the MDPP formula on the end- value of the multi- dimensional plot lease, the incorporated variables have been weighted and reduced to reflect their partial importance in the model. The weights and the reduced values have been selected based on through reviews, group discussions and data experiments. As such and as show in the Appendix, the location Allowance is weighted in percentage, the IRR effect in the Adjusted Return on Investment is set at 20%, the Allowance for the Commercial - Noncommercial ratio are both set at 10%, the Maintenance Expenditure Allowance is set at 5%, the Investment Expenditure and the project Contribution to National Objectives are divided by 100 and so it the weight of national labor categories[1].

As discussed in section 4.1, the MDPPM when its parameters are assigned various values would generate different pricing scenarios to choose from.

# **4.** The Plot Pricing Decision Support System (PPDSS)

In the following subsections the architecture and information flow of the PPDSS is presented followed by the implementation aspect and PPDSS functionality.

# **4.1** The Architecture and Information Flow of the PPDSS

Figure. 2 shows the system architecture and the information flow within its components. The components of the system are a simplified version of a typical dss framework [17] and is presented to show the iterative nature of the environment in which the MDPPM would be utilized.

-As a data-driven System, PPDSS's data requirements such as general parameters, standard project, projectsand scenarios creation are handled by the data Management component.

-Model Management is responsible for creation and maintenance of various aspect of MDPPM.

-Scenario Management is responsible for the scenario creation, what-if analysis (through scenario creations), scenario evaluation and reporting.

### 4.2. Implementation of the PPDSS

The PPDSS is built within an object-oriented paradigm using VB.NET and SQL Server. The PPDSS is derived by the MDPP Class representing and implementing the MDPP model specified in the section 3 and the Appendix. The MDPP Class encapsulates all the data requirements of the MDPP model as embedded classes and all the MDPP dimensions equations as its methods. These embedded classes are as follows



# Figure 2. Decision support system architecture and information flow

- 1. General Requirement Classes
  - LW Class encapsulates the data and equation requirements for the computation of Location Weight
  - IE Class encapsulates the data and equation requirements for the computation of Investment Expenditure
  - NLC Class encapsulates the data and equation requirements for the computation of National Labor Categories
  - SNOW Class encapsulates the data and equation

requirements for the computation of National Objective Weights

- 2. Standard Project Class: encapsulates the data and the methods required for the standard project manipulation
- 3. Project Class: encapsulates the data and the methods required for the project manipulation
- 4. Scenario Class: encapsulates the data and the methods required for the scenario manipulation
- 5. MDDP Class: an object of class MDDP, the cornerstone of the DSS, once instantiated in turn instantiates and populates other embedded objects
- 6. Result Class: the data elements contained within the Result Class are:*Year*, *DRate*,*EMPL*, *PL*, *LWA*, *IRI*, *CNR*, *AME*,*IE*, *ACNO*, *ECC*, *NLA*, *MDPP*

The objects for these classes are instantiated using the forms shown in Figures 3, 4,5,6 and 7.

#### 4.3. PPDSS Functionality

The PPDSS is used in three main iterative steps: 1) General Requirements Setup; 2) Projects and Scenarios Generation and Execution; 3) Scenario Analysis and Reporting. In the following subsections, each of these component are briefly described.

#### 4.3.1. General Requirements Setup

Through the forms depicted in Figure 3 and Figure 4, the model's general requirements objects of types SNOW, LW, NLC, IE classes and various standard projects objects of type standard project class are instantiated and manipulated. This is an infrequent step performs once at the initial system setup or when attributes of the above mentioned classes change or a new standard project object comes into existence.



# Figure 3. General requirements setup

# **4.3.2.** Projects and Scenarios Generation and Execution

In this step a project is created and an initial scenario is generated and subsequently is executed. New scenarios can be generated in an iterative manner by changing attributes of the scenario form and then executed these scenarios. The cycle of generation-execution provides the user with the what-if analysis capability necessary for the generation of various scenarios' outcomes that would allow the user to evaluated and select the most "optimum" or appropriate scenario or the most cost-effective one. Figure 5 and 6 shows the forms for project and scenario



Figure 4. Standard Project

creation and figure 7 shows the outcome of the execution of a scenario, scenario 1 for project 1.

