

CUSTOMER-FOCUSED E-BUSINESS MODEL FOR THE OIL INDUSTRY

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ABSTRACT

This paper aims at developing customer-focused e-business solutions to achieve oil energy security. There were two phases involved. In the first phase, an oil electronic-customer chain (OECC) model was developed to study the effective adoption of information technology (IT) in the oil industry. Thirty-six e-business solutions were identified based on the OECC model. In the second phase, pattern analysis of IT adoptions in the top twenty oil companies worldwide was conducted. The e-business solution pattern analysis resulted in developing an adoption pyramid that classified these thirty-six e-business solutions into three categories. The company implementation versatility pattern analysis investigated the e-business implementation patterns among these 20 companies. The study concludes that the electronic customer chain based e-business solutions are crucial to accelerate the IT adoption in the oil industry; and thereby, enhancing oil electronic energy security and reducing disequilibrium in supply and demand in the near future.

Keywords: electronic business, customer chain management, oil electronic energy security

1. INTRODUCTION

The US marketplace is in a position that it has never been seen before. The crude oil prices broke \$100 a barrel early in 2008 for the first time ever and shot up close to \$140 a barrel in the early June of 2008. According to Standard & Poor's, a market premium on oil prices may currently exist due to a number of reasons including the Organization of Petroleum Exporting Countries (OPEC)'s slow production growth, geopolitical tensions, tight global refinery conversion capacity, peak oil fears, and accelerating demand for transportation fuels [7]. One reason for the oil price increase is that the oil demand keeps increasing while existing oil wells worldwide are depleting, and new oil wells are more difficult to explore. In order to explore new oil wells that are deeper under the surface, higher capital investments are required. However, many of the countries with significant reserves are reluctant to accept international investors [22]. Another reason for the oil price increase is that companies and countries overestimate the available reserves to influence the prices [31]. For example, new studies about available oil reserves raised doubt about the number of Saudi reserves [6]. How reliable the forecasts on the available oil reserves are still unclear.

World petroleum consumption has steadily increased over the past decade and is expected to continue to increase slightly each year, but many factors would contribute to the price per barrel of crude oil dropping. Throughout the next five years, large supplies of crude should be entering the market due to big new oil and gas field developments, which might help to ease market concerns over the availability of crude supply through 2012

[7]. The increase in supply and reduction in the marginal cost of production are also the expansions to refinery capacity taking place around the world through 2012 [7].

Despite its importance, scientific studies on adoption of Information Technology (IT) in the oil industry are still lacking in the literature. The current research aims at developing customer-focused electronic-business (e-business) solutions to achieve the oil energy security and reduce the disequilibrium in supply and demand. In order to reduce the disequilibria of supply and demand geographically and politically, companies should make their supply chain more efficient in order to manage the increased competition in the oil industry and the change in supply and demand. It is important to invest in advanced IT in order to optimize the use of energy in the future [20].

The rest of the paper is organized as follows: Section 2 presents literature review. Section 3 provides an electronic-customer (e-customer) chain model for the oil industry. In Section 4, a decomposition of the developed oil e-customer chain (OECC) model is conducted to derive e-business solution items in the oil industry. In Section 5, findings on e-business applications from the top twenty companies in the oil industry are discussed. In Section 6, managerial implications and conclusions are addressed.

2. LITERATURE REVIEW

2.1 Information Technology Impacts on the Oil Industry

According to American Petroleum Institute (API) [2], the oil and natural gas industry's segments include steps in finding, producing, processing, transporting, and marketing oil and natural gas. API breaks the oil and natural gas industry down into five major sectors, including the Service and Supply sector, the Marine sector, the Pipeline sector, the Refining and Marketing (downstream) sector, and the Exploration and Production (upstream) sector [36].

The upstream segment makes up the crude petroleum and natural gas extraction industry. The upstream segment deals with the exploration and production of oil and natural gas using tools ranging from cutting-edge geology to high-tech offshore drilling platforms [2]. One of the main benefits that technology has been applied to the upstream sector is the elimination of poor prospects which substantially reduces costs involved with drilling a dry hole. Technology also improves the recovery processes allowing more petroleum and natural gas to be extracted, but the most impressive is the ability to produce from reservoirs that were never reachable or known about. The greatest benefit that technology provides the oil industry is to make processes safer. Any technology that can prevent explosions like the BP refinery in Texas during 2005 is needed [12].

Technology has been utilized in the downstream sector of the oil and natural gas industry as well, but not to the same extent as

that in the upstream sector. Foti [14] presented the industrial race to invest on IT in the downstream to improve oil industries' supply chain efficiency. The downstream petroleum supply chain has a relative lack of analytical sophistication, organizational alignment, information integration, and technological sophistication [14]. In order to generate operational efficiencies required to remain competitive, technology needs to be utilized in refiners [5] [19].

