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Article *in* International Journal of Production Research · August 2020
DOI: 10.1080/00207543.2020.1806369

International Journal of Production Research

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tprs20

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To cite this article: Zhiping Zhou , Jun Pei , Xinbao Liu , Hong Fu & Panos M. Pardalos (2020): Effects of resource occupation and decision authority decentralisation on performance of the IoT-based virtual enterprise in central China, International Journal of Production Research, DOI: 10.1080/00207543.2020.1806369

To link to this article: https://doi.org/10.1080/00207543.2020.1806369

Published online: 19 Aug 2020.

INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH
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Effects of resource occupation and decision authority decentralisation on performance of the IoT-based virtual enterprise in central China

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ABSTRACT

Enterprises in China are extensively involved in collaborative virtual enterprise (VE) supported by the internet of things (IoT). This paper investigates the effects of member enterprises' resource occupation on performance of the IoT-based VE, and examines how such effects are moderated by decision authority decentralisation. We obtained the research data from a survey administered to 141 small- and medium-sized enterprises (SMEs) that participate in IoT-based VEs. Hierarchical regression analysis was adopted to test the proposed hypotheses. Our findings suggest that information and operational resources are positively associated with both business and market performance. Strategic decision authority decentralised to SMEs with superior information or operational resources enhances the overall performance, whereas decentralisation of operational decision authority facilitates the positive effects of operational resource on performance. Our study provides directive guidance for IoT-based VEs to cultivate and acquire specific superior resources, and allocate decision authorities reasonably for effective resource utilisation and collaboration.

ARTICLE HISTORY
Received 31 October 2019
Accepted 26 July 2020

KEYWORDS
Resource occupation; decision authority; decentralisation; performance measures; virtual enterprise

1. Introduction

Advances in information technology have fundamentally altered traditional business structure and market competition modes, among which a remarkable representation is the establishment of the virtual enterprise (VE) (Khalil and Wang 2002). Member enterprises contribute respective core competencies and jointly undertake risks, aiming at seising emerging market opportunities (Lin, Yang, and Arya 2009). Recent progress in wireless sensors, information and communication technologies (ICT) supported the applications of the internet of things (IoT) in an explosive increasing manner, which enables real-time acquisition of accurate and consistent information from the shop-floor frontlines (Zhang et al. 2015; Liu et al. 2020). Enterprises equipped with IoT to sense, identify and track business processes can be integrated into an ecological task-oriented dynamic IoT-based virtual enterprise (Qu et al. 2016). Such collaborative organisations are widely employing the IoT in business planning, implementation and coordination.

Superior resource occupation is among the most important factors to be considered in selecting the appropriate partner from alternative candidates. The required resources, such as financial, information and technical resources, are heterogeneously distributed across participating members. Specifically, the VE is a channel to seek resource complementary, as well as a platform to enhance a firm's market status in affecting the outcomes (Lin, Yang, and Arya 2009). Liu, Raahemi, and Benyoucef (2011) focus on three layers of the knowledge structure, and declared that the performance of a VE depends highly on effective partner collaboration in orchestrating resources, knowledge and skills. Further, scholars assert the facilitating impacts of decision authority allocation on leveraging the relationship between resource occupation and firm outcomes (Kasper, Mühlbacher, and Müller 2008; Graham, Harvey, and Puri 2015; Goodale et al. 2011). To improve decision efficiency, decision authority allocation toward participating enterprises remains to be investigated.

Decision authority decentralisation reflects the extent to which subdivisions undertake decision responsibilities that are generally accepted within an organisation (Graham, Harvey, and Puri 2015; Lin, Yang, and Arya 2009). Extant literature has found support for the moderating effects of decision authority between participative tasks

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and performance. For example, scholars have empirically tested the existence of complementarity between financial incentive contract and decentralisation of decision authority for tasks from principals to employees (Hong, Kueng, and Yang 2019). Other studies also investigated the sequential allocation process of multilevel hierarchical structure of the customer segments given limited resources to maximise profits (Fleischmann et al. 2020). The synergistic effect of both resource occupation and decision authority allocation in one alliance, however, has rarely been examined. Thus, investigating how participants' resource affects the VE's performance contingent upon contextual characteristics of decision structure would boost the understanding of the underlying influential mechanisms.

Interenterprise collaboration among China's small- and medium-sized enterprises (SMEs) has expanded to scenarios like 'global manufacturing' and 'networked manufacturing'. Nevertheless, most of the SMEs are struggling in initial stages compared with their major counterparts, among which an estimation of two-thirds do not survive the first year (Parnell, Long, and Lester 2015; Huang et al. 2013). Alawamleh and Popplewell (2011) identified speedier network decision-making and market response result from enhanced knowledge sharing of the SMEs attached to virtual organisations. The outcomes of a VE are highly affected by the competencies of participating members, as well as appropriate decisions that facilitate resource interaction (Inman et al. 2011). However, VEs in China have a long tradition of using informal rules to coordinate partner relationships, and firms are facing market competition with ambiguous and unpredictable regulations (Li, Poppo, and Zhou 2008). As such, the decision authority allocation often results in prudent and conservative behaviours of the member enterprises, which is emerging as an enormous obstacle to improve the VE' performance (Yang, Shi, and Zhang 2014; To 2016).

Building on the existing literature (Wu and Chiu 2015; Ahmed, Kristal, and Pagell 2014; Nath, Nachiappan, and Ramanathan 2010; Hitt, Xu, and Carnes 2016), this paper develops a framework model for resource classification consisting of basic, information and operational resources, based on which multi-dimensional relationships between resource occupation and performance of the IoT-based VEs are evaluated. In addition, we draw upon the Resource-Based View (RBV) and examine the moderating effects of decision authority decentralisation (Kasper, Mühlbacher, and Müller 2008; Chen, Chen, and Chu 2008). Our study fills the research gap of existing literature by indicating a practical way to cultivate and utilise specific resources, and properly arouse the contributing enthusiasm of SMEs structured in the virtual organisation. The moderating effects also provide guidance for rational decision authority allocation and relationship regulation among participants to improve the overall performance.

2. Literature review

2.1. IoT-based virtual enterprise

Virtual organisation has evolved as a paradigm of organisational design in pursuit of competitive advantages, and in response to dynamic market environment with low cost, high quality and quick responsiveness (Khalil and Wang 2002). Virtual organisation contributes to integrating independent and heterogeneous enterprises temporarily by sharing core competencies and risks to achieve the common objectives (Romero and Molina 2009; Maznevski and Chudoba 2000; Liu, Raahemi, and Benyoucef 2011). Supported by this organisational form, the VE is a business consortium of autonomous, diverse and geographically dispersed entities that interact through interdependent tasks with links strengthened by information and communication technologies (Maznevski and Chudoba 2000). With the specialisation of competencies and division of tasks, the outcomes of dynamic VEs rely heavily on resource collaboration across industrial, spatial and cultural boundaries (Liu, Raahemi, and Benyoucef 2011; Parnell, Long, and Lester 2015).

Virtual enterprises typically implement horizontal organisation management structure to ensure efficient information transmission. This organic structure could yield many situational competitive advantages, such as linking complementary competencies (Dowlatshahi and Cao 2006; Romero and Molina 2009). As a foundation for creating and managing the VE, information technology (IT) facilitates the coordination among loosely coupled participants, overcomes the spatio-temporal barriers of traditional hierarchies, and promotes flexibility by reducing formal managerial control (Khalil and Wang 2002; Dowlatshahi and Cao 2006). Moreover, the development of IT acts as a reliable enabler to redesign responsive organisation, together with high collaborative mechanisms capable for emergency of new business practices (Romero and Molina 2009; Khalil and Wang 2002).

