

# Research on the Dynamic Evolution of Manufacturing Industry Cluster Network-The Perspective of the Synergy of Core Enterprise Transformation and Cluster Members

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## Abstract

*China's traditional industry clusters meet challenges and opportunities as the global economy goes ups and downs. Following the trend of industry upgradation is a highlight in both theoretical and practical domain. This paper focuses on the principles of dynamic evolution of China's industry clusters in order to pursuit and establish its enduring growing drive and competitive advantages. This paper gives research into dynamic evolution of cluster network, centering on its inherent relationship with the core enterprise transformation and the restructure flexibility of cluster members and defines "the transformation and up gradation of the core enterprises in cluster network", finds out the dynamic and persistent effect of transformation and upgradation of the core enterprises on network resources and puts forward the dilemma of the dynamic evolution and upgradation of China's cluster network.*

**Keywords:** *Core enterprises, Cluster Evolution, Enterprise Transformation*

## 1. Introduction

Many scholars have all proposed that enterprises in cluster must timely carry out transformation and upgrading when they are studying how to maintain the competitiveness of China's industrial cluster (Xihong Zhu, Aiqing Wu, 2004; Lipparini, 1995; Youjing Liu, 2005). Only focusing on factors on the level of enterprises' their own while ignoring their network resources will usually make the analyses lack certain foresight. So scholars in the analysis of the factors of enterprise transformation proposed that when studying strategic changes, in addition to the analysis of internal resources, the role of inter-enterprise network needs to analyzed more. Therefore, this study will expand the connotation scope of theoretical research of dynamic capability to network evolution, with in-depth analysis and discussion on whether transformation and upgrading of core enterprises in the cluster driven by the global value chain can mobilize to achieve benign interaction between cluster members in resource integration and collaborative innovation, enhance the overall innovation capability of the cluster network and realize cluster upgrading.

## 2. Theoretical Basis and Proposed Model

### 2.1 Transformation Capability of Core Enterprises and Cluster Innovation Performance and Competitiveness

The dynamic transformation capacity of the core enterprises is directly related to the fate of the upstream and downstream partner enterprises in the entire cluster network value chain. (Lorenzoni & Baden-Fuller, 1995; Dyer&Singh, 1998, Vlachopoulou &

Manthou, 2003), Stronger dynamic transformation capacity helps core enterprises to capture new market orientation and consumer demand constantly and quickly, which is also reflected in that absorptive capacity of the core enterprises will continue to learn new technology and develop targeted and innovative products according to new market demands. In the transformation process, according to the industry chain and value network, incompetent enterprises will be constantly re-screened and removed, which will objectively bring pressure to the cooperative partners, stimulating them to continuously improve their productivity, improve product quality and service standards, promote collaborative innovation and continue local cluster's competitiveness in the market.

Therefore, this study presents the following hypotheses:

Hypothesis 1a: Transformation capability of core enterprises in the cluster network has positive impact on cluster innovation performance.

Hypothesis 1b: Transformation capability of core enterprises in the cluster network has positive impact on cluster competitiveness.

## **2.2 Transformation of Core Enterprises and Cooperative Capability of Cluster Resources**

Core enterprises, through resource complementarities at different nodes in the cluster enterprise network, join their own resources with other partner enterprises' resources to enhance their own resource base and selectivity of resource allocation (Gang Fang, 2008, Nerkar & Paruchuri, 2004). In the conscious interaction, coordination and learning process of core enterprises in the cluster with other partner enterprises within the cluster, the sharing and re-integration of knowledge, technology, relationships, and other heterogeneous resources will be facilitated. Core enterprises, by identifying opportunities, based on their own resource situation and strategic transformation need, constantly reconstruct and re-integrate the network resources and values (Dyer & Nobeoka, 2000, N. Naujok, 2003). Continually removing and replacing enterprises that are no longer competent will also promote the integration of resources within the cluster and cooperate to achieve optimization. The dynamic transformation capability will lead the changes of the entire cluster network capability.

Therefore, this study presents the following hypotheses:

Hypothesis 2a: Transformation capability of core enterprises in the cluster has positive impact on cluster resource cooperative capability.

Hypothesis 2b: Cluster resource cooperative capability plays an intermediary role in the mechanism of transformation capability of core enterprises in the cluster influencing cluster innovative performance.