IT has affected the oil and gas industry in numerous ways. More organizations need to take advantage of the benefits from electronic business. Most of the technology impacts have been in the exploration and production sector of oil and gas industry. Technology advancements by revolutionizing the information available about the features of a geologic structure have allowed the industry to find, extract, and produce petroleum from places never being thought possible [11].

2.2 Energy Security

In order to bridge the gap between energy-sufficient and energy-lacking countries, and to supply the world with stable deliveries and predictable energy prices to ensure high quality of energy supply, it is important to have a reliable and effective worldwide energy security plan [33]. Energy security is generally characterized by several principles, including supply diversification, resilience factor, integration reality recognition, information importance, global energy security recognition, and entire energy supply chain protection [38].

At the government level, energy security was the major theme on the agenda of G8. The G8 is a group of the eight major industrial countries in the world that meet every year to discuss about major issues worldwide [6]. The chairman of the G8 mentioned that a stable and open investment environment with timely decision making was a cornerstone of energy security [30]. To stimulate stabilization of the global energy market, development of innovation technologies, use of renewable energy sources and protection of the environment are important [6].

At the enterprise level, energy security involves managing operation processes effectively and making a more efficient use of oil capacity in order to minimize costs and avoid shortages at gas stations [38]. Development of IT solutions with a customer focus can support the enterprise level energy security [38] and improve service quality including greater customer satisfaction [8] [17] [34]. The application of IT will make the world oil market more transparent and create better possibilities for buyers to indicate which resources are available and where the oil can be purchased. It will increase efficiency in use of oil and improve the supply and demand equilibrium so that resources of oil around the world are better allocated. These improvements in transparency and market efficiency will create a better and sustainable competitive environment and will make the industry less vulnerable for shortages in supply or increases in demand [4] [28] [29]. There are several advanced IT systems available that allow companies and institutions to forecast the demand of oil across the whole supply chain. These systems make predictions based on historical data from similar periods, and forward trade data based on deals done or committed in the forward months and macroeconomic indicators to forecast the consumer demand. Also, it is important to predict the forward price of crude oil which will prevail in the market in the future months. Systems like intelligent neural network algorithms that evaluate various statistical forecasting methods can support prediction processes [3].

3. AN OIL E-CUSTOMER CHAIN (OECC) MODEL DEVELOPMENT

Energy security on the company level involves several kinds of solutions for oil companies that allow them to manage their operation processes, and make a more efficient use of their capacity so that they can minimize their costs and avoid shortages at gas stations. Several IT solutions can support energy security in strategy [16] [25] [26]. An important concept that highlights the role of IT is customer chain.

Customer chain can be defined as provider–customer links that extending from origin of product or service through sale to the end customer and on to post-sale service [37]. In these provider–customer links, every employee has a customer, i.e., the next process or where the work goes next [21] [23]. Every employee has a customer and is also a customer of a previous process. In the current paper, electronic customer (e-customer) chain is defined as using the companies' IT infrastructure or Internet capabilities to share information with each member of the customer chain in order to ensure process enhancements rather than hampers the next process (your customer).

Vital [36] divided the chains of the oil industry into three different segments: upstream, midstream, and downstream. Based on modifying Vital's model, an e-customer chain (OECC) model was developed (Figure 1).

In Figure 1, the processes inside each stream (Upstream, Midstream, and Downstream) have been presented as e-processes since each process needs to be conducted through electronic media (including IT support). The e-customer refers to the customer who interacts with oil companies via electronic media.

In Figure 1, the upstream activities are for exploration and production sectors that find and produce crude oil and natural gas. The midstream segment stores, markets and transports commodities including crude oil, natural gas and natural gas liquid. The downstream segment includes oil refineries, petrochemical plants, distributors, and fuel and gas stations distributing the oil products to the end e-consumer.

Each of these three segments has to maintain a relationship as a customer or as a provider with the party that is next or preliminary to it in a supply chain. Some act as internal e-customers and some as external e-customers. An external e-customer directly purchases the products or service from a business enterprise, like the end e-consumer or in the situation that an independent operator sells its product to a company in the midstream or downstream segment. An internal e-customer is a group in the distribution channel that receives processes, products and services from others in the organization. The different possible relationships can be categorized by four e-business categories: business-to-business (B2B), business-to-consumer (B2C), consumer-to-business (C2B), and business-to-internal (B2I). Whether the relationship is B2B, B2C, C2B or B2I, both internal e-customers and external e-customers have six general demands, including high levels of quality, a high degree of flexibility, high levels of service, low costs, quick response and little or no variability [21]. The goal of this integrated approach towards internal customer-provider relationships is to create a common set of goals that fulfills all internal and external e-customer needs. On this way, the company can optimize its business processes and make a better use of its resource which will eventually decrease lead-time, minimize costs, and reduce the disequilibrium in demand and supply.