#### 4.3.3. Scenario Analysis and Reporting

Scenario(s) are evaluated and those that maximize public revenue and provide the necessary protection for the public fund would be accepted and reported to the executive management. If rejected, Scenario Generation and Execution cycle would be repeated with different parameters values and scenario results would be evaluated until an acceptable result is generated.

erai kequiremen	r Setup Projects a	nu scenarios creau	Scenario Execution	Scenario Evalution	Scenario Report
roject Scena	rio				
Project No	1	Project Hame	Avenues		
Project Code	Mali	Value/ Capacity	43000000		
Project Secto Acitvity	Mall				
Output Type	Trading				-
Project No	Name	Code Sect	or Type	Value	
1	Avenues	Mall Ma	I Trading	430000000	7
					8

Figure 5. Project

#### 5. Experimentation

The system was initialized with a set of general requirements and standard projects as shown in Figure 3 and Figure 4. A significant BOT project, Avenues the largest mall ever built in Kuwait was selected as the project as shown in Figure 5. We have created three scenarios as follows:

1. Scenario 1: the values of its parameters are depicted in Figure 6 and its execution outcome is shown in Figure 7.



Figure 6. Scenario

- 2. Scenario 2 and 3: the values of their parameters are shown in Tables 1 to 5 and the their execution outcomes are shown in Figure 8 and 9 respectively.
- 3. Scenario 3: in this scenario we have changed the following parameters with the shown values and the outcome of its execution is shown in Figure 9.

#### 5.1. Analysis of the Scenarios'Outcomes

As mentioned above, through an iterative what-if analysis we have created three scenarios the interpretation of their outcomes are described in the following subsections.

#### 5.1.1. Interpretation of Scenario 1 Outcome

Interpretation of Columns in Figure 7 are as follows:

enera	l Require	ement Setup	Projects and S	cenario	s Creation	Scena	nio Exec	ution	Scenario Ev	alution	Scenario	Reportin
Projec	ct Ho	•										
Scena	rio lle	1										
Vear	<b>D.Rate</b>	EMPL	PL	LWA	API	CHR	AME	r.	ACHO	tcc	IILA	MOPP
1	100.00	5 315.000.000	7.875.000	787.500	189.000	135,784	37.318	531.485	1.575.000	2,210,824	1.715.518	2.917.139
2	95.69 %	301,435,407	7,686,603	762,660	184.478	132,536	36,425	518,770	1,537,321	2,157,934	1,674,477	2,847,351
1	91.57 %	288,454,935	7,355,601	735,560	176,534	126,829	34,856	496,431	1 1,471,120	2,665,008	1,602,370	7,724,738
4	87.63 %	276,033,430	7,038,852	703,885	168,932	121,367	33,355	475,054	1 1,407,770	1,976,085	1,533,369	2,607,405
5	83.86 %	264,146,823	6,735,744	673,574	161,658	116,141	31,919	454,591	1,347,149	1,290,990	1,467,338	7,495,174
6	80.25 %	252,772,988	6,445,688	644,569	154,697	111,139	30,545	435,021	1 1,289,138	1,209,560	1,404,152	2,387,679
1	76.79 %	241,887,158	6,168,123	616,812	148,035	106,354	29,229	416,788	1,233,625	1,731,636	1,343,686	2,284,860
	73.48 %	231,470,964	5,592,510	599,251	141,668	101,774	27,971	398,362	1,180,502	1,657,068	1,285,824	2,186,469
9	70.32 %	221,503,315	5,648,335	564,833	135,560	97,391	26,766	381,707	7 1,129,667	1,585,711	1,230,453	7,092,315
10	67.29 %	211,964,895	5,405,105	540,510	129,723	93,197	25,613	364,793	1,881,821	1,517,427	1,177,467	2,082,215
11	64.39 %	202,837,220	5,172,349	517,235	124,136	89,184	24,511	349,083	1,034,470	1,452,683	1,126,763	1,915,995
12	61.62 %	194,102,603	4,949,616	494,962	118,791	\$5,343	23,455	334,051	1 989,923	1,389,553	1,078,242	1,833,488
13	58,97 %	185,744,117	4,736,475	473,647	113,675	81,668	22,445	319,664	6 947,295	1,329,716	1,031,811	1,754,534
14	56.43 %	177,745,567	4,532,512	453,251	108,788	78,152	21,478	385,996	906,582	1,272,456	987,378	1,678,988
15	54.00 %	170,091,452	4,337,332	433,733	104,096	74,786	20,554	292,721	7 867,466	1,217,661	944,868	1,686,679
16	51.67 %	162,766,939	4,150,557	415,056	99,613	71,566	19,668	280,122	2 830,111	1,165,226	904,172	1,537,492
17	49.45 %	155,757,837	3,971,825	397,182	95,324	68,484	18,822	268,055	9 794,365	1,115,048	865,236	1,471,284
18	47.32 %	149,050,561	3,800,789	389,079	91,219	65,535	18,911	256,510	6 769,158	1,057,032	827,977	1,407,928
19	45.28 %	142,632,116	3,637,119	363,712	\$7,291	62,713	17,235	245,470	727,424	1,021,083	792,323	1,347,299
<u>C(</u>	40.00 %	136,496,963	3,450,497	346,030	*3,332	44,912	16,473	234,67		977,413	156,284	1,209,202
	, Pur	n				itw						Clear

