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NETWORK CENTRIC ORGANIZATIONS IN SHIPPING

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Abstract. The concept of Network Centric Organization as a result of information technology evolution in business process and organization is one of items in the so called revolution in business affairs. The value creation process and the impact of Information Technology forms the network Centric Enterprise structure and leverages the role of competitive awareness, the virtual world and the precision operating . The Network Centric Computing based on Internet and its associated technologies is the key technology from the fundamental shift from platform-centric computing to network-centric computing. The characteristics of shipping companies concerning their operation and competitiveness are examined and the potential of Network Centric organization concept applied in shipping business is exploited. The focus is on the specific characteristics of shipping and how those are fitted with the Network Centric requirements.

Keywords. Network-Centric Computing, Network Centric Organizations, Value Creation Process, Information Technology, Shipping Organizations

1. INTRODUCTION

Network-Centric computing is a model of computing which attempt to match more accurately the model of modern enterprises and their commercial activities. Theses are increasingly being reformulated in the light of the radical changes in the communications infrastructure. The boundaries of organizations are changing. They have business process, which are increasingly connected to those of other companies. They have changing communications relationships within the enterprise. Their professional staff is increasingly mobile. The architecture of the company changes more rapidly.

The concept of Network-centric organization and all of its associated revolutions in business affairs grow out of and draw their power from the fundamental changes in global society. These changes have been dominated by the co-evolution of economics, information technology, and business processes and organizations, and they are linked by three themes:

- The shift in focus from the platform to the network
- The shift from viewing actors as independent to viewing them as part of a continuously adapting ecosystem
- The importance of making strategic choices to adapt or even survive in such changing ecosystems

In this paper, the network-centric organization in shipping is examined. The structure of the paper is as follows. In section 2 we begin by first examining the underlying value-creation processes that are central to developing competitive advantage, then the role played by information and information technologies in enabling and enhancing these processes. In the following section 3 the Network Centric Computing concept is presented and its impact on the business environment. In section 4, the shipping companies operation and competitiveness is analyzed followed by the implementation potential of Network Centric concept to shipping businesses is section 5. Finally, section 6 summarizes the conclusions.

2. VALUE CREATION PROCESS AND INFORMATION TECHNOLOGY

Creation of value is at the heart of creating competitive advantage. The value chain describes the links or processes that transform inputs and/or raw materials into value in the form of products [Port 85]. The value chain concept states that competitive advantage can be better understood and hence improved by breaking down the value-creation process depicted in Figure 1 taken from [Alb 99] into its parts so that the contribution of each activity to the firm can be assessed.

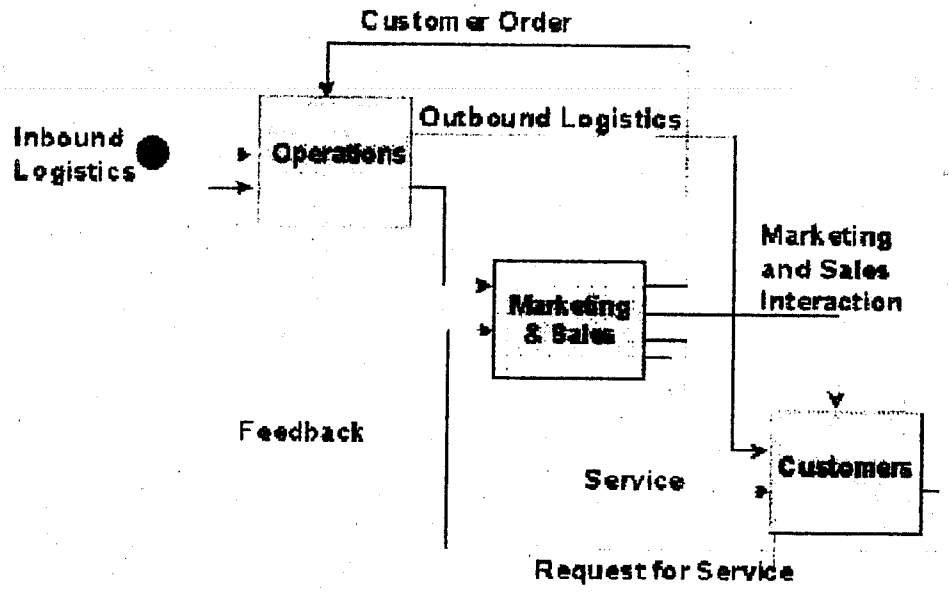

Figure 1. Information Flow in the Value-Creation Process [Alb 99]