The companies IT infrastructure and Internet capabilities can support information sharing with each member of the customer

chain so that the processes in the relationships among the three segments can be integrated and optimized. The primary goals if segment integration and optimization are to streamline information flow, eliminate waste and reduce costs, in order to satisfy the basic six customer demands through customer chain management.

Applications for the internal relationships of B2I are characterized by management systems to integrate the different activities and systems within the company to create synergy among departments. Systems like Enterprise Resource Managements and Track and Trace systems can make information available on different levels of a company [9]. Applications for external relationship between B2B, B2C and C2B are mainly focused on the transfer of information in the direction from provider to customer (supply to demand) and in the opposite direction from customer to provider (from demand to supply). These systems are mainly focused on the possibility for the customer to get insight in products or services that are available at the supplier. These systems also allow the customer to make use of electronic business applications to make the order-relationship with the provider more efficient and customized in aspects such as transactions (payment-options) and delivery (just-in-time). The applications allow the provider to better satisfy the needs and expectations of the customer and contribute to a better customer-provider relationship.

4. RESEARCH METHODOLOGY

4.1 E-Business Solution Items

Mihlmester and McKelvey [24] developed a set of e-business applications in general energy services. Ende and Wei developed a set of e-business applications in the oil industry, and further developed a set of 32 e-energy security items [10] [11]. Based on Mihlmester and McKelvey's e-business applications [24] and expanding the security items developed by Ende and Wei [10] [11], in the current paper, thirty-six e-business solution items in

the oil industry were mapped and derived from the developed e-customer chain model in terms of four e-business categories: B2B, B2C, C2B, and B2I (Appendix A). Every category has its own application that can be implemented in the organization to improve business value on physical or information-processing components [15] [29].

4.2 Data Collection

There are two types of companies involved in the industry of crude petroleum and natural gas: the majors and the independents. The majors are large, vertically integrated companies that operate and own all the three different segments (in Figure 1) relatively independent. In contrast, the independent operators are those companies that tend to operate at the domestic level and are specialized in the upstream segment of the e-customer chain in Figure 1 [36].

The largest oil producing companies in the world are state-owned that operate differently from the non-state-owned companies. Most of the time, the state-owned companies mainly operate in the upstream activities of the industry; and therefore, have a different usage of e-business applications than that in non-state-owned companies. Although these companies have a large influence on the oil industry, the best known companies in the oil industry are the vertically integrated non-state-owned multinationals. Therefore, the current paper investigates the status of e-business solution implementation in the oil industry based on the largest vertically integrated companies worldwide.

The selection of the top vertically integrated companies in the worldwide oil industry is based on revenue. In 2007, the top twenty vertically integrated companies in the worldwide oil industry based on their revenues are Royal Dutch Shell, British Petrol, Exxon Mobil, Total, Chevron Texaco, Eni, Conoco Philips, Statoil, Repsol, Occidental, Devon, Amerada Hess, Apache Corp, EnCana, Anadarko Petroleum, Marathon, Kerr Mc Gee, Unocal, Burlington Resources, and Bhp Billiton [27]. The revenues from