Figure 7. Project 1, scenario 1 execution

H         H         H         H         S<	Veat 1	DJute	EMPL	PL.	LWA	API	CHR	AME	IE	ACHO:	ECC	HLA .	MOPP
TUDATS         HALBALWIT         TARADIT	1	195.09 %	315,883,803	7,875,800	787,548	152,584	47,894	18,316	1,414,412	3,465,000	1,965,683	3,291,158	-1,249,673
111.57*/         PALE#A3D         LAILMEN         TAULT         MADE         LAILMEN         MADE         LAILMEN         LAILMEN <td>ż.</td> <td>93.63%</td> <td>301,435,407</td> <td>7,685,603</td> <td>768,669</td> <td>153,732</td> <td>46,758</td> <td>\$9,852</td> <td>1,306,574</td> <td>3.387.985</td> <td>1,915,633</td> <td>3,797,691</td> <td>-1.225.296</td>	ż.	93.63%	301,435,407	7,685,603	768,669	153,732	46,758	\$9,852	1,306,574	3.387.985	1,915,633	3,797,691	-1.225.296
III.2015         STARLED         LALLEST         NULLEST         NULLEST         LALLEST         <	3	28.57%	211.454.535	7,355,601	725,948	147,112	44,737	3,636	1,321,124	3,235,464	1,835,969	3,854,747	-1,185,931
5         DLB*S         N-5448427         C/D/244         C/D/244 <thc 244<="" d="" th=""> <thc 244<="" d="" th=""> <thc 244<="" d="" td=""><td>4</td><td>17.63%</td><td>216,413,439</td><td>7,831,857</td><td>743,885</td><td>146,777</td><td>42,818</td><td>8,221</td><td>1,754,733</td><td>3,097,495</td><td>1,757,265</td><td>2,232,773</td><td>-1.134.062</td></thc></thc></thc>	4	17.63%	216,413,439	7,831,857	743,885	146,777	42,818	8,221	1,754,733	3,097,495	1,757,265	2,232,773	-1.134.062
6         BLTS         PL27T2-MB         6.66.838         64.848         70.841         20.85         6.444         5.75.78         20.85.67         20.85.77         20.87	6	13,85%	264,146,873	6,735,748	673,874	124715	40,967	8,824	1,299,792	2,963,722	1,687,168	2,896,481	-1,885,997
Τ         TAT"S         PHAB7.39         CHAB7.39         CHAB7.39 <thchab7.39< th="">         CHAB7</thchab7.39<>	6	18,25%	252,772,888	6,845,688	641.163	178,914	29,263	8,455	1,157,696	7,836,162	1,665,730	2,685,678	-1.038,227
1         1.0.4%         2.0.46%3.84         5.0.219         10.46%         2.0.48         10.72         2.0.5%         10.46%         2.0.82%         2.0.84%         10.46%         2.0.84%         0.46%4         2.0.82%         0.46%4         0.	1	76.79 %	241,847,158	6,165,123	416,212	123,362	37,515	8,463	1,107,543	2.713.874	1.540,411	2,569,079	-99-6-626
9         PLS7*         21GBA325         G46235         G46325         TG27         21GBA325         G46235         G46245         TG27         G46345         D270         G46445         G46375         G46345         G46375         G46345         G46375         G46375 <thg46375< th="">         G463755         G463755</thg46375<>		73,48 %	231.470.964	5.392.510	\$10,251	115,010	35,809	8.732	1,004,137	2.597.104	1.474.478	2,455,384	-958,458
H         C 275*         2.1584.409         S.46.109         S.46.12         D.247         Z 4415         S.267.20         S.218.408         -2.152.40		70.32 %	221,543,215	5.448.335	\$44.833	112,967	34353	7,309	1.014.105	2.485.267	1,410,601	2,153,494	-918,471