The IoT is an extension of Internet-based network benefit from recent progresses in wireless sensing and communication technologies, through which objects are uniquely identified and interconnected (Lee, Tseng, and Shieh 2010; Qu et al. 2016). Consequently, comprehensive on-site information can be real-timely and accurately captured, shared and analysed for efficient decision-making. IoT allows time and capital cost reduction of partner coordination in information sharing and resource interaction processes, and enables reaction to changes with high agility and responsiveness (Zhang et al. 2015; Ben-Daya, Hassini, and Bahroun 2019; Yang, Shi, and Zhang 2014). Therefore, IoT-based VEs differ from general alliances in three distinct aspects: (1) participants are tightly interconnected through frequent information and business interactions; (2) operating activities requires exploration, cultivation and integration of extensive resources; (3) decision authority allocation should match well with resource occupation so as to motivate contributions.

2.2. Resource occupation

Resource occupation refers to the amount of possessed tangible and intangible resources, which is imperfectly imitable and non-substitutable to be transformed into capabilities that embedded in organisational routines for sustainable competitive advantages (Chen, Chen, and Chu 2008; King, Slotegraaf, and Kesner 2008; Zhang et al. 2014). Extant literature has concentrated on the acquisition and deployment of such peculiar and heterogeneous resources, and the multidimensional effects of resource occupation on firm outcomes have been explored (Cao and Dowlatshahi 2005; Morgan, Vorhies, and Mason 2009; Inman et al. 2011). For instance, Morgan, Vorhies, and Mason (2009) argued that 'it is the capabilities by which firm resources are acquired and deployed that explains interfirm performance variance'. Scholars also suggested that internal resources, such as sharing infrastructure and R&D resources, enhance product innovation and company reputation (Dowlatshahi and Cao 2006; Graham, Harvey, and Puri 2015). Following the study of Lin, Yang, and Arya (2009) and Collins and Smith (2006), resource occupation is a construct comprising basic, information and operational dimensions.

Basic resource refers to financial capital, critical assets and manpower that serve in making firms' capabilities inimitable to survive market competition (Collins and Smith 2006; Bharadwaj 2000). Nath, Nachiappan, and Ramanathan (2010) asserted that the utilisation of capital and manpower contribute to improving infrastructure and upgrading technics. Likewise, IT infrastructure provides platforms for the process alignment of information sharing to achieve agilities, meanwhile IT assimilation diffuses and routinises IT applications (Liu et al. 2013). Operational resource implies technical skills, business capacities and bargaining power that can strengthen product processing and distribution processes. These resource dimensions were illuminated to influence performance directly. Specifically, IT applications support decision processes respond to market dynamics in a rapid and precise manner (Khalil and Wang 2002). Operational capabilities, such as new product development and flexible delivery, can improve product quality with lower costs (Yu, Ramanathan, and Nath 2014).

Although complementary resource interactions were discovered to be positively associated with firm performance (Lin, Yang, and Arya 2009; Choi, Lee, and Yoo 2010), existing literature was primarily conducted in mature market scenarios (Choi, Lee, and Yoo 2010; Yu, Ramanathan, and Nath 2014). As an emerging entity of market economy, China has a plenty of planned economic elements that previous insights may not be directly applicable. Meanwhile, managerial policies should be consistent with recent advances in emerging information technologies like the IoT, especially in the contexts of VEs (Huang et al. 2013; Parnell, Long, and Lester 2015). Furthermore, how such relationships are moderated by decision authority allocation remains obscure.

2.3. Decision authority decentralisation

Following the decision structure of a single enterprise, decision authority decentralisation reflects to which extent participants are involved in the VE's decision processes and can take initiatives without asking permission from the core enterprise (Andersen 2004; Goodale et al. 2011). In fact, most top management teams rely on hierarchical status in determining decision outcomes, whereas divisions with operating expertise and capabilities are in relative unfavourable positions (Boone and Hendriks 2009). Venkatesh, Bala, and Sykes (2010) suggested reducing unnecessary reports, and presented that organisational flattening is an effective approach to improve autonomy. Appropriate decision authority distribution can enhance the relationship between the dispersed resource and the decision efficiency (Kasper, Mühlbacher, and Müller 2008).

Strategic decisions implicate important plans that concern a firm's business directions, survival and development. Operational decisions such as material acquisition and business arrangement, guarantee rapid market response by ensuring in-time delivery and product quality (Graham, Harvey, and Puri 2015; Andersen 2004; Preston, Chen, and Leidner 2008). The importance of decision authority allocation in corporate governance has been widely touted. For instance, Andersen (2004) suggested distributed decision authorities so that low-level managers can take initiatives without formal approval, and indicated its effectiveness in dynamic environments. In a similar vein, Boone and Hendriks (2009) stressed that both decentralised decision authority and collaborative behaviours are essential in coordinating functional divisions.

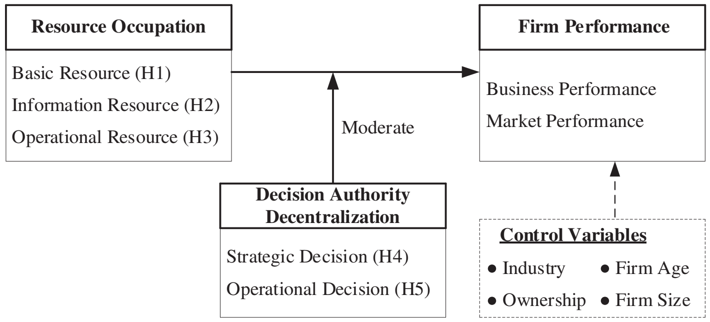

Figure 1. The conceptual framework and hypotheses.

Recent literature has analysed the effects of the alignment between resource occupation and decentralisation on improving firm outcomes (To 2016; Goodale et al. 2011; Kasper, Mühlbacher, and Müller 2008). Preston, Chen, and Leidner (2008) declared that strategic decision authority directly influences the contribution of IT to firm performance. Goodale et al. (2011) suggested decentralising more responsibility to the knowledgeable and skilful front-line members for operational execution and control. As such, a member enterprise could induce greater performance when provided with appropriate decision authority. Following these studies, this paper focuses on resource collaboration among member enterprises, and examines the moderating effects of strategic and operational decision authority decentralisation.

2.4. *Firm performance*

An explicit definition of the VE's performance is required when elaborating the role of resource occupation and decision authority decentralisation. Since a VE shares both profit and risk among participants under revenue-sharing contracts, the overall performance can be reflected by that of a member enterprise (Chen, Chen, and Chu 2008; Romero and Molina 2009). Previous literature frequently considered business and marketing dimensions when evaluating firm performance. Specifically, Dowlatshahi and Cao (2006) analysed business and market performance in agile manufacturing when exploring the alignment of VE and IT. Ravichandran and Lertwongsatien (2005) suggested the financial and operating measures as valid indicators of firm performance. Morgan, Vorhies, and Mason (2009) highlighted the profitability and market responsiveness when examining the deployment of firm resources. As such, our study focuses on the business and market performance of the surveyed member enterprises. Business performance refers to the financial revenues like investment return, profitability, and cost savings. Meanwhile, market performance implies the product delivery efficiency, such as new product introduction and market development, in response to customer demands compared to the major competitors.

3. Conceptual model and hypotheses

The conceptual framework raised in this study is depicted in Figure 1. The framework illustrates how member enterprise's resource occupation components (i.e. basic, information and operational resource) influence business and market performance of the focal IoT-based VE. The moderating roles of strategic and operational decision authority decentralisation are further investigated. This section analyses the construct interactions and proposes the hypotheses on these relationships.

