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Big Data Analysis Capability, Supply Chain Flexibility and Manufacturing Firm Performance

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Abstract: *Big data analysis ability has gradually become the core weapon for manufacturing enterprises to gain market competitiveness, which can provide strong support for enterprises to improve performance. Based on the data of 215 questionnaires of manufacturing enterprises, this paper uses structural equation model to test the influence of big data analysis ability on enterprise performance, and further verifies the mediating role of supply chain flexibility in the influence process. The results show that: first, big data analysis ability can positively affect enterprise performance; Second, big data analysis can positively affect supply chain flexibility; Thirdly, supply chain flexibility can positively affect enterprise performance; Fourth, supply chain flexibility plays a mediating role between big data analysis capability and enterprise performance.*

Keywords: *Big data analysis ability, Supply chain flexibility, Enterprise performance, Manufacturing companies*

1. Introduction

In recent years, the further development of the Internet and the wide application of big data indicate the arrival of a new round of industrial revolution. At the same time, the report of the 19th National Congress of the Communist Party of China pointed out that it is necessary to accelerate the integration of manufacturing industry with the Internet, big data and artificial intelligence. The functions of big data real-time detection, information transmission and demand forecasting have played an important supporting role in the development of personalized products that meet customer needs, shortened delivery time, improved product quality and production management, and played an important role in corporate strategic decision-making. However, according to corporate practice feedback, only 15% of companies can successfully use big data in their internal processes. The fundamental reason is that big data itself, as a resource, cannot directly become a competitive advantage for companies. Only companies can fully Only by mastering the use of big data and forming an enterprise's big data analysis capability can its commercial value be realized.

At the same time, the diversification of customer demands and the substantial growth of data and information have exacerbated the uncertainty of the market environment. In addition, domestic manufacturing enterprises are faced with the lack of real-time monitoring equipment for traditional supply chains, and the upstream and downstream of the supply chain cannot be effectively coordinated. The lack of rapid response ability and anti-risk ability of enterprises, as well as the dilemma of information distortion and lag, have a serious impact on the development of supply chain management of domestic manufacturing enterprises. As an effective way to deal with uncertain environment, supply chain flexibility, driven by big data analysis technology, can bring more flexibility and faster response to enterprises, help enterprises get rid of difficulties and achieve "transcendence", Accordingly, the industry has gradually shifted its attention to the application of a new generation of information technology such as big data, in order to improve the flexibility of the supply chain and promote better corporate performance.

Therefore, this paper puts supply chain flexibility into the study of the relationship between big data analysis capabilities and enterprise performance, and from the perspective of supply chain flexibility, studies the impact mechanism of domestic big data analysis capabilities on the performance of manufacturing companies, and analyzes the impact of supply chain flexibility in large-scale The mediating role of data analysis ability on the performance of manufacturing enterprises, explores the internal relationship between big data analysis ability, supply chain flexibility and enterprise performance.

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2. Theoretical assumptions

2.1. Research on big data analysis ability and enterprise performance

Big data analysis capability is the ability to integrate, integrate and make decisions on specific digital resources, and it is also the key force for big data to empower enterprises (Gupta, 2016) [1].Srinivasan and Arunasalam (2013) [2] take healthcare companies as the research object and believe that big data analysis ability can improve the quality of care (i.e. the safety and effectiveness of treatment process) and reduce their operating costs to ensure better benefits for companies. Some scholars have proved the positive effect of big data analysis ability on enterprise performance from the perspective of social material (Arket,2016) [3], business model (Jing Hao, 2014) [4], and strategic management (Dutta and Bose, 2015) [5].Therefore, if an enterprise has excellent big data analysis ability, then the enterprise can make full use of it to promote the improvement of enterprise performance, but how to transform the insight of big data into execution power needs further discussion by scholars. Based on this, hypotheses are made:

H1: Big data analysis capability positively affects corporate performance.

2.2. Research on big data analysis ability and supply chain flexibility

At present, there are few researches on big data analysis capability and supply chain flexibility. Domestic and foreign scholars explain its impact on supply chain flexibility based on different dimensions of big data analysis capability. In terms of basic capabilities of big data analysis, enterprises have semi-structured and unstructured data resources. Such basic resources not only expand the knowledge reserve of supply chain management, but also further improve the flexibility of supply chain. Enterprises can reasonably use big data analysis technology to dig and analyze businesses, so that each link of the supply chain can be monitored, optimized and upgraded more intuitively, and the improvement of its technical ability can promote the improvement of supply chain information level, so the whole supply chain is more flexible (Chen Yongping et al.,2015) [6].In terms of big data analysis and management capabilities, it is believed that enterprises have an important impact on supply chain flexibility in terms of optimizing business processes and managers' decision-making (Jing Hao, 2014) [4].To sum up, enterprises can mine effective information from massive data through big data analysis technology, providing accurate and rich information resources for each link of the supply chain, and focusing on promoting the flexible development of the supply chain of enterprises to form their core competitiveness. Based on this, hypotheses are proposed:

H2: Big data analysis has a positive impact on supply chain flexibility.

