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Engineering Analysis of the Abouhenidi Gas Station in Yanbu Albahar

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I. The Abouhenidi Gas Station

Description of company

The Abouhenidi Gas Station was founded by my father, Mohammad Abouhenidi, in December 1999, in Yanbu Albahar, a small city in the west of Saudi Arabia (Figure 1). Only one type of gasoline was sold in Saudi Arabia at time, when the Ministry of Municipal and Rural Affairs had many rules for gas station owners and entrepreneurs. For instance, a certain distance between any two gas stations had to be observed in order not to create an excessive concentration of gas stations within one single area. This aim has now been translated into a policy according to which gas stations have to be located at a minimum of 500 meters distance from each other within a city, and 5 km if on a highway.

Figure 1. Location of Yanbu. Source: maps.google.com/ retrieved on May 5, 2013.

Today, in Saudi Arabia there are three different types of gas stations within city limits: A, B and C. Only two types of gas stations may be located on the highway: Types A and B. The specifications for each type of Gas Station are provided in Table 1. There are major differences in the types of gas stations that may be built in the city and on highways regarding minimum area, types of fuel, parking capacity, and services provided. A detailed description of the features and characteristics of the gas station types is included in the Table 2.

Type of Gas Stations within the city and highway

Type	A	B	C
Minimum area required inside the city	3000 m2	2000 m2	1200 m2
Type of pump	Gasoline/ Diesel	Gasoline /Diesel	Only Gasoline
Services	Market, ATM, workshop, car wash oil and filter change Store.	Market, ATM, car wash Oil and filter change store.	Market, ATM, small oil change.
Minimum number of parking slots	12	8	4

Table 1. Types of gas station on the highway

Type	A	B
Minimum area required on the highway	8000 m2	4000 m2
Type of pump	Gasoline/ Diesel	Gasoline/ Diesel
Services	Supermarket, ATM, workshop, car wash oil and filter change store.	Super Market, ATM, workshop, Car wash oil and filter change store.
Minimum number of parking slots	20	15

Table 2. Types of gas station on the highway

Problem description

The Abouhenidi gas station is a type C: gas station, as is located within city limits. According to regulations, it can only feature tanks with capacity up to 60,000 liters. The station has two 30,000-liter tanks. At the time the station was founded, there was no significant gas delivery problem to the gas station since only one type of gasoline was sold on a standardized basis, and 15 trucks was recorded as the average number of orders per month. Nowadays the store carries two types of gasoline (red and green).Additionally, general increases in demand have resulted in a surge in orders from 15 to 35 trucks per week, this and other details are provided in Table 3, in which we depict historical demand data over 36 months of recent operations. The data were provided by store management and include monthly sale totals (in Saudi riyals, the cost of gasoline purchases, profits, shipping cost to the gas station, the number of shipments made to the station, and gas station Labor). The noticeable increases in the demand for gas have created a host of delivery problems for our business. There is an explicit increase in demand for gasoline by private consumers and by corporations, especially the businesses that use trucks on a daily basis (e.g., food and beverage industry, retailers, transportation companies) that has to be met by increasing and enhancing the existing offering through an analysis of the preferred gas suppliers. By the term “preferred”, I refer to suppliers that offer a competitive price for our company, and that have acquired relevant experience in this business.

Literature review

Monte Carlo simulation has been a fertile arena for modeling plant operations. Douglas (1994), David (2009), Butenko (2007) and Arsham (1995) utilized a blend of simulation and optimization to support the decision-making processes for asset management. Lu et al. (2003) built a model to simulation operations at a Hong Kong concrete plant. Gillot et al. (1997) improved the design of a wastewater treatment facility by the use of simulation and the development of an economic index. In an elegant paper, Cantonio et al. (2000) utilized a blend of genetic algorithms and Monte Carlo simulation to enhance safety at a manufacturing facility. A similar approach was followed by Marseguerra and Zio (2000) who enhanced maintenance and repair policies.