3.1. *Resource occupation and performance*

The VE's competitive advantage relies on complementary resources from alliance partners. In turn, the interdependence among enterprises reveal the driving force that integrates formal organisation into interorganisational arrangements (Lin, Yang, and Arya 2009; Drees and Heugens 2013). From the RBV, a firm is conceptualised as a bundle of valuable and inimitable resources it controlled considering the complexity of external environment (Jeffers, Muhanna, and Nault 2008; Nath, Nachiappan, and Ramanathan 2010). Extant literature has indicated the importance of deploying critical resources, and recognised different perspectives to explore the multidimensional effects of resource occupation on performance. Nath, Nachiappan, and Ramanathan (2010) claimed that resources distributed across firms are likely to generate heterogeneous performance when conceiving and implementing strategic decisions. Only firms with superior resources can acquire higher achievements by meeting customer demands with lower costs.

Firm resources differ in nature and vary in level. Scholars have recognised that firm resource comprises tangible and intangible components. The tangible component includes finance, physical assets, and well-structured manpower, whereas intangible resource is usually referred to as market information, knowledge, operational skills, etc. (Yu, Ramanathan, and Nath 2014; Wu and Chiu 2015). Specifically, intangible resource is classified into information and operational resources (Nath, Nachiappan, and Ramanathan 2010). The possession and integration of these resources are beneficial for the creation of firm capabilities. Researchers have explicitly recognised the importance of resource classification since it provides theoretical basis to explore how resource cultivation promotes performance improvement.

In our study, basic resource is a generalised tangible resource that includes dedicated financial capital, advanced infrastructure and assets, and well-structured employee hierarchy. For instance, physical assets reinforce the competitive advantage once they 'outperform' the key competitors' equivalent assets (Wu and Chiu 2015). However, resource-based theorists insisted that superior basic resource can be easily purchased or duplicated by competitors, through which it is unlikely to determine a firm's effectiveness (Bharadwaj 2000; Ravichandran and Lertwongsatien 2005). Such a reduction view values the basic resource solely in terms of its technical aspect, and ignores the synergistic benefits of integrated systems. Building the corporate platform of the IoT-based VE, indeed, involves accumulated efforts and experiences. Others emphasised the enabling effects of basic resource on rapidly developing IT applications, and implementing transaction processing and business management across enterprises (Bharadwaj 2000; King, Slotegraaf, and Kesner 2008). As such, to integrate the individual components of the basic resource is not only conducive to the creation of market competitiveness, but to the improvement of business effectiveness of the IoT-based VE:

H1. Occupation of basic resource positively affects the (a) business performance and (b) market performance of the IoT-based VE.

Synergistic and complementary information resource can be applied to the VE's decision process, which directly affects the construction of business advantages. Specifically, firms with information resource advantages can create IT capabilities, and in turn, enhance business performance (Lin, Yang, and Arya 2009). The integration of information resource improves the traceability of business processes, thereby reducing the cost of on-site control. In an IoT-based VE, knowledge exchange and information sharing can support partner cooperation on planning and operational processes. This collaboration eliminates potential interest conflicts and opportunistic behaviours, and promotes resource utilisation to enhance production efficiency (Liu et al. 2013; Dowlatshahi and Cao 2006). Furthermore, Jeffers, Muhanna, and Nault (2008) indicated that the deployment of information resource could reduce inventory, therefore freeing up financial resource for pursuing other strategic goals.

In addition to its positive effects on business performance, information resource improves market performance. In particular, information infrastructure enables rapid detection of market changes and the sharing of market information among participants, and supports business-wide transactions and cross-functional communications (Bharadwaj 2000). In addition, knowledge management system satisfies organisational learning and provides experience sharing, thus transforming the IT-based VE into a flexible organisation (Jeffers, Muhanna, and Nault 2008). The proprietary information sharing contributes to business coordination, which promotes market response by improving product delivery (Strader, Lin, and Shaw 1998). Finally, discovering customer preferences facilitates long-term customer relationships (Khalil and Wang 2002).

H2. Occupation of information resource positively affects the (a) business performance and (b) market performance of the IoT-based VE.

Operational resource refers to the production and marketing-related capabilities and skills, through its integration can optimise a firm's production efficiency, market responsiveness and operational costs (Nath, Nachiappan, and Ramanathan 2010; Garrison, Wakefield, and Kim 2015). The assimilation of operational resource has been recognised as an important source of high performance (Garrison, Wakefield, and Kim 2015; King, Slotegraaf, and Kesner 2008; Goodale et al. 2011). Firms with operational advantages can utilise assets and material efficiently through the acquisition and dissemination of process knowledge. As Yu, Ramanathan, and Nath (2014) suggested, the association between operational resource and competitive success lies in a firm's abilities on market flexibility, production costs and product quality. Inman et al. (2011) indicated that firms adopting agile manufacturing modes would experience improved business performance. Similarly, Ahmed, Kristal, and Pagell (2014) declared that operational capabilities imply effectiveness and flexibility in procurement, manufacturing and distribution processes. These capabilities are essential in staying profitable under end-user demand and pricing pressures.

Previous literature also indicated the critical role of marketing capability in transforming firm resource into outcomes. Marketing capability involves market development and segmentation, knowledge of competitors and customers, and strategies in advertising, bargaining and pricing (Morgan, Vorhies, and Mason 2009; Yu, Ramanathan, and Nath 2014). Specifically, marketing capability creates a strong brand image that maintains long-term relationship with channel members and customers (Nath, Nachiappan, and Ramanathan 2010; Yu, Ramanathan, and Nath 2014). In addition, superior marketing capability helps to develop broader distribution channels, contributes to the understanding of competitor strategies and customer requirements (Morgan, Vorhies, and Mason 2009). These advantages enable effective resource combination to match market conditions, which in turn, leads to the improvement of market performance.

H3. Occupation of operational resource positively affects the (a) business performance and (b) market performance of the IoT-based VE.

3.2. Moderating effects of decision authority decentralisation

Decision authority decentralisation acts as a contingency factor in leveraging the relationship between resource occupation and firm performance (Andersen 2004; Kasper, Mühlbacher, and Müller 2008; Preston, Chen, and Leidner 2008). Kasper, Mühlbacher, and Müller (2008) contended that decentralised organisations might be more adaptive, innovative and capable to cope with complex problems. Previous studies on the decision authority allocation were concentrated on the optimisation of transaction and delegation costs. However, these researches ignored firms' efforts in acquiring superior resource (Graham, Harvey, and Puri 2015). The RBV highlights resource occupation as an important source of decision efficiency, and suggests that the resource occupant should be allocated sufficient decision authority (Wu and Chiu 2015). This opinion suggests evaluating the resource occupation of member enterprises when allocating decision authorities to ensure management efficiency.

The coordination of inter-enterprise and cross-functional activities requires integration of essential resources (Andersen 2004). Since the core enterprise has limited capabilities to acquire and analyse relevant information on each activity, a decentralised decision-making structure is more reliable (Graham, Harvey, and Puri 2015). Preston, Chen, and Leidner (2008) indicated that effective strategic leaders can appropriately implement strategic initiatives and fully utilise the advantages of information resource in improving firm performance. In addition, the decentralisation of strategic decision authority is important for knowledge management and organisational innovation through information acquisition with lower costs, especially under market uncertainty (Kasper, Mühlbacher, and Müller 2008; Graham, Harvey, and Puri 2015). As such, the strategic decision authority decentralised to member enterprises with effective information resource can positively moderate the effects of the information resource and its contribution on the overall outcomes.