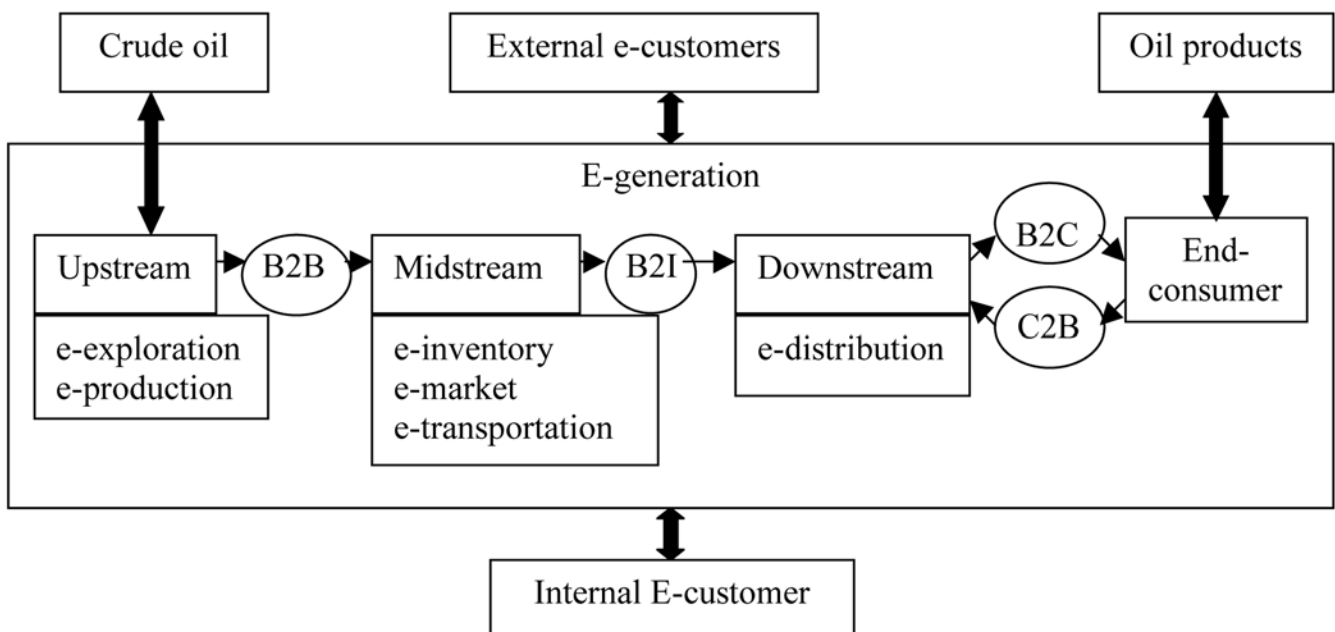


Figure 1: The OECC Model for the Oil Industry

TABLE 1
E-Business Solution Implementation Status from Top Twenty Companies

Items	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	
B2B	A1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	
	A2	Y	Y	Y	Y	Y		Y		Y		Y	Y	Y		Y				Y	
	A3	Y	Y			Y			Y			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	A4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						
	A5	Y	Y	Y	Y			Y				Y	Y	Y	Y	Y					Y
	A6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y				Y	Y
	A7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	A8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						
	A9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
B2C	B1																				
	B2	Y	Y	Y	Y	Y															
	B3	Y	Y	Y		Y	Y			Y				Y	Y						
	B4	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
	B5	Y	Y	Y	Y	Y	Y														
	B6	Y	Y	Y	Y	Y	Y	Y	Y	Y					Y	Y					
	B7																				
	B8																				
	B9	Y	Y	Y	Y	Y			Y	Y		Y	Y	Y							
	B10	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y							
	B11	Y		Y	Y																
	B12	Y	Y	Y	Y	Y															
	B13	Y	Y	Y	Y	Y	Y	Y			Y	Y	Y								
	B14	Y	Y	Y	Y	Y		Y		Y		Y									
	B15	Y		Y	Y	Y				Y											
	B16	Y	Y	Y	Y	Y	Y			Y	Y	Y	Y				Y				
C2B	C1								Y												
	C2								Y												
	C3	Y	Y																		
B2I	D1	Y	Y	Y	Y	Y			Y		Y	Y	Y								
	D2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	D3	Y	Y	Y	Y	Y	Y		Y	Y		Y									
	D4																				
	D5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	D6	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	D7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	D8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: C1-C20 are oil companies, including Shell (C1), BP (C2), Exxon Mobil (C3), Total (C4), Chevron Texaco (C5), Eni (C6), Conoco Phillips (C7), Statoil (C8), Repsol (C9), Occidental (C10), Devon (C11), Amerada Hess (C12), Apache Corp. (C13), EnCana (C14), Anadarko Petroleum (C15), Marathon (C16), Kerr Mc Gee (C17), Unocal (C18), Burlington Resources (C19), and Bhp Billiton (C20). E-business solution items are listed in Appendix A.

other companies fall much far behind Bhp Billiton. Hence, a total of these twenty dominant companies were selected as the study group.

For each company, research was done about whether a

TABLE 2
Analysis of E-business Solution Items

E-Business Solution Items *	Total # of Companies Adopt Each Item	% for Each Item (%)
A7	20	100.0
A9	20	100.0
D2	20	100.0
D5	20	100.0
D6	20	100.0
D7	20	100.0
D8	20	100.0
A1	19	95.0
B4	17	85.0
A6	16	80.0
A3	14	70.0
A4	14	70.0
A8	14	70.0
A2	12	60.0
B10	12	60.0
A5	11	55.0
B6	11	55.0
B16	11	55.0
B9	10	50.0
B13	10	50.0
D1	9	45.0
D3	9	45.0
B3	8	40.0
B14	8	40.0
B5	6	30.0
B2	5	25.0
B12	5	25.0
B15	5	25.0
B11	3	15.0
C3	2	10.0
C1	1	5.0
C2	1	5.0
B1	0	0.0
B7	0	0.0
B8	0	0.0
D4	0	0.0

* Indices and descriptions of e-business solution items are presented in Table 1.

company used certain e-business solution items. The data was retrieved from the individual companies' website, the individual companies' annual report, and various other websites that give different insights on different topics. The phone interviews were also conducted to IT experts in these companies. The results from data collection are summarized in Table 1. In Table 1, the companies and e-business solution items are listed in no particular order of significance. A "Y" in Table 1 refers that a particular company implements an e-business solution, and a blank refers that does not implement.

