Evaluating Distribution Options for Horizontal Portals Using Data Envelopment Analysis

Tapati Bandopadhyay, Pradeep Kumar, Nivedita Roy

ICFAI Business School, ICFAI University,IDPL Corporate Office complex
Old Delhi-Jaipur Road, Dundahera, Gurgaon 122016, Haryana, India
Phone: 91-124- 2455485 / 486 Fax : 91-124-2455484
Email: tapati@ibsdel.org, pkgarg@ibsdel.org, nivedita@ibsdel.org

ABSTRACT

Focusing the distribution channels for horizontal portals, various aspects of e-business, in their new ways and processes, have been explained and then three types of distribution channels for a generic horizontal portal have been identified and a novel approach using data development analysis (DEA) has been suggested to address the option selection issues in this paper.

INTRODUCTION

E-business models are recently the most discussed aspects of the Internet. In a basic sense, a business model evolves around a basic revenue-generation model, supported by the other necessary business activities like finance, marketing models etc. [1,2]. Whatever the business models are, there is a lot of research evidence about the basic fact that the web has incorporated radical paradigm shifts in the traditional business models [3,4,5,8], and also has given rise to new kinds of business models. The web has actually complemented or reinvented tried-and-true models and has opened hitherto unseen revenue-earning models [18] for companies. The Web has popularized the auction model and broadened its applicability to a wide array of goods and services.

But, even though many services related to traditional business or e-business models and processes have been e-enabled and have thus become better defined, structured, measurable [4, 8] and efficient, cost-effective logistics management is still seen as the bane of most companies' existence.[9, 10] The bulk of many organizations' budgets – both for information technology (IT) and process improvement initiatives – is spent improving the processes involved in getting materials and products through the supply chain with maximum efficiency and minimum cost, and then the distribution network is another significant bottleneck with many mid-warehouses, intermediaries etc. [5, 6, 9]

The problem in maximizing the efficiency of logistics networks is that information, applications and processes have been stove-piped. [5, 9] These vertical silos of information have engendered years of disarray and inefficiency in logistics management, customer service and analysis capability. A recent survey presented by Cheung et al shows “demand-side obstacle factors in the form of perceived low e-shopping comparability, e-shopping inconvenience, e-transaction insecurity, and poor Internet privacy…translate into…supply-side hurdles.” [5] In this

environment, processes and information systems are separate, uncommunicative parts of the organization that often work at cross- purposes.

However, the picture is not as dim as it may look. New solutions are being suggested to address these logistics decision problems. For example, there is the two-part IT model to build, manage and integrate logistics networks; [7, 10]. First model depicts a technical architecture that deploys extraction, transformation and loading (ETL) tools; enterprise application integration (EAI) tools; and business analytic (BA) tools, and second model- the use of these sophisticated tools to perform complex analysis to enable better distribution decisions and collaboration between trading partners. Collaboration between manufacturers, distribution centers and retailers is now the key to success in e-business, with the merging or replacing of old-line, standalone ETL, EAI and BA tools with flexible, scalable, intelligent information networks that route data to and from information-craving entities based on prescribed business rules. But information sharing is not necessarily the panacea for all ills. Choice, design and implementation of the decision making tools and processes based on shared information can actually make the information productive and the decision more effective. In this context, we propose a new approach Data Envelopment Analysis (DEA) in decision making about the distribution models based on information sharing of the trading partners involved in the distribution network.

HORIZONTAL PORTALS AND E-BUSINESS MODELS

Horizontal portals in the context of e-business models have a broader user base due to its capability to cater to the versatile areas of interest of the users like Indiatimes.com, Yahoo.com etc. However, the vertical portals serve a particular industry or a user community's supply chain like indiamart.com acts as the e-marketplace for automobile industry.
For the vertical portals, the supply chains are mainly B2B supply chains which are quite well-defined by traditional business and can be followed in e-business as well and therefore, the issue of distribution logistics can be handled and resolved in a much better and elaborate form in vertical portals as compared to the horizontal portals. [21, 22]

The horizontal portals operate primarily as e-shopping malls wherein a diverse range of products of various companies are available. These portals eliminate mid-warehouses and thereby also eliminate the necessity of an effective inventory management and control system. Instead they handle the orders by acting as in intermediary between the product manufacturers, importers or dealers.