Hypothesis 2c: Cluster resource cooperative capability plays an intermediary role in the mechanism of transformation capability of core enterprises in the cluster influencing cluster competitiveness.

## **2.3. Cluster Members Restructuring Resilience and Cluster Performance and Cluster Competitiveness**

Network relationships in a cluster should not be too long-lasting, because a lasting network relationship is not so suitable for the requirement of flexible specialization, and will lead to the danger of being locked by the relationship (Tolstoy & Agndal, 2010). The better the resilience of reorganization relationship among members within the cluster network is, the higher the frequency of interaction within the cluster will be (Kenis & Knoke, 2002, Galunic & Eisenhardt, 2001), and the more easily can it activate various heterogeneous resources dispersed among the member enterprises in the cluster, which will help to increase the resource base of the cluster, better facilitate the integration of resources within the cluster, better bring dispersed innovation resources within the cluster together, improve the utilization of various innovation resources and knowledge within

the cluster and enhance the innovation performance of the cluster. Meanwhile collaboration between enterprises in the cluster, through heterogeneous resources and capability complementation, can form greater cluster competitiveness. Through interaction and restructuring between enterprises, acceptance of new ideas and collision of new knowledge will help cluster to overcome the existing path dependence and ossification and form new capacity to respond to environmental changes.

Therefore, this study presents the following hypotheses:

Hypothesis 3a: Cluster member enterprises' restructuring resilience has positive impact on cluster competitiveness.

Hypothesis 3b: Cluster member enterprises' restructuring resilience has positive impact on cluster innovation performance.

Hypothesis 4a: Cluster member enterprises' restructuring resilience has positive impact on cluster resource cooperative capability.

Hypothesis 4b: Cluster resource cooperative capability plays an intermediary role in the mechanism of cluster member enterprises' restructuring resilience influencing cluster innovation performance

Hypothesis 4c: Cluster resource cooperative capability plays an intermediary role in the mechanism of cluster member enterprises' restructuring resilience influencing cluster competitiveness

## **2.4 Cluster Resource Cooperative Capability and Cluster Innovation Performance and Competitiveness**

In cluster development, there are two important levers must be focused on. The first is how to gather resources with the help of the cluster; the second is how to take full advantage of resources through synergies between partner enterprises with the help of the cluster (Sirmon, 2007). The result of cluster resource integration is to enhance existing capabilities or create new capabilities. The stronger the resource integration capability is, the more opportunity will there be to enhance the core competencies of the cluster. For a single enterprise in the cluster network, it can acquire the resources which a lot of enterprises did not have before through synergy of network resources, and convert the acquired resources to a unique advantage of the enterprise. (Okhuysen & Eisenhardt, 2002) Enterprises in cluster through integration of a variety of capabilities and resources will bring higher performance and enhanced competitiveness. Improvement of the ability of various member enterprises within the cluster will eventually contribute to the development of the overall cluster performance and competitiveness.

Therefore, this study presents the following hypotheses:

Hypothesis 5a: Cluster resource cooperative capability has positive impact on cluster competitiveness.

Hypothesis 5b: Cluster resource cooperative capability has positive impact on cluster innovation performance.

## **2.5 Network Position Property of Core Enterprises**

Qian Xihong, *et al.*, (2010) considered that different network positions in enterprise network represent different opportunities to acquire new knowledge and resources. Wasserman & Faust (1994) considered the performance of enterprises, capture of resources and other acts can be interpreted as the function where the enterprises lie in the innovation network. Powell (2004) also considered that enterprises occupying preponderant network positions can link different network nodes through their positions to acquire resources and control resources. This study selects network centrality as the characteristic variable to measure the property of individual network position. The more centrally do the core enterprises locate in the cluster network (network centrality), the more conducive the transformation and growth of the core enterprises will be to

integration and coordination of cluster resources. This study presents the following hypotheses:

Hypothesis 6: The impact of transformation capability of core enterprises in the cluster on cluster resource cooperative capability is positively adjusted by network position property of core enterprises in the cluster.