5. FINDINGS

The e-business solution items gathered from top twenty oil companies' are tallied. Specifically, first, the numbers of companies that provide each solution item are tallied to find the most widely used items. Second, the numbers of solution items that various companies provide are tallied to analyze the versatility of those solution items.

5.1 E-Business Solution Item Analysis

The distribution of 36 solution items among twenty companies from Table 1 is tallied to separate the most widely used solution items from those that are not. Table 2 presents this distribution.

In Table 2, the ten most widely used e-business solution items are A7, A9, D2, D5, D6, D7, D8, A1, B4, and A6 (80% or above), which are usually found in the B2B and B2I categories. The eleven least commonly used e-business solution items are B2, B12, B15, B11, C3, C1, C2, B1, B7, B8, and D4 (25% or below). Most of these items are shown in the B2C and C2B categories. Even though these items are important and have potential benefits, they still have not been widely adopted. The rest fifteen of the items are A3, A4, A8, A2, B10, A5, B6, B16, B9, B13, D1, D3, B3, B14, and B5, which were implemented by some companies.

Moreover, seven of thirty-six e-business solution items (7 out of 36 items or 19.4%) are the applications that are fully implemented with 100% usage among the analyzed companies (A7, A9, D2, D5, D6, D7, and D8). The least commonly used applications (5%) are C1 and C2. Items not implemented by any of these companies (0%) are B1, B7, B8 and D4.

Based on the examination of existing e-business solution items for these twenty dominant companies, an e-business solution adoption pyramid is constructed in Figure 2. The solution items that equal to or more than 80% of the companies implemented are classified as most widely used items (Most Adopted Items), those equal to or less than 25% least commonly used items (Least Adopted Items), and the rest items (Enhanced Items).

Some other major findings from Figure 2 are:

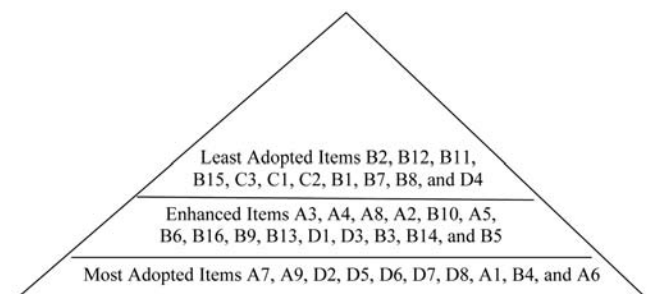


Figure 2: E-Business Solution Adoption Pyramid

- In the Most Adopted Items category in Figure 2, four items (A7, A9, A1, and A6) are in the B2B, five items (D2, D5, D6, D7, and D8) in the B2I, and one item (B4) in B2C. In the Least Adopted Items category, seven items are in the B2C (B2, B12, B11, B15, B1, B7, and B8), three items (C3, C1, C2) in C2B, and one item (D4) in B2I. This means that the oil industry has a high use of electronic media in the refining and production processes (B2B and B2I) but a relatively low use in relations with customers (B2C and C2B). The low implementation and use of IT in the C2B and B2C can be explained by the fact that oil products are not sold to consumers online.
- Careful attention must be paid, however, in translating the tallied numbers. Some solution items are more hindrance than assistance to the users. At the same token, some of the solution items that are not as widely used as others can be of great assistance to the customers. For example, solution items such as the Customer Auction System (C1), Consumer-Initiated Aggregation (C2), and

Online Customer Feedback (C3) items in C2B have great assistant to customers; however, only 5% to 10% of the top twenty companies implemented these three items.

- In oil companies, the least commonly used solution items become more important than those used in the current oil e-commerce environment. For example, Item B1 “Sign-On Online Rebates and Online Discounts” provides the most convenience and attraction for consumers and travelers.

5.2 Implementation Versatility

The versatility of these twenty oil companies’ e-business implementation status is studied in the current research. The total number of items and percentages for each of the twenty companies are presented in an ascending order in Table 3.