The primary value-creating activities include operations and production, marketing, sales and service, and logistics (both to get the raw material or the inputs to the place where they are processed, assembled, and/or integrated, and get the final product to the customer). Other activities contribute to the value-creation process by playing a supporting role. These support activities include technology development, financial and human resource management, and general infrastructure. The concept of value creation applies equally well to transportation services such as shipping The key components of the value-creation process, involves producing an attractive product or service, and making it available in a timely manner at a competitive price.

The competitive advantage requires an increase in the relative value delivered to customers. Value can be enhanced by increasing the attractiveness of a product or service

by incorporating the features that customers desire, including the *ilities* (reliability, maintainability, usability, etc.); increasing responsiveness and tempo of operations by reducing time lines (between product innovations and the time from order to delivery); creating concurrent processes; or lowering prices.

Information and IT are providing the means for innovative companies to create value in ways that were not possible before the advent of the Information Age. The result that comes from IT can be quantified using the *Metcalfe's Law* [For 92]. Metcalfe's Law describes the potential value of a network. It states that as the number of nodes in a network increases *linearly*, the potential "value or "effectiveness" of the network increases *exponentially* as the *square* number of nodes in the network.

The source of potential value is a function of the interactions between the nodes. For every "n" node in a network, there are "n-1" potential interactions between the nodes. Therefore, the total number of value creating interactions is: $n(n-1)$, or n^2-n. For large n, the potential value scales with n^2, or "n squared." The existence of the network enables the interactions between nodes to be information intensive. We can observe that information has the dimensions of relevance, accuracy, and timeliness. Therefore, an upper limit in the information domain is reached as information relevance, accuracy, and timeliness approach 100 percent. Of course, organizations may not be able to achieve these 100-percent conditions. Consequently, the objective in the commercial sector is to approach these upper bounds faster than a competitor. The objective is to leverage this superior information position to create and maintain a competitive advantage.

Information Superiority is a state that is achieved when a competitive advantage is derived from the ability to exploit a superior information position. The mechanism for creating and exploiting information superiority is a function of the dynamics of competition in a domain of competition. Across many sectors of the economy, dominant competitors are successfully employing information-based strategies to create a competitive advantage in their respective domains. Across these domains a number of fundamental themes and concepts have emerged that have coalesced to enable the Network-Centric Enterprise. A Network-Centric Enterprise is characterized by an information-based strategy for creating and exploiting information superiority. The elements of this strategy are depicted in Figure 2 which is slightly modified from [Alb 99].

It all begins with the infostructure ("the entry fee"), which in turn enables the processes that create vastly improved competitive space awareness and share this awareness through the enterprise. This in turn enables a set of processes for exploiting this awareness that results in an improved "bottom line." Note that the bottom line is a measurable product.

2.1 Competitive Awareness

In previous section it was mentioned that one of main characteristics of network-centric organization is to view the actors as a continuous adaptive ecosystem. The ability of a

competitive ecosystem to generate and exploit competitive awareness (an awareness of one's competitive domain or competitive space) has emerged as main point of effective decision making and a principle component of competitive advantage in multiple sectors

