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## Article

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Open Economics

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De Gruyter

*Suggested Citation:* Kvedariénė, Audronė (2019) : Strategic technology management within global value systems, Open Economics, ISSN 2451-3458, De Gruyter, Warsaw, Vol. 2, Iss. 1, pp. 43-52, <https://doi.org/10.1515/openec-2019-0005>

This Version is available at:

<https://hdl.handle.net/10419/236597>

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## Review Article

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# Strategic technology management within global value systems

<https://doi.org/10.1515/openec-2019-0005>

Received June 11, 2018; accepted May 27, 2019

**Abstract:** Contemporary the concept of global value system extensively elaborated by scientist and applied by practices in the fields of management, economics and politics. The aim of this article is to provide the theoretical background and evolution of the global value system methodological approach from the global strategy management perspective. The technologies are considered as the main source of added value. Therefore the main scholars of technologies strategic management are provided in the article, though in the global value system concept it is implied that the source of added value originates from the allocation of added value activities across borders. Recently scholars analyse various sources for the added value upgrading, though critics of global value chain concept emphasise that besides economic added value, social issues should be considered.

**Keywords:** strategic technology management, global value chain, global value system

**JEL Classification:** O32, M16.

## 1 Introduction

The role of technologies in the globalisation of the economy is widely discussed in academic literature, though the peculiarities of technology management are still vague. Majority of the authors are stressing the importance of technologies as core competence causing major market shifts, thus simultaneously business management issues. The aim of this article was to overview principal theoretical management evolution of paradigms dedicated to the strategic management of technologies in the context of the global value chain.

The scope of the term ‘technology’ is very extensive though in this article considered those technologies which could impact the business strategy.

First of all, the key theories of technology strategy as they relevant to international management highlighted. Afterwards, the evolution of the global value chain methodological approach overviewed.

Considering that global strategy management in its nature is an *eclectic* paradigm and analysis of global value chains is a *multi-disciplinary* methodological approach it is an intricate objective to achieve completeness overviewing the fundamental paradigms and emerging thoughts. Thus in this article, the emphasis is on the key themes of strategic international management.

The analysis of global value chain network offers helpful information about value-added activities and how the global value network is configured, thus valuable insights identifying the key drivers of various forms of the global integration could be identified. Increased number of studies over the last year evince the relevance of global value systems topic. Thus there is an essential need to understand the theoretical background of global value chains, basic concepts, definitions and terminology as well as the trends in this

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field. Therefore these issues are covered in this article considering that technology is one of the essential elements in the global value system.

## 2 Technology as a Driving Force of Innovation Life Cycle and the Changing Concept of Innovation Systems

The characterization of technology varies through disciplines though numerous recent research in technology transfer, incorporating the knowledge and information defining the technology (Dunning 1994). There is a trend to extend the notion of technology and consider technology as the element of a cultural system that links the society and environment. In early technology transfer concepts, the emphasis was on knowledge transfer, though it evolved within multiple contexts like information transfer between companies, markets or countries.

The technology transfer concept tightly related to technology life cycle (TLC) theories, concentrated on technology transfer from product to process innovations. The TLC embraces both the technology and processes innovations for the novel added value adoption, assimilation and exploitation. Though technology is one of the basic pillars of TLC process existence, therefore there is the need to manage the creation of the new technology as well as diffusion through mutually interconnected product innovation and process innovation. The sourcing of the technology requires complex technology transfer process management also due to the nature of technology – the embracement of tangible and intangible asset (Nonaka, 2008).

There are numerous investigations on new technology diffusion. The most commonly used model is so-called *epidemic model*. It assumes that the speed of the adoption of an innovation tends to follow ‘S’-shaped curve (fig.1.). The development of new technology is fast, till the limits of the technology are reached and technology becomes mature. The invading new technology may be developed, and at a point where the performance of new innovation is higher, the old technology gradually becomes obsolete.