In Table 3, for example, company C1 implements all 9 solution items in B2B, a 100% is inserted for company C1 in the % column under B2B category ($9 / 9 * 100\%$). Company C3 implements 8 out of 9 solution items in the B2B, an 88.9% ($8 / 9$)

TABLE 3
Analysis of E-Business Solutions Implementation Versatility

Company *	B2B (total 9 items)		B2C (total 16 items)		C2B (total 3 items)		B2I (total 8 items)		Total (total 36 items)	
	Count	%	Count	%	Count	%	Count	%	Count	%
C1	9	100.0	13	81.3	1	33.3	7	87.5	30	83.3
C2	9	100.0	11	68.8	1	33.3	7	87.5	28	77.8
C3	8	88.9	13	81.3	0	0.0	7	87.5	28	77.8
C4	8	88.9	12	75.0	0	0.0	7	87.5	27	75.0
C5	8	88.9	12	75.0	0	0.0	7	87.5	27	75.0
C6	7	66.7	8	50.0	2	66.7	7	87.5	24	66.7
C7	8	88.9	6	37.5	0	0.0	7	87.5	21	58.3
C8	9	77.8	5	31.3	0	0.0	6	75.0	20	55.6
C9	6	77.8	7	43.8	0	0.0	6	75.0	19	52.8
C10	9	66.7	4	25.0	0	0.0	6	75.0	19	52.8
C11	8	88.9	5	31.3	0	0.0	5	62.5	18	50.0
C12	7	100.0	3	18.8	0	0.0	6	75.0	16	44.4
C13	8	100.0	3	18.8	0	0.0	5	62.5	16	44.4
C14	6	88.9	4	25.0	0	0.0	5	62.5	15	41.7
C15	7	77.8	2	12.5	0	0.0	5	62.5	14	38.9
C16	7	44.4	0	0.0	0	0.0	5	62.5	12	33.3
C17	4	33.3	2	12.5	0	0.0	5	62.5	11	30.6
C18	5	44.4	0	0.0	0	0.0	5	62.5	10	27.8
C19	3	55.6	1	6.3	0	0.0	5	62.5	9	25.0
C20	4	77.8	0	0.0	0	0.0	5	62.5	9	25.0
Average	7.0	77.8	5.6	34.7	0.2	6.7	5.9	73.8	18.7	51.8

* Companies are: Shell (C1), BP (C2), Exxon Mobil (C3), Total (C4), Chevron Texaco (C5), Repsol (C6), Devon (C7), Amerada Hess (C8), Eni (C9), Apache Corp. (C10), Conoco Philips (C11), Statoil(C12), EnCana (C13), Occidental (C14), Anadarko Petroleum (C15), Bhp Billiton (C16), Marathon (C17), Burlington Resources (C18), Kerr Mc Gee (C19), and Unocal (C20).

* 100%) is inserted for company C3 in the % column under B2B category.

In Table 3, companies C19 and C20 implements a total of 9 (in the total column) solution items, i.e., out of these thirty-six items available, all of the twenty companies have at least 9 or more of the solution items that are implemented.

Other major findings include:

- Half of the twenty companies have implemented above 50% for these thirty-six items, and another half (ten companies) implemented 50% and below for these items.
- There are ten companies that offer more than the average number of items (18.7) and another ten companies that offer less than the average number of items.
- The percentages out of the thirty-six items implemented in the twenty companies are between 25.0% and 83.3%. “Shell (C1)” has the highest number of items (30 items), and “BP (C2)”, and “Exxon Mobil (C3)” have the second highest number of items (28 items), while “Kerr Mc Gee (C19)” and “Unocal (C20)” have the lowest number of items (9 items).
- The oil industry has a high use of electronic media in the refining and production processes in B2B and B2I, but a relatively low use in B2C and C2B. It can be seen that the average utilization percentage in the B2C and C2B are the lowest with 34.7% and 6.7% compared to the B2B and B2I segment that show higher percentages with 77.8% and 73.8%. The low percentage of implementation and use of technology in the C2B and B2C categories can be explained by the fact that oil products are not sold to consumers online. Fuel for consumers to use in the car cannot be delivered at home, and, therefore, the consumer has to go with his or her car to the gas station. Because the companies do not offer their products online, the companies do not have the technology to support the online buying system simply because the companies do not need the system. This absence of an online buying system might also explain why the utilization rate of e-business applications in the consumer to business segment is almost zero.
- Despite this relatively low utilization of e-business applications in B2C compared to B2B, it can be seen that the companies with the most extensive network of gas stations (Shell, BP, Exxon, Total and Chevron) compared to the companies without a network of gas stations still show the highest level of e-business application utilization in the B2C segment. This high level of utilization can be explained by the fact that although the oil industry does not use the actual online buying system, the companies do implement several other applications to serve their customers like information and education, online reward systems, and online advertising to manage the relationship with the consumer. In addition, the companies those are less vertically integrated and mostly state-owned or formerly state-owned show remarkable lower e-business applications rate, especially regarding the point of sale. The overall utilization rate of e-business applications regarding new sources of energy is low as well.