A number of methods have been proposed to provide maximum likelihood estimates, including those reported by Stephens, (1989), Aslan (2002), Zech (2002) Narsky (2003) and Schoemaker (1995). Goodness-of-fit analysis has proven to be beneficial in diverse areas. Patterson et al. (2009) describe the use of this technique in the prediction of the incidence of diabetes in Europe. The risk of breast cancer was estimated by Claus et al. (1991) by combining goodness-of-fit tests in a steroid hormone study. Traffic safety engineers used goodness-of-fit analysis to develop accident prediction models (Oak Ridge National Lab, 1997.)

Month	Revenue (SR)	Gasoline cost (SR)	Gross Profit (SR)	Total shipping cost (SR)	Number of Shipments	Labor (SR)
1	302,664	251,508	51,156	7,700	35	5,200
2	287,873	236,316	51,557	7,260	33	5,200
3	313,856	263,351	50,505	7,920	36	5,200
4	318,101	260,928	57,173	7,920	36	5,200
5	311,413	260,514	50,899	7,920	36	5,200
6	293,465	240,160	53,305	7,260	33	5,200
7	301,554	256,899	44,655	7,700	35	5,200
8	299,985	245,449	54,536	7,260	33	5,200
9	314,776	269,800	44,976	7,920	36	5,200
10	319,888	262,458	57,430	7,920	36	5,200
11	308,890	258,949	49,941	7,700	35	5,200
12	299,098	249,840	49,258	7,260	33	10,400
13	312,330	264,980	47,350	7,920	36	5,200

14	330,988	274,909	56,079	8,140	37	5,200
15	290,090	247,689	42,401	7,480	34	5,200
16	319,900	264,598	55,302	7,920	36	5,200
17	312,780	265,839	46,941	7,920	36	5,200
18	313,390	267,830	45,560	7,920	36	5,200
19	338,800	274,875	63,925	8,140	37	5,200
20	327,809	264,345	63,464	7,920	36	5,200
21	316,587	268,475	48,112	7,920	36	5,200
22	319,098	269,483	49,615	7,920	36	5,200
23	314,900	261,532	53,368	7,920	36	10,400
24	294,008	249,870	44,138	7,480	34	5,200
25	297,408	245,098	52,310	7,260	33	5,200
26	298,790	245,939	52,851	7,260	33	5,200
27	335,980	268,479	67,501	7,920	36	5,200
28	337,809	270,986	66,823	8,140	37	5,200
29	339,800	278,989	60,811	8,140	37	5,200
30	327,709	263,468	64,241	7,920	36	5,200
31	335,600	277,894	57,706	8,140	37	5,200
32	296,600	245,768	50,832	7,480	34	5,200
33	303,089	255,639	47,450	7,480	34	5,200
34	308,720	255,586	53,134	7,700	35	5,200
35	314,590	267,890	46,700	7,920	36	5,200
36	296,798	248,870	47,928	7,260	33	10,400
Total	**11,255,136**	**9,355,203**	**1,899,933**	**278,960**	**1,268**	**202,800**

Table 3. Historical demand data

Project goal

The Abouhenidi gas station faced steep competition at the time of this report. In order to enhance the economic position of the company, we analyzed three options for the delivery of fuel to the station:

1- Buying a new truck at the cost of SR1 400,000
2- Buying a used truck which would cost SR 150,000
3- Leasing a truck, for a cost of SR 70,000 /year

In order to determine the preferred delivery method for our business, I carried out a comprehensive analysis to estimate a proper solution for the transportation problem. I purport to implement the following methods:

1. goodness-of-fit analysis, to determine which probability distributions would be used to model demand data, and
2. simulation, to conduct what-if analysis of the options proposed.

Methods

Goodness of fit

The goodness-of-fit hypothesis-testing procedure is designed for problems in which the population or probability distribution is unknown. We conducted goodness-of-fit analysis on monthly sales and number of shipments. For calculation ease a software package called StatFit® was utilized. StatFit® is provided as a companion to the ProModel simulation package. Analysis included the Chi-Squared, Anderson-Darling, and Kolmogorov-Smirnov tests. The hypothesis that demand data could be modeled using a normal distribution was not rejected by any of the test and received the highest possible rank on StatFit®. Similar results were obtained for the number of shipments. In Table 4 we show the StatFit® output for analysis conducted on 36 months of monthly data. The fact that the *P*-values for the tests ranged from 0.625 to 0.775, gave us confidence that the use of the normal distribution to model sales and shipments was indeed a good decision. Thus, we concluded that a normal distribution would indeed be an appropriate way to simulate the sales and the number of shipments per month. The simulation was carried on Excel and is described in the following section.