Therefore, the horizontal portals have to cater to the demands of individual customer with small size orders and varied transactional values, which is a unique distribution problem in itself. How the distribution channels can be used optimally and cost-effectively, is a major concern. While minimizing on the cost of distribution, at the same time, the customers have to be satisfied with the speed of order fulfillment and delivery of goods.

Based on the above concerns, E-business models- horizontal or vertical, have been defined, analyzed and categorized in many different ways. Internet business models continue to evolve. New and interesting variations can be expected in the future as many theoretical and practical research activities are focusing all their attention to these e-business models. Most of the

research in these areas primarily deals with Supply chain management, order procurement, order fulfillment and distribution-marketing, customer satisfaction and CRM, e-CRM, Cost vs. Quality of service [20, 22, 23].The cost to quality of service aspect is one area which includes procurement and distribution logistics. However, the distribution options are still the traditional ones, which are not letting an e-business company to fully exploit its' unique e-enabled infrastructure.

The key to profitability in the entire E-supply chain [4,8] can be summed up as under:

- It has to inspire confidence from supplier to customer
- It should be more available than possible in the physical world
- It must protect data integrity to ensure future growth.

The first two elements are primarily dependent on the value-chain including procurement and distribution issues. This paper handles these issues relating to the distribution models of e-business portals focusing on speed of delivery and customer satisfaction which reflects the quality of service aspect, customer relationship and cost associated with distribution channels.

The traditional mathematical foundation of distribution logistics has been operations research techniques like transportation and assignment models. But the typical characteristics of e-business portals, especially horizontal portals, say for example, the huge range of transactional values, huge variations in the volume of products etc. are neither taken into account nor analyzed in these traditional methods. An attempt is made in this paper to address this particular issue. Selection amongst various options available to decide on distribution logistics is inherently dependent on the type of business model the portal uses. Therefore, in the following sections, firstly various business models of the horizontal portals have been outlined and analyzed. There after the corresponding distribution options applicable to these models have been analyzed.

BUSINESS MODELS OF HORIZONTAL PORTALS

Some of the successful business models of the horizontal portals [8, 12, 13, 22] are mentioned and analyzed in this section which strongly corroborates our claim that collaboration between the partners in the distribution network is the key factor of effective functioning of these models.

Direct Producer-Consumer Model

In this model, E-business removes intermediaries from the supply chain, creating a direct, efficient link between producers and consumers. Here, a manufacturer sells directly to customers, increasing profitability while reducing consumer costs by eliminating warehouse and reseller markups. Even the primary contact for service and support also moves through online channels resulting in reduced overhead and speedy service response like lgezybuy.com [29].
Despite various advantages of this model like direct reach to customers, elimination of dealer side warehouses and margins, the biggest drawback of this model is that the choices of consumers are restricted to just one manufacturer and also the customers' inability of 'seeing & feeling' the product that of course happens to be a generic problem of any e-business scenario.

E-Business Intermediary Model

In the second business model, E-business introduces an intermediary for creating an E-Market where none has existed before. This is the biggest area of e-business with a great number of e-shopping malls and horizontal portals operating like indiatimes.com, easybuymusic.com, planetmindia.com, amazon.com etc. The model has advantages where best and competitive prices can be offered with an elimination of mid-warehouses and multiple options of products from various manufacturers available for customers to choose from.

C2C and Customizable Models

The third model has prominent examples of online business, which include auction houses and online brokerages. By opening their networks to ordinary consumers, these organizations create investing and merchandising opportunities that were previously impossible like baazee.com.
Apart from these common models, E-business operates with various other business options too, for example, it reintegrates a market under a name brand, using that awareness to introduce branding into an otherwise fragmented business niche. Used booksellers and travel reservation services are prominent examples of this process. The value in this model comes from uniting many back-end vendors into a single branded identity. These businesses may or may not deliver the best possible price, but both suppliers and customers find the convenience of a single point of contact worth the exchange.
For effective and timely functioning of the order fulfillment cycle of any of these types of portals, it is very crucial for the portals to define suitable distribution models for the products they sell.

TYPES OF DISTRIBUTION OPTIONS FOR HORIZONTAL PORTALS

For portals like Indiatimes.com selling a huge range of goods from different manufacturers and importers, there are several distribution channels available to complete the order fulfillment cycles with a defined efficiency and in a cost-effective way. These models are shown in Figure 1, which has been developed by the authors based on the study of operations of various popular horizontal portals like indiatinmes.com, yahoo.com, rediff.com, easybuymusic.com, baazee.com, lgeazybuy.com etc.