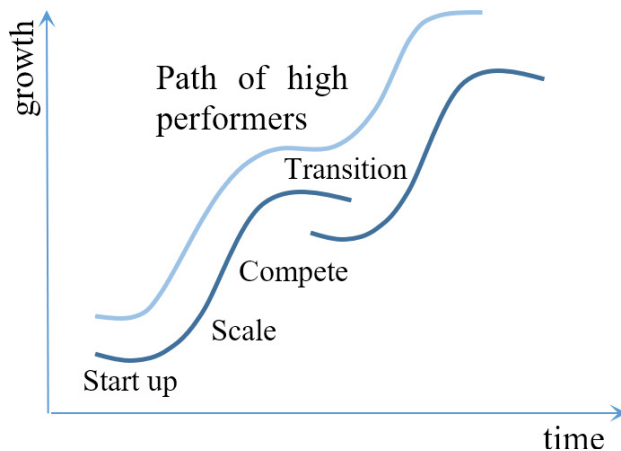


Fig. 1. Standard life cycle of innovations. The speed of the adoption of an innovation (Byun et al., 2018)

Epidemic model is built on the presumption that diffusion happens too slowly because the social structures affect technology transmission rather than the strategic settings of the firm. This simplification ignores the important fact that decisions are made by individuals (firms). Therefore the leading alternative *probit model* of technology diffusion is proposed, which evaluates the different goals and abilities of firms to adopt technology as well as forces of legitimation and competition are considered. *Information cascades* models follow the premise that new technology has different variants, thus this initial choice affects the technology diffusion speed. Geroski (2000) highlights that the dominance of epidemic model created a set of limited policy presumptions and that the probit and cascade models broadens the range of policies implications.

The technology in a business is highlighted as a strategic asset for the competitive advantage. Therefore, enterprises are developing technology strategies in order to capture and exploit the opportunities posed by the technology. These technology strategies varies, but generally embraces: the *audit* of the technology, *sourcing* of the technology, the *exploitation* of the technology and the *protection* of the competitive advantage. The audit of the technology aims to diagnose the gaps and strengths of the technology capabilities within the company. Gresov (1984) states that successful management of technologies at organizations embraces the distinct processes of innovation and implementation, highlighting that centralization for business structures favours to implementation as well as homogeneous organizations at the expense of innovations. Therefore the cultural heterogeneity has to be encouraged. Recent empirical research validates this proposition (Niebuhr, 2010).

The basic decisions are based on the choices for the sourcing of the technology: developing it internally or outsourcing. The companies in technology-based industries in large part generate technologies through internal sourcing as the R&D result, though it is important to evaluate the alternative external sources for technology transfer. Many mergers and acquisitions (M&A) of high-technology industries are not motivated only by the need to get access to the markets but also by intentions to acquire the technologies.

The external sourcing approach particularly important due to the increased acceleration of the speed, rate and extent of technology transfer (Giudice et al., 2017). The shortening of the product life cycles reflects the transnational demand to transfer technologies throughout the international network to benefit from the competitive advantage.

In many countries governments supporting the effort of R&D in high-tech industries as well as wide array of joint R&D strategic alliances, therefore the technological innovation system (TIS) concept was introduced especially for explanation of firm strategies, evaluation of their ability to develop new technologies and recommendations for innovation policies (Bergek et al., 2015). The notions TLC and TIS in numerous literature are treated as synonyms, though the latter is based on system theory and distinguish the network of *participant* and *institutions*. Participants embrace such research institutes, suppliers, distribution channels, associations, government institutions or non-government organizations while the institutions depict formal and informal structures like regulation, technological standards or collective expectation, social norms or culture. Early system standpoint for technology management was introduced by Burns and Stalker (1961) denoting that, the transfer of technologies requires a new approach to organization models from the mechanistic to organic, while the companies require frequent or even constant process change.

Innovation systems are analyzed considering numerous criteria, therefore technological, sectorial innovation systems developed. Recently, the spatial dimension is taken into account, thus the local, national, regional, international or global innovation systems are proposed. The complexity of spatial dimension raises the question about the suitability of innovation systems models for the further scientific research, though other authors argue that it is possible to adopt the innovation systems changing the concepts, mainly converging the various innovation systems to global innovation systems and functional value systems, like multi-scalar attitude proposed by Binz and Truffer (2017).