2.3. Research on supply chain flexibility and enterprise performance

Scholars gradually pay attention to the research on the impact of flexibility on enterprise performance under the dynamic external environment, and generally agree that flexibility is one of the important factors affecting the technological innovation and enterprise performance of manufacturing enterprises (Celuch etal.,2007) [7].Flexible implementation can not only meet the diverse needs of customers, but also further realize customer value, and ultimately achieve the purpose of enhancing the competitiveness of enterprises. In terms of theory, Jian Zhaoquan (1994) [8], a domestic scholar, proved the importance of the influence of flexibility on enterprise performance on the basis of the proposed model of flexibility promotion. In practice, empirical studies in multiple fields (Wang Tienan et al.,2010) [9] have confirmed that supply chain flexibility has a significant positive impact on enterprise performance. With further research, scholars have verified that different dimensions of supply chain flexibility have different impacts on enterprise performance from the perspective of environmental uncertainty (Cui Fengge et al.,2012) [10], active and passive perspectives (Fan Zhigang et al.,2014) [11], organizational learning perspectives (Wang Tienan et al.,2010) [9], etc.To sum up, there is a close relationship between supply chain flexibility and enterprise performance. The study of different dimensions of supply chain flexibility can provide more comprehensive and rich research results and approaches for enterprises to improve their performance. Based on this, hypotheses are proposed:

H3: Supply chain flexibility positively affects enterprise performance.

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2.4. Research on big data analysis ability, supply chain flexibility and enterprise performance

Big data analysis ability can effectively process multi-source data, and the information resources obtained from it can provide scientific and reasonable decision-making opinions for managers (Choi et al.,2018) [12].Galbraith (1974)[13] pointed out that enterprises need more flexibility to implement decisions quickly and effectively, especially decisions across various functions. Supply chain flexibility is regarded as one of the key levers to reduce supply chain risk. Therefore, we believe that managers can use insights gained from big data analytics more effectively when companies have a high level of flexibility. Moreover, flexible organizations with a high level are more capable of coping with the uncertainty and imbalance of demand and supply and obtaining competitive advantages (Yusuf et al.,2014) [14]. To sum up, compared with enterprises that only rely on limited databases or only process data mechanically, enterprises with big data analysis capability will have better development in improving supply chain flexibility. Therefore, this paper believes that big data analysis capability can achieve significant impact on enterprise performance through effective transmission of supply chain flexibility. Based on this, hypotheses are proposed:

H4: Supply chain flexibility plays an intermediary effect between big data analysis ability and enterprise performance.

3. Research Design

3.1. Samples and data

This research adopts the method of questionnaire survey to collect data, and the questionnaire is distributed mainly through three ways: one is to entrust ningbo Enterprise Research Association, Household Appliances Association, development Zone management Committee and other institutions to distribute to member units; The second is to participate in the enterprise research seminar in the city enterprise field research for on-site distribution; Third, the tutor inside and outside the school will assist the wechat group distribution. During the survey, the industry type is set as manufacturing, and a total of 300 questionnaires will be issued. The enterprises in which the respondents work do not have an information department or the departments in which they work do not understand the information contained in the questionnaire will have the following invalid samples: (1) incomplete answers (2) failed to answer according to the instructions (3) All the answers in the whole questionnaire were the same option. Therefore, such invalid samples were removed. A total of 215 valid questionnaires were collected with effective recovery of 71.7%.

3.2. Measurement of variables

The maturity scale verified in existing literature was adopted in this study, and likert5-set scale was used to measure each item. 1 to 5 respectively represent strongly disagree, somewhat disagree, neutral, somewhat agree and strongly agree. The scale of Wamba, Akter (2016) [15] and Gupta (2016) [1] was used to measure the big data analysis ability, and 5 items were set for the basic ability of big data analysis, 4 items were set for the technical ability of big data analysis, and 4 items were set for the management ability of big data analysis, altogether 13 items. Supply chain flexibility was measured by Pujawan (2004) [16] and Qi Yibing (2010) [17], and 3 items were set for supply flexibility, production flexibility and logistics flexibility, altogether 9 items. Vickery (1999)[18] et al., set 3 items for financial performance and market performance respectively, and there are 6 items in total.