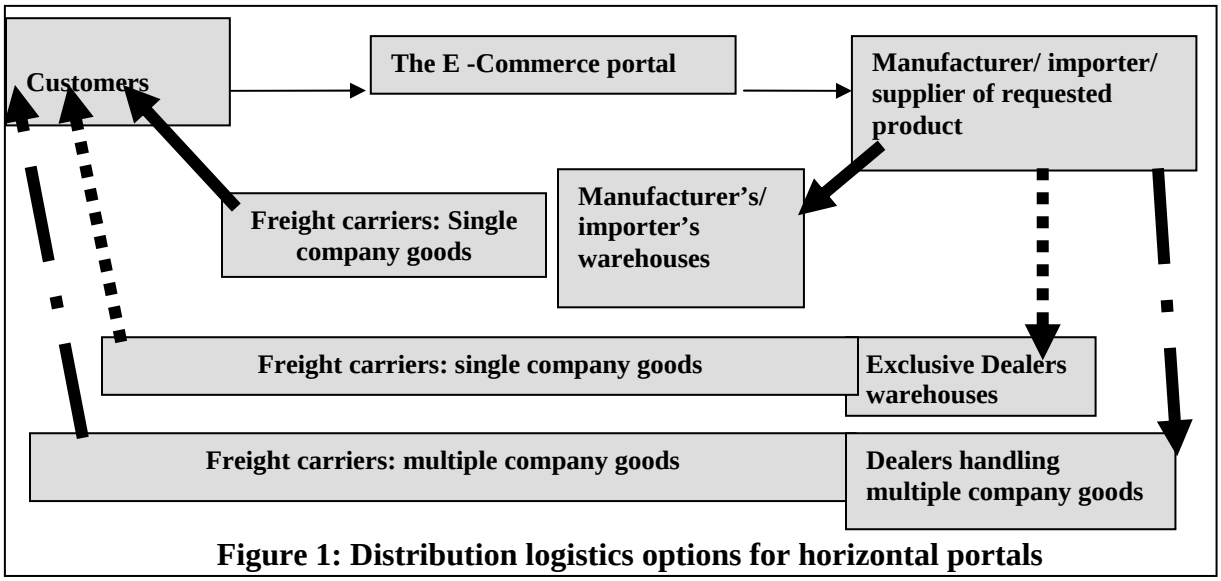

Figure 1: Distribution logistics options for horizontal portals

Comparative Analysis Of The Three Options

The first option eliminates mid-warehouses completely and provides best quality product available as company inspected goods are sent straight to customers without getting stored by dealers. However, it may not prove to be cost-effective.

The second option provides relative location advantages and bulk handling. However, dealers' commission can not be eliminated. Therefore, the company can not get maximum profit and so is unable to pass on cost savings to customers. The quality control can not be ensured.

The third option makes shared distribution channels and transportation infrastructure possible between companies but it can not eliminate dealers' margin.

USING DATA ENVELOPMENT ANALYSIS FOR DECIDING ON THE DISTRIBUTION OPTIONS OF HORIZONTAL PORTALS

In the previous sections, we have discussed about the horizontal portals, some of their common business models and the distribution options that are predominantly available for these portals to deliver the goods to their e-customers. Now we will discuss how a portal will decide on which of these options to choose from, while deciding on the distribution on an individual order, individual customer basis. The viability of the trading parameters and their roles in the distribution network is also to be incorporated in to the analysis. One observation in this context is required to be made, that is, no solution in this context can 'absolutely' satisfy both the objectives of cost minimization and profit maximization. Therefore, traditional central-tendency-based statistical methods which focus more towards 'absolute' efficiencies than relative or optimal efficiencies are not typically suited for horizontal portals' distribution problems. This is where the benefits of a new approach using DEA can be fully exploited.

DEA and it's Applicability

Data Envelopment Analysis (DEA) is commonly used to evaluate the relative efficiency of a number of producers of any goods/ services. A typical statistical approach is characterized as a central tendency approach and it evaluates producers relative to an average producer. In contrast, DEA is an extreme point method and compares each producer with only the "best" producers. A producer is usually referred to as a decision making unit or DMU.