### 3 The Value System Theory as the Core for International Strategies

Sanchez and Heene (1997) characterized organization as model of open system with tangible and intangible capital –inputs converting into added value outputs. The aim of this open system is to add value to the capital by not exceeding the value of the resources processing the outputs. Thus the competitive advantage is based on the ability to organize the added value at a lower cost or of higher perceived value than competitors. The technique of organization's value chain analysis was introduced by Porter (1985). The primary or core activities and support activities were distinguished in order to define the activities of the greatest value and reinforce core. The value chain analysis of separate organization would yield an incomplete understanding of value-adding activities while the partnership with external organizations may cause unique mutually reinforced added-value collaborative network. It is, therefore, the *value system* of interlinked organizations should be analyzed.

The value chain concept is similar to value system, though the latter emphasizes the external interactions and relations with an organization and its suppliers, distribution channels and customers and the importance to manage and coordinate the synergies provided by networks. The external linkages may create a distinctive and sophisticated source of a competitive advantage, which is not easy to imitate for the competitors.

The decision, positioning in the value chains and migration within the value chain, have a major implication for the organizations' strategy. Focusing on upstream activities requires different approaches than operating in downstream spheres. Though shifts in value chain may be observed as a response to the global competitive pressure (Jacobides et al., 2006).

The globalization offers opportunities and challenges for the reconfiguration of the new global value chains. The complex forms of a global value system which is dispersed between national and international activities may provide a distinctive global competitive advantage. The concepts of *configuration* and *coordination* of the global value chains should be understood and examined.

The configuration of the business defines its upstream and downstream value chain and internal value-adding activities, which can be *concentrated* or *dispersed*. Global businesses configure their value chain activities to different nations, thus the business environment should be monitored continuously in order to identify opportunities, which could be obtained from the value chain architecture. In some industries concentrating activities, the competitive advantage could be gained from location factors. The competitive advantage from the dispersed activities may be gained when transactions cost are high, like transportation, political risk, different markets, etc. There are also some industries that inevitably involve foreign direct investments such as telecommunications, health care, etc.

The co-ordination required to define and sustain the value-added networks. Porter (1990) defines coordination as an activity that comprises 'sharing information, allocating responsibility and aligning efforts. Global businesses which arrange coordination in the most efficient manner would get a competitive advantage from an international strategy.

Prahalad and Doz (1986) defined that the main successful international strategies are able to configure and coordinate global activities, simultaneously responding to the local changing business environment. The three characteristics of global management distinguished: global, integration of activities; global strategic co-ordination and local responsiveness. *Global integration management* is based on centralized management of across national boundaries dispersed activities to get optimum scale economy. *Global strategic coordination* is dedicated to the strategic management of the geographically dispersed resources like R&D activities, technology transfer, etc. When due to the particular market conditions the global approach is not appropriate *local responsiveness* is required.

The forces for the global coordination comes from the worldwide universal markets demands, global competition, heavy investments, intensive technology development and access to the scattered resources. The restraining pressures for local responsiveness include: differences in markets demands, pricing, promotion, distribution channels and other marketing activities, market structure with natural substitutes and high concentration of local competitors, etc.

Bartlett and Ghoshal (1989) highlighted that the strategies should combine valuable geographical management with global integration management and with global strategic coordination to benefit from the multiple strategic approaches. This adaptation of local and global demands is defined as a *transnational strategy*. The forms of transnational strategy vary between global and local, and the deviation between them is determined by the pressures and forces of globalization and localization.

Prahalad and Doz (1986) identified that in certain circumstances business has to focus on the 'critical markets' rather on the entire world. The preference should be devoted to the regions that sustain 'profit sanctuaries' due to the limited cultural differences and the size of the markets. The emerging free trade areas and customs unions favour for these *regional strategies*. The main difference between multi-domestic and regional strategy is that the political, cultural or other distinctions exist within a region.

The *total global strategy* defined by Levitt (1983) implies that the products and marketing have to be standardized for the entire world, though Yip (1992) argued that global strategy is not defined by global standardization but the flexibility of the strategy. Yip (1992) depicted three phases of total global strategy: the core strategy development, the core strategy internationalization and globalization of the international strategy.