3.3. Reliability and validity of the questionnaire

The purpose of reliability analysis is to ensure the validity of the model's fitting degree evaluation and hypothesis testing. The consistency degree of variables in the questionnaire of this study on each measurement item can be judged by the results of Cronbach's Alpha coefficient. For detailed analysis, see Table 1. It can be seen that the Cronbach's Alpha coefficients of the three variables studied in this paper are all greater than the standard of 0.7, and each sub-dimension is also greater than the standard of 0.7, that is, there is a high level of consistency between the dimensions of each variable. In the validity analysis, the KMO values of big data analysis capability, supply chain flexibility and enterprise performance were 0.866, 0.822 and 0.796, respectively, which were all greater than 0.8, and the Bartlett coefficients were all 0.00, indicating high validity of all variables in the questionnaire.

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Table 1: Reliability analysis results

variable	Alpha	The dimension	Alpha
Big data analysis capabilities	0.883	Big data analysis basic ability	0.852
		Big data analysis skills	0.811
		Big data analysis management capabilities	0.832
Supply chain flexibility	0.837	Supply flexibility	0.781
		Production flexibility	0.805
		Logistics flexibility	0.803
Enterprise performance	0.811	Financial Performance	0.781
		market performance	0.784

4. Empirical Analysis

4.1. Confirmatory factor analysis

In order to test the construct validity of its scale, this paper uses AMOS21.0 to conduct confirmatory factor analysis, the main purpose is to ensure the validity of each measurement item of the questionnaire. It can be concluded from Table 2 that the indicators of the following three models are All meet the standards of structural model research, which means that the model has a high degree of matching, and the standardized factor load of each item is greater than 0.5.The composition reliability of big data analysis ability is 0.783, the average variation extraction amount is 0.551, and the composition reliability of the next three dimensions: big data analysis basic ability, big data analysis technical ability, and big data analysis management ability are 0.853, 0.811, 0.837, all greater than 0.7, and the average variation extraction amounts were 0.539, 0.519, and 0.566, respectively;The compositional reliability of supply chain flexibility is 0.781, the average variation extraction amount is 0.547, all greater than 0.5, and the compositional reliability of the next three dimensions of supply flexibility, production flexibility, and logistics flexibility are 0.783, 0.806, and 0.804, all greater than 0.7. The average variation extraction amounts are 0.546, 0.581, and 0.578, which are all greater than 0.5; the composition reliability of corporate performance is 0.742, the average variation extraction amount is 0.591, and the composition reliability of the next two dimensions, financial performance and market performance, are 0.784, 0.788, all greater than 0.7, the average variation extraction amounts were 0.550 and 0.554, all greater than 0.5, and the three models all met the criteria of convergent validity.

Table 2: Results of confirmatory factor analysis

Dimension	Item	Nonstandardized factor load	S.E.	C.R.(t-value)	P	Standardized factor load	CR	AVE
Big data analysis capabilities	Big data analysis basic ability	1				0.647	0.783	0.551
	Big data analysis skills	1.777	0.354	5.019	***	0.881		
	Big data analysis management capabilities	1.059	0.212	5.007	***	0.677		
$X^2/DF=2.304$, GFI=0.905, AGFI=0.860, CFI=0.933, IFI=0.934, TLI=0.916, RMSEA=0.078								
Supply chain flexibility	Supply flexibility	1				0.792	0.781	0.547
	Production flexibility	0.964	0.185	5.202	***	0.612		
	Logistics flexibility	1.288	0.249	5.171	***	0.799		
$X^2/DF=1.553$, GFI=0.961, AGFI=0.927, CFI=0.981, IFI=0.981, TLI=0.972, RMSEA=0.051								
Enterprise performance	Financial Performance	1				0.815	0.742	0.591
	market performance	1				0.719		
$X^2/DF=1.182$, GFI=0.986, AGFI=0.962, CFI=0.996, IFI=0.997, TLI=0.993, RMSEA=0.029								

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4.2. Hypothesis testing

AMOS was used to perform data fitting, and the fitting indexes were CMIN/DF=1.344＜3, GFI=0.874 ＞ 0.8, AGFI=0.849 ＞ 0.8, TLI=0.947 ＞ 0.9, IFI=0.953 ＞ 0.9 、 CFI=0.952 ＞ 0.9, RMSEA=0.040<0.08, The results of all the indicators are up to the standard requirements, so it can be judged that the model has good fitness.

Based on the above assumptions, by referring to the fitting results of structural equation model, can be collected from the three paths of size and whether there is significant, the next table 3 shows that refer to the standard, general SEM studies the test result of each fitting indexes meet the requirements, so that the model has good with moderation. The standardization coefficient of path 1 is 0.392 (P＜0.05), indicating that big data analysis ability has a significant positive correlation with enterprise performance, that is, hypothesis H1 is valid. The standardization coefficient of path 2 is 0.371 (P<0.05), indicating that big data analysis ability has a significant positive correlation with supply chain flexibility, that is, H2 is assumed to be valid. The normalization coefficient of path 3 is 0.537(P<0.05), indicating that supply chain flexibility has a significant positive correlation with enterprise performance, that is, hypothesis H3 is valid.

