The Influence of Information Technology Capability on Virtual Integrated Network Capability of Shipbuilding Industry Chain

NAN REN¹, YA-YUN ZHANG, MENGJIAO HE, LIJUN LU

ABSTRACT

To enhance the competitiveness of the shipbuilding industry chain and give full play to the role of information technology capability on the virtual integrated network capability of shipbuilding industry chain, and study on the influence of information technology capability on the virtual integrated network capability of shipbuilding industry chain, this paper chose a number of Shipbuilding Groups and related enterprises as research object and distributed questionnaires to them, then built hypothesis by using qualitative research and using structural equation model (SEM) to give quantitative data to test the hypothesis. The results show that information technology resources (ITR) have a direct effect on the virtual integrated network capacity; information technology capability building (ITCB) has no obvious effect on network adjustment capability (NAdC) of virtual integrated network capacity, but has significant positive effects on other dimensions. And based on these results, we described in detail on how to improve the virtual integrated network capability of shipbuilding industry chain.

INTRODUCTION

Shipbuilding is a typical complex product manufacturing, Digital Support System for Ship manufacturing life cycle is being formed of the world's shipbuilding power and Shipping industry is to develop in the direction of "virtual enterprise"[1]. "Virtual enterprise" is based on Agile manufacturing ideas to establish a highly efficient and flexible, reciprocal coexistence of dynamic business alliances, Its essence is the effective use of Internet technology to achieve the reorganization of design, manufacturing and logistics, and other resources to enhance the virtual integrated network capacity[2]. Information technology capability is the ability that the enterprise to develop and use information technology and it’s an important factor that affect the success of virtual...
integration[3-5], but it’s still lack of in-depth study on the action path that the information technology capability on the formation and development of the industry chain collaboration network under the virtual integration environment. The paper discusses the mechanism of the information technology capability on the virtual integrated network capability of the shipbuilding industry chain, and can provide useful reference for improving the research of this field.

THEORETICAL BASIS AND RESEARCH HYPOTHESIS

IT CAPABILITY

Information technology capability refers to the ability that the Information technology adapt to business process and business strategy and that the organization proactively seek new value from information technology to identify business opportunities[6, 7]. For the dimensions, there are examples of dimensions as IT infrastructure, IT human resources and IT driven intangible assets[4]; or the dimensions as IT infrastructure capability, IT business spanning capacity and IT positive position [7]; or the dimensions as resources and capacity building, and the resources level include IT infrastructure, IT human resources and IT relationship resources, and capacity building level include IT business spanning capacity and IT positive position[8].

Combining previous dimension division of information technology capability, and considering the organization is the set of resources and ability, information technology capability is divided into two dimensions of IT resources and IT capability building in this paper, and IT infrastructure resources (ITIR), IT human resources (ITHR), IT relationship resources (ITRR) can be classified as IT resources; IT business spanning capacity (ITBPC) and IT positive position (ITPP) can be classified as IT capability building.

VIRTUAL INTEGRATED NETWORK CAPABILITY

Virtual integrated network capability is the ability that the enterprise use Inter-organizational Information Systems to deal with the resources and knowledge in the network as integration, configuration, and remodeling, and learn from each other to obtain sustainable competitive advantage[2], it’s the ability that integrate and use resources in the way of virtual integration[2, 9, 10]. And network capability is the ability that the enterprise acquire the resources of technology, service, material and manpower from the external network through the inter-organizational network relationships[11], it has positive effect on enterprise performance and help enterprises to develop through intermediate factors as competitiveness, innovation, resource acquisition and knowledge acquisition[12-15]. Therefore, it can be known that the virtual integrated network capability is a special form of network capacity under the information technology environment, the difference between the two lies in: the former emphasizes to access network resources through inter-organizational information system platform, the latter acquire resources through various relationships, including social network relationships, so the information technology capability is especial important in the virtual integrated network and it’s necessary to study its action path to the virtual
integrated network capability. What they have in common is that they focus on the acquisition and utilization of resources and the coordination among enterprises, so they can refer to each other about the dimensions.

For the dimensions of network capability, the popular classifications are shown below: four dimensions as cooperation, relationship skills, network partner knowledge and internal communication[11]; or four dimensions as network planning capability, network configuration capability, network operation capability and network occupancy capability[15]; or four dimensions as network vision capability, network construction capability, relationship management capability and relationship combination capability[16]; or three dimensions as network awareness capability, network integration capability and network adjustment capability[2], these classifications can be summarized as network relationship establishment and network relationship usage that based on the establishment. So we divide virtual integrated network capability of shipbuilding industry chain as dimensions of network relationship establishment and network relationship usage, and the network relationship establishment capability (NREC) is the ability that to seek and identify the network partners through the Inter-organizational Information system, and then to establish network cooperation relationship with them, it includes dimensions of network awareness capability (NAwC) and network construction capability (NCC); while the network relationship usage capability(NRUC) is the ability that collaborate with partners online and offline by means of inter-organizational information system to complete the coordination, sharing and acquisition of resources, it includes dimensions of network adjustment capability(NAdC) and network operation capability(NOC).