## 4 Eclectic Approach to the Global Strategy Decisions

Similarly to Porter's (1986) perception of the global strategy with the emphasis on the configuration and coordination of value-added activities, Doz (1986) defined global strategy as 'specialization of plants across countries into an integrated production and distribution network involving substantial cross border flows of components or products'.

Defining the global strategies for the value chain set up numerous factors are considered. Dunning (1980) introduced the 'eclectic' theory approach for the international production and highlighted the fundamental location-specific factors affecting the decision on foreign direct investments: natural resource seeking (natural resources, communication infrastructure, tax structure, etc.); market seeking (market characteristic, political conditions, etc.); efficiency seeking from the product specialization and concentration or process superiority due to labour cost etc.); strategic asset seeking of any country that possess other assets required for the business; trade and distribution to local markets (import and export merchandising); support services.

The issues concerning the configuration and coordination of the global value chains gained significant attention within the researchers. The most notable early attempts dedicated to the strategic management of the global value chains remains relevant. Doz (1978) argued that the regionalization due to free trade areas and custom unions serving to the large scale specialization and rationalization of production, serving the global markets. Starr (1984) developed the network model for the global sourcing, production, and marketing involving complex alternative combinations of domestic and international nodes that should be considered and analyzed. Dicken (1998) further developed international value-adding activities as a network of relationships excluding internal network of within business and external network with independent or quasi-independent business. *Internalization* would be an extreme example when entire added value activities would be performed within a business, and *externalization* would characterize another extreme example when each function is an independent business. In reality, numerous combinations of relationship exist between these defined extremes. Dicken (1998) based on Porters (1986) configuration and coordination concepts identified internalization alternatives. Globally concentrated added value activities are consistent with the Porters (1986) purest global strategy of highly coordinated and geographically concentrated activities. Local value added activities for the local markets coherent with Porte's (1986) multi-domestic strategy of low co-ordinated and geographically dispersed activities. Specialization of value-added activities as a rationalized product and process strategy is expanding due to the regionally integrated markets like free trades and customs unions. Transnational vertically integrated value-added activities are consistent with a Porte's (1986) extensive foreign direct investment strategy with extensive coordination between geographically dispersed activities. Dicken (1998) argued that offshore processing is an important aspect of a transnational vertically integrated global value-added network. The selection of the international strategy of the internal network is a choice between the economies of scale and other factors that are highly dynamic.

Most of the conventional (Prahalad and Doz, 1987; Porter, 1990) models explain that the sources of competitive advantage originate from the configuration and coordination of business activities. Prahalad and Hamel (1990) highlight the core competencies and 'the collective learning in the organisation, especially how to co-ordinate diverse production skills and integrate multiple streams of technologies'. Thus competitive advantage success is dependent on the process of core competencies identification and concentration on activities that are essential for the core competencies or outsourcing of these activities. Though researchers have stressed that collaboration is also source of competitive advantage (Contractor, Lorange, 1988). The horizontal and vertical collaboration relationships arrangements could be distinguished. Horizontal relationships embrace the competitors that collaborate together against other ones, and vertical relationships could be upstream – with suppliers or downstream - with distributors and customers. The benefits of the collaboration are relay on shared risk, cost, technology, etc.

## 5 The Evolution of Concepts Concerning Global and Regional Value Chain

The Porters (1991) conceptualization of value chains was adapted to the international environment and numerous definitions evolved, including global production networks (Coe et al., 2008), value networks (de Reuver, Bouwman, 2012), international production networks (Baldwin, Venables, 2013), global commodity chains (Selwyn 2015, Gereffi, 1994), supply chains (Connelly et al., 2013) global value chains (Gereffi et al., 2005), etc. Commodity chains theories focus on specific industry and its power relations with other agents.

Supply chains theories analyze the relationship with supplier and customer. The value chain scholars explain that entities may become the source of added value. This theory considers the perception of value by customers.

Recently numerous researchers focused on different theoretical aspects of global value chains: disaggregation levels (Asmussen et al., 2007); the types of governance (Buckley, Strange 2015; Gereffi et al., 2005), geographic scope (Mudambi, Puck, 2016), upgrading processes (Lema, 2015).