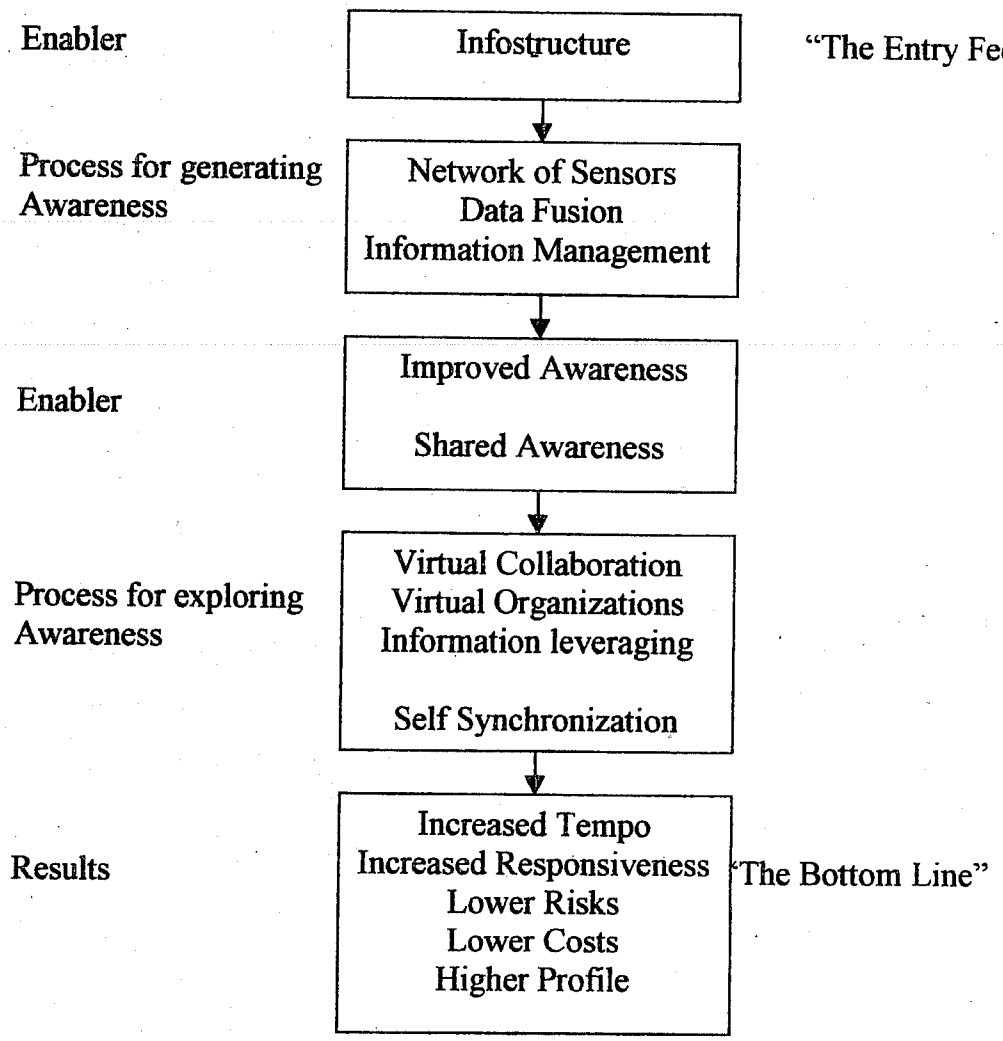

Figure 2. The Network Centric Enterprise

of the economy. So, dominant competitors have demonstrated the ability to generate high levels of awareness of what is going on in their respective enterprises and extended business ecosystems. This high level of awareness has been key to both developing strategy and improving effectiveness at the operational level.

Awareness of one's customers, competitors, and the environment is essential to allow organizations to better understand what the characteristics or attributes of their products or services are or need to be to maximize value. Awareness of customer needs also contributes to improved production, capacity, and logistics planning that, in turn, can improve product availability and reduce business risk.

The ability of an enterprise to share information across functional areas can enable resource allocation decisions to be made that maximize value from an overall enterprise perspective rather than a purely functional perspective.

Increased awareness of emerging technology will also contribute to leveraging technology to make all of the activities in the value chain more effective and efficient, thus reducing costs and risks. Finally, awareness of the future contributes to the ability to adapt value-creation processes over time to maintain and increase value.

2.2 The role of virtual world

In the process for exploring awareness the most significant item is the role of virtual world. The concept of virtual world is the fundamental idea of network centric enterprise. The terms of virtual organization, virtual collaboration, virtual integration and outsourcing are described briefly in the following paragraphs.