## **2.6 Network Link Property of Cluster Members**

Some scholars believe that the more lasting the established link relationship is the more stable the network relationship will be, which is more beneficial for the establishment of mutual trust relationship between members and shared code of conduct and strengthens the exchange of information and knowledge between member enterprises in the network (Ahuja, 2000; Salman and Saives, 2005) . But the same with the point of view of this study, there are also a lot of studies suggest that the relationship in the cluster network should not be too lasting, otherwise there will be the danger of being locked by the relationship and ossification so as to lead to recession of the cluster. Therefore, for the consideration of how lasting the link should be, different specific situations need be combined to do analysis. Therefore, this paper proposes a path hypothesis on how link property influences the impact of cluster members' restructuring resilience on cluster resource collaboration and integration:

Hypothesis 7: The impact of cluster members' restructuring resilience on cluster resource cooperative capability is positively adjusted by link property of enterprises in cluster.

## **3. Research Methods**

### **3.1 Variable Measure**

#### **(1) Cluster Innovation Performance**

According to the conceptual model proposed earlier, measurement of cluster upgrading in this study uses two latent variables of cluster innovation performance and cluster competitiveness respectively representing the internal impetus performance and external market performance of cluster evolution, adapted and designed according to measurement scale of S. Thorgren (2009) and other scholars. The study uses three questions to measure innovation performance of the cluster network. The interviewed enterprises in cluster give subjective scoring according to comparison of the average level of their own cluster and the competitor cluster in the last three years.

#### **(2) Cluster Competitiveness**

In this study, "cluster competitiveness" is taken as another explained variable (dependent variable) of "cluster upgrading". Measurement of cluster competitiveness puts particular emphasis on competitive advantage of cluster in strategic flexibility and market performance. In this study, research thought of Zaheer & Bell (2005) and other related scholars is used for reference, and measurement scale of S. Thorgren (2009) And other scholars are adapted for new design. This study uses three question items, including: growth rate, strategic competitiveness and flexibility; measure the cluster competitiveness from market share, profitability and other angles.

#### **(3) Transformation Capability of Core Enterprises**

This study suggests that transformation capability of core enterprises is an important manifestation of dynamic capability of core enterprises embedded in the cluster network. Measurement based on the constructs in this paper refers to relevant research on dynamic capability and uses research for reference. Scale in existing studies is adapted and

modified, and seven-level Likert scale is added to enhance the scale reliability. With the use of program developed from standard scale, the study builds the construct of transformation capability of core enterprises, and takes this construct as a formed second-order factor model. Six question items are used to measure market orientation (Paul A. Pavlou & Omar A. El Sawy 2005), the ability of effective generation and dissemination of and response to market information. (Jaworski & Kohli 1993). Four question items are used to measure absorptive capability (Zahra & George 2002), the ability of effective acquisition, assimilation, transformation and development of knowledge and resources in cluster. Three question items are used to measure coordinate capability, the ability of effective resource allocation, task assignment and action synchronization. In this study, at last, 13 question items are formed to measure transformation capability of core enterprises.

#### **(4) Cluster Members' Restructuring Resilience**

"Cluster members' restructuring resilience" proposed in this study, as manifestation of cluster dynamic capability on the other hand, refers to that enterprises in cluster can quickly and efficiently search for potential partners and quickly link with existing resources or reallocate resources by re-selection and re-association of network partners to achieve efficient allocation of internal and external resources and technologies owned by various enterprises in the cluster. With comprehensive reference of related literature and views of Paul A. Pavlou, five question items are used to measure the variable of "cluster members' restructuring resilience".

#### **(5) Cluster Resource Cooperative Capability**

In this study, cluster resource cooperative capability is taken as an intermediary variable. Cluster resource synergy means combine knowledge and resources of different member enterprises to form new knowledge and resources. This paper proposes cluster resource cooperative capability, and takes it as a formed second-order latent variable. With reference of Kauffeld-Monz (2008), use scale adapted from Lewis (2003) and others to measure resource interface integration performance between the member enterprises and measure the ability that can effectively integrate respective professional experience and resources on strategic cooperation level and achieve good project connection and innovative development.

#### **(6) Network Position and Link Properties of Core Enterprises in the Cluster**

Network position centrality is used to indicate the position feature of enterprises in the network structure, which can be used to measure the ability of the enterprises to communicate with other enterprises. With reference of relevant literature (Powell, 1996), four question items are used to measure in this study. Link intensity, relationship strength, is an important variable of link property of enterprises in the cluster network, on behalf of the important indicator of the degree that enterprises are embedded in the strategic network. Based on related research literature and combination of relevant expert advice, considering the practical operability of the questionnaire, only first-level enterprise network is considered in this study, and eventually adopts three question items to measure the link intensity of enterprises within the cluster. Inquire about the degree of cooperation and exchange among member enterprises in the cluster (with key suppliers, customers and other companies) and use three question items to measure.