6. MANAGERIAL IMPLICATIONS AND CONCLUSIONS

The current research developed an oil e-customer chain model by considering the IT adoption in the existing e-business environment. The breakdown of the OECC model can allow oil companies determine what e-business solution items need to be concentrated on; and thereby, differentiate themselves from their competitors. The findings from the current research indicate that acceleration of IT adoption in the oil industry is crucial to the success of oil e-business. Several major findings in the current study are presented below, along with the discussions of management implications.

First, the developed OECC model supports information sharing with each member of the customer chain so that the processes in the relationships between the three segments can be integrated and optimized. The primary goals are to streamline information flow, eliminate waste and reduce costs so that the basic customer wants are satisfied throughout the customer chain. This OECC model based on integration of business activities in three segments can be used as a base for managers when considering business process (re)design.

Second, managers should understand that it is not the number of e-business solution items but the usefulness of the items that is critical to the success of oil e-business. Ten e-business solution items are most widely implemented (80% or above), while eleven e-business solution items were least implemented (25% or below). All of the twenty companies studied in the current research have implemented between 9 and 30 solution items out of a total of 36 items. However, some solution items are better than others so that the customers can conduct e-business with an oil company faster and more efficient than they could have done with other oil companies.

Third, the e-business solution item adoption pyramid developed in the current research reflects the availability of IT adoption items in oil e-business. Managers in an oil company need to consider implementing more solution items in the Least Adopted Items category to distinguish its e-business from those of the competitors to enhance the customer relationship management; and thereby, increase business value. For example, online payment option (B2), which has been implemented by only five companies, may become more prevalent once e-business becomes more popular. The Customer Auction System (C1), Consumer-Initiated Aggregation (C2) and Online Customer Feedback (C3) items would allow customers conduct online business with oil companies more efficiently. However, items C1 and C2 have been implemented by only one company, and the C3 has been implemented by only two companies.

Fourth, it can be concluded that the oil companies are highly utilizing e-business application in the direction from supply to demand (B2B and B2I), but less utilizing e-business applications in the direction of demand to supply (B2C and C2B) (Figure 1). Applications that are merely used for one-way communication from supply to demand indicate a relatively higher utilization can also be used for interactive communication from demand to supply. Examples of e-business applications with low utilization rate that can be used for interactive communication are A3 (Online Commodity Trading), A5 (Online Business Resource Planning), B2 (Automatic Payment), B12 (Online Customization Tools), and the two applications in the C2B segment. Managers need to aware that existing pattern and make the e-business applications

in a two-way communication in an oil organization in order to sufficiently adopt IT solutions.

Previously, the challenge was in getting the best deals on buying crude. Now, the focus of oil companies is shifting to create a competitive advantage by giving customers what they want. To make the customer chain respond more to demand and less vulnerable to disruptions in supply, there should be a movement from the supply-driven push to a demand-driven pull in the industry for non-state owned companies as well as for state-owned companies. Whereas state-owned oil firms always tend to operate only in the exploration and production of oil (downstream activities), they are now also increasingly expanding investments at the downstream end of consumer markets. This tendency is likely to result in more secure sources of supply and increased competition for the non-state owned companies [32].

Fifth, it is important for the companies in the oil industry to broaden their competitive scope in order to exploit interrelationships between the specific components of the customer chain in different industry segments, as well as in geographic areas and other related industries. This broadening of the competitive scope can be done at four dimensions: vertical scope, segment scope, industry scope, and geographic scope [28]. Broadening the segment scope involves getting a better insight into the segment by managing the customer chain of the oil industry on different levels; and thereby, minimizes operation costs. The e-business solutions developed in the current paper can support this improvement.

Expanding the vertical scope in the oil industry implies getting more influence in the upstream activities that are currently dominated by large state owned companies and governments. These activities will make the industry less dependent on the state-owned supply parties. For example, several western countries are increasingly dependent on the importing oil from the countries that dominate the supply. An important role for the governments in these western countries such as the United States and the European Union is to organize a new type of Organization of Petroleum Importing Countries, so that they can make use of their customers' bargaining power. The unification of the larger oil importing countries and the joined bargaining power will create a better negotiation position for these countries with the OPEC [35]. In addition, this unification will also create a better foundation to encourage oil exporting countries to invest in the economies of these western oil-importing countries. By investing in western economies, oil producing countries will become economically more dependent on western economies, and create awareness on investments about the importance of the western economy for the oil demand. Investments of oil producing countries in the western economies and thereby supporting the oil demands from western countries will also benefit to create a stable worldwide oil market. Therefore, an awareness of mutual dependency will become the base of a new oil trading system by the fact that western countries are more dependent on oil from oil producing countries, and oil producing countries are more dependent economically on western oil importing countries [1].