[1] At the time of this proposal, the prevalent exchange rate was 1 USD = 3.75 Saudi Riyal

Description	**Result**
data points	36
estimates	maximum likelihood estimates
accuracy of fit	3.e-004
level of significance	5.e-002
	Normal
mean	312643

Table 4. Goodness-of-fit results for monthly sales

sigma	14516.4
	Chi Squared
total classes	5
interval type	Equal probable
net bins	5
chi**2	2.61
degrees of freedom	4
alpha	5.e-002
chi**2(4,5.e-002)	9.49

Table 4. Goodness-of-fit results for monthly sales.

p-value	0.625
result	DO NOT REJECT
	Kolmogorov-Smirnov
data points	36
ks stat	0.106
alpha	5.e-002
ks stat(36,5.e-002)	0.221
p-value	0.775
result	Do NOT REJECT
	Anderson-Darling
data points	36
ad stat	0.514
alpha	5.e-002
ad stat(36,5.e-002)	2.49
p-value	0.732
result	Do NOT REJECT

Auto Fit of Distributions

distribution	Rank	Acceptance
Normal(3.13e+005, 1.45e+004	100	Do NOT REJECT
Lognormal(2.8e+005, 10.3, 0.505	47.9	Do NOT REJECT
Uniform(2.88e+005, 3.4e+005	26.1	Do NOT REJECT
Exponential(2.88e+005, 2.48e+004)	0.397	Do NOT REJECT

Table 4. Goodness-of-fit results for monthly sales (cont).

Simulation

The simulation model was based on the assumption that the application of financial modeling can benefit strategic decisions on whether our business should invest on a lease truck or choose different alternatives.

Data Analysis

Due to the very high level of competition, it was important for us to investigate which option would benefit the business. A description of the simulation analysis is provided in this section.

Option A: Leasing a truck for a cost of SR 70,000 /year

In Table 6 we show a 60-month simulation for the leasing system. An analysis of simulation results reveals that expenses amounted to approximately 31.4 % of the net profit, which was SR 2,365,085. Expenses include shipping cost and labor. For option A, we simulated three factors: sales, gas cost, and the number of fuel delivery trips. We kept labor cost fixed at SR 5200/month. For simulation analysis, firstly we calculated the total shipping cost by using equation

Shipping cost = (number of trips) (shipment cost, which was SR 220 / trip)

Then, we calculated the total average of sales, gas cost and number of trips based on historical data (Table 3). We used the mean and standard deviation values of sales, gas cost, and number of trips in the simulation. The goodness-of-fit analysis suggested that we could use the normal distribution to model the aforementioned variables. The information was used on the function NORMINV (RAND (), Mean, STDEV) to simulate the data for the next 60 months. All prices used in the analysis were based on market trends at the time of this report.

