The Impact of Network Capability and Structural Embeddedness on Service Performance Based On Servitization Manufacturing Enterprises

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Abstract. The relationship between network capability and service performance is studied by introducing structural embeddedness in the servitization manufacturing enterprises, and the main contribution of network capability to service performance and the mediating effect of structural embeddedness are analyzed respectively. An empirical study is presented by using factor analysis, correlation analysis and regression method to analyze the sample data collected from 236 servitization manufacturing enterprises. It can be shown that network capability is beneficial to service performance and significantly positive correlated with structural embeddedness, structural embeddedness has a significantly positive impact on service performance and plays a partial mediating role in the relationship between network capability and service performance.

1. Introduction

《China manufacturing 2025》encourages traditional manufacturing enterprises to increase service investment, promotes the development of servitization manufacturing. When traditional manufacturing transfer to servitization manufacturing enterprises, the strategic focus transfers gradually from product innovation to service innovation, which not only relies on manufacturing enterprises to grasp their own scarce resources, more importantly, on the critical resources from the external network. The ability of manufacturing companies to maintain and manage the relationships among external networks and to obtain critical resources is called network capability [1], it can greatly improve performance and competitiveness [2]. Therefore, how to effectively manage network capability to improve service performance has become an important research issue.

However, network capability mostly is focused on service enterprises or start-ups [3, 4, 5], there is a lack of research on servitization manufacturing enterprises, its relationship with service performance is rarely reported in literatures. In fact, process and mechanism should be understood clearly. Through analyzing the practical experience of servitization manufacturing enterprises such as ShaanGu Power, Shaanxi Automobile, this paper finds that structural embeddedness plays an important mediating role between network capability and service performance However, the published from the perspective of network embeddedness is very rare.

Therefore, this paper brings structural embeddedness into relationship between network capability and service
Performance. The survey data is to be collected from the service-oriented equipment manufacturing industry, the empirical test is to be conducted, which strives to deepen and expand the theoretical research on network capability, social network and servitization. Simultaneously, it aims to provide some theoretical guidance for servitization manufacturing to effectively leverage and manage network capability to improve service performance.

2. Theoretical and hypotheses

2.1. Network capability and service performance
Network capability has been described differently by researchers [1, 6, 7], so its measurement dimension did not reach a consensus around the domestic and foreign [1, 3, 6]. Based on previous research, this paper argues that network capability mainly emphasizes relationships processing capability among network members who involve in product service systems. Therefore, network capability of servitization manufacturing enterprises can be described from three aspects: network coordination, network integration and network learning.

Torkkeli accounted that network coordination capability included sharing development goals and visions with network members, relationship development and members' knowledge and communication skills, which would improve enterprise performance [8]. Soosay found if enterprises could actively cooperate with other enterprises to establish relations, they would seize more business information and get more knowledge, performance would be improved [9]. Goh and Ryan suggested learning capability was conducive to knowledge transfer and absorption, which would create new knowledge to solve the problems [10]. Accordingly, the following hypotheses are proposed:

Network coordination capability (H1a), network integration capability (H1b) and network learning capability (H1c) are positively related to service performance in servitization manufacturing enterprises.

2.2. Network capability and structural embeddedness
Granovetter pointed out that structural embeddedness was a relational characteristic among the whole network. In this paper, structural embeddedness is measured with centrality and structural holes. Centrality is the reputation and influence power, structural hole is the information intermediary and cooperative intermediary.

Human verified that the enhancement of network coordination capability would rise position, improved the reputation and influence of the enterprises in the network [11]. Harland analyzed enterprises as different roles to manage their own network, mainly reflected coordination capability of enterprises to manage the network [12]. One of the important attributes of learning capability is communication skills, more communicative enterprises would gain more information resources [13]. Accordingly, the following hypotheses are proposed:

Network coordination capability (H2a), network integration capability (H2b) and network learning capability (H2c) of servitization manufacturing enterprises are positively related to centrality in the supply network.

