



On the Strategic Impact of Internet of Things: The Development of a Research Framework

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Abstract

Innovative developments in Internet of Things (IoT) have invoked tremendous attention from both academics and industries. Studies suggest that IoT not only serves as an innovative resource for enterprise operations but also triggers impacts on business performance. As researchers increasingly raise interests about the business value of IoT, this study examines its direct and indirect managerial effects by investigating the link between IoT and business strategy. Referring to the organizational capability perspective, this study constructed a research framework in which marketing intelligence capability mediates the effect of IoT capability on business strategy formation. Possible applications and extensions of the research framework are then discussed.

Keywords: Internet of Things, marketing intelligence, business strategy, organizational capability

1. Introduction

Recent development of the extensive globalization, the meticulousness of enterprise internationalization and business integration, and the rapid development of innovative technologies have caused business environments to change rapidly and enormously. For enterprises, customers require an increasingly fast response and personalized fulfillment. To respond effectively to changing internal situations and external environments, a firm must interact closely with changes through its distinctive capabilities to form a highly robust competitive strategy. This makes a firm's organizational capabilities especially critical facing competitions, because organizational capabilities are the source of competitive advantage [1-6].

To many organizations worldwide, the evolution of Internet of Things (IoT) is considered as "the next big thing" [7, 8] of information technology. The development of various IoT related technologies is expected to affect enterprises' managerial paradigm, including business strategy. IoT attracted attention as a possible source of strategic advantage for firms [9]. It may provide business opportunities for companies, and may even change the future market [10]. Therefore, aligning with the development of IoT has become critical for the formulation and execution of a firm's business strategy.

The perceived capability of IoT implies that firms make strategic decisions more efficiently. By employing IoT, firms should be able to recognize new business opportunities, identify possible threats, and maintain competitiveness. However, so far studies of the relationship between IoT and business strategy are rare in the literature. To fill this gap, this study intent to investigate the link between IoT and business strategy.

In addition, a firm is a value chain assembled with various value activities [11]. These value activities include primary functional operations such as productions, marketing, sales and services, as well as supportive functional operations such as human resource management, research and development (R&D), and information systems. In order to use IoT, a firm needs to integrate IoT with these functional operations. Therefore, these functional operations have influence on the link between IoT and business strategy. Among these functional operations, this research focuses on marketing for several reasons. First, marketing strategy plays a key role in shaping overall business strategy of a firm [12, 13]. Second, marketing is tightly related to many other functional operations of a firm, such as production, sales and customer service [14-19]. Finally, IoT enabled products are expected to transform future marketing paradigm [9, 20, 21].

Furthermore, in a firm's marketing operations, marketing intelligence is the foundation of overall marketing activities, because marketing decisions rely on the capability of acquiring and interpreting accurate marketing intelligence [22]. Therefore, the objective of this research is to investigate the linkage between IoT and business strategy, and the effect of marketing intelligence in this linkage.

The paper begins with a review of the relevant literature about the relationships between Internet of Things, marketing intelligence and business strategy. Then it proposes a model which links these variables. Following that, the model is presented as a research framework. Finally, possible applications and extensions of the framework are discussed with recommendations for future work.

2. Method

A bottom-up approach is employed in the development of the research framework. First, key phrases in the problem domain are identified. These include organizational capability, Internet of Things, marketing intelligence and business strategy. Next, literature review is performed to discover possible linkages between pairs of the key phrases. These linkages are then hypothesized. Finally, the hypotheses are integrated into a model and depicted as a research framework. Details of the development process are as follows.

2.1 Internet of Things and Organizational Capability

Several researchers have elaborated the technological features of Internet of Things [7, 8, 23-28]. These features are classified and summarized as follows.

- Ubiquitous sensing: This is the mechanism that the “things” or devices in IoT perceive the surrounding physical environment, detect and record the changes in the environment, and respond to the changes. Ubiquitous sensing is enabled by wireless sensor network (WSN) technologies [7, 24, 25].
- Pervasive connectivity: IoT contains multiple layers of communication networking infrastructure to provide the pervasive communications between people and people, people and things, and things and things, to form a smart environment [23, 24].
- Embedded computing: IoT devices contain embedded hardware and software to work intelligently within the environment. The embedded hardware includes processor chips, data storage units and power units. The embedded software includes embedded operating systems, mobile apps and middleware. In particular, IoT devices can be embedded further in other devices [24, 26].
- Real-time analytics: IoT monitored and detected information are invisibly embedded in the environment around users, results in the generation of big data in real-time which are distributed, stored, processed, presented and interpreted in a seamless, efficient, and easily understandable form [24, 26, 29, 30].
- Cloud support: Cloud services are deployed to assist the processing and storage of IoT analytics, and provide IoT users ubiquitous access of supporting services initiated by IoT devices around the smart environment [23-25, 31].
- Interactive user interface: Visualization, touching and voice are critical for an IoT application as this allows the awareness and interaction of IoT users with the

environment. 3D viewing and printing technologies, personal mobile assistants, wearable devices, and augmented-reality devices provide novel interface for users to interact with the smart environment [24, 25, 32].