Virtual organizations bring the necessary people and processes together to accomplish a particular task. When the task is over, these resources can be released for other tasks. Virtual organizations, enabled by networking, allow enterprises to take advantage of the potential gains in productivity that are associated with virtual collaboration, virtual integration, and outsourcing. Since networking makes location less important, the opportunities for collaboration, integration, and outsourcing are increased.

Virtual collaboration enables individuals to collaborate in a virtual domain. These individuals can be geographically dispersed which is very common in shipping business. One of the major payoffs of collaboration is an improved product design process—one that is not only faster and less costly, but also produces better designs. Major design efforts, such as the design of ships have been facilitated by the implementation of collaborative digital design processes [Tap 96].

Virtual integration enables companies to operate with others as if they were a single, vertically integrated, company. This enables product or market-specific virtual entities to be formed as required to reduce time lines, reduce costs, and improve responsiveness.

Outsourcing is an approach for focusing an organization on its core activities or competencies by divesting activities that must be done but are not where the organization's expertise or experience lies—in other words, areas where it does not possess a competitive advantage. Many organizations have found that outsourcing some of their activities to companies that specialize in a particular service can achieve economies of scale, keep them current with the latest in concepts and technology. Increasingly, companies have employed outsourcing to accomplish key supporting

functions such as information infrastructure, facilities and logistics management, and legal and accounting services. In some cases, activities that used to be considered primary, such as production, have been outsourced and bought as a commodity or turnkey operation.

Virtual organizations reduce time lines and increase the tempo of operations. They do this by turning 8-hour days into 24-hour days, by reducing dead times in processes, and by facilitating concurrent processing. In many sectors, increasing the tempo of operations is the key element in achieving competitive advantage. It contributes to reducing costs as well as differentiating products or services based on responsiveness to customer needs. Successful organizations have been able to increase the tempo of their operations by organizing in a manner that allows them to leverage both available information and available assets. Additional gains can be realized when some of the *collaborators* are, in fact, automated processes or *expert* systems that can provide both greatly increased functionality and simultaneity, along with significant reductions in task processing time.

One of the benefits of adopting network-centric operations is the ability to work projects continuously across time zones. For example after a design team in one location finishes a day's work, another software design team in a separate time zone picks up the ball to continue additional development or testing. . This basis of "following the sun" can provide significant competitive advantage when time-to-market or service responsiveness is a key source of competitive differentiation.

The ability to use information to suppress costs and reduce prices is at the core of numerous information-based strategies. A key theme of cost suppression is the ability to substitute information for inventory. The capability to effectively accomplish this can have a truly significant impact on competitive advantage Risk translates directly into increased costs and/or reduced value. Hence, the reduction of risk and its proper management are an inherent part of value creation. Information (competitive awareness) is, of course, a key to risk suppression.

2.3 Precision Operating

Information can be used to create a competitive advantage in a value chain. Central to a company strategy for creating value is its direct sales model, which offers in-person relationships with corporate and institutional customers, some examples of this kind of operations are telephone and Internet purchasing; phone and on-line technical support; and next-day, on-site product service.

This approach enables a company to use as strategy based on *"sense and respond"* to offer services only when there is real demand [Mag 98]. As a result, a company has developed a significant competitive advantage over the *"make and sell"* strategies of their competitors. It forges strong direct relationships with customers, which among other things allows it to sense more precisely the types and kinds of services attributes that are important to various segments of its customer base. This has as result for a company to be able to design services that are more attractive. Equally important, the direct model

enables rapid *response* to customer demand while simultaneously reducing operational risk as well as the total cost.

The rapid pace of innovation in the information technology sector provides both risks and opportunities. Two of the primary sources of operational risk are large inventories in the form of excess spares and obsolete or high priced components. Minimizing operational risk in this fashion requires a shift in focus from how much inventory there is to how fast the inventory is moving. The company manages the *velocity of inventory* by using a constant flow of information to drive operating practices, from performance measures to how they work with suppliers. It describes its relationship with its suppliers by using the term *virtual integration*. Virtual integration requires an intensive real-time sharing of information between the company, its customers, and its suppliers. The ability to share information in near real time among all relevant elements of the ecosystem enables a company to *substitute information for inventory* and to simultaneously increase flexibility and responsiveness. The near real-time sharing of information within the enterprise provides decision makers with a common operational picture that helps facilitate self-synchronization as well as increase the tempo and responsiveness of operations.