RESEARCH HYPOTHESIS

Information technology resources can support more complex and diverse information exchange between enterprises[17], the in-depth information exchange can help the enterprises of the industrial chain to fully understand the operation of the industry to make a reasonable analysis and accurate judgments, and thus improve their network awareness capability. At the same time, the reasonable combination of information technology resources can form a competitive advantage of the organization[18], information technology can combine with organization, process, business strategy and human resources to form a strong ability of information technology applications[19], this is conducive to exchanges and contacts about technology, knowledge and emotion between enterprises, and it’s benefit to develop a long-term cooperative relationship to promote the construction of virtual integrated network. So based on this, we give the following hypothesis:

H1a: Information technology resources have a significant positive effect on the network awareness capability of shipbuilding industry chain.

H1b: Information technology resources have a significant positive effect on the network construction capability of shipbuilding industry chain.

In the support of the advanced information technology infrastructure and excellent information technology personnel, the information management system of the enterprise can handle the resources in unified planned and shared, it can enhance the overall management level of the shipbuilding industry chain[20], and it has a positive effect on the adjustment and operation of the virtual network. Meanwhile, the trust and cooperation between the IT department and the
management staff can promote the information sharing and coordination between enterprises, and coordination plays an important role in the manufacturing engineering of the shipbuilding industry chain[21-23], it can effectively promote the coordination and distribution of tasks and the reasonable utilization of key resources, and then ensure the efficient operation of the network. So based on this, we give the following hypothesis:

H2a: Information technology resources have a significant positive effect on the network adjustment capability of shipbuilding industry chain.

H2b: Information technology resources have a significant positive effect on the network operation capability of shipbuilding industry chain.

The information technology capability can help enterprises to collect and use information efficiently[24], the possession and usage of various information is benefit to understand their own situation and the external environment and improve the ability of predict and communicate, then to find suitable network partners and improve the network awareness capability. At the same time, information technology capability can encourage enterprises to coordinate various activities and make use of information technology resources to achieve the desired results[25], it can reduce the obstacles and friction of the network construction process, and make it easier to construct the virtual integrated network. So based on this, we give the following hypothesis:

H3a: IT capability building has a significant positive effect on the network awareness capability of shipbuilding industry chain.

H3b: IT capability building has a significant positive effect on the network construction capability of shipbuilding industry chain.

Combination of information technology and shipbuilding system, that’s beneficial to the timeliness of information feedback and information processing and the transparency of the ship manufacturing system, and to achieve the goal of timely coordination[26], and timely coordination is conducive to improve the adjustment capacity of the virtual integration network of the industrial chain. Meanwhile, the deepening application of information technology in management is important to the integration and utilization of manufacturing resources in the inter-organizational Information system, and can effectively promote the operation of virtual integrated network. So based on this, we give the following hypothesis:

H4a: IT capability building has a significant positive effect on the network adjustment capability of shipbuilding industry chain.

H4b: IT capability building has a significant positive effect on the network operation capability of shipbuilding industry chain.

As a part of network relationship establishment, network awareness capability can help enterprises to understand the needs of their own and their partners, to predict the future development, and to develop a good plan of cooperation. The virtual integrated network based on this will be more able to meet the needs of the enterprises of the industrial chain, so it can form a stable and harmonious cooperation network relationship. Strong network relationship can also help enterprises to collect market information and solutions to problems, enhance learning ability and get emotional and technical support[27], and make it easier to access and share resources between enterprises and reduce the barriers to cooperation. So network relationship has a supporting role for the subsequent operation of the virtual integrated network. So based on this, we give the following hypothesis:
H5a: network awareness capability has a significant positive effect on the network adjustment capability.
H5b: network awareness capability has a significant positive effect on the network operation capability.
H5c: network construction capability has a significant positive effect on the network adjustment capability.
H5d: network construction capability has a significant positive effect on the network operation capability.

Based on the above analysis and hypothesis, a conceptual model is constructed, as shown in Figure 1.

Figure 1. Theoretical model of the effects of information technology capability on the virtual integrated network capability of shipbuilding industry chain.

DATA COLLECTION AND MODEL MEASUREMENT

DATA COLLECTION

We collect data by means of questionnaires for hypothesis testing. From June 2016 to August, we conducted a questionnaire survey of China Shipbuilding Industry Corp and the shipbuilding group and enterprises under the China State Shipbuilding Corporation, and some local shipbuilding enterprises and the supporting enterprises of Jiangsu, we sent out 450 questionnaires, collected 215 copies, the recovery rate of the questionnaire was 47.8%. Among the respondents, the senior managers accounted for 74.42%, people with more than 11 years of working experience accounted for 41.86%, people with more than 4 years of working experience accounted for 70.23%, the data of questionnaire is reliable and representative.

MODEL MEASUREMENT

Carrying on the reliability analysis and validity analysis of the questionnaire before the hypothesis test, the results of the analysis are shown in table 1 and table 2.
TABLE 1. RELIABILITY AND VALIDITY TEST RESULTS.