Months	Revenue (SR)	Gasoline Cost (SR)	Gross profit (SR)	Total shipping cost (SR)	Number of Shipments	Labor (SR)
1	298,019	253,669	44,349	7,700	35	5,200
2	295,135	251,081	44,054	7,920	36	5,200
3	332,659	255,499	77,160	8,580	39	5,200
4	318,809	252,683	66,126	7,480	34	5,200
5	350,733	265,832	84,901	7,260	33	5,200
6	298,298	256,061	42,237	8,140	37	5,200
7	301,995	247,113	54,882	7,700	35	5,200
8	303,907	266,397	37,510	7,700	35	5,200
9	308,789	268,602	40,187	8,140	37	5,200
10	303,828	272,984	30,844	7,920	36	5,200
11	299,391	259,679	39,712	7,260	33	5,200
12	316,631	247,846	68,785	7,480	34	5,200
13	332,700	261,034	71,666	7,260	33	5,200
14	283,936	269,854	14,083	7,700	35	5,200
15	294,376	272,275	22,101	7,700	35	5,200
16	297,887	262,801	35,086	7,700	35	5,200
17	307,361	257,204	50,157	7,260	33	5,200
18	301,733	250,189	51,544	7,920	36	5,200
19	302,218	250,761	51,457	7,480	34	5,200
20	347,009	243,717	103,292	7,700	35	5,200
21	312,833	249,282	63,551	7,480	34	5,200
Table 6. Leasing a used truck						
22	307,701	246,464	61,236	8,140	37	5,200
23	315,299	256,222	59,077	7,700	35	5,200
24	322,705	275,365	47,340	7,700	35	5,200
25	314,408	259,433	54,975	8,140	37	5,200
26	306,541	258,829	47,712	7,920	36	5,200
27	335,643	264,564	71,079	7,700	35	5,200
28	336,888	261,917	74,971	7,040	32	5,200
29	297,625	262,737	34,889	7,920	36	5,200
30	324,717	277,609	47,107	8,140	37	5,200
31	330,744	235,074	95,670	7,700	35	5,200
32	320,157	284,570	35,587	7,920	36	5,200
33	317,030	269,953	47,077	7,700	35	5,200
34	305,447	252,335	53,112	7,920	36	5,200
35	276,781	261,066	15,715	7,700	35	5,200
36	312,220	283,028	29,193	7,920	36	5,200
37	299,212	271,916	27,295	7,700	35	5,200
38	286,572	273,692	12,880	7,480	34	5,200
39	318,668	241,034	77,634	7,260	33	5,200
40	316,574	251,928	64,646	7,480	34	5,200
41	320,832	233,397	87,435	7,920	36	5,200
42	324,365	262,281	62,084	7,920	36	5,200
43	335,206	268,778	66,428	7,700	35	5,200
44	307,023	256,598	50,425	8,580	39	5,200
45	310,174	276,881	33,293	7,480	34	5,200
46	334,080	258,118	75,962	7,700	35	5,200
47	312,420	250,961	61,458	7,700	35	5,200
48	306,827	261,149	45,678	7,920	36	5,200
49	355,475	245,534	109,941	7,920	36	5,200
50	323,473	266,909	56,564	8,140	37	5,200
51	331,232	244,995	86,237	7,920	36	5,200
52	313,613	264,438	49,175	7,260	33	5,200
53	257,233	248,260	8,972	7,920	36	5,200
54	332,366	239,240	93,125	7,480	34	5,200

55	315,014	264,261	50,753	7,700	35	5,200
56	295,699	259,499	36,200	7,700	35	5,200
57	298,669	265,650	33,019	7,700	35	5,200
58	303,089	239,103	63,986	7,700	35	5,200
59	296,784	261,313	35,470	8,580	39	5,200
60	318,175	236,639	81,535	7,480	34	5,200
Total	**18,744,921**	**15,506,302**	**3,238,619**	**464,860**	**2,113**	**312,000**
Net Profit = (Profit-Total shipment Cost-Labor)= (3,238,619 - 464,860 - 312,000) = SR 2,461,772						

Table 6. Leasing a used truck (cont).

Months	Revenue (SR)	Gasoline Cost (SR)	Gross profit (SR)	Total shipping cost (SR)	Number of Shipments	Labor (SR)
Total	**18,744,921**	**15,506,302**	**3,238,619**	**464,860**	**2,113**	**312,000**

Net Profit = (Profit-Total shipment Cost-Labor)= (3,238,619 - 464,860 - 312,000) = SR 2,461,772

Option B: Buying a used truck for SR 150,000

In Table 7 we show a 60-month simulation results for buying a used truck. An analysis of simulation results reveals that expenses amounted to approximately 36.9% of the net profit which was SR 2,337,085 In addition to the income and expense categories considered in the previous option, we included truck amortization, fix maintenance, driver wages, tires and maintenance. Fixed costs included labor (SR 5,200), the truck driver wages (SR 2,000), amortization (SR 2,500/month), fixed maintenance (SR 400), and tires (SR 18,000). Total sales and gas cost were simulated as described for the first model.