Although regarded as a source of competitive edge, basic resource is more frequently combined to develop operational capabilities for product quality and delivery (Nath, Nachiappan, and Ramanathan 2010; Parnell, Long, and Lester 2015). Basic resource can be easily purchased, imitated or duplicated by competitors when realised to be rent-yielding, and therefore resulting in the diminishment of competitive advantages (Bharadwaj 2000; Ravichandran and Lertwongsatien 2005). When granted strategic decision authority, member enterprises with advantages in basic resource may induce lower level or even adverse influence on the contribution to the performance (Preston, Chen, and Leidner 2008). Operational resource captures the production efficiency in the value creation process and is associated with cost and time savings that yield short-term benefits. Organisations that overemphasise flexible strategic decisions may forgo other opportunity benefits, which result in imbalance between short-term profitability and long-term adaptability (Kortmann et al. 2014; Andersen 2004):

H4(a). Strategic decision authority decentralization positively moderates the relationship between information resource and performance of the IoT-based VE.

H4(b). Strategic decision authority decentralization negatively moderates the relationship between basic, operational resources and performance of the IoT-based VE.

Similarly, operational decision authorities decentralised to member enterprises can moderate the multi-dimensional influences of resource occupation on the overall performance. Specifically, the acquisition of superior operational resource is of crucial importance in enhancing product lifecycle managerial efficiency and implementing precise and rapid operational initiatives (Zhang et al. 2015; Morgan, Vorhies, and Mason 2009). Individual decision-makers in operational front-lines are expected to be the most knowledgeable about chances of business succeeding, and how they might be best pursued (Kortmann et al. 2014; Yu, Ramanathan, and Nath 2014). The decentralised control mechanism directed at the operational level contributes to establishing clear organisational behaviour routines /boundaries, specifying work tasks, and administering incentives that are more likely to promote the long-term operational interests of the firm (Goodale et al. 2011). Meanwhile, information resource supports operational requirements in the processes of IoT-based VE formation, opportunity identification, and inter-firm coordination (Ravichandran and

Lertwongsatien 2005; Khalil and Wang 2002). The basic resource, in contrast, is less likely to create competitive advantage, partly because its value and functions can easily be identified by rivals (Wu and Chiu 2015; Yu, Ramanathan, and Nath 2014). More specifically, as Hitt, Xu, and Carnes (2016) suggested, relational assets featured with interfirm linkages are more valuable than the benefits obtained from basic resource sharing:

H5(a). Operational decision authority decentralization positively moderates the relationship between information, operational resources and performance of the IoT-based VE.

H5(b). Operational decision authority decentralization negatively moderates the relationship between basic resource and performance of the IoT-based VE.

4. Research methods

4.1. The sample and data collection

We employed a questionnaire survey to collect data for hypotheses testing. The target sample were SMEs participating in VEs as member enterprises supported by sensing network to seise dynamic market opportunities and achieve common goals. We conducted this survey in mainland China, a powerhouse for global economic growth and an important manufacturing base for consumption products, especially when 'Made-in China 2025' was designed to upgrade China's industry (Xu, Xu, and Li 2018). With the widely application of emerging information technologies, multi-field firms in China are actively engaged in supply channel cooperation and increasing their efforts to operate businesses collaboratively (Liu et al. 2013; Li, Poppo, and Zhou 2008). As such, scholars have gradually realised the importance of Chinese market when exploring the relationships between resource occupation and performance (Parnell, Long, and Lester 2015). Considering that the economic development across regions is uneven, the survey was conducted in central provinces with approximately the average GDP per capita, that are actively undertaking industrial transfer from the eastern region.

Respondents were required to have specific knowledge on their firm situations and be familiar with related concepts like resource occupation and decision authority decentralisation. However, collecting feasible data through a questionnaire survey in China is difficult, especially considering that most executives have never received professional training (Liu et al. 2013). We thus worked with an educational institution that provides in-job business administrative training programmes for senior management executives. Despite the possible cognitive deviation of actual situations, these executives were regarded as appropriate informants for the following reasons (Liu et al. 2010): (1) they were familiar with our research topic since they have been involved in related training programmes; (2) they had accurate perception of their firms' actual situations; (3) they were expected to participate in the decision processes on behalf of their firms, considering their positions in the organisation.

We first developed an English questionnaire based on extant literature, and carefully translated it into Chinese. Two professional translators were invited to compare the English and Chinese versions, and no semantic discrepancies were found. The research objectives, methodology and related concepts were explained in detail to make sure an explicit understanding of our research background. The questionnaire was pretested among a dozen of randomly selected participants and then modified until no obvious understanding barriers exist. As provided in the Appendix, all instrument items were measured with 7-point Likert scales, ranging from 'strongly disagree' to 'strongly agree' with 4 representing 'not sure'.

The questionnaires were first distributed via social platforms for anonymous responses. We also sent follow-up reminder messages and emails to encourage their immediate feedback. Out of 840 potential respondents, a total of 166 replied to us, including 25 discarded questionnaires that were incomplete or completed too fast. In total, we obtained 141 useful questionnaires, representing a response rate of approximately 16.8%. Table 1 shows the demographic information of the samples, including position of respondents; firms' industry, ownership and age; and employee scale of the IoT-based VE. Following Armstrong and Overton (1977), we assessed the possible non-response bias by comparing the first 25% of the respondents with the latest 25% responses on all variables. Several t-tests indicated no significant differences between the two groups, which implied that the non-response bias was not serious. The results of one-way analysis of variance (ANOVA) showed no significant differences between manufacturing and service industries for all constructs that, the two datasets can be considered as a single sample set in the following analysis.

4.2. Measures

We developed the measurement items based on previous validate instruments, which defined the contents of each construct clearly in terms of what should be included or excluded. Specifically, inspired by Bendickson and Chandler (2019) and Raguseo and Vitari (2018), three items were used to evaluate the perceived basic resource occupation. Among them, the first two items

Table 1. Sample demographic ($n = 141$).

Measure	Items	Frequency	Percentage
Respondent titles	President, Managing director, CEO	23	16.31
	CIO, CTO	39	27.66
	Senior VP of Operations and COO	31	21.99
	Senior VP of other Functions	48	34.04
Industry	Manufacturing	53	37.59
	Service	88	62.41
Ownership	State-owned	60	42.55
	Privately owned	58	41.13
	Foreign-controlled	23	16.31
Firm age	$\leq$5 years	36	25.53
	5–10 years	28	19.86
	10–15 years	26	18.44
	More than 15 years	51	36.17
Number of employees	< 20	54	38.30
	20–100	44	31.21
	100–300	20	14.18
	More than 300	23	16.31

evaluated the extent to which member enterprises possessed vital financial resource and assets that were necessary for the operations of the IoT-based VEs. The other item assessed the task-oriented employee hierarchical structure and high-level human resource. Meanwhile, four items measuring information resource occupation were adjusted from Kim, Wimble, and Sambamurthy (2018) and Garrison, Wakefield, and Kim (2015), which depicted firms' resource in areas of data mining and analysis to exploit potential market and competitor information, identify market opportunities and risks. Finally, we developed four items from Lin, Yang, and Arya (2009), Yu, Ramanathan, and Nath (2014) and Nath, Nachiappan, and Ramanathan (2010) to evaluate the operational resource of the member enterprises. The first three items respectively measured the perceived operational skills of production technics, product planning and marketing, and irreplaceable operational technologies, whereas another item assessed the efficiency to which a firm integrated core competitiveness of the cooperative partners.

The measurement items of strategic decision authority decentralisation of the IoT-based VE were developed from Preston, Chen, and Leidner (2008) and Gunasekaran, Lai, and Cheng (2008). The scope of strategic decision-making items contains organisational reconstruction, business process reengineering, long-term and global business policy discretion, business scope and cooperative partner selection, strategic goal setting and supervision over execution. Likewise, we develop four measurement items according to Graham, Harvey, and Puri (2015) and Goodale et al. (2011) to assess operational decision authority decentralisation, which reflects the member enterprises' autonomy to take initiatives on business and technical processes selection, production planning and scheduling arrangement; and resource acquisition for business requirements.