H         6.4375         PRIATZ200         S.G.T.210         PGIATZ200	14	67,29 %	211.944.895	5.445,105	\$40.910	168,162	32,474	2,401	976,799	2.378.246	1,349,857	2,252,064	-871.450
12         14.27*         19.4.02.260         4.38.468         58.58         4.68         59.69         5.48         81.69         2.07.27         2.25.62         2.26.22         78.88           1         14.27*         19.4.02.260         4.38.468         58.58         50.27 <td>11</td> <td>6439%</td> <td>292,837,229</td> <td>5,472,349</td> <td>\$17.235</td> <td>103,417</td> <td>38.458</td> <td>6,775</td> <td>921,994</td> <td>2.275.834</td> <td>1,291,730</td> <td>2,155,085</td> <td>-\$33,929</td>	11	6439%	292,837,229	5,472,349	\$17.235	103,417	38.458	6,775	921,994	2.275.834	1,291,730	2,155,085	-\$33,929
D         DATY         BL744117         L734.07         CAR4         N/77         DATA         Direct Action         Direct Action <thdirect action<="" th="">         Direc</thdirect>	12	01.02 %	15-1,102,663	4,949,615	491.942	56,992	38,164	6,461	882,550	2.477.831	1,235,105	2,462,282	.793,#13
H         DALPS         TT225557         AD2.024         MS201         MS404         ZE         Sec         MS405         Sec	12	58.57 %	185,744,117	4,756,475	473.447	\$4,729	20.807	6,265	\$50,700	2.081.6-25	1,582,825	1,573,476	-763,454
ME         Data         D	14	54.63%	177,745,567	4,632,612	453,251	96,453	27,567	5,938	814,475	1.991.345	1,131,930	1,858,455	-738,769
HE 51.47"5 HE2/34.259 4256.577 H546 E2.91 2524 547 76.47 102.94 547 78.47 102.75 505550 (2753) 440,07 7 104,05 1057407 557407 557407 557407 55740 757511 (240,00 1954) 455404 442,00 1954 455404 4554 4554 4554 4554 4554 4554	15	54.00 %	170,491,452	4,337,552	433,733	86,747	21,584	5,682	775,015	1,988,426	1,883,194	1,837,171	-499,504
17 04655 155272227 357025 397.00 75615 94.00 74557 5283 71521 124.00 191.91 (342.00 191.91)))))))))))))))))))))))))))))))))	16	51.67%	162,763,929	4,450,557	415.456	83.011	25,244	5,437	745,473	1.876.745	1,836,558	1,729,550	-643.137
01 47.22*5 140,850,561 5,389,789 300,879 36,916 73,116 4,599 482,652 1,572,542 549,789 4,525,612 412,795 15 45,74*5 142,622,116 3,421,119 303,717 22,749 22,574 22,574 235,555 1,580,729 180,255 4,514,244 345,466 14 43,73* 151,860,867 3,480,867 33,486 8,656,919 24,668 4,556 45,567 1,557,491 1658,241 4,565,46	17	43.45%	155,757,837	3,971,825	397,187	25,436	24.157	5,293	713,371	1,747,683	191,954	1,454,000	-640,379
19 452875 442,432,146 3,437,149 363,717 72,740 22,424 4,765 453,255 4,660,332 366,355 4,566,404 -566,504 -566,504,504 -5	12	47,32*5	141,853,551	3,860,709	380,879	26,915	23,116	4.929	422,453	1,677,347	5.25.765	1,523,682	-412,795
26 41.31% 131.460.463 2.480.463 2.480.463 45.510 24.558 4.553 625.124 1.531.419 109.211 4.454.556 .554.554	15	45.2815	142,432,115	3,437,119	363,712	72,742	22,121	4,765	452,255	1,680,132	188,325	1,515,434	-585,405
	28	43.33%	135,890,863	3,480,497	348,458	65,612	24,168	4,553	621,124	1.531.415	165,211	1,458,966	-561,45.8