A fundamental assumption behind an extreme point method is that if a given producer, A, is capable of producing Y(A) units of output with X(A) inputs, then other producers should also be able to do the same if they were to operate efficiently. Similarly, if producer B is capable of producing Y(B) units of output with X(B) inputs, then other producers should also be capable of the same production schedule. Producers A, B, and others can then be combined to form a composite producer with composite inputs and composite outputs. Since this composite producer does not necessarily exist, it is typically called a virtual producer.

The heart of the analysis lies in finding the "best" virtual producer for each real producer. If the virtual producer is better than the original producer by either making more output with the same input or making the same output with less input then the original producer is *inefficient*. The subtleties of DEA are introduced in the various ways that producers A and B can be scaled up or down and combined.

The procedure of finding the best virtual producer can be formulated as a linear program. Analyzing the efficiency of *n* producers is then a set of *n* linear programming problems. For example, we have a vector describing the percentages of other producers used to construct the virtual producer and the input and output vectors for the analyzed producer. The producer's efficiency will reflect the comparative efficiency.

Characteristics of problems suitable for DEA applications

From the numerous examples, we can see that problems which can be better solved by DEA other than the traditional Operations Research approaches or fuzzy set theories or similar alternatives, have some typical characteristics which actually can be directly mapped on to the characteristics of DEA, for example:

- Problems with multiple inputs and outputs with different units of measurement
- Unstructured, not well-defined problems where no or minimally stable functional forms are available or can be assumed to relate inputs to outputs
- Problems dealing with similar level player comparisons
- Problem domains which have no/minimal/ extremely dynamic or changing/ evolving benchmarking standards (extreme point techniques can actually be useful to derive the benchmarks ion such situations)
- Problems/ systems where "relative" efficiency is more important than "absolute" efficiency
- Problem domain where the parameters are not clearly defined so it can not modeled around parameters as is possible with many traditional operations research techniques

Distribution option selection problem of horizontal portals and DEA applicability

The problem of selecting a viable distribution option for horizontal portals on an individual customer/order basic reveals some typical characteristics i.e.

1. Generally solutions in this context can not be the best i.e. absolute because none of the options will necessarily be maximum cost effective as well as yielding maximum customer satisfaction for speedy delivery etc. So the solution has to be 'relatively' better or more optimal than the other options. This is the fundamental application potential of using DEA in this problem.
2. The set of parameters can be varying, another aspect which DEA can handle very well.
3. The unit of measurements for different parameters can also vary which again can be well taken care of by the DEA method.
4. The traditional methods of statistics or operations research do not address these issues adequately. This is where DEA method proves to be more useful than those traditional ones.

THE DEA METHOD FOR SELECTING AN OPTION

The horizontal portals have to decide on their distribution options and consequently the trading partners which are the DMUs in DEA application context. These DMUs can be relatively evaluated for various objectives i.e. maximization of customer satisfaction, cost minimization etc. The assessment and decision making process is hereby developed and discussed as a process model which can later on be mapped onto an algorithm or a flow chart with more specific application orientation. In this paper the process model is developed and presented so that a generic understanding of the process can be achieved.

The procedure of finding the best option can be formulated as a linear program. The best option may, but not necessarily, coincide with a real option. If it does not coincide with a real option, it can be taken as the virtual best option. Analyzing the efficiency of *n* options is then a set of *n* linear programming problems. The following formulation is one of the standard forms for DEA. *lambda* is a vector describing the percentages of other options used to construct the virtual option. *lambda X* and *lambda Y* and are the input and output vectors for the analyzed producer. Therefore *X* and *Y* describe the virtual inputs and outputs respectively. The value of theta is the option's applicability.

DEA Input-Oriented Formulation

$$\min \quad \Theta,$$

$$s.t. \quad Y\lambda \geq Y_0,$$

$$\Theta X_0 - X\lambda \geq 0,$$

$$\Theta \quad free, \quad \lambda \geq 0.$$

It should be noted that an LP of this form must be solved for each of the options. The first constraint forces the virtually best option to generate at least as much output (e.g. customer

satisfaction parameters' maximization) as the studied option. The second constraint finds out how much less cost input the virtually best option would need or incur. Hence, it is called input-oriented. The factor used to scale back the inputs is theta and this value is the applicability of the option.