month	Revenue (SR)	Gas cost (SR)	Gross profit (SR)	Driver (SR)	Amortization (SR)	Fix maint (SR)	Labor (SR)	Tires (SR)
1	298,019	253,669	44,349	2,000	2,500	400	5,200	18,000
2	295,135	251,081	44,054	2,000	2,500	400	5,200	
3	332,659	255,499	77,160	2,000	2,500	400	5,200	
4	318,809	252,683	66,126	2,000	2,500	400	5,200	
5	350,733	265,832	84,901	2,000	2,500	400	5,200	
6	298,298	256,061	42,237	2,000	2,500	400	5,200	
7	301,995	247,113	54,882	2,000	2,500	400	5,200	
8	303,907	266,397	37,510	2,000	2,500	400	5,200	
9	308,789	268,602	40,187	2,000	2,500	400	5,200	
10	303,828	272,984	30,844	2,000	2,500	400	5,200	
11	299,391	259,679	39,712	2,000	2,500	400	5,200	
12	316,631	247,846	68,785	2,000	2,500	400	5,200	
13	335,215	295,200	40,015	2,000	2,500	400	5,200	
14	324,544	295,540	29,004	2,000	2,500	400	5,200	
15	300,454	284,560	15,894	2,000	2,500	400	5,200	
16	322,352	254,565	67,787	2,000	2,500	400	5,200	
17	298,019	253,669	44,349	2,000	2,500	400	5,200	
18	295,135	251,081	44,054	2,000	2,500	400	5,200	
19	332,659	255,499	77,160	2,000	2,500	400	5,200	
20	318,809	252,683	66,126	2,000	2,500	400	5,200	
21	350,733	265,832	84,901	2,000	2,500	400	5,200	
22	298,298	256,061	42,237	2,000	2,500	400	5,200	
23	301,995	247,113	54,882	2,000	2,500	400	5,200	
24	303,907	266,397	37,510	2,000	2,500	400	5,200	
25	308,789	268,602	40,187	2,000	2,500	400	5,200	
26	303,828	272,984	30,844	2,000	2,500	400	5,200	
27	299,391	259,679	39,712	2,000	2,500	400	5,200	
28	316,631	247,846	68,785	2,000	2,500	400	5,200	
29	335,215	295,200	40,015	2,000	2,500	400	5,200	
30	324,544	295,540	29,004	2,000	2,500	400	5,200	
31	300,454	284,560	15,894	2,000	2,500	400	5,200	

32	322,352	254,565	67,787	2,000	2,500	400	5,200	
33	298,019	253,669	44,349	2,000	2,500	400	5,200	
34	295,135	251,081	44,054	2,000	2,500	400	5,200	
35	332,659	255,499	77,160	2,000	2,500	400	5,200	
36	318,809	252,683	66,126	2,000	2,500	400	5,200	
37	350,733	265,832	84,901	2,000	2,500	400	5,200	
38	298,298	256,061	42,237	2,000	2,500	400	5,200	
39	301,995	247,113	54,882	2,000	2,500	400	5,200	
40	303,907	266,397	37,510	2,000	2,500	400	5,200	
41	308,789	268,602	40,187	2,000	2,500	400	5,200	
42	303,828	272,984	30,844	2,000	2,500	400	5,200	
43	299,391	259,679	39,712	2,000	2,500	400	5,200	
44	316,631	247,846	68,785	2,000	2,500	400	5,200	
45	335,215	295,200	40,015	2,000	2,500	400	5,200	
46	324,544	295,540	29,004	2,000	2,500	400	5,200	
47	300,454	284,560	15,894	2,000	2,500	400	5,200	
48	322,352	254,565	67,787	2,000	2,500	400	5,200	
49	298,019	253,669	44,349	2,000	2,500	400	5,200	
50	295,135	251,081	44,054	2,000	2,500	400	5,200	
Table 7. Buying a used truck								
51	332,659	255,499	77,160	2,000	2,500	400	5,200	
52	318,809	252,683	66,126	2,000	2,500	400	5,200	
53	350,733	265,832	84,901	2,000	2,500	400	5,200	
54	298,298	256,061	42,237	2,000	2,500	400	5,200	
55	301,995	247,113	54,882	2,000	2,500	400	5,200	
56	303,907	266,397	37,510	2,000	2,500	400	5,200	
57	308,789	268,602	40,187	2,000	2,500	400	5,200	
58	303,828	272,984	30,844	2,000	2,500	400	5,200	
59	299,391	259,679	39,712	2,000	2,500	400	5,200	
60	316,631	247,846	68,785	2,000	2,500	400	5,200	
Total	**18,760,460**	**15,779,375**	**2,981,085**	**120,000**	**150,000**	**24,000**	**312,000**	**18,000**
Net Profit	= (Profit- Labor - Amortization - Driver wages - Tires) = (3,137,633 - 120,000 - 312,000) = SR 2,305,633							
Table 7. Buying a used truck (cont).								