Figure 8. Project 1, Scenario 2 Execution

Year	D.Rate	EMPL.	PL.	LWA	ARI	CHR	ALE	r	ACIRO	ECC.	HLA.	MOPP	
1	100.00%	315,099,049	7,875,000	787,584	228,588	195,821	3.035	453,044	1,102,500	-860,206	1.458.375	6,824,473	
2	35.65 %	301,435,497	7,686,603	768,464	215,225	\$90,345	8,819	442,294	1.476,124	-452,946	1.839.663	6,641,200	
3	91.57 5	208,454,935	7,355,601	735,554	295,957	\$\$2,948	8,139	423, 163	1.423,784	131.435	1.081.974	6,374,362	
4	\$7.63 %	276,033,410	7,838,852	763,885	197,088	174.123	3,676	404.521	585,419	419.555	1,035,382	6,095,868	
4	83.86 %	264,186,822	4,735,744	473,574	155,091	\$66,210	7,778	317,585	540,094	-301.485	994,794	5,837,193	
6	88.25 %	252,772,686	6,485,088	612,519	138,175	108,433	7,395	174,847	942,396	381,740	948,170	8,685,834	
7	74.78 %	211,007,158	6,108,123	415,812	172,747	452,759	7,877	354.6.88	843,537	-347,450	\$67,304	5,345,293	
	73.48 %	711,478,944	5,507,588	588,254	\$85,770	141.121	6.772	319,568	876.351	.351.824	\$18,774	5.015.003	
	78.32 %	221,503,315	5,648,335	564,813	158,153	175,885	6,528	374.545	796,767	-336,673	836,843	4.094.645	
10	47.25 %	211,554,895	5,405,105	540,514	151,343	\$33,842	6,291	316,553	754.715	-377.576	795,865	4.451.967	
11	64.35 %	242,837,228	5,172,349	\$17,335	144,176	\$21,895	6.834	257,542	774.875	-308.307	TGA.R28	4,482,356	
42	61.62 %	134,182,643	4.949.646	414.967	138.585	\$72.682	5.679	254749	692.546	.295.826	778.845	4,785,336	
13	68.92 %	125,244,117	4.736.475	473,847	132,624	\$12,385	6.434	272,487	663.886	-787, 124	616,713	4.184.678	
14	56.43 %	177,745,567	4532.542	453,254	175.550	112,752	5,768	718,253	634.557	-778.944	455.711	3.577.574	
15	54.00 %	174,031,412	4,337,337	433,733	171,445	\$97.418	4.176	249,574	647,226	-758,538	638,801	3,758,738	
16	\$1.57 %	162,256,939	4158.557	415,814	196,796	\$82,792	4167	218,779	181,878	341.291	414,577	3,591,377	
17	49.45 %	155,257,837	1,971,875	207,187	181,291	98,166	4.557	228,497	556,855	-736,744	\$84,717	3,441,587	
18	47.32 %	105,058,591	1,809,739	355,879	196,472	94.120	4.361	718,657	537.811	-226.640	813,878	3,293,753	
12	45.28 %	142,632,316	3,537,319	363,712	121,129	38,076	4173	209,241	149.897	-216,793	\$35,803	2,151,825	
20	41.33 %	174,459,843	1,488,497	345,454	87,454	36,197	3,513	294,221	487,279	-242.451	511,314	2,416,197	

Figure 9. Project 1, Scenario 3 Execution

- EMPL: The estimated market plot price(EMPL) is adjusted, starting from the second year, by multiplying the original estimated market plot price by the d, the discount computation variable as shown in subsection 3.2
- PL: The plot leasing (PL) column takes into consideration the incentives to private investors by cutting the EMPL by 50% and assumes 5% of the remaining value to stand for the annual rent, as it has been indicated in equation (1) in subsection 3.2. It also

considers the inflation rate starting from year 2.

• LWA: The Location Allowance LWA column considers the adjustment for the significance of the plot location. This Project is located in a less significant commercial area ( Location code LS) which has a weight of 10% and hence LW is 10% and *PL<sub>i</sub>* is

of 10% and hence L w is 10% and  $IL_i$  is

adjusted by LW according to formula 2 and the value for  $LWA_i$ , is shown in under

LWA column.

• ARI: IRR for the project was set at 12% and IRA becomes .024 after dividing it by 5 and and *PL<sub>i</sub>* is adjusted by IRA according to

formula 3 and the value for  $IRA_i$ , is shown in under IRA column.

• CNR: The percentage of the commercial size to the plot size, CR, is 85% (15888 sq meters / 187836) and the percentage for the standard project, CS, is 70%. As such CNR becomes 0.017 and *PL<sub>i</sub>* is adjusted by

CNR according to formula 4 and  $CNR_i$ , is

shown in under CNR column.