Researches have extensively explored the relationship between firms' resource occupation and their business and market performance (Ravichandran and Lertwongsatien 2005; Liu et al. 2013; Yu, Ramanathan, and Nath 2014). In accordance with Liu et al. (2013) and Inman et al. (2011), the two aspects of the IoT-based VEs' performance were perceived through eight measurement items compared to that of their key market competitors. Among which the first four items measured the business performance: return on investment, profits as a percentage of sales, net income before tax, and the present value of the firm. The other four items were to assess the market performance, including response speed of market demand, product/service delivery time, new market development and new product/service introduction.

Finally, four control variables that might affect the overall performance were included: industry, ownership, firm age and firm size. Specifically, a dummy variable was employed for the industry, with IND $= 1$ and IND $= 0$ representing manufacturing and service industries respectively, based on whether a firm manufactures products or provides services (Liu et al. 2013). Two dummy variables were used for the three categories of ownership of the member enterprises: state-owned, privately owned, and foreign-controlled. We measured firm age as the number of years since the foundation of a member enterprise. Finally, the size of an IoT-based VE was estimated by the number of its full-time employees.

5. Data analysis and results

5.1. Common method bias

All the data in our study was perceptually collected from a single source at one point in time, thus common method bias might be a threat to the validity of the results. We tested such possible bias using Harman's one-factor test on all measurement items. The results of the principal components factor analysis indicated that all the items could be categorised into seven constructs, with eigenvalues greater than 1.0, accounting for 84.52% of the variance. The first construct did not account for the majority of the variance (38.09%), indicating that the common method bias was not a serious concern (Yu, Ramanathan, and Nath 2014). Meanwhile, we compared the fit between the one-factor model and the measurement model. The results showed that the fit of the one-factor model ($\chi^2 = 4075.57$, df $= 351$) was considerably inferior ($p < 0.01$) to the fit of the proposed model ($\chi^2 = 1137.25$, df $= 55$), which further supported that the common method bias was not a significant factor to affect the findings.

5.2. Measurement validity

The content validity of the instrument was efficient as the items were selected and refined through an extensive review of relevant literature and pilot testing. We tested the convergent validity and discriminant validity of the measures through confirmatory factor analysis (CFA) using PLS graph, which is appropriate to examine the effects of formative constructs and conduct analysis without limitation of sample size.

We assessed the Cronbach's alpha, composite reliability and average variance extracted (AVE) to test the convergent validity. As shown in Table 2, the loadings of all items were higher than the suggested benchmark of 0.70, with the exception of BR3 (0.68). Although did not meet the recommended criterion, the item was significant at a level of 0.001, and was retained in the analysis to ensure content validity. The Cronbach's alpha ranged from 0.77 to 0.94, all being greater than 0.60, and the composite reliability values ranged from 0.78 to 0.96, which were all above the 0.70 recommended level. The AVE scores for every construct range from 0.54 to 0.81, which were all higher than the 0.50 recommended benchmark (Liu et al. 2010). These results demonstrated an adequate convergent validity of the measurement.

The discriminant validity of the constructs was assessed by comparing the relationship between the square roots of AVEs of the constructs and the correlations among them. As presented on the diagonal of Table 3, the square root of AVEs for each construct is greater than the correlations between different constructs. In other words, none of the constructs shared more variance with another construct than with its own measures, which ensured sufficient discriminant validity.

To ensure that the multicollinearity was not an issue, the variance inflation factors (VIFs) and tolerance values of the independent values were tested. When VIFs are lower than 10 or tolerance values are higher than 0.10, multicollinearity may not be an issue (Li, Poppo, and Zhou 2008; Garrison, Wakefield, and Kim 2015). The results showed that the highest VIF was 4.78 and the lowest tolerance value was 0.21. Therefore, multicollinearity did not appear to be significant in this study.

5.3. Hypotheses testing

Hierarchical regression analysis was used to test the hypotheses. The independent variables and moderators were mean-centred to minimise the possible effects of multicollinearity. In particular, for business performance,

Table 2. Results of confirmatory factor analysis.

Construct	Items	Loading	Cronbach's α	Composite Reliability	AVE
Basic Resources	BR1	0.79	0.77	0.78	0.54
	BR2	0.73			
	BR3	0.68			
Information Resources	IR1	0.87	0.92	0.94	0.73
	IR2	0.80			
	IR3	0.87			
	IR4	0.89			
Operational Resources	OR1	0.83	0.92	0.94	0.73
	OR2	0.86			
	OR3	0.86			
	OR4	0.87			
Strategic Decisions	SD1	0.91	0.94	0.96	0.81
	SD2	0.90			
	SD3	0.89			
	SD4	0.90			
Operational Decisions	OD1	0.86	0.93	0.95	0.76
	OD2	0.85			
	OD3	0.88			
	OD4	0.91			
Business Performance	FP1	0.85	0.90	0.92	0.68
	FP2	0.79			
	FP3	0.82			
	FP4	0.84			
Market Performance	MP1	0.86	0.91	0.94	0.72
	MP2	0.85			
	MP3	0.81			
	MP4	0.86			

we included different types of resource occupation as the independent variables in Model 1. Furthermore, strategic and operational decision authority decentralisation are separately added in Models 2 and 3, as well as their interaction terms. Likewise, models for market performance are established. Table 4 reveals that the dummy variables of industry and ownership, and the control variables of firm age and firm size were not significantly related to the overall performance. For the hypotheses regard to the effects of resource occupation, the results (Models 3 and 6) indicate significant and positive impacts of information resource ($\beta = 0.31$, $p < 0.01$; $\beta = 0.32$, $p < 0.01$) and operational resource ($\beta = 0.41$, $p < 0.01$; $\beta = 0.38$, $p < 0.01$) on business and market performance of the IoT-based VE, respectively. This finding supports *H2* and *H3*. By contrast, *H1* that predicted positive effects of basic resource occupation ($\beta = -0.12$, $p < 0.01$; $\beta = -0.11$, $p < 0.05$) on business and market performance, is not supported.

Finally, the moderating effects of decision authority decentralisation were tested. Based on the graphical procedure of Aiken and West (1991), Figures 2 and 3 summarise the results for *H4* and *H5*. Strategic and operational decision authority decentralisation were assigned the values of one standard deviation above and below their means to plot their moderating effects. Table 4

Table 3. Mean, SD and correlation.

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Basic Resource	4.17	1.4	0.74											
2. Information Resource	4.66	1.6	−0.13	0.85										
3. Operational Resource	4.78	1.69	0.01	0.17	0.85									
4. Strategic Decision	4.25	1.84	0.03	0.62	−0.24	0.9								
5. Operational Decision	5.13	1.63	0.08	−0.07	0.46	−0.06	0.87							
6. Business Performance	5.01	1.46	−0.29	0.55	0.5	0.34	0.28	0.83						
7. Market Performance	5.18	1.45	−0.28	0.56	0.46	0.37	0.24	0.37	0.85					
8. Dummy Variable (manu.)	–	–	−0.09	−0.15	0.07	−0.09	0.07	−0.03	−0.03	–				
9. Dummy Variable (state)	–	–	−0.1	−14	−0.08	−0.04	−0.03	0.03	0.04	0.07	–			
10. Dummy Variable (private)	–	–	0.07	0.18	0.12	0.08	0.1	0.06	0.05	0.01	−0.29	–		
11. Firm Age	–	–	0.07	0.05	−0.12	0.14	−0.08	−0.1	−0.09	0.04	0.4	0.01	–	
12. Firm Size	–	–	−0.06	0.1	−0.16	0.27	−0.04	0	0.03	−0.07	0.29	0.17	0.57	–

Note: The diagonal elements are the square roots of AVEs.