3. NETWORK CENTRIC COMPUTING

Information technology is undergoing a fundamental shift from platform-centric computing to network-centric computing. Platform-centric computing emerged with the widespread proliferation of personal computers in business and in the home. The significant investment the IT sector makes in research and development and product development has led to key technologies that have created the conditions for the emergence of network-centric computing.

This shift is most obvious in the explosive growth of the Internet, intranets, and extranets. Internet users no doubt will recognize transmission control protocol/internet protocol (TCP/IP), hypertext transfer protocol (HTTP), hypertext markup language (HTML), Web browsers (such as Netscape Navigator, and Microsoft's Internet Explorer), search engines etc. These technologies, combined with high-volume, high-speed data access (enabled by the low-cost laser) and technologies for high-speed data networking (hubs and routers) have led to the emergence of network-centric computing. Information "content" now can be created, distributed, and easily exploited across the extremely heterogeneous global computing environment.

Network-centric computing is governed by Metcalfe's Law, as mentioned in previous section, which asserts that the "power" of a network is proportional to the square of the number of nodes in the network. The "power" or "payoff" of network-centric computing comes from information-intensive interactions between very large numbers of heterogeneous computational nodes in the network. Under competitive pressure, and

sensing a strategic opportunity in this fundamental shift in computing. The compelling business logic for this shift in strategy was the opportunity for a company to link its heterogeneous computing lines more effectively and provide increased value for its customers. This is the same value proposition we seek in warfare.

Dominant competitors across a broad range of areas have made the shift to network-centric operations--and have translated information superiority into significant competitive advantage--but the benefits are particularly apparent in transaction-intensive operations, such as retailing and securities trading [Moo 96]. Companies that have made the shift to network-centric operations have gained tremendous competitive advantages by co-evolving their organizations and processes to exploit information technology. Characteristic of those companies is that they employ network-centric operational architectures that consist of a high-powered information backplane (or information grid), a sensor grid, and a transaction grid. These architectures provide the ability to generate and sustain very high levels of competitive space awareness, which is translated into competitive advantage.

Leading firms have come to understand and employ this network calculus well. The three main characteristics of this approach are:

- The shift from platform to network is what enables the more flexible and more dynamic (and profitable) network-centric operation. Therefore, the construction of high-quality networks is their top priority.
- The shift from viewing partners as independent to viewing partners as part of a continuously adapting ecosystem increases speed and profitability in both sales and production. Therefore, they have developed high-speed sensor grids and automated command-and-control systems closely coupled with their transaction grids.
- The key to market dominance lies in making strategic choices appropriate to changing ecosystems..

4. SHIPPING COMPANIES' OPERATION & COMPETITIVENESS

Shipping is a global industry with companies that draw their resources and offer their services on a global basis. Shipping companies are not liable to geographic restrictions regarding either their resources or their services' sales. Thus, every global shipping company competes with all other companies that participate in the same freight markets and operate ships of similar characteristic. Furthermore, the production units are dispersed around the globe and certainly miles away from the companies' headquarters. This fact, even in the age of information technology where the complexity of managerial tasks has decreased, causes certain limitations to their organization and management.

Having these traits in mind, we will try to examine the usefulness of the idea of network centric organizations in shipping.

Shipping companies are able to increase their competitiveness either by reducing their operational cost or by increasing the value delivered to their customers. Given that shipping companies are price takers that operate in markets of a volatile character, they are obliged to operate even below break-even point for extended periods. Under these circumstances, they must be prone in securing that no matter what the freight rates' level are, not only their cost level is always the minimum possible but also that the reliability of their service is the maximum possible [Theo 01]. Having secured these two operational goals, they will be able to deliver their customers with services of increased value, an ability that leads to the increase of their competitiveness. At the same time, shipping industry is transaction intensive. The production of shipping services is the combined result of many stages of production each of which includes various transactions. Shipping companies directly or indirectly control a certain percentage of these transactions, as they can be considered as parts of their value chain. In this category fall transactions with ships' agents, manning agents, P&I clubs, Hull and Machinery Insurers etc. However, they also transact with ports, pilots, flag states, classification societies and other factors that intervene in the production of shipping services without being able to determine or define the terms under which the transactions are executed. Consequently, competitiveness is strongly dependent on their ability to internalize as much transactions as possible.