If an enterprise in the supply network has a certain degree of network coordination capability, it would like to play the "bridge" role [14]. Vissa pointed out that enterprises with dominant location and network integration capability could establish a resource allocation relationship in a dynamical network and build a "bridge" between non-connected enterprises [15]. Yang et al. pointed out that when members in the network searched for knowledge and technical information, a dynamic cooperation opportunity between network members would generate [16]. Accordingly, the following hypotheses are proposed:

Network coordination capability (H2a), network integration capability (H2b) and network learning capability (H2c) of servitization manufacturing enterprises are positively related to structural hole in the supply network.
2.3. Structural embeddedness and service performance

Gulati found that enterprises in the core position of the network could get more rich network resources, thereby improve enterprise performance [17]. Uzzi discovered that enterprises at the center of the network position could benefit more rich [18]. Kim pointed out that manufacturing enterprises with a central position in the supply network would have more business transactions with other partners, get access to more advantageous resources from partners, thereby enhance competitiveness and improve corporate performance [19]. Burt pointed out that structural hole prompted members to get rich non-redundant information and competitive advantage to improve business performance [14]. Accordingly, the following hypotheses are proposed:

Centrality (H3a) and structural hole (H3b) in the supply network are positively related to service performance of servitization manufacturing enterprises.

2.4. The mediating effect of structural embeddedness

Hagedoorn et al. pointed out that the centrality-based enterprise with the stronger network capability would be likely to influence the behavior of other members [20]. Gilsing et al. studied the alliance network and pointed out that enterprises with higher centrality could be able to affect other partners, would increase the number of patents through promoting cooperation with themselves [21]. Accordingly, the following hypotheses are proposed:

Centrality in the supply network mediates the relationship between network coordination capability (H4a1), network integration capability (H4b1), network learning capability (H4c1) and service performance in servitization manufacturing enterprises.

Gnyawali studied cooperative network from the perspective of structural embeddedness and suggested that advantages of structural hole in the cooperative network would affect behavior and cooperation willingness of other members, thereby their own competitiveness [22]. Fritsch explored regional innovation network and claimed that information and knowledge transfer might be influenced by network structure, strong relationship node was more favorable to their own innovation activities, weak relationship node is opposite [23]. Accordingly, the following hypotheses are proposed:

Structural hole in the supply network mediates the relationship between network coordination capability (H4a2), network integration capability (H4b2), network learning capability (H4c2) and service performance in servitization manufacturing enterprises.

Based on the above analysis, the research framework of this paper is as Fig. 1.

![Figure 1. The research framework](image-url)
3. Methodology

3.1. Sample and data source
This research conducts a survey and interview among manufacturing enterprises that provides either service based on products or based on customer needs by using the Likert seven-level scale in the form of questionnaires. The pre-research is conducted in Xi'an High-tech Zone to determine the form and content of the questionnaire, which are sent to 300 servitization manufacturing enterprises in Xi'an, Shenyang and other cities, and the form of sending and collecting are fax, email, post and so on. A total of 300 questionnaires were sent and 243 were returned. Missing data reduced the sample size to 236.

3.2. Measurement of variables
In terms of network capacity, we mainly adopt and adapt items from Walter [6]. In the aspect of structural embeddedness, we mainly refer to the research results of Burt [14], Kim [19] and Gulati [17]. Service performance is mainly measured by customer relationship quality and service revenue. In addition, enterprise size, nature and types are analyzed the control variable in order to obtain more accurate research results.

The reliability and validity of each variable are shown in Table 1 and Table 2. The measurement models display adequate reliability, convergent validity and discriminant validity. Pearson correlation analysis is used to investigate the correlation between the main variables (Table 3). The results show that there is a significant positive correlation among variables.