### **3.2 Control of Research Methods**

In this study, 385 formal questionnaires are distributed to enterprises in cluster in several regions like Guangdong, Fujian, Jiangsu, Shanghai, and 273 questionnaires are

recovered, of which 210 are effective questionnaires. Questionnaire recovery is 70.9% (273/385), and the effective recovery reaches 76.9% (210/273). So unanswered bias of this questionnaire survey recovery can be ignored.

#### 4. Empirical Data Analysis and Result Discussion

In this paper, structural equation model based on PLS method is mainly used to test the theoretical model and test the related research hypotheses, with integrated application of SPSS 15.0 and other software based on the structural equation modeling (SEM) technology to carry out statistical analysis and test the research hypotheses. This study will first evaluate reliability and validity of the measurement model, and then use the structural model to test the hypotheses.

##### 4.1 Analysis of Measurement Model

###### (1) Analysis on Reliability and Validity

This study first examines standardized factor loading of each question item of the scale on its respective constructs, and deletes all the question items with factor loading less than 0.5 to determine the final scale. The measurement scales for all constructs have reached the minimum requirements of Cranach's alpha coefficient and overall reliability pc coefficient, indicating that scales in this paper have good internal consistency reliability. Since for the second-order formed construct, convergent validity needs not be considered, so except other latent variables, the AVE value of all the data shown from the table are more than 0.5, indicating that all constructs in this study have high convergent validity . In order to meet certain discriminate validity, the correlation coefficient between the variables must be less than 0.9, and the square root of AVE value must be greater than the correlation coefficient between the internal constructs (Fornell & Larcker, 1981). The results of the correlation coefficient matrix are shown in Table 1. Square root of the AVE values is between 0.7417 ~ 0.924, all greater than the correlation coefficient between the latent variables, indicating that there is high discriminant validity between these constructs.

**Table 1. The Correlation Coefficient Matrix**

Variable	Std.Dev	correlation coefficient matrix				
		CIP	CC	CPSC	CRIC	HFTC
CIP	.8225281086	<b>0.8391</b>				
CC	.8340814820	0.7822	<b>0.8470</b>			
CPSC	.6968	0.7040	0.7172	<b>0.7413</b>		
CRIC	.653604	0.7240	0.7213	0.7620	<b>0.6907</b>	
HFTC	.5623563006	0.6997	0.6822	0.7259	0.8767	<b>0.6669</b>

CIP: Cluster innovation performance ;CC: Cluster competitiveness;CPSC: Cluster members restructuring resilience ; CRIC: Cluster resource cooperative capability; HFTC : Transformation capability of core enterprises

###### (2) Analysis on Second-order Latent Variable

This study suggests that the transformation capability of core enterprises includes market orientation, absorptive capability and coordinate capability, so the transformation capability of core enterprises is taken as the second-order formed construct, and whether the second-order formed construct is appropriate is tested based on research steps recommended by Pavlou & El Sawy (2006). The second-order construct of transformation capability of core enterprises, can be acquired through calculating the weights of

first-order construct and second-order construct as well as the use of principal component analysis method:

The result shows that it is more appropriate to take the constructs in this study as formed constructs. The study also uses mediation effect testing to determine whether the second-order construct of transformation capability of core enterprises fully mediates the impact of first-order constructs (market orientation, absorptive capability and coordinate capability of core enterprises) on cluster resource integration. This step ensures that second-order constructs represent more compact meaning of first-order constructs, and also ensures that second-order constructs can fully realize their ability to predict the dependent variables according to the theory (Chin 1998).

Calculating the variance inflation factor of first-order constructs, the results show a lower variance inflation factor (VIF): VIF of market orientation of core enterprises = 2.548, VIF of absorptive capability of core enterprises = 2.344, VIF of coordinate capability of core enterprises = 1.428, VIF of cluster partner cooperation = 2.432, VIF of cluster resource integration = 2.432, so the collinearity issue can be excluded.