Mudambi (2008) besides *upstream activities* that embrace the basic and applied research and *downstream activities* concerning marketing and services and maintenance after sales also highlighted the *middle-end activities* that depict repetitious processes (standardized manufacturing and routines services delivery, etc.). Some authors (Ha, Giroud, 2015; Cantwell, Piscitello, 2015) classify added value activities as *competence exploration*, those that concerns with technology creation, and as *competence –exploiting* activities that imply the deployment of existing technologies. Some authors emphasize the processes of ‘servicification’ (Hoekman, Shepherd, 2015), highlighting that in the production networks, the added value share of customer services increases (De Backer et al., 2015).

Other authors divide added value activities into core and non-core activities (Espino-Rodriguez, Rodriguez-Diaz, 2014); high added value with distinctive impact for the competitive advantage, essential, those are required for continuous and sustain performance and non-core activities, which potentially could be outsourced (Linares-Navarrio et al., 2014). Moreover, traditional models dedicated to comparative advantages refer mainly to the final goods, though currently the international specialization of ‘trade in task’ rather trade in final goods should be considered (Grossman, Rossi-Hansberg, 2008).

In the last decades the configuration of global value chains has evolved, and authors pointed out that activities cannot be divided into traditional ones like R&D, design, manufacturing, service, etc. The processes of activities have to be *fine-sliced* (Mudambi, Punck, 2016) to get implication about the organization systems and redefine the core and non-core activities to allocate more time and resources for the core activities (Linares-Navarro et. al., 2014, Mudambi, Punck, 2016), besides these core processes have to be monitored continuously (Buckley, 2011).

An attempt to integrate international business theories with new trends in trade theory burst the *contract incompleteness* analysis, considering it as the main factor deciding insourcing or outsourcing activities (Antras, Yeaple, 2015).

The interest in global value chain phenomena is based on the last wave of globalization with emerging international fragmentation of added value activities (Dicken, 2015) due to trade and investments liberalization and the development of communication and transportation technologies. Baldwin (2016) defined these phenomena as second ‘unbundling’. The first one was in the second half of the 19<sup>th</sup> century and was related with an unbundling of production and consumption countries while the latter depicts the division emerged due to the trends to specialize in high-skill-intensive activities in developed economies and emerging economies with concentration to the capital-intensive production (Timmer et al., 2013). The cross-border fragmentation process explains the emergence of ‘supertraders’ with abnormally high exports but with modes share of domestic added value (Kierzkowski, Chen, 2010). The analysis of differences of domestic value-added and gross exports can be used to identify the role to the trade barriers, the causes of trade imbalances (Johnson, 2014).

Though the term ‘global value chain’ is used, examining the geographic scope of the global value chains, the regional blocks may be established. Baldwin and Lopez-Gonzalez (2015) exclude three ‘world factories’:

Factory Europe, Factory North America, and Factory Asia. Multinational corporations prefer to co-operate with larger supplier, thus favoring regionalization by reducing the dispersion of strategic locations all over the world (Gereffi, Fernandez-Stark, 2011), though some authors (Los et al., 2015) argues that these regional effects are overestimated.

Strategic management literature still focuses on the exploration of the factors that should be considered configuring the dispersion of activities to gain a competitive advantage (Gupta, Govindarajan, 2001), though the particular interest in the relation of characteristics of the host country with dispersed locations (Demirbag, Glaister, 2010; Jensen, Pedersen, 2011). It is not possible to analyze several factors evaluating the preferences of global value chain configuration. Therefore there are explorations of overall global value system exploring the 'degree of globalness' (Verbeke, Amussen, 2016). Though some research indicates that when internal and external linkages of activities evaluated, the footprint is close to global (Mudambi, Puck, 2016).

## 6 Global Value Chain Governance

Gereffi et al. (2005) analyzed the global value chains governance referring it to 'the authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain'. In international business transaction cost theory explaining the operation abroad, the traditional governance modes are based two extremes through *hierarchical* or on the *market* structure. The *market governance* mode implies the structure of buyers and suppliers along the value chain with little cooperation, thus switching to new partners is not a complex and costly process. The tendency is that the value chains of organizations becoming interconnected and coordinated by a leading firm, providing the context of reliance (Buckley, 2016). The *hierarchical governance* mode implies vertical integration of the firms with a management control from the leading firm. The hierarchical governance is common for the complex products, and the suppliers have to be competent (Gereffi, Fernandez-Stark, 2011).