Table 4. Results of regression analysis.

	Business performance			Market performance		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Dummy Variable (manu.)	−0.01	−0.04	−0.03	0.00	−0.03	−0.02
Dummy Variable (state)	0.12	0.04	0.04	0.12	0.05	0.05
Dummy Variable (private)	−0.04	0.04	0.01	−0.15	0.02	−0.01
Firm Age	−0.10	−0.08	−0.02	−0.11	−0.10	−0.04
Firm Size	0.05	−0.03	−0.05	0.08	−0.01	−0.03
Basic Resource (BR)	−0.23**	−0.17**	−0.12**	−0.20**	−0.16**	−0.11*
Information Resource (IR)	0.45**	0.35**	0.31**	0.48**	0.37**	0.32**
Operational Resource (OR)	0.43**	0.49**	0.41**	0.40**	0.44**	0.38**
Strategic Decision (SD)		0.23**			0.23**	
Operational Decision (OD)			0.31**			0.29**
BR*SD		0.05			0.07	
IR*SD		0.48**			0.48**	
OR*SD		0.38**			0.35**	
BR*OD			−0.09*			−0.13*
IR*OD			0.06			0.09
OR*OD			0.28**			0.30**
R^2	0.54	0.80	0.86	0.53	0.78	0.84
Adjusted R^2	0.51	0.78	0.84	0.50	0.75	0.82
F	19.14**	41.78**	47.31**	18.23**	36.45**	40.71**

Note: Significant at: *$p < 0.05$ and **$p < 0.01$ (two tailed).

and the figures indicate that the relationships between resource occupation and performance are differently moderated by decision authority decentralisation.

Particularly, the results indicated no significant moderating effect of strategic decision authority decentralisation on the relationship between basic resource occupation and the performance. On the contrary, its positive moderating effects on the relationship between operational resource occupation and performance were significant ($\beta = 0.38$, $p < 0.01$ for business performance, Figure 2(C); $\beta = 0.35$, $p < 0.01$ for market performance, Figure 2(D)). As such, *H4(b)* was not supported. The results also revealed its significant positive moderating effects on the association between information resource occupation and firm performance ($\beta = 0.48, p < 0.01$ for business performance, Figure 2(A); $\beta = 0.48, p < 0.01$ for market performance, Figure 2(B)), which provided support for *H4(a)*.

Furthermore, the results showed significant negative moderating effects of operational decision authority decentralisation on the relationship between basic resource occupation and business performance ($\beta = -0.09$, $p < 0.05$, Figure 3(A)) and market performance ($\beta = -0.13$, $p < 0.05$, Figure 3(B)), respectively. Thus, *H5(b)* was supported. The results also revealed that the positive effects of operational decision authority decentralisation on the relationship between operational resource occupation and business performance ($\beta = 0.28$, $p < 0.01$, Figure 3(C)) and market performance ($\beta = 0.30$, $p < 0.01$, Figure 3(D)) were significant. However, no significant effect on the relationship between information resource occupation and firm performance was indicated. These findings provided partial support for *H5(a)*.

6. Discussion

Hierarchical regression analysis shows that the control variables (i.e. firm age and firm size) and the two dummy variables (i.e. industry and ownership) are not identified as significant factors that can create an impact on the overall performance.

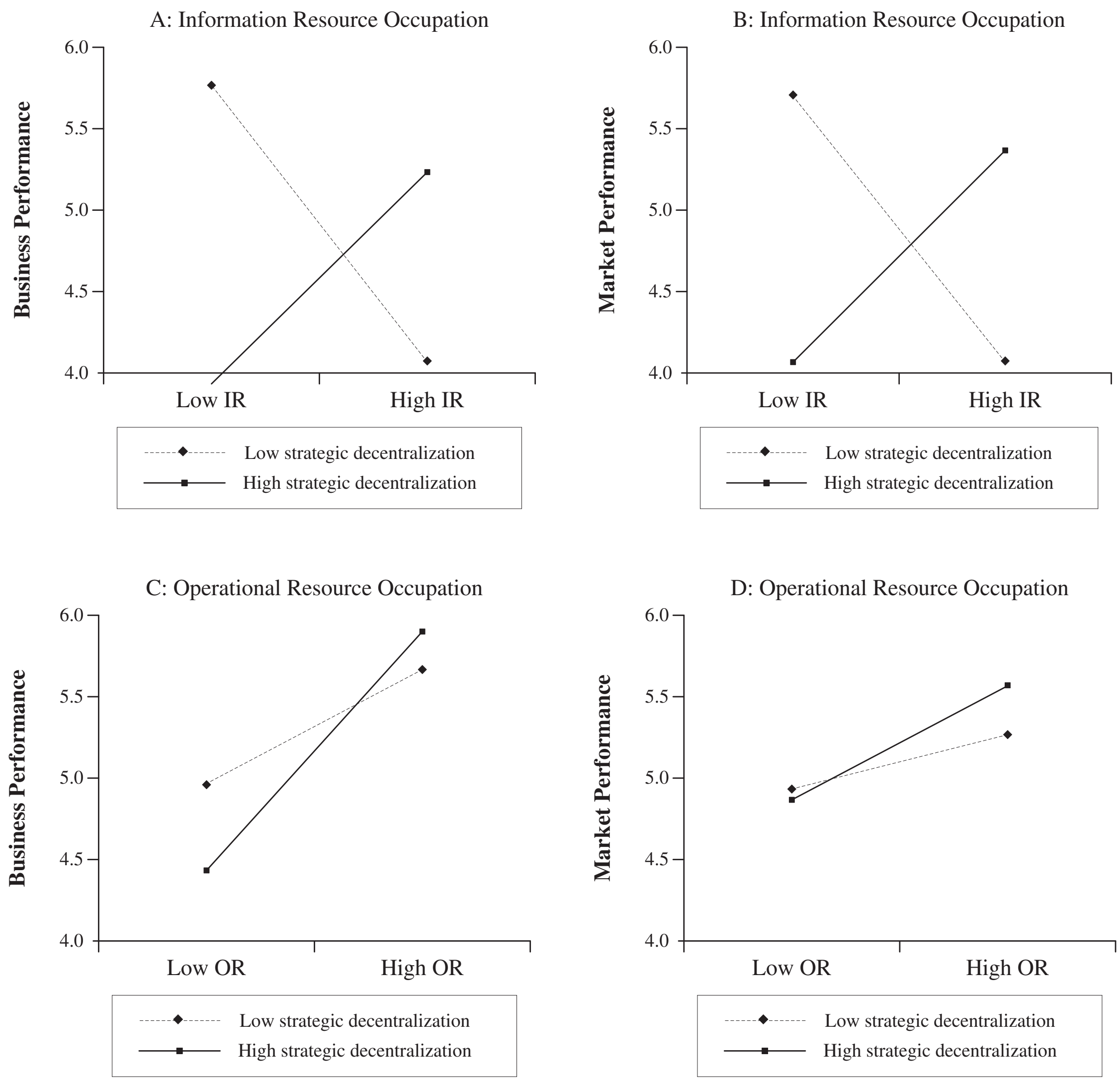

Figure 2. Moderating effects of strategic decision authority decentralisation.