The DEA Method

The basic constant returns to scale output maximization (output-oriented) DEA problem model with *n* options (DMUs), *s* output variables and *r* input variables can be expressed as:

Minimize

$$e'_0 = \frac{\sum_{i=1}^{r} v_i x_{i0}}{\sum_{j=1}^{s} w_j y_{j0}}$$

subject to:

$$\frac{\sum_{i=1}^{r} v_i x_{im}}{\sum_{j=1}^{s} w_j y_{jm}}$$ for m = 1 to n

$w_j 0$ for j = 1 to s and $v_i 0$ for i = 1 to r

Note that this is the reciprocal measure of the input minimization model, which considers the ratio of weighted outputs over weighted inputs. Here e'_0 is therefore a reciprocal of the usual efficiency score. The variables w_j and v_i are weights on the input variables, also known as virtual multipliers. The option under evaluation is known as *option 0.*

The linear form can further express this as follows:

Minimize

$$e'_0 = \sum_{i=1}^{r} v_i x_{i0}$$

subject to:

$$\sum_{i=1}^{r} v_i x_{im} - \sum_{j=1}^{s} w_j y_{jm}$$ for m = 1 to n

$$\sum_{j=1}^{s} w_j y_{j0} = 1$$

$w_j 0$ for j = 1 to s and $v_i 0$ for i = 1 to r

The above formulation is known as the multiplier form, as it uses weights on the input and output variables, which form the method's decision variables.
After calculating the virtual best option and then the real option values for their corresponding minimum cost variables' values and maximum satisfaction variables' values (with their appropriate weightings), the variances between the best virtual option and the real options are calculated.

The minimum variance option is chosen as the best real option for the specific parameter value-set and weightings used in that particular instance of the selection problem.

The Decision Variables

Table 1 shows the key business parameters associated with decision making which are to be used as the decision variables here for choosing an option out of the three alternatives as mentioned above. These variables reflect the aspects which have been discussed in the introduction, i.e. the first two parameters T1 and T2 include the cost aspect, T3 and T4 deals with customer value which in turn reflects indirectly customer satisfaction and relationship parameters. T5 incorporates the value of the trading partner. For example, whatever options among options 1, 2, 3 the portal has been using for previous deliveries, cumulative values of those transactions with it's trading partners (the manufacturer in case of option 1, the exclusive dealer in case of option 2, or the multi-company dealer in case of option 3) can be retrieved from the historical transactional data warehouses. This can reflect a particular trading partner's value and effectiveness to the portal.

T1: Relative location of individual customers and company/ warehouses X transport cost per unit distance	*T2:* Freight charges: based on weight OR volume	*T3:* Transaction al value	*T4:* Cumulative historical transactional values with the customer	*T5:* Trading partners value: total cumulative transaction value of deliveries via the partner

Table 1: Decision variables

HIGHLIGHTS OF THE PROPOSED METHOD

The method proposed in the previous section can be seen as:

1. A fresh approach, unbiased on the side of traditional operations research techniques, is reflected in this method which takes care of typical e-business aspects discussed in section 1.
2. The method is flexible and has a solid mathematical foundation so that it can be easily integrated to traditional mathematical/ statistical formulation of the same problem and therefore a suggested expansion potential of this method is development of hybrid

solution methods using the goodness of traditional methods in combination with the extreme point-based DEA method

3. This method therefore need not completely replace the well-researched areas of transportation and assignment problems but can complement them by addressing typical e-business issues in addition to the traditional business issues that are well handled by the traditional methods.
4. This method does not necessarily give the best or most cost-effective absolute solution, but it gives a realistic and easily usable way to evaluate various options relatively.
5. The method is mathematically simple and easy to comprehend.
6. It can easily be converted to an algorithm, ample LP solutions packages being available, and a computable program can implement it without any hidden conflicts. The computational requirements are also minimal and therefore the program will be highly computationally feasible i.e. processing requirements will be less.
7. It can be used by e-business organizations of any size and capabilities.

CONCLUSION

The distribution options for the horizontal portals and the proposed DEA method to choose the best option in a particular problem instance (i.e. in terms of individual customer/ order basis) as shown in this paper has a very realistic application potential. That is primarily because the DEA method, as has been shown here with various examples and research/ application instances, has some typical characteristics being an extreme-point, relative-efficiency-based method which makes it a better suited one for the distribution decision problem for portals which also typically shows similar nature. The method is also easy to implement and execute. It does not necessarily guarantee a best solution; actually it converges very slowly to the best solution than the traditional central-tendency-based statistical methods. But, it does address the distribution issues typical to various horizontal portals more effectively where a relatively better solution works fine that any theoretically best one.

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