**Table 2. Factor Loading of Formed Construct**

Latent Variable	Factor	Loading	t-Value
Transformation capability of core enterprises	market orientation	0.440	24.815 (***)
	absorptive capability	0.370	22.614 (***)
	coordinate capability,	0.326	12.152 (***)
Cluster members restructuring resilience	Members synergy	0.544	26.560 (***)
	Cluster Resource integration	0.517	22.241 (***)

†: p<0.1, \*: p<0.05, \*\*: p<0.01, \*\*\*: p<0.001

Six question items are used to measure market orientation (Paul A. Pavlou & Omar A. El Sawy 2005), the ability of effective generation and dissemination of and response to market information. (Jaworski & Kohli 1993). Four question items are used to measure absorptive capability (Zahra & George 2002), the ability of effective acquisition, assimilation, transformation and development of knowledge and resources in cluster. Three question items are used to measure coordinate capability, the ability of effective resource allocation, task assignment and action synchronization. In this study, at last, 13 question items are formed to measure transformation capability of core enterprises.

#### 4.2 Structure Model Analysis and Hypothesis Testing

This section will successively analyze the internal model, inspect the path influence relations between variables and determine significance of empirical research model.

##### (1) Analysis on Explanatory Intensity of the Endogenous Variables

Based on the above analysis results, it can be learnt that scales in this study have relatively good reliability and validity. For the conceptual framework proposed in this study, carry out the hypothesis testing of main effect of the model, and this study uses partial least squares regression analysis to conduct hypothesis testing. Explanatory intensity of the structural model can be evaluated through R<sup>2</sup> values of various endogenous variables. R<sup>2</sup> values of various endogenous variables are shown in Figure 1. R<sup>2</sup> value of cluster resource cooperative capability in the structural model is 80.2%, R<sup>2</sup> value of cluster innovation performance is 61% and R<sup>2</sup> value of cluster competitiveness is 60.2%, indicating that the research model constructed in this paper have a strong explanatory power to each research construct.

## **(2) Analysis on Significance of Path Coefficient**

In this study, through observing the path coefficient between each construct and its significance, the relationship between various structure variables in the model can be determined, and the path coefficient in the model represents the direct influential effect between variables. Figure 1 shows standardized path coefficients between various constructs in the empirical model. In this study, Bootstrap re-sampling method based on PLS is used to determine the level of significance of each structure path, and the Bootstrap method is simultaneously used for analysis of t statistic corresponding to each path (the number in parentheses on the path, which is located below the corresponding path coefficient). Determine the significance of path coefficients according to the t statistic. The results show that, in the basic structure model of the this study, except that the path coefficients between HFTC and CC as well as CIP fail to pass the significance testing, the path coefficients between other variables all have certain statistical significance.

## **(3) Research Hypothesis Testing**

In this study, analysis of empirical data in the structure model is carried out. Based on the results of Bootstrap significance testing, test whether each hypothesis is supported. In this study, the determination is made through T statistic of standardized path coefficient, and all the path coefficients and the results of the explanatory variance will be got. The results show that there is a significant positive relationship among transformation capability of core enterprises, cluster members' restructuring resilience and cluster resource integration capability; cluster members' restructuring resilience have positive direct effect with cluster innovation performance and cluster competitiveness; at 99% significance level, research hypotheses H2a, H3a, H3b and H4a of the main effect are supported.

In addition, the path coefficients from cluster resource cooperative capability to cluster performance and cluster competitiveness are highly significant; indicating that cluster resource cooperative capability plays an important role in improving cluster performance and cluster competitiveness. Cluster resource cooperative capability has a significant positive relationship with cluster innovation performance, and also with cluster competitiveness. Therefore, hypotheses H5a and H5b are supported.

Transformation capability of core enterprises and cluster members' restructuring resilience together explain 80.2% of the variation in resource cooperative capability. Resource cooperative capability respectively explains 60.2% of the variation in variance of cluster competitiveness and 61% of the variation in variance of cluster performance.

According to the results of hypothesis test in this study and the structural equation model finally established, the conceptual model of mechanism of action of core enterprise transformation and cluster member restructuring resilience on cluster network upgrading is corrected as shown in this Figure.