The high frequency of transactions leads shipping companies to plan and implement strategies that could minimize both the cost and the risk they create [Har 01]. Strategies of internal development, vertical and horizontal integration, mergers and acquisitions as well as strategic alliances, allow shipping companies to internalize transactions, thus reducing their cost and their inherent risk. On the other hand, for companies that are not able or not willing to apply the above-mentioned strategies, the solution for the minimization of the cost and the risk of transactions is to cooperate with other companies of similar characteristics, and to enlarge their value chain forming networks. Co-operation is usually based on common culture, as it allows the arm-length contracts and minimizes the risk of transactions.

At the same time, shipping is an information intensive operation. Information regarding freight rates, freight demand, market forecasting, supply of human resource, port conditions, port state control' requirements etc., is vital for the minimization of risk of transactions. The obtaining of the requested information at the proper time and with the optimum cost can vastly increase the competitiveness of a shipping company. For companies that achieve the situation of information superiority exploiting a superior information position, competitiveness is enlarged. However, the cost of obtaining this information is high. As the shipping environment becomes more complex and the competition more intensive, the information acquisition turns to be presupposition for the preservation and enlargement of competitive advantage.

5. NETWORK CENTRIC ORGANIZATIONS IN SHIPPING

Information technology and IT revolution has already differentiated the patterns of shipping operation. New tools and new organizational forms allow the rapid information diffusion. However, the cost for the acquisition of information continues to be high. Shipping companies that achieve the situation of information superiority are able to control their operating cost and at the same time to increase the reliability of their services. This comes from the fact that the quantity and the quality of information reduce the risk of each transaction and thus, decrease its cost. For example, knowledge of the requirements that the surveyors of a port state control have, allows companies to reduce the time needed for control in the port and more importantly, to avoid delays or even detentions that might cost in time and income. Consequently, a critical task for every shipping company is to form and develop an information-based strategy for creating and exploiting information superiority.

Shipping companies wishing to achieve the situation of information superiority should move toward two directions. The first is related to their organizational structure while the second to their competitive environment. In both cases, what is vital, is the exploitation that the advantages that the information technology and IT revolution offers. Of course, various shipping companies have already adapt to the new technology advancements. However, their platform-based organizational structures merely allow the full exploitation of the advantages that this move could offer. Using the above-mentioned example, we will try to show this limitation. Transferring the information regarding the requirements of the port state control' surveyors to the captain of the ship and giving him the necessary help, the port survey could be transformed to a typical process. This transformation however, leads to the minimization of the risk that the transaction creates to the company. To achieve this, a company must of course acquire the information (and this means that it should have the infrastructure that will allow the acquisition), must elaborate the information and give the necessary instruction to the captain (and this means that its operation must support this aim). Regarding the former, information acquisition should be achieved either from a company's ship that had recently approached the port or from other companies whose ships had or at the time experience the survey procedures in this port. Probably, the most efficient source of information is the latter. Repeated reports on the same subject received from different sources are a mean for the increase of the quality and quantity of information. Regarding the companies ability to elaborate and transfer the information giving in parallel the necessary help to those in ship who need it, the conditions that should prevail is information dissemination and cooperation of the involved persons that work in different department or functions. As it has already stated, the ability of a company to share information across functional areas can enable resource allocation decisions to be made that maximize value from an overall company. perspective that a purely functional perspective. However, the traditional shipping company is a platform-based organization, focused on functions or operations that are performed. Information flow is not always optimum while departmental competition does not always allow the needed cooperation. Information availability in

vertical systems is invariably on a need to know basis and perhaps only to selected staff, while team systems emphasize transparency of information [Mot 98].