| Variables                   | Items                  | reliability | convergent validity |
|-----------------------------|------------------------|-------------|---------------------|
| Network coordination capability | NCC1                  | 0.728       | 0.618 0.839         |
|                             | NCC2                  | 0.731       |                     |
|                             | NCC3                  | 0.734       |                     |
|                             | NCC4                  | 0.703       |                     |
|                             | NCC5                  | 0.653       |                     |
| Network integration capability | NIC1                  | 0.832       | 0.613 0.748         |
|                             | NIC2                  | 0.657       |                     |
|                             | NIC3                  | 0.684       |                     |
|                             | NIC4                  | 0.697       |                     |
| Network learning capability | NLC1                  | 0.741       | 0.662 0.830         |
|                             | NLC2                  | 0.635       |                     |
|                             | NLC3                  | 0.790       |                     |
|                             | NLC4                  | 0.741       |                     |
|                             | NLC5                  | 0.687       |                     |
|                             | NLC6                  | 0.816       |                     |
|                             | NLC7                  | 0.645       |                     |
| Centrality                  | C1                    | 0.814       | 0.671 0.746         |
|                             | C2                    | 0.807       |                     |
|                             | C3                    | 0.815       |                     |
|                             | C4                    | 0.787       |                     |
| Structural hole             | SH1                   | 0.904       | 0.675 0.881         |
|                             | SH2                   | 0.799       |                     |
|                             | SH3                   | 0.634       |                     |
|                             | SH4                   | 0.711       |                     |
| Service performance         | SP1                   | 0.924       | 0.648 0.735         |
|                             | SP2                   | 0.766       |                     |
|                             | SP3                   | 0.699       |                     |
|                             | SP4                   | 0.821       |                     |
|                             | SP5                   | 0.807       |                     |
|                             | SP6                   | 0.801       |                     |
|                             | SP7                   | 0.769       |                     |
|                             | SP8                   | 0.756       |                     |
|                             |                       |             |                     |
4. Result
The hypotheses are tested by using questionnaires data collected. TABLE 4 and TABLE 5 report the results of regression models. The results in TABLE 4 show that in the case of three control variables, three of network capabilities are all positively related to service performance in servitization manufacturing enterprises. H1a, H1b and H1c are supported. Three of network capabilities are all positively related to centrality and structural hole in the supply network. H2a1, H2b1, H2c1, H2a2, H2b2 and H2c2 are supported. Both of centrality and structural hole are all positively related to service performance. H3a and H3b are supported. The results in TABLE 5 show that although network capacity is still positively related to service performance, the correlations decrease significantly, which indicates that centrality and structural hole in the supply network play a part of the intermediary role between network capability and service performance in servitization manufacturing enterprises. H4a1, H4b1 and H4c1 are partially supported. The same as that, H4a2, H4b2 and H4c2 are partially supported.

5. Discussion and conclusion
The theoretical contributions and innovations of this paper are mainly reflected in the following aspects. Firstly, we try to reveal the "black box" about the influence of network capacity on service performance, and find that structural embeddedness plays an important mediating role. That is, three of network capabilities can help servitization manufacturing enterprises to improve centrality and promote the formation of structural hole, which would ensure direct profits from the provision of services and obtain high customer relationship quality. Secondly, this paper verifies the influence of structural embeddedness on service performance. Although almost all of the researchers proved that structural embeddedness is positively related to enterprise performance, it will be necessary to examine empirically "antecedents——structural embeddedness——performance" so as to confirm the stable relationship between structural embeddedness and performance.

However, this paper just reveals a part of the relationship in "black box", there are still more questions that need to be explored further, such as other regulatory variables are needed for further study.

| Table 2. Discriminant validity of each variable |
|-----------------------------------------------|
| model          | $\chi^2$ | DF  | RMSEA | TLI  | CFI  |
| six-factor model | 761.02   | 361 | 0.078 | 0.915 | 0.922 |
| four-factor model 1 | 832.4    | 378 | 0.106 | 0.873 | 0.889 |
| four-factor model 2 | 879.6    | 378 | 0.087 | 0.821 | 0.842 |
| four-factor model 3 | 921.91   | 378 | 0.091 | 0.746 | 0.768 |
| four-factor model 4 | 1053.51  | 378 | 0.110 | 0.789 | 0.802 |
| single-factor model | 1211.63  | 385 | 0.120 | 0.740 | 0.762 |

| Table 3. Descriptive statistics and Pearson correlation matrix |
|---------------------------------------------------------------|
| mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 |
| NCC  | 2.53 | 0.72 | 1 |  |  |  |  |
| NIC  | 3.23 | 0.61 | .179** | 1 |  |  |  |
| NLC  | 3.16 | 0.58 | .181** | .362** | 1 |  |  |
| C    | 2.3  | 0.63 | .169** | .513** | .325** | 1 |  |
| SH   | 3.58 | 0.65 | .224** | .257** | .194** | .606** | 1 |  |
| SP   | 3.59 | 0.69 | .565** | .301** | .350** | .388** | .359** | 1 |