• AME: The annual Maintenance Expenditure(ME) is KD 762940 for this scenario, and according to subsection 3.6, the annual amount of the estimated capital depreciation (ECD) is KD8,050,000 (calculated by multiplying the total project investment ( excluding the land value) by the capital depreciation rate(7%)). AME becomes 0.005 ( the ratio of ME to ECD

divided by 20) and as such  $PL_i$  is adjusted

by AME according to formula 5 and

 $AME_i$ , is shown in under AME column.

- IE: The per sq meter investment expenditure of this project in commercial area, noncommercial area and exterior surrounding are KD800, KD200 and KD50 respectively as opposed to KD850, KD250, and kd120 for the standard project. Multiplying the ratio between these figures by their corresponding weights of 20%, 40% and 40% according to subsection 7 and using formula 6 resulted in IE of 0.067 and an adjusted  $PL_i$  as shown by the value under IE.
- ACNO: The contribution of this project toward the strategic national objectives of promoting of economy, diversification,

improvement of health and education, inauguration of new urban centers and environment improvement and protection were med, med, low, high and med respectively. Multiplying the contribution of toward the national objective by their corresponding weights, as described in section 3.8 and according to formula 7 resulted in ACNO of 0.20 and an adjusted  $PL_i$  as shown by the value under ACNO.

• ECC: The energy consumed by the project per unit of output is 0.004 and the one for the standard project is 0.0055. And as such ECC becomes 0.28 and the adjusted  $PL_i$ 

value is shown under ECC.

• NLA: NLA for this project is 0.22,

computed according to section 3.10 and  $PL_i$ 

is adjusted according to formula 9 and its value is shown under NLA.

 
 Table 1. Values for certain key model parameters

Scenario No	1	2	3
IRR	0.12	0.1	0.14
Total Investment	115,000,00 0	205,000,00 0	65,000,00 0
Commercial Area	158,880	140,000	174,768
Maintenance Expenditure	762,940	953,675	610,352
Total Value	85,795,200	65,800,000	85,795,20 0
Electricity Expenditure	339,400	271,520	500,000

Table	2.	Non-Kuwaiti Employment
Lunc	_	

Scenario No	Admin. Job	Office Job	Tech. Job	Service Job	Indirect Job
1	49	31	31	23	0
2	49	31	35	25	40
3	60	40	35	25	0

Table 3. Kuwaiti national employment

Scenario No	Admin. Job	Office Job	Tech. Job	Service Job	Indire ct Job
1	12	2	4	0	0
2	12	2	8	2	15
3	18	1	0	0	0

Table	4.	Investment	expenditure
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Scenario	Commercial	Non-	External					
No	Area	Commercial	Surrounding					
		Area						
1	800	200	50					
2	600	300	150					
3	1000	150	30					

Table 5. Contribution to national ojectives

Scenario No	1	2	3
Diversification Of the Economy	MED	HIGH	LOW
Of the Economy.			
Improvement Of Health &	LOW	LOW	LOW
Education			
Inaug. Of New Urban	HIGH	HIGH	LOW
Cent			
Environment Improvement	MED	HIGH	MED
&			
Protection nt			
Promotion	MED	MED	MED
Of Economy			

#### 5.2 Interpretation of Scenarios 2 and 3 Outcomes

Our what-if analysis attempts were to create two extra scenarios, 2 and 3. Tables 1 to 5 shows some of the values of key parameters for the two scenarios. We have also included the values for scenario 1 as well for comparison. As shown in Figure 8 and Figure 9, scenario 2 reduced the MDPP significantly while scenario 3 increased it substantially.

As noted earlier, due to the multi-period nature of the BOT contract, future values of fund were discounted to their present values. In feasibility studies of private enterprizes, it is usually common to use the market average interest rate which reflects private preferences. However, during the past three decades, many feasibility studies in Kuwait have applied the rate of 10% to private investments as a standard discount rate. Nevertheless, because major BOT projects have high initial costs but a long stream of benefits, a low discount rate would make a project looks more favorable[19].

Given the fact that allocating plots of land to BOT projects must be regarded as an incentive to private sector involvement in developmental projects, their proceeds should be discounted at a favorable rate. Thus, it is fairly reasonable to use the rate of return on long-term government bonds as a benchmark. Between 1995 and 2007, the interest rate on the long-term Kuwaiti treasury bonds has been 6.5%[18]. Additionally, in development literature, economists frequently advise to reduce the discount rate by certain ratio, say 2%, when considering a project with development dimensions[20]. Consequently,

all values in RUN1, RUN2, RUN3 were discounted at the interest rate on the long-term Kuwaiti treasury bonds minus 2%, i.e., at 4.5%.