The traditional platform based shipping operation leads shipping companies to act independently, planning and implementing strategies that are based to the fact that other players are competitors. This approach fits the analysis of the competitive environment according to which a company is surrounded by competitors and faces threats even from its suppliers or customers, and does not create conditions that will allow cooperation in fields or functions that could be mutually beneficial. The case that was mentioned above, fall in this category. However, as Panayides and Gray [Pan 99] state, "cooperation rather than competition may contribute towards achieving competitive advantage in the shipping industry". Here comes the second direction that a shipping company should follow to achieve the situation of information superiority, that is its relation to competitive environment.

The implementation of information based strategies for creating and exploiting information superiority presupposes not only the change of the traditional organizational approach but also the realization of the fact that organizations are parts of a continuously changing ecosystem and other companies or players could be partners, given that certain conditions for cooperation exist. Of course, competition will always be present. All involved in a business ecosystem can prevail against counterparts in another competing ecosystem [Mil 98]. Information based strategies will foster the competitive awareness of shipping companies as they will create conditions for performing the internal and external analysis based on the increase of the knowledge regarding customer needs, competitors position and environmental conditions.

The transformation to network centric organizations with nodes internally and externally facilitates the information flow and allow the resource allocation in a way that minimize the cost and the risk and maximize the value that is created by companies. Internal integration based on networking will allow the information flow and the focus on project and not on functions. The creation of virtual teams for the management of specific projects will lead to the increase of effectiveness, as it will be based on the combination of specialization of particular employees. Furthermore, it will reduce time lines and increase the tempo of operations. By increasing the working hours, by reducing dead time in processes and by facilitating concurrent processing of the information, companies are able to reduce their operating cost and to adapt their services to their customers' needs. In other words, companies are able to enlarge their competitiveness. For example, the management of a claim could be performed from a virtual team that will enable employees from different departments, each of whom could be at the same time member of other project teams. In the specific example, the captain of the ship, the ship manager and the insurance manager could compose the project team. In parallel, networking could allow the acquisition of relevant information or know how from other companies-nodes of the network who have managed the same claims recently.

More importantly, the networking of various companies-nodes could increase the sources of information for each shipping company as well as the potential resources and capabilities. The idea of building a network organization and of drawing on the best services and knowledge one can get, rather that relying on in house applications is a point

to which every shipping company should focus in deciding its strategy [Lor 01]. Network centric organizations are able to collaborate and integrate, sharing resources and capabilities, surpassing the disadvantages that the location or the particular characteristics of each node create. Instead of simply outsourcing functions, a shipping company could exploit the other nodes' core competencies drawing from their experience or assigning them the responsibility to perform the particular task, undertaking in parallel to perform by itself tasks or responsibilities that are performed more efficiently by its resources and capabilities. For example, for a company whose core competency is the efficient technical management of the ships, it could be optimal to cooperate and form network with companies that are more efficient in the fields of commercial management or in particular aspects of ship operation. This does not mean that the various nodes of the network will abandon activities or functions that already perform. Simply, they will not be obliged to invest resources in enlarging competencies related to fields that could be obtained by other nodes more efficiently. In this way, they will be able to free resources that could be invested more efficiently to the invigoration of functions that create their competitive advantage.

6. CONCLUSIONS

The growth of the Internet has obliged many organizations to start think in Network-Centric terms. The information technologies enable firms to create a high level of competitive awareness within their organizations and extended enterprising. Networking is enabling the creation of the new types of information-based relationships with and among organizations that are able to leverage increased competitive awareness.

In this paper we begin by first examining the value-creation process which is central to develop competitive advantage, then the role played by information and information technologies in these processes is examined. The characteristics of network centric organization are described and terms like competitive awareness, virtual world, precision operations are explained together with a technical description of Network Centric Computing. Finally, our work was focused on the shipping industry examining its characteristics and the potential of an application of the concept of Network Centric Organization to it. The analysis showed that the applicability of the notion to the shipping industry could be enormous high, in case that shipping companies move toward transforming their traditional platform based organizational structures and their approach to competition and to formation of competitive advantage.

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