- Interconnected smart products: IoT enables evolution of various products such as smart home appliances, robots, drones, unmanned cars, automated factory machines and business equipment, and many other innovative devices [8, 26, 28, 33].
- Cyber-physical convergence: The convergence of computer network, telecom network and IoT triggers further convergence of cyber space and physical space, and results in various smart spaces, such as smart home, smart office, smart factory, smart laboratory, smart store, smart marketplace, smart hospital, smart museum and smart city [8, 24, 25, 27].

With these technological features, IoT has been asserted as essential for organizational innovation and adaptation in a changing environment [34, 35], especially for firms with high amounts of connectivity and data. However, so far few studies have examined the capabilities needed to adopt IoT in an organization, and how these relate to different types of business strategy, particularly from the perspective of an innovative and market-oriented organization. Therefore, to contribute with a required research framework of IoT and business strategy, this study examines the role of IoT capability further in business strategy formation.

IoT capability refers to the firms' ability to integrate firm resources and skills arising from IoT to align with the firms' strategic directions [2, 36]. IoT capability enables an organization to exploit and incorporate the above IoT technological features for business value. By using IoT, firms are able to identify new business opportunities and potential threats, and maintain competitiveness, thus establishing the IoT capability to be a source of competitive advantage [37]. Depending on different industry sectors and business models, a firm with IoT capability could be competent in developing or deploying IoT core components for business applications, or it could be competent in making or using IoT connected products for business benefits, or it could be competent in implementing or operating IoT enabled environments for business value [9, 28].

2.2 Internet of Things and Business Strategy

Organizational capabilities play a pivotal role in the business strategy which a firm pursues. The essence of strategy formulation is to design a strategy that makes the most effective use of these core capabilities [3]. Furthermore, designing strategy around the most critical capabilities implies that the firm focuses its strategic scope to those activities where it possesses a clear competitive advantage [5]. These propositions suggest that IoT capability can have potential effect on business strategy formation.

From the strategic management perspective, cost leadership and differentiation are two important approaches to competitive advantage and basic choices of business strategy [38, 39]. Furthermore, researchers have argued that cost leadership and differentiation are not mutually exclusive, but rather are compatible approaches to dealing with external situations, and a combination of strategies could lead to success in various circumstances [40-42]. In the IoT context, whether a firm wants to achieve cost advantage, differentiation advantage, or a combination of both through its IoT capability is an important strategic intent, which causes the firm to formulate and implement IoT facilitated cost leadership strategy, differentiation strategy, or a combination of both types of strategy.

Cost leadership strategy requires organizational capabilities to achieve operational efficiency, including time efficiency, cost efficiency and flexibility. The problem is that people have inadequate time and imperfect accuracy and therefore they are not very good in capturing information about things in the physical world. The IoT sensor technology enables connected devices to sense, observe, and understand the physical world – without the limitations of human-entered data [43]. Furthermore, enterprises will be flexible enough to respond to production changes swiftly with IoT capability. The functions of IoT enabled smart factory integrate technologies of many disciplines. IoT capability enables an enterprise to make extensive use of artificial intelligence, simulation, automation, robotics, sensors, data collection systems and networks towards advanced engineering and precision machining. These systems make possible the establishment of efficient, collaborative and sustainable industrial production to achieve cost leadership [44].

Differentiation strategy requires organizational capabilities to achieve product or service uniqueness for higher customer premium. Products or services differentiation are realized through innovation or customization. IoT capability provides higher accuracy on analyzing and identifying distinctive customer preferences through hidden analytics of interconnected products. Sensor-based information collected through IoT embedded products covers actions of customer purchase and use, and can therefore be analyzed to obtain a much more precise and complete picture of the customer's characteristics and of their preferences [45]. Smart laboratories can provide test fields for innovative products and services before delivery to customers. Customer feedbacks are collected and transmitted in real-time through various sensor networks and supportive cloud services for further refinement of innovation or customization. Thus IoT capability could expand opportunities for product or service differentiation, moving competition away from cost alone.