The Gereffi et al. (2005) defined alternative governance modes between market and hierarchical governance extremes, basing on combination of three conditions: complexity of transactions; capability to codify transactions; capacity in the supply base. The growth of explicit coordination was linked to the power asymmetry, thus identifying five types of governance: *market*, *modular*, *rational*, *captive*, and *hierarchical*. *Modular governance* depicts the highly competent suppliers that make products according to lead firm's specifications, while the lead firm creates, penetrates the market with the end products. The *relational governance* is relevant when information is complex, knowledge-based with greater levels of interactions, and mutual trust is required. The *captive governance* structure implies the depended suppliers that operate under control and management of the lead firm.

There are numerous research defining the factors that define the configuration of the value chain. First, external condition are considered, like the type of the industry - a traditional focus (Rodriguez, Nieto, 2016; Castaner et al., 2014), the life cycle of the industry (Qian et al., 2012; Gereffi, Lee, 2012), the entry barriers (Mahutga 2012), the dynamics of the industry (Buckley 2011), etc. Second, the internal conditions are investigated, like the commodity type buyer-driven or producer driven (De Marchi et al., 2014), size of the firm (Buciuni, Mola, 2014), available capabilities of the firm (Qian et al., 2012), including skills to develop and global and local responsiveness (Yeniyurt et al., 2013), the need to innovate in the market (Mudambi, 2008). Mudambi and Veniz (2010) argue that firms with stronger manufacturing or standardized service delivery competencies may maintain control over the value chain and link them with knowledge-intensive activities like R&D, marketing, etc.

## 7 Conclusions

The extensive analysis of the international management theories revealed that technologies considered as the dominating factor that enabled a new wave of the business globalization, though the international strategies theories based on the trade-off between configuration and coordination causing the spatial dispersion of business activities, meanwhile the technologies are not distinguished and perceived as



ordinary value. The theories dedicated to the management of technologies originate from technology life cycle models. Engagement of the public sector into R&D processes triggered the system theory methodology applications and vast of technological innovations system models proposed. Intensive internationalization processes increased the scale of business functions fragmentation as well as approaches sourcing the technologies. Therefore numerous spatial technology innovation systems evolved, though the complexity of methodology consequently increased the doubts about the relevance of innovation systems approach. Simultaneously to innovation systems, the global value chain concepts elaborated and recent convergence of these theories yield promising methodologies which have to be further explored.

The upgrading of value networks strategies initially understood as shifting from relatively less added value activities to higher added value segments, gradually embrace product upgrading by moving into more sophisticated product lines, process upgrading through organizational optimization and/or technological progress, intra-chain upgrading by the exploration of opportunities in existing value chain and inter-chain upgrading by applying specific competencies acquired in one chain to other sector value chain. Although upgrading was initially perceived as a framework related to organization strategy, gradually the concept was overtaken by policy-makers for designing and analysis of country development strategies. The global value chains frameworks considered formulating and implementing policies like industrial policies, R&D, investment and export promotion policies, regional development policies, etc. The global value chain becomes politicized by distinguishing economic and social upgrading categories. The interest in global value chains of business for identifications the bets international strategies and recent engagement of public and non-government sectors for exploration of a global problems, requires novel theoretical and empirical insights, combining these two attitudes, but it should be investigated what type of new statistical data should be gathered for the global value systems comprehension.

The application of innovation system concept could be an opportunity. Due to an eclectic nature of global strategic management, there is no single approach to the methodology of the global value chain analysis, but it is a powerful analytical tool that could be used to investigate phenomena caused by interactions of various complex systems with numerous nodes like agents acting in different geographical scales, etc. Though currently, it is common that researches apply a single-layer of network analysis mainly comprising sector or country nodes. There is a trend to investigate internal and external nodes of global value networks, though due to the emerging complexity of foreign direct investments structure and ownership, the distinction between internal and external nodes is getting blurred. The potential to perform analysis of several layers is still not properly explored.

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