Month	**Revenue (SR)**	**Gas cost(SR)**	**Gross profit (SR)**	**Driver (SR)**	**Amortization (SR)**	**Labor (SR)**
Total	**18,574,529**	**15,436,896**	**3,137,633**	**120,000**	**400,000**	**312,000**
Net Profit		**= (Profit- Labor –Amortization- Fix maintenance - Driver wage -Tires) = (3,137,633 - 120,000 - 312,000) = SR 2,305,633**				

Option C: Buying a new truck for SR 400,000

In Table 8 we show a 60-month of simulation of the decision to acquire a new truck. An analysis of simulation results reveals that expenses amounted to approximately 40.98% from the total profit, which is SR 2,305,633 and includes the amortization, driver and Labor. However, if we bought a new truck, we would receive free maintenance. In this model, the fixed factors were labor (SR 5,200) the truck driver wages (SR 2,000), and amortization (SR 6,667/month). The simulation analysis was similar to that conducted before.

Month	Revenue (SR)	Gas cost(SR)	Gross profit (SR)	Driver (SR)	Amortization (SR)	Labor (SR)
1	298,019	253,669	44,349	2,000	6,667	5,200
2	295,135	251,081	44,054	2,000	6,667	5,200
3	332,659	255,499	77,160	2,000	6,667	5,200
4	318,809	252,683	66,126	2,000	6,667	5,200
5	350,733	265,832	84,901	2,000	6,667	5,200
6	298,298	256,061	42,237	2,000	6,667	5,200
7	301,995	247,113	54,882	2,000	6,667	5,200
8	303,907	266,397	37,510	2,000	6,667	5,200
9	308,789	268,602	40,187	2,000	6,667	5,200
10	303,828	272,984	30,844	2,000	6,667	5,200
11	299,391	259,679	39,712	2,000	6,667	5,200
12	316,631	247,846	68,785	2,000	6,667	5,200
13	305,455	254,498	50,957	2,000	6,667	5,200
14	298,500	250,985	47,515	2,000	6,667	5,200
15	301,511	254,674	46,837	2,000	6,667	5,200
16	312,500	254,647	57,853	2,000	6,667	5,200
17	298,019	253,669	44,349	2,000	6,667	5,200
18	295,135	251,081	44,054	2,000	6,667	5,200
19	332,659	255,499	77,160	2,000	6,667	5,200
20	318,809	252,683	66,126	2,000	6,667	5,200

Table 8. Simulation data for the option of acquiring a new truck

21	350,733	265,832	84,901	2,000	6,667	5,200
22	298,298	256,061	42,237	2,000	6,667	5,200
23	301,995	247,113	54,882	2,000	6,667	5,200
24	303,907	266,397	37,510	2,000	6,667	5,200
25	308,789	268,602	40,187	2,000	6,667	5,200
26	303,828	272,984	30,844	2,000	6,667	5,200
27	299,391	259,679	39,712	2,000	6,667	5,200
28	316,631	247,846	68,785	2,000	6,667	5,200
29	305,455	254,645	50,810	2,000	6,667	5,200
30	298,500	250,454	48,046	2,000	6,667	5,200
31	305,444	256,410	49,034	2,000	6,667	5,200
32	312,500	254,647	57,853	2,000	6,667	5,200
33	298,019	253,669	44,349	2,000	6,667	5,200
34	295,135	251,081	44,054	2,000	6,667	5,200
35	332,659	255,499	77,160	2,000	6,667	5,200
36	318,809	252,683	66,126	2,000	6,667	5,200
37	350,733	265,832	84,901	2,000	6,667	5,200
38	298,298	256,061	42,237	2,000	6,667	5,200
39	301,995	247,113	54,882	2,000	6,667	5,200
40	303,907	266,397	37,510	2,000	6,667	5,200
41	308,789	268,602	40,187	2,000	6,667	5,200
42	303,828	272,984	30,844	2,000	6,667	5,200
43	299,391	259,679	39,712	2,000	6,667	5,200
44	316,631	247,846	68,785	2,000	6,667	5,200
45	305,455	254,645	50,810	2,000	6,667	5,200
46	298,500	250,454	48,046	2,000	6,667	5,200
47	305,444	256,410	49,034	2,000	6,667	5,200
48	312,500	254,647	57,853	2,000	6,667	5,200
49	298,019	253,669	44,349	2,000	6,667	5,200
50	295,135	251,081	44,054	2,000	6,667	5,200
51	332,659	255,499	77,160	2,000	6,667	5,200