#### **6** Summary and Future Research

The paper presents a decision support system for plot pricing of BOT projects in Kuwait. Included in this DSS a multi-dimensional plot pricing model reported in a previous paper by the same authors [1]. The PPDSS reported in this paper enable the decision makers to create various scenarios for a particular projects and thought this what-if capability, empower them to fulfill the demand and requirement for optimum revenue generation, protection of public properties and a transparent and just system.

Future research is underway for a BOT Proposal selection using a Multi-Criteria (Goal-Programming) approach the results of which will be reported in an upcoming paper.

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#### Appendix

#### **Pricing of the Plot Lease**

Initially, MDPP formula could be calculated using the plot leasing rent equation given that the market price of the designated plot is established. For that we first compute the discount calculation using the following formula:

$$d_i = [\frac{1}{(1+r)^{i-1}}]$$

where  $d_i$  is the result of discount calculation for the period i when i > 1 and accordingly  $EMPL_i$  would be as follows:

$$EMPL_i = initEMPL * d_i$$

where initEMPL is the initial market price of the designated plot. And consequently the plot lease equation would be computed as follows:

$$PL_i = (\frac{EMPL_i}{2} \times 0.05) \times (1+F_j) \tag{1}$$

Where PL stands for the annual lease value of the plot measured at 5% of half of the estimated market price of the plot (*EMPL*). The 5% represents the lowest ratio of annual rent of a commercial site in Kuwait, while the 50% discount in this value represents an incentive provided to the BOT leaseholder. F stands for Inflation Rate and *i* and *j* for time periods where i = 1, , *n* and j = 2, ..., *n* 

#### **Location Allowance**

The Leasing Rent should also be adjusted based on the location of the land. To this end, the possible location of BOT projects are divided between five zones with different economic importance. These zones and their corresponding weights are as follows:

- 1. 50 percent for Coastal front of Kuwait City
- 2. 30 percent for Commercial Urban Centers
- 3. 10 percent for Other Less-Significant Commercial Centers
- 4. 0 percent for Low-Inhabited Areas
- 5. -40 percent for New Development Areas

These weights are assigned based on evaluation of the importance of each zones to the Kuwaiti economy. The formula for calculating the Location Weight Adjustment  $(LWA_i)$  is as follows:

 $LWA_i = PL_i(LW)$ 

Where LW stands for the location weight in percentage. And accordingly equation (1) should be adjusted as follows:

$$PL_i = PL_i + LWA_i \tag{2}$$

#### **Return on Investment**

Though, return on investment reflects financial ability of concessionaires, one must be cautious in adding this component to the plot lease estimate equation because an increase in the plot lease along with an increase in the project's rate of return would represents a penalty for efficient operation. Thus, the present approach reduces the weight of such component in the formula to 0.20% of the ratio. Hence its effect on plot lease is minimized by the Adjusted Return on Investment ( $ARI_i$ ) formula:

$$ARI_i = PL_i(IRR/5)$$

Where IRR is the project internal rate of return. And consequently, equation (1) should be adjusted as follows:

$$PL_i = PL_i + ARI_i \tag{3}$$

## **Commercial-Noncommercial Ratio**

Also, given the public nature of these projects, allowance has been added to lesser commercial or incomegenerating areas as a ratio of the maximum commercial area which is permitted in a similar customary project.

The following formula represents the allowance for Commercial-Noncommercial Ratio ( $CNR_i$ ):

$$CNR_i = PL_i(1 - (1/(Cr/Cs)) \div 10)$$

Where Cr stands for actual commercial areas in the project and Cs for maximum commercial areas that is permitted in a similar customary project. And consequently, equation (1) should be adjusted as follows:

$$PL_i = PL_i + CNR_i \tag{4}$$

#### **Maintenance Allowance**

Since it is important for the State to receive the project at the end of the BOT agreement with good operational conditions, the quality of maintenance, shown by the amount of maintenance spending, becomes crucial for such projects. As such, concessionaires who spend sufficiently on maintenance, must be rewarded and others who do not must not. This implies that the investor will be rewarded whenever the gap between his/her spending on maintenance and the actual consumption of fixed capital get smaller. The formula for calculating the Adjustment for Maintenance Expenditure ( $AME_i$ ) is as follows:

$$AME_i = PL_i((ME_i \div ECD_i) \div 20)$$

Where ME stands for Maintenance Expenditure, ECD for the Estimated Capital Depreciation, i for the particular period. And accordingly equation (1) should be adjusted as follows:

$$PL_i = PL_i - AME_i \tag{5}$$

#### **Investment Expenditure**

Given the public nature of the BOT infrastructural projects, higher weights have been assigned to any increase in investment spending per square meter above a selected standard level of spending in similar typical customary project. For this purpose, project's areas were divided into three different type of areas:

- 1. areas that generate income or commercial areas. 20 points have been assigned to investment expenditure in such areas.
- 2. none-commercial areas which were assigned 40 points.
- 3. exterior surrounding areas which were assigned 40 points.

The following formula represents the positive reception of these extra expenditure.

$$IE_{i} = PL_{i} \sum_{h=1}^{h=3} [(Er_{h}/Es_{h}) \times (W_{h}/100)] \div 10$$

Where h = 1, ..., 3 representing the project areas, Er stands for real or actual investment expenditure per square meter, Es for the chosen standard investment expenditure per square meter, and W for weight assigned to each area. And accordingly, equation (1) should be adjusted as follows:

$$PL_i = PL_i - IE_i \tag{6}$$

#### **Strategic National Objectives Allowance**

Given the large number of the country's long term national objectives as stated in development plans, government action programs, and other official documents, and in order to simplify the model, five major national objectives were selected to weigh BOT projects contribution with regard to these goals. These objectives, which were given an equal weight of 20%, given their almost equal significance to the national economy, are:

1. Promotion of the economy to become a regional commercial and

financial center.

- 2. Diversification of economic sources of income.
- 3. Improvement of health & education services.
- 4. Inauguration of new urban centers.
- 5. Environment improvement and protection.

The contribution of the project to each one of these objectives is weighted by the following five levels which have the corresponding assigned points to represent degrees of project contribution to each objective: 40 points for Excellent, 30 points for High , 20 points for Moderate , 10 point for Low , and zero for none.

Thus, the following equation represents the plot lease Adjustment for Contributions to National Objectives  $(ACNO_i)$ .

$$ACNO_{i} = PL_{i}\sum_{n=1}^{n=5} (NO_{n}) \times (C_{n}/100)$$

Where  $NO_n$  stands for the weight of each national objective, i.e., 0.20,  $C_n$  for the corresponding degree of contribution to each objective and n = 1, ..., 5. And accordingly equation (1) should be adjusted as follows:

$$PL_i = PL_i - ACNO_i \tag{7}$$

#### **Efficient Energy Consumption**

Given the far-reaching value of energy conservation to the society in general and to the environment in particular, an allowance has been given to concessinares that achieve efficient use of energy per unit of output by calculating this coefficient, i.e. the Energy Consumption Coefficient( $ECC_i$ ), as follows:

$$ECC_i = PL_i(1 - (Eq/Es))$$

Where Eq stands for energy consumed by the project

per unit of output and Es for energy consumed per unit of output by a similar customary project. And consequently, equation (1) should be adjusted as follows:

$$PL_i = PL_i - ECC_i \tag{8}$$

### **National Labor Allowance**

Employment opportunities in a BOT project were classified into five major categories, and a specific weight was given to each category based on its significance to the Kuwaiti society. However, indirect jobs were given a lower weight as concessionaires do not pay salaries to their holders and hence do not incur an additional cost. As such the weights for labor categories are: 20 points for administrative jobs, 20 points for work office jobs, 40 points for technical jobs, 10 points for service and marginal jobs, and 10 points for indirect jobs.

Thus, the following equation represents the plot lease adjustment for weighted national labor adjustment( $NLA_i$ ).

$$NLA_i = PL_i \sum_{z=1}^{z=5} (KL_z/LB_z) (WNL_z/100)$$

Where z = 1, ..., 5, *KL* stands for the total number of Kuwaitis hired at each of the *z* categories of job, *LB* for the total number of people employed at all *z* categories of job and *WNL* for the point weight of national labor at each of *z* categories. And consequently, equation (1) should be adjusted as follows:

$$PL_i = PL_i - NLA_i \tag{9}$$

## **Environment Protection**

Based on techniques available at the Public Authority for Environment, effect of each BOT project on the quality of environment aspects must be scientifically assessed using a measurable system in order to incorporate such effect into the BOT plot pricing formula.