Therefore, the following two hypotheses are proposed:

H1a. IoT capability is positively associated with cost leadership strategy formation.

H1b. IoT capability is positively associated with differentiation strategy formation.

2.3 Internet of Things and Marketing Intelligence

Effective marketing requires adequate information for planning and allocating resources properly to different markets, products, territories, and marketing tools [46]. Marketing intelligence is the systematically collected and extracted information for making marketing decisions. Marketing intelligence is a critical component for overall marketing activities of a firm. Acquisition and effective use of marketing intelligence is vital in shaping the firm's sustainable competitive advantage [47, 48]. Marketing intelligence capability concerns a firm's ability to learn about customers, competitors, channel members and the broader market environment in which it operates [1, 49].

IoT capability is expected to enhance marketing intelligence capability, because IoT capability enables a firm with better ability to sense and collect information from customers and competitors [37]. IoT capability indicates the ability in merging of the digital world with the world of things. It involves the ability of convergence of the industrial systems with the power of advanced computing, analytics, low-cost sensing, and new levels of connectivity provided by the internet [27]. For a firm with IoT capability, large scale real-time customer surveys can be conducted with the assistance of sensing and recognition technology. Augmented reality enhanced user interface allows users to view and test products and services using their smartphones, tablets or 3D viewing glasses. The big data from IoT connected products provides a clear picture of product use, showing the features customers prefer. By comparing usage patterns, firms can identify finer market segmentation information [28]. Firms can then apply this knowledge to generate more valuable intelligence, and develop more sophisticated pricing strategies that better match price and value at the market segment.

Furthermore, it is easier in a smart environment such as a smart marketplace or a smart store to collect and disseminate user opinions and user experiences about competitors' products or services [24]. The ubiquitous sensing with intelligent pattern recognition and machine learning functionalities enables the analysis and simulation of competitors' products and services. Using this information, further realization of competitors' products or services can be accomplished digitally or physically in a smart laboratory using 3D animation or 3D printing technology. The big data of feedback opinions collected from customers and distributors can also be exploited to make more accurate analysis of competitors' situations. IoT embedded analytics can invoke corrective processes to address immediate operational issues or inform managers of discoveries regarding competitors' strategic moves that will impact their short-term and long-term business activities [35].

IoT capability also facilitates the collaborations between firms and business partners. Information sharing and collaboration in the IoT can occur between people, between people and things, and between things. Firms with IoT capability are easier to form virtual alliances or virtual groups with partners. These partners could be customers, suppliers, intermediaries,

governments and competitors, all of which are important in IoT context [37]. Sensing a predefined event is usually the first step for information sharing and collaboration. Information sharing and collaboration enhance situational awareness and avoid information delay and distortion [35]. This is the essence of marketing intelligence.

As such, IoT capability can enhance firm's marketing intelligence acquisition efforts, representing the extent to which they can generate and disseminate marketing intelligence, and which may lead to novel interpretations and recombination of prompt responses to marketing situations. Thus with IoT capability, a firm is able to transform marketing intelligence capability and enhance marketing results. In summary, we propose the following hypotheses:

H2. IoT capability is positively associated with marketing intelligence capability.

2.4 Marketing Intelligence and Business Strategy

Marketing intelligence is about staying ahead of the competition by gathering information which could be converted to actionable intelligence and which can then be applied to both short and long term strategic planning [50, 51]. Marketing intelligence is considered as a strategic resource that enables a firm to strengthen its opportunity recognition, threat identification and achieve a positional advantage over its competitors [1]. Hence it is related to the firm's business strategy formation.

Business strategy formation is comprised of mission and goal clarity, situation analysis, comprehensiveness of alternative evaluation, and strategy formation process [52]. A business strategy concerns the competitive positioning, market segmentation and industry environment of a company [38]. To survive, grow and sustain, a firm needs to constantly monitor its internal and external status for possible changes. Thus the formulation and execution of a business strategy rely heavily on the collection, extraction, analyze, interpretation and prediction on internal and external status data of the company, in order to make accurate managerial decisions [53, 54]. Therefore, a firm's marketing intelligence capability is critical in facilitating its business strategy formation. Furthermore, business strategies of most companies are frequently a combination of their intended strategies and the emergent strategies [55]. Business leaders need to analyze the status information of emergence and to make strategy adjustment when appropriate [56]. For this purpose, marketing intelligence capability is also essential as the ability for the strategic decisions to be accurately updated and aligned with competition changes [57, 58].