52	318,809	252,683	66,126	2,000	6,667	5,200
53	350,733	265,832	84,901	2,000	6,667	5,200
54	298,298	256,061	42,237	2,000	6,667	5,200
55	301,995	247,113	54,882	2,000	6,667	5,200
56	303,907	266,397	37,510	2,000	6,667	5,200
57	308,789	268,602	40,187	2,000	6,667	5,200
58	303,828	272,984	30,844	2,000	6,667	5,200
59	299,391	259,679	39,712	2,000	6,667	5,200
60	316,631	247,846	68,785	2,000	6,667	5,200
Total	18,574,529	15,436,896	3,137,633	120,000	400,000	312,000

Net Profit = (Profit- Labor - Amortization - Driver wages - Tires) == (3,137,633 - 120,000 - 312,000) = SR 2,305,633

Table 8. Simulation data for the option of acquiring a new truck (cont).

Statistical analysis of results

An analysis of simulation results revealed that the differences in the bottom line figures among the alternatives was relatively small. We proceeded to conduct ANOVA analysis of the simulation results. The null hypothesis was that the mean value of the net profits resulting from the three decisions (buy new car, buy used car, lease) were equal. The alternate hypothesis was that at least one of the mean values would be different. Sixty replications for each decision were used. The response variable was *Net Profits*, which was given by the formula

$$Net\ profits = Revenue - \sum(All\ costs)$$

A simple ANOVA model was used with a single factor (decision) with three levels (buying a new truck, buying a used truck, or leasing). A software package called Design Expert ® was utilized. As shown in Table 9, the differences in the response variable were *not* statistically significant at the 5 percent significance level. Thus, the null hypothesis that the mean net profit figures produced by three options were equal could not be rejected.

Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	df	Mean Square	F value	p value	Truck decision		
Model	2.174E+008	2	1.087E+008	0.30	.7413	2.174E+008	2	1.087E+008
Pure	6.415E+010	177	3.624E+008					
Core	6.437E+010	179						
Total								

Table 9. Analysis of variance of simulation results.

Final remarks

A statistical analysis of the decision making process of the Abouhenidi Gas Station of Yanbu, Saudi Arabia, was conducted. The analysis included the following components:

1. Data collection. Demand data over a 36-month study period was provided by Management.
2. Goodness-of-fit tests. The use of the package StatFit® suggested that the normal distribution could be used to model monthly revenues, fuel cost, and the number of delivery trips made by supplier trucks to the station.
3. Simulation. We used Excel to simulate fuel sales over a 60-month study period under three scenarios: (1) buying a new delivery truck, (2) buying a used delivery truck, (3) leasing a delivery truck.
4. Analysis of variance. The simulation results were fed to an ANOVA package called Design Expert®. The hypothesis that the net profits yielded by the three alternatives were equal could not be rejected.

The station owner was informed about the results of this study. His opinion is that since the null hypothesis could not be rejected, he would opt to implement the decision that would minimize the perceived risk. He favored the lease alternative, as it would minimized the risks presented by maintenance. The author plans to enhance the simulation model in the future to continue to aid in the decision making process at the gas station. A possible embellishment is the implementation of a conditional rule in the Used Truck alternative by which the ownership would decide to sell the used truck if the cumulative maintenance cost reached a certain threshold. The station would switch to leasing a truck from that point on.

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