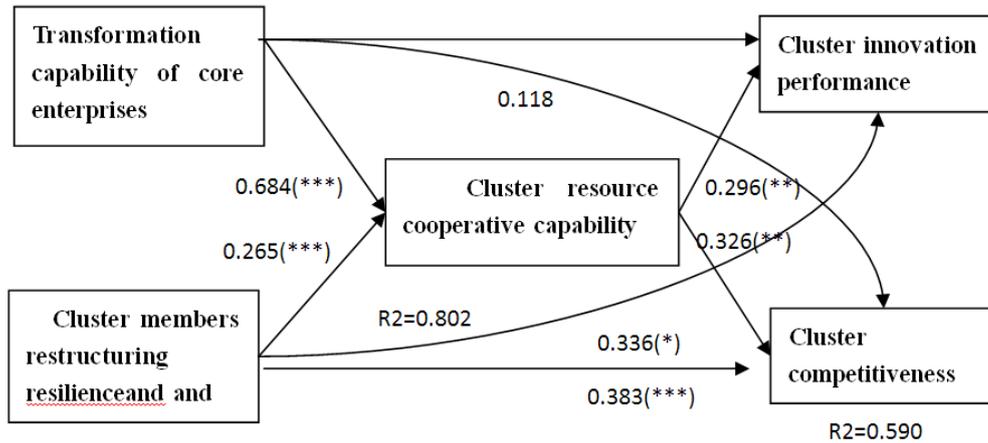


Figure 1. Research Results of Model

## 5. Result Discussion and Proposed Countermeasures

Empirical data show that 10 of the 14 hypotheses in the interaction empirical model are supported. The results further illustrate the resource synergistic effect of dynamic interaction integration of resources and generated collaboration behavior of partners within the cluster. Cluster members have flexibility of cooperative relations needed to adapt to market competition, specifically seeking for the best matched partner objects according to the task requirements of different periods, as well as the collaboration capability to coexist with the cluster network.

Analysis in this study suggests that the transformation behavior of core enterprises in the cluster network should be treated dialectically. When core enterprises carrying out reasonable reconstruction of network resources and values and achieving a conscious benign interaction with partner enterprises in the cluster during the transformation, if they can coordinate and link knowledge, technology, relationships and various heterogeneous resources within the cluster to achieve the complementary and sharing process, through optimized resource integration within the cluster and collaboration of cluster members, new resources and capabilities will be integrated and formed, and they will lead changes in the entire cluster network capability. In this case, resource integration and cooperative capability of the cluster network will help improve cluster competitiveness and innovation performance. But transformation of core enterprises may fail, transformation of core enterprises in cluster means extension of the existing industry chain or diversified investment, which will bring vertical integrative deconstruction of the original value chain, resulting in fracture of cluster member value chain in time and space, which will inevitably lead to reorganization of the cluster network resources. Though core enterprises have certain transformation capability, if resource coordination problem is not well solved during the transformation, even if transformation of core enterprises success, it may also weaken the local cluster, and when it violates the trend of cluster development, it may lead to the cluster developing in a wrong direction and inhibit performance and competitiveness of the cluster. This also shows that we must pay close attention to and monitor the impact of transformation of core enterprises in cluster on dynamic evolution of the cluster. For transformation of core enterprises, only when integration and synergistic effect of resources within the cluster is achieved, can development and restructuring of leading enterprises in the cluster give overall consideration to synergistic symbiosis of various resources within the cluster, and play its role of positive interaction in cluster upgrading. The research result just confirms that the positive impact of transformation capability of core enterprises on cluster upgrading is realized through an important intermediary mechanism, cluster resource cooperative capability.

## 6. Research Limitations and Future Research Directions

The constructed theoretical analytical framework model is in theoretical exploration stage, so the limitations of the study may be the directions of future research for further improvement:

Due to the complexity of the issues discussed in the study, there may also exist other influence factor variables affecting cluster network dynamic changes in the real environment. For example, there are many other situation feature dimensions in cluster network, such as structural symmetry of cluster network, density of cluster network, etc. may affect or regulate network evolution. If in future studies, other variables that affect the cluster dynamic evolution can be found to add in and perfect indicator variables of the model, or analyze and explore the evolution issue of cluster network from more angles and build a more complete theoretical framework, it will contribute to a more comprehensive study of the mechanism and role relationship of cluster network dynamic evolution.

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