6.1. Resource occupation and performance of the IoT-based VE

Our study reveals that different dimensions of superior resources occupied by member enterprises have diverse effects on the performance of the IoT-based VE. Specifically, information resource positively affects both business and market performance. This is consistent with previous studies conducted in mature market economies (Cao and Dowlatshahi 2005). That is, the application and integration of information resource to information/coordination-intensive processes can generate operating-level competitive advantages and stimulate full competitive potential of other resources (Jeffers, Muhanna, and Nault 2008). In the context of the IoT-based VEs in China, this finding indicates that sufficient information resource facilitates intensive partner cooperation across the whole process comprising production and distribution. Managerial efficiency and business profitability are thus consolidated enabled by precise perception of customer requirement and rapid market changes.

Similarly, operational resource turns up to have significant positive impact on both dimensions of firm performance. As the customer demand dimensions are uncertain, the IoT framework may require changing the operational procedures of a production system (Yin, Stecke, and Li 2018). According to Yu, Ramanathan, and Nath (2014) and Ahmed, Kristal, and Pagell (2014), operational capability contributes to flexibility delivery of products with high quality and reduction of operational costs, which can further ensure high profitability. In other words, operational resource implies flexibility and cost effectiveness in operations during product procurement, manufacturing and distribution. In the emerging market economy of China, SMEs are encouraged to properly exploit operational resource with full utilisation of

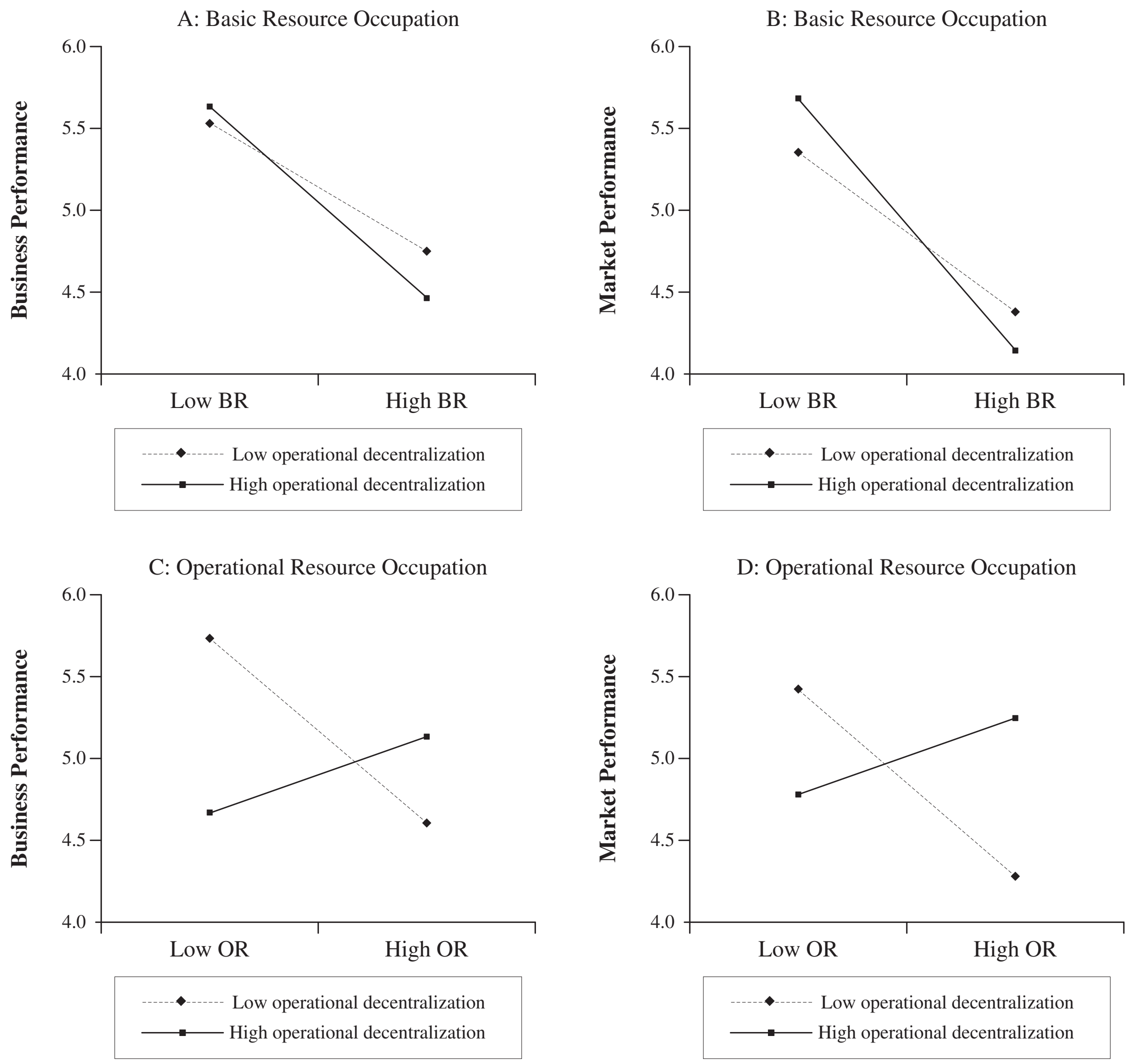

Figure 3. Moderating effects of operational decision authority decentralisation.

sensing network, so as to develop broader distribution channels and better fulfil customer requirements.

However, our results show that the effect of basic resource on business and market performance are in the opposite direction from that suggested by previous findings (King, Slotegraaf, and Kesner 2008; Wu and Chiu 2015). Although somewhat surprising, a possible explanation for the negative direct effects is that, the fully utilisation of firm assets must be coupled with capabilities, complex bundles of skills and accumulated knowledge. Simply basic resource can be easily duplicated by imitators when realised to be competitively advantageous (Bharadwaj 2000). Instead of seeking resource through market channels, China's SMEs often depend on established *guanxi* with government agencies or business partners to reap greater market share and profit margins. As such, activities such as forms of collusion with competitors, lobbying legislators, and negotiating with regulators, are more subtle and prevalent in emerging economies (Parnell, Long, and Lester 2015). More importantly, decision authorities are generally allocated in China according to their basic resource occupation, which greatly damp the collaboration willingness and enthusiasms of cooperative partners.

6.2. Moderating effects of decision authority decentralisation

The moderating effects of strategic and operational decision authority decentralisation vary across the relationships between resource types and performance aspects. Instead of strategic decision authority decentralisation, the relationship between basic resource occupation and performance is negatively moderated by operational decision authority decentralisation. Although basic resource can be easily acquired and imitated by market competitors when realised to be rent-yielding, we highlight the optimal deployment and integration of basic resource for operational capabilities to maintain competitive advantages. As Nath, Nachiappan, and Ramanathan (2010) contended, how the scarce resources and capabilities are deployed, utilised and complemented can bring 'immobility and inimitability' to a firm's resource-capability framework. Due to market competition, IoT-based VEs in China must not only focus on the selection of partners with adequate assets, human resource and financial capital, but practice integration of heterogeneous resources across business boundaries to facilitate the efficiency of their operations.

The results also show that strategic, rather than operational decision authority decentralisation, moderates the relationship between information resource and performance. Prior research argued that, an information resource occupant was able to select from business strategy options, and have greater decision-making latitude due to a solidified relationship with the dominant coalition of the organisation that is responsible for strategic decision-making (Preston, Chen, and Leidner 2008). The operation of the IoT-based VE involves different decision processes comprising product design, marketing, manufacturing and distribution. However, as Strader, Lin, and Shaw (1998) indicated, these processes rely heavily on external information access and interorganisational coordination. In the fast-changing market of China that lacks standard translation software and data format for data storage and transfer, information interchange cannot support communication within the virtual organisations, thus reducing the flexibility of customer response in the operation decision processes. Moreover, the concern of rising information security breaches has destructed the information architecture that is suitable for supporting efficient internal governance of the IoT-based VE.