<table>
<thead>
<tr>
<th></th>
<th>AVE</th>
<th>Composite Reliability</th>
<th>R Square</th>
<th>Cronbachs Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITR</td>
<td>0.707</td>
<td>0.975</td>
<td></td>
<td>0.963</td>
</tr>
<tr>
<td>ITCB</td>
<td>0.696</td>
<td>0.931</td>
<td>0.547</td>
<td>0.865</td>
</tr>
<tr>
<td>NAwC</td>
<td>0.579</td>
<td>0.846</td>
<td>0.398</td>
<td>0.872</td>
</tr>
<tr>
<td>NCC</td>
<td>0.589</td>
<td>0.811</td>
<td>0.558</td>
<td>0.771</td>
</tr>
<tr>
<td>NAdC</td>
<td>0.549</td>
<td>0.785</td>
<td>0.560</td>
<td>0.894</td>
</tr>
<tr>
<td>NOC</td>
<td>0.713</td>
<td>0.881</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2. VALIDITY TEST RESULTS.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITR</td>
<td>0.841</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITCB</td>
<td>0.828 0.835</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAwC</td>
<td>0.714 0.700 0.761</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCC</td>
<td>0.618 0.581 0.722 0.767</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAdC</td>
<td>0.649 0.600 0.662 0.674 0.741</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOC</td>
<td>0.673 0.658 0.672 0.624 0.629 0.844</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tested the reliability of the sample data, found that Cronbach’s α coefficient of each variable is greater than 0.7 (Table 1), the composite reliability (CR) is greater than 0.7 (Table 1), which indicates that the scale has good reliability, stability and internal consistency. Tested the validity of the data, the AVE values of six variables are greater than 0.5 (Table 1), the factor loadings of measurement items are above 0.7, so the convergent validity of the scale is well; at the same time, the square root of each variable’s AVE is greater than the correlation coefficient of themselves (Table 2), so the discriminant validity of the scale is well. So we can test the hypothesis based on the sample data (Table 3).

TABLE 3. CORRELATION PATH COEFFICIENT VALUE.

<table>
<thead>
<tr>
<th>Path</th>
<th>Path Coefficient</th>
<th>T value</th>
<th>P value</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a ITR→NAwC</td>
<td>0.427</td>
<td>4.218</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H1b ITR→NCC</td>
<td>0.437</td>
<td>4.326</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H2a ITR→NAdC</td>
<td>0.250</td>
<td>2.995</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H2b ITR→NOC</td>
<td>0.219</td>
<td>2.114</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H3a ITCB→NAwC</td>
<td>0.347</td>
<td>3.267</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H3b ITCB→NCC</td>
<td>0.220</td>
<td>1.976</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H4a ITCB→NAdC</td>
<td>0.056</td>
<td>0.661</td>
<td>&gt;0.05</td>
<td>non-significant</td>
</tr>
<tr>
<td>H4b ITCB→NOC</td>
<td>0.195</td>
<td>1.986</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H5a NAwC→NAdC</td>
<td>0.194</td>
<td>2.279</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H5b NAwC→NOC</td>
<td>0.227</td>
<td>2.396</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H5c NCC→NAdC</td>
<td>0.347</td>
<td>4.579</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
<tr>
<td>H5d NCC→NOC</td>
<td>0.211</td>
<td>2.238</td>
<td>&lt;0.05</td>
<td>significant</td>
</tr>
</tbody>
</table>
As we can see from Table 3, in addition to the hypothesis 4a, other hypothesis have been validated.

CONCLUSION

In this paper, we take the IT capability as independent variable, to explore its role of the virtual integrated network capacity of shipbuilding industry chain, and get the following conclusions.

First, IT resources have a significant positive impact on the Virtual Integrated Network capability. IT resources can promote the development of virtual integrated network capability from various dimensions, so strengthening the construction of IT resources is an important way to improve the virtual integrated network capability. Enterprise should not only ensure the advanced level of its software and hardware facilities, but also continuously improve the technical ability and communication skills of the information technology personnel, to ensure the Organizational willingness can be transmitted accurately and timely to the Information technology personnel.

Second, the impact of IT capability building on Virtual Integrated Network capability is not so significant. IT capability building has significant effect on other dimensions of Virtual Integrated Network capability except the network adjustment capability, it may be for that the Network adjustment capability to a great extent dependent on the trust and cooperation between enterprises, while the dependency of technical level is little. So IT capability building is also an indispensable factor of virtual integrated network capability, it’s the necessary skill of enterprises to strengthen the usage of information technology in the operation of the organization, and to promote the integration of information technology and organizational business processes.

Third, there is interaction between the dimensions of virtual integrated network capability, network relationship establishment capability has a significant impact on the network relationship usage capability. It is the premise of the activities of the subsequent network adaptation and network operation to be carried out smoothly, that analysis the demand of the enterprises in the industrial chain, make an accurate judgment and establishing a network cooperation relationship to meet the interests of all partners. Enterprises need to constantly improve their cognitive ability, information analysis ability and external communication ability to improve their network relationship establishment capability.

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