Table 3: Path coefficients of structural equation model

Path Relationship	Normalization coefficient	Nonstandardized coefficient	standard error	T	P	result
EP ← BDAC	0.392	0.496	0.141	3.523	***	support
SCF ← BDAC	0.371	0.549	0.173	3.177	0.001	support
EP ← SCF	0.537	0.628	0.154	4.086	***	support
X^2/DF=1.344, GFI=0.874, AGFI=0.849, CFI=0.952, IFI=0.953, TLI=0.947, RMSEA=0.040						

Notes: ***=P<0.001

The bootstrap method was used to test the mediation effect, and the bootstrap sample digit was set as 1000. The corresponding criterion for the existence of indirect effects is that the Bootstrap confidence interval does not contain 0. It can be concluded from Table 4 below that the estimated indirect effect of supply chain flexibility is 0.211, and the confidence intervals of Bias-corrected method and Pereentile method are [0.070,0.458] and [0.058,0.421] respectively at the 95% confidence level, and the results show that both are in line with the standard. It does not include 0, so its indirect effect exists, indicating that supply chain flexibility plays an intermediary effect in big data analysis ability on enterprise performance, that is, hypothesis H4 is established.

Table 4: Mediation validation

Path	The indirect effect	Bias-Corrected 95%CI		Percentile 95%CI	
	Meter value	Lower	Upper	Lower	Upper
BDAC-SCF-EP	0.211	0.070	0.458	0.058	0.421

5. Conclusions and enlightenment

5.1. Conclusion

In this paper, SPSS and AMOS were used to analyze the reliability and validity of the maturity scale. On the basis of good reliability and validity, structural equation model was used to test the four hypotheses proposed in this paper. The results show that all the hypotheses are supported. Consistent with the conclusion of Akter (2016) [3], the study proves that enterprises keep the same strategy and business. Meanwhile, the hypothesis also proves that big data analysis ability has a positive impact on supply chain flexibility and supply chain flexibility has a positive impact on enterprise performance, and supply chain flexibility plays an important intermediary role between big data analysis ability and enterprise performance. Nowadays with the diversified development of consumer demand, manufacturing enterprises gradually shorten the product production cycle, product varieties for rapid expansion as well as to the date of delivery of the demand is higher and higher, and enterprise data analysis can help the information to the user quickly seize market opportunities, and through the large data analysis ability can play a role of supply chain flexibility, Make the whole supply chain more flexible in supply, production, logistics and other aspects, so as to shorten product development and production cycle and meet consumer demand in the shortest possible time.Based on this research, the author believes

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that big data analysis ability can play an important role in improving the performance of Manufacturing enterprises in China. In the era of big data, the country actively encourages the integration of big data and manufacturing enterprises to improve the market competitiveness to promote the improvement of enterprise performance. When manufacturing enterprises are good at using big data, they should also improve the development of supply chain flexibility, so as to ensure that all links of the enterprise supply chain maintain flexible development, so as to enable enterprises to adapt to the complex changing environment and avoid risks brought by market changes.

5.2. Enlightenment

In order to improve enterprise performance, long-term strategies must be formulated. Combined with the empirical research of this paper, the following two aspects should be started.

First, focus on improving the big data analysis capabilities of enterprises. Manufacturing enterprises urgently need to a new height to re-examine the role of big data, big data as an enterprise of a kind of digital resources, with a rich and multiple sources of information content, the enterprise can through the large data analysis out useful information from huge amounts of data mining, which not only can grasp the market opportunities timely response user demand for competitive advantage, It can also provide effective and abundant information resources for each link of the supply chain, and provide strong guarantee for enterprise managers to make scientific and reasonable decisions. In addition, data is the most core resource in the big data resource base. Data obtained from multiple channels can provide enterprise users with a richer knowledge reserve in supply chain management, which can effectively give play to their supply chain flexibility and promote enterprise performance.

Second, improve the level of supply chain flexibility. Companies need to do is shift development object, focus on consumers this subject to complying with the market supply and demand of supply, will give full play to the important role of supply chain flexibility, not only depends on supply, production, logistics and other link flexible operation of reasonable configuration, more to strengthen product innovation, production innovation, service innovation, etc., And the key to ensure the stability of supply chain flexibility is the unimpeded and complete information. Flexibility is a kind of ability to respond to environmental changes, which helps enterprises to respond quickly and deal with the uncertainty brought by the deteriorating market environment in a timely manner, clearly and actively respond to consumer demand, so as to obtain more traffic and obtain competitive advantages, and then improve the performance level of enterprises.

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