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APPENDIX A
Descriptions of E-Business Solutions in the Oil Industry

No.	E-Business Item	Description
B2B Business to Business		
A1	News Portals	Provide online information to track current events, and provide analysis about changes in the national and international oil industry
A2	Green Energy Tariff	Provide green energy rules and regulations online to help a company meet environmental objectives, and improve relationships with customers, employees and local community
A3	Online Commodity Trading	Include online term trading, hourly trading, scheduling and market policy Energy commodity trading of crude oil and gas
A4	Corporate Website	Provide information about company's activities/performances
A5	Online Business Resource Planning	Provide cross-functional information system by streamlining business processes, integrating business units and providing managers access to real time information
A6	Just In Time	Use information technology to manage operations with little or no delay time or idle inventories between one process and the next
A7	Statistical Process Control System	Provide computer-based statistical process control system
A8	Stock Management System	Use computer-based information system to identify inventory requirements, set targets, and report actual and projected inventory status. This system can help the company to optimize the inventory levels, eliminate stock-outs, increase sales, and squeeze the most out of the supply chain

A9	Online Catalogue	Show online which products be offered to the B2B market
B2C Business to Consumer		
B1	Sign-on Online Rebates/Discounts	Offer cash rebates on eligible renewable energy saving systems through Emerging Renewable Programs
B2	Automatic Payment	Offer customers choices for paying their bills
B3	Online Consolidated Bill	Allow customers to receive online consolidated bill statements per month rather than an individual bill for each account
B4	Online News Letter	Provide up to date information about the companies' activities, news and about new products or discounts.
B5	Online Education	Broaden understanding of the evolving oil industry and its changing business environment
B6	Interactive Frequent Asked Questions	Provide online interactive frequently asked questions and concerns
B7	Gas Service/Electricity	Offer gas or electricity service online by oil companies for product differentiation
B8	Online Car Insurance and Maintenance	Offer service on online car insurance and maintenance for by oil companies for product differentiation
B9	Online Multilingual Services	Provide online multilingual communication services including translation and interpretation
B10	Green Energy	Provide energy produced in an environmentally friendly manner online. Generation resources for green energy may include environmental friendly produced fuel or other sources of environmental friendly energy like sun, wind, water and landfill gas
B11	On-Line Real Time Energy & Appliance Usage with Money Saving Suggestions	Provide suggestions online regarding real time energy and appliances usages so that customers can control their energy demands
B12	Online Customization Tools	Provide customers with preferred view of their online account category to ease navigation and ensure the presentation of relevant account management features, and provide flexible customer service online desktop environment to deliver accurate and integrated customers requests
B13	Online Outlet Locater	Allow customers to find the nearest gas station online.
B14	Online Reward System	Allow customers to get insight into personal reward systems to check its balance, get information about the redeem options and exchange credits or certain rewards
B15	Online Advertising	Advertise products, discounts or other services online
B16	Links to Related Websites	Provide links to partners' websites that relate to its business
C2B Consumer to Business		
C1	Customer Auction System	Offer online consumer price bidding
C2	Consumer-Initiated Aggregation	Provide a online party that assembles and represents groups of 'small' customers for retail access
C3	Online Customer Feedback	Allow customers to provide feedback through interactive web pages
B2I Business to Internal		
D1	Knowledge Management and Sharing System	Provide knowledge management information system to share knowledge from intellectual and knowledge-based assets, involving sharing among employees, departments and other related companies
D2	Online Human Resource Services	Support employee development and ensure accuracy of employee information: consolidates all people programs into one comprehensive plan — a roadmap for developing people and accomplishing business results; provide and support Knowledge Management/performance management, and report capabilities that can be used to track and report on performance versus targets; pursue developmental opportunities to rotate employees between business and IT in order to facilitate knowledge sharing of best practices (e.g. recruitment and retention of diverse groups); provide reliable and secure communication channels and evaluate and promote the use of effective and efficient technologies to support skill development (e.g. e-learning capabilities)

D3	Virtual Team Work	Provide the framework to proactively and effectively manage business units IT, which will result in system-wide cost-effective, reliable and efficient technology solutions in support of a business unit strategy.
D4	Online Tracking System	Allow the company to track and trace the raw materials and several oil products in the supply chain.
D5	Inventory Management System	Help to identify inventory requirements, set targets, and report actual and projected inventory status. It can help the company to optimize the inventory levels, eliminate stock-outs, and increase sales.
D6	Internal Resource Planning	Streamline business processes internally to allocate resources by integrating all business units
D7	Online Insurance and Warranties	Provide employee's information regarding group medical plan prescription drugs, dental plans, mental health and substance abuse treatment, accident sickness insurance, employee assistance program, long-term disability plan, accidental death and dismemberment insurance, group life insurance and business travel insurance
D8	Intranet Technologies	Communicate with employees through Intranet technologies