(Note: n = 236; * p < 0.05, ** p < 0.01, *** p < 0.001)
## Table 4. The relationship between variables

| independent variable | dependent variable | SP | SP | SP | C | C | C | SH | SH | SH | SP | SP |
|----------------------|--------------------|----|----|----|---|---|---|----|----|----|----|----|
|                      | H1a                | H1b| H1c| H2a | H2b | H2c | H3a| H3b |
| NCC                  | 0.565              |    |    | 0.160 |    |    |    |    |
| NIC                  |                    | 0.358 | ** | 0.210 | ** | 0.191 | ** |
| NLC                  |                    | 0.356 | ** | 0.310 | ** | 0.180 | ** |
| C                    |                    | 0.380 |    |      |    |      |    |
| SH                   | 0.355              |    |    |      |    |      |    |
| size                 | 0.023              | 0.058 | 0.049 | 0.120 | 0.124 | 0.110 |    |
| nature               | -0.093             | -0.060 | -0.112 | -0.011 | -0.000 | -0.042 | -0.020 | 0.034 | 0.008 | -0.066 | -0.078 |
| types                | 0.060              | 0.043 | 0.036 | 0.117 | 0.095 | 0.072 | 0.081 | 0.067 | 0.065 | 0.053 | 0.067 |
| R²                   | 0.332              | 0.142 | 0.137 | 0.056 | 0.074 | 0.122 | 0.065 | 0.047 | 0.042 | 0.157 | 0.142 |
| Adjusted R²          | 0.320              | 0.127 | 0.122 | 0.040 | 0.058 | 0.107 | 0.049 | 0.030 | 0.025 | 0.142 | 0.127 |
| F                    | 28.69              | 9.564 | ** | 9.170 | 3** | 3.445 | 4.615 | 8.005 | 4.037 | 2.840 | 2.514 | 10.76 | 9.579 | ** |

(Note: n = 236; * p < 0.05, ** p < 0.01, *** p < 0.001)

## Table 5. Mediating effect

| independent variable | dependent variable | H4a | H4b | H4c | H4d | H4e | H4f |
|----------------------|--------------------|-----|-----|-----|-----|-----|-----|
|                      | H4a1               | H4b1| H4c1| H4d | H4e2| H4f2| H4f3|
| NCC                  | 0.518              |    |    |    |    |    |    |
| NIC                  |                    | 0.291 | ** |    |    |    |    |
| NLC                  |                    | 0.263 | ** |    |    |    |    |
| C                    |                    | 0.23 |    |    |    |    |    |
| SH                   | 0.302              |    |    |    |    |    |    |
| size                 | -0.012             | 0.019 | 0.016 | 0.024 | 0.055 | 0.048 |
| nature               | -0.090             | -0.060 | -0.099 | -0.098 | -0.070 | -0.114 |
| types                | 0.025              | 0.013 | 0.242 | 0.041 | 0.023 | 0.016 |
| R²                   | 0.414              | 0.236 | 0.216 | 0.384 | 0.227 | 0.225 |
| Adjusted R²          | 0.402              | 0.219 | 0.199 | 0.371 | 0.210 | 0.208 |
| F                    | 32.541**           | 14.197** | 12.686** | 28.689*** | 13.515*** | 13.380*** |

(Note: n = 236; * p < 0.05, ** p < 0.01, *** p < 0.001)

## Acknowledgments

This work was supported by the National Natural Science Foundation of China (Program No. 71272117), the National Social Science Foundation of China (Program No. 16CGL008), the Ministry of Education Humanities and Social Sciences Research General Project in Shaanxi Province of China (Program No. 16YJC630170).
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