Our study further finds that both strategic and operational decision authority decentralisation can strengthen the positive effects of operational resource on business and market performance. Although it may be inconsistent with previous researches conducted in mature market, strategic decision authority delegated to top managers in China is a prerequisite for ambidextrous behaviour that nurtures product innovations. Kortmann et al. (2014) argued that strategic decision-making is important in guiding innovative activities that, in turn, enable operational efficiency. An IoT-based VE can benefit from extended product variety and broader product lines that allow entry into diverse markets. In addition, front-line decision-makers have the most advanced and specialised operational knowledge and skills that decentralised operation control can promote successful introduction of new products and technologies, as well as innovative initiatives and behaviours (Goodale et al. 2011).

7. Implications and limitations

This study explores the impacts of resource occupied by member enterprises on the performance of the IoT-based VE in central provinces of China. The results generally support our hypotheses on the relationships between resource occupation and performance, and the moderating effects of decision authority decentralisation. Our research has three theoretical contributions to the extant literature. First, previous researches on the cultivation of market competitiveness are enriched by three distinguishing dimensions of firm resource. This distinction is important for IoT-based VEs to select appropriate cooperative partners. On this basis, we explore how the overall performance of the IoT-based VE is directly enhanced by these superior resources (Lin, Yang, and Arya 2009; Wu and Chiu 2015). Our study contributes to investigating the competitiveness-outcome relationships of firm alliances from the resource occupation perspective.

Second, in accordance with Lin, Yang, and Arya (2009), this paper also contributes to the extant literature by exploring the moderating effects of the extent to which strategic and operational decision authorities are decentralised. In addition to the direct effects, resource occupation is realised to affect the performance combined with efficient decision authority decentralisation mechanism in the scenario of emerging markets. Different from extant literature that focuses on the moderating effects of organisational strategy or market orientation (Nath, Nachiappan, and Ramanathan 2010; Morgan, Vorhies, and Mason 2009), the current study suggests that reasonable allocation of decision authorities is another important factor to promote utilisation and coordination of superior resources, and further enhance firm outcomes.

Third, our research on the relationships between resource occupation and firm performance is conducted in central provinces of China, an emerging and fast-growing market that is undertaking industrial transfer. Environmental uncertainty in China creates both threats and opportunities for SMEs, whereas research on resources has been limited (Parnell, Long, and Lester 2015). Thus, to verify the differences of resource occupation-firm performance relationships between mature market and the Chinese market is of managerial significance and interest. Our findings extend the understanding of multidimensional resources required for the operations of the IoT-based VEs in affecting firm outcomes in different social, political and economic contexts.

In addition, this study has important managerial implications for SMEs structured in the virtual organisation to achieve superior performance. First, the conceptualisation of resource occupation enables managers to understand the distinct relationships between its different dimensions, and indicates directions to improve dedicated competencies. The present study provides managers with guidelines on the cultivation and acquisition of target resources. Second, the causalities between resource occupation and outcomes suggest the IoT-based VEs to select appropriate partners with caution. Different effects of resource occupation provide support for making the right choices of business strategy to improve the overall performance. Third, this paper highlights the critical role of decision authority decentralisation in leveraging the relationship between resource occupation and performance. Member enterprises should be delegated with certain authority in accordance with the specific resource they possess. Finally, IoT-based VEs in China should note that market factors of environmental uncertainty and *guanxi* network also play a strong role in explaining the inconsistency of management strategies conducted in mature markets.

The contributions of the current study should be evaluated along with certain limitations. First, the survey data was collected through a single informant from each IoT-based VE. Considering that most strategic decisions are jointly made by top management teams, the actual situations faced by their respective VEs might be misinterpreted. Further studies are suggested to integrate perceptions of multiple executives from separate member enterprises to enhance the validity of the research results. Second, we used cross-sectional data from survey responses. Given that the VEs at different life-cycle stages may encounter discrepant task priorities, the longitudinal study can be more appropriate for exploring the causal relationships between independent and dependent variables. Finally, our research data was collected through informants who have received business training from a same educational institution in central China, the demography of the respondents may limit the generalisability of our findings. Future studies that compare the results of this study with more diverse backgrounds are also encouraged.

Acknowledgements

The authors are grateful to four anonymous referees for their valuable suggestions that improve the content of this study.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work is supported by Natural Science Foundation of Anhui Province [No. 2008085QG341], 'the Fundamental Research Funds for the Central Universities' [Nos. JZ2019HGTA0051, JZ2019HGBZ0131] and National Natural Science Foundation of China [Nos. 71521001, 71871080, 71922009, 71801071].

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Appendix. Measurement items[a]

A. ***Resource occupation***

A.1. *Basic resource (Adapted from Bendickson and Chandler (2019) and Raguseo and Vitari (2018))*

BR1. Our firm possesses vital financial resources, such as capital and bond, which is necessary for the virtual enterprise.

BR2. Our firm possesses critical assets, such as factory and equipment, which is necessary for the virtual enterprise.

BR3. Our firm owns well-structured employee hierarchy and abundant high-level human resource.

A.2. *Information resource (Adapted from Kim, Wimble, and Sambamurthy (2018) and Garrison, Wakefield, and Kim (2015))*

IR1. Our firm masters core technologies of big data analysis, which provide information support for firm decisions.

IR2. Our firm masters market information and competitor information involved in the operation of the virtual enterprise.

IR3. Our firm can utilisze the IoT and data mining technologies to exploit potential valuable information.

IR4. Our firm is independently capable of market opportunity identification and risk assessment.

A.3. Operational resource (Adapted from Lin, Yang, and Arya (2009), Yu, Ramanathan, and Nath (2014) and Nath, Nachiappan, and Ramanathan (2010))

OR1. Our firm masters operation skills in aspects of production technics and equipment maintenance.

OR2. Our firm masters operation skills in aspects of product planning, marketing and negotiation.

OR3. Our firm masters key operational technologies and irreplaceable core competitiveness.

OR4. Our firm often effectively integrates the core competitiveness of each cooperative enterprise.

B. ***Decision authority decentraliszation***

B.1. *Strategic decision (Adapted from Preston, Chen, and Leidner (2008) and Gunasekaran, Lai, and Cheng (2008))*

SD1. Our firm has the decision authorities to design the organiszational structure of the virtual enterprise.

SD2. Our firm has the decision authorities on long-term, overall strategic items of the virtual enterprise.

SD3. Our firm is qualified for virtual enterprise's business selection and strategic partner selection.

SD4. Our firm is responsible for goal setting, implementation supervision and performance evaluation of strategic items.

B.2. Operational decision (Adapted from Graham, Harvey, and Puri (2015) and Goodale et al. (2011))

OD1. Our firm is qualified to select the business or technical processes of the virtual enterprise.

OD2. Our firm is responsible to arrange production plan and schedule for the virtual enterprise.

OD3. Our firm has the decision authority on new technology adoption and new product development.

OD4. Our firm can decide investments on requisition of new resources to satisfy business requirements.

C. ***Firm performance****(Adapted from Liu et al. (2013) and Inman et al. (2011))*

Compared with our key competitors, our virtual enterprise performs much better than them in terms of

C.1. *Business performance*

BP1. Return on investment.

BP2. Profits as a percentage of sales.

BP3. Net income before tax.

BP4. The present value of the firm.

C.2. *Market performance*

MP1. Decreasing product/service delivery time.

MP2. Responding market demand rapidly.

MP3. Developing a new market timely.

MP4. Introducing new product/service to the market quickly.

[a]All items are measured using 7-point Likert scales, ranging from '1 = strongly disagree' to '7 = strongly agree'.