Marketing intelligence capability enables a firm to acquire and analyze the cost structures and distinctive features of products and services of peers in the marketplace. It helps the firm to determine which market segments are suitable for cost leadership, and which market segments are feasible for differentiation. Marketing intelligence about cost analytics of all levels needs to be collected and accurately analyzed for a firm to maintain a

viable leading cost status. Marketing intelligence about customer preferences and distinctive features are required for a firm to determine the need to differentiate its products against the need to keep its cost structure under control in order to offer a distinctive product at a competitive price [52, 59].

Therefore, the following two hypotheses are proposed:

H3a. Marketing intelligence capability is positively associated with cost leadership strategy formation.

H3b. Marketing intelligence capability is positively associated with differentiation strategy formation.

3. Results

The development process results in the following hypotheses.

H1a. IoT capability is positively associated with cost leadership strategy formation.

H1b. IoT capability is positively associated with differentiation strategy formation.

H2. IoT capability is positively associated with marketing intelligence capability.

H3a. Marketing intelligence capability is positively associated with cost leadership strategy formation.

H3b. Marketing intelligence capability is positively associated with differentiation strategy formation.

Based on our proposed hypotheses, the research framework is illustrated in Figure 1.

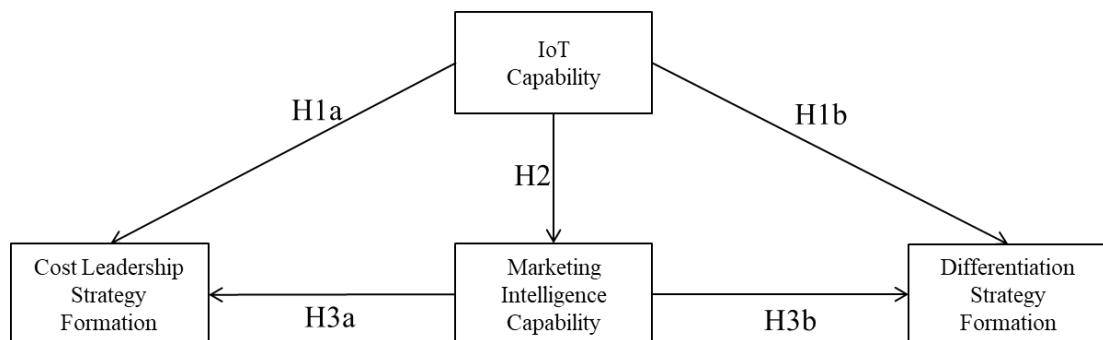


Figure 1 Research framework

Note that in Figure 1 we have not included possible control variables such as firm size, IT department size and industry sector which have been noted in several studies to affect deployment of information technologies [69, 70].

4. Discussion

4.1 Applicability and Extensibility of the research framework

This paper provides a research framework for internet of things, marketing intelligence and business strategy. The effectiveness of this framework is based on theories of organizational capability and competitive strategy. The framework is generic and is applicable to manufacturing, service sector or public organizations.

The research framework presented in Figure 1 could be viewed as a core framework and extended in several directions.

For research emphasizing technology based resource and capability, the IoT capability construct can be regarded as a high level construct and decomposed into formative or reflective sub-constructs.

For research focusing on marketing, the marketing intelligence capability can be further linked to marketing operations, marketing strategy, market orientation, market effectiveness, market performance or customer satisfaction.

For research toward competitive strategy, formative or reflective secondary constructs of differentiation and cost leadership could be extended. Other strategy typology could also be employed. Furthermore, the output of the strategy construct could be linked to competitive advantage, business performance, value creation or profitability.

Also noticed is the possible mediating role of marketing intelligence capability in the framework. Other mediators or moderators could be included in the framework. For example, innovation capability, customer service competence and supply chain competence [60] are some of the candidates for consideration.

4.2 Suggestions for Further Research

Empirical studies are suggested to test the core framework in Figure 1 or its extensions. Both of quantitative data or qualitative data from enterprises of various sizes are recommended.

Further research efforts which focus on accumulating more empirical evidence for assessing and validating the research framework or its derivatives are recommended to overcome the scope of the present study. Such research is required to address how other emerging technologies relate to business strategies and functional operations. For example, wearable interface technology [61-63] and augmented reality technology [64-66] have received inadequate attention from strategic considerations and organizational capability theories. Further research could also investigate the relative importance of the factors affecting each stage of the strategy shaping process. These efforts should involve studies identifying the organizational capabilities which affect business operation, information processing, and decision support. In addition, special attention could be focused on data collected in various sub-industries or specific contexts over an extended period of time. The

analysis of these data may enable conclusions to be drawn about more generalized relationships among business level strategy, functional level strategy, and technology based organizational capability.

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