The Role of Modularity and Absorptive Capacity in the Context of Information Systems Outsourcing

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Abstract: - Many empirical findings point towards a high probability (about 50%) of failing to achieve the intended targets specified in information systems (hereafter IS) outsourcing contracts. The pattern of IS outsourcing failure is consistent, and includes premature contract terminations and/or dissatisfaction due to unaccomplished targets. Even though many possible 'remedies' have been proposed (e.g., a high quality service level agreement), very few studies examined in-depth the root cause of the high failure rate. This paper aims to do so and argues that practitioners may facilitate effective outsourcing through the implementation of evolvable modular designs 'in technology, in the organization, and in business processes' (referred to as 'systems'), which eventually reduces the complexity, minimizes the size of combinatorial effects, and consequently enhances the agility (adaptability) in the systems. As such, this paper builds on (and enhances) an existing reconceptualization of the relationships between 'systems modularity', and 'outsourcing'. In addition, this paper adds valuable new knowledge in that it: (1) recognizes the importance of heuristic (i.e., trial an error) methods; (2) proposes a remedy which is rooted in absorptive capacity theory, a management / organizational theory which now also provides a crucial tool to use in the context of modular systems and IS outsourcing. The main characteristic of this tool is that it adheres to the principles of absorptive capacity theory (i.e., acquire, assimilate, transform, and exploit new external knowledge) and, at the same time, optimally benefits from the concept of modularity by creating systems which are agile, evolvable, and free of combinatorial effects. To add new knowledge the results from an in-depth literature review are presented and a conclusion is made based on inference logic.

Key-words: - Modularity, Absorptive capacity, Outsourcing, System integrator, Evolvable, Reversible, Combinatorial effect, Agility.

1   Introduction

Contemporary organizations are in pursuit of a winning (economic) strategy which facilitates the achievement of their intended targets, if necessary making use of the possibility to outsource management of information systems (IS). IS outsourcing is defined as *"turning over to a vendor some or all of the IS functions"* [1]. These contemporary organizations presume that outsourcing may be instrumental in further developing their core competencies, reducing costs, and minimizing risk [2]. A core competence is an activity in which an organization excels and that contributes substantially to competitive advantage [2].

Porter's analysis of competitive advantage posits that value (created) should be in excess of costs; this principle now underlies many well-known theories explaining business strategies [3], including the Resource Based View [4], Game Theory [5], Transaction Cost Theory [6, 7]. Another theory, namely Dynamic Capabilities theory, shows that organizational routines may be deployed to alter a resource base. By acquiring, creating, shedding, integrating and recombining existing resources an organization may successfully derive new value propositions [8]. Furthermore, absorptive capacity theory argues that a business organization should manage to acquire, assimilate, transform, and exploit knowledge from external sources [9]. A common motivation for (IS) outsourcing is found in an organization's desire to gain access to and then exploit technical knowledge which it currently does not have [10]. Absorptive capacity theory helps in explaining the cyclic (i.e., phased) process of

acquiring new knowledge from external partners and exploiting this knowledge for commercial purposes. Managing complex IT-outsourcing partnerships is everything but an easy job [11]. On the one hand, adhering to the basic principles of absorptive capacity theory (i.e., acquiring new knowledge to remain competitive) is vital to success in IS outsourcing but, on the other hand, outsourcing is a very complex maneuver, especially in dynamic environments. Unfortunately, absorptive capacity theory does not have a good track record in controlling systems complexity in a changing environment. Adequate management of systems complexity in a changing environment may be fostered by adopting a modularization strategy.

This paper is structured in the following way. Section two discusses in detail the importance of modularity in the context of outsourcing. The discussion leads to the formulation of a hypothesis. In Section three, the importance of absorptive capacity in discussed, also in the context of outsourcing. This way one more hypothesis is derived. Section four elaborates on the relationship between modularity, absorptive capacity, and outsourcing. Based on this elaboration a new conceptualization of the interrelationships between modularity, absorptive capacity, and outsourcing is provided. Finally, in Section five, the literature review conducted proved to be instrumental in drawing a conclusion based on inference logic. Last but not least, suggestions are proposed for future research.

2   Methodology

An in-depth, systematic, and step-by-step literature review has been conducted to collect, synthesize, analyze, and highlight the relevance of the modularity concept and absorptive capacity theory in the context of outsourcing. As a crucial phase in academic research [12], the literature review started with a systematic approach to identify relevant papers which may be instrumental in achieving the study objectives. Next, data (i.e., the paper texts) were analyzed thoroughly. Pre-determination of what is important to capture and report is a critical aspect for an effective and efficient literature review [13]. In this study, the modularity concept, absorptive capacity theory and all related concepts were focused on. Through in-depth analysis the relationship between modularity and absorptive capacity in the context of outsourcing has been identified. Based on the models proposed by the Sako, and Campagnolo & Camuffo, a new model

has been proposed (Figure 4.2) illustrating the linkage between the modularity concept and absorptive capacity theory. This study adds new insights to the existing body of knowledge.

3   Modularity

Herbert Simon (1962) introduced the concept of modularity in his seminal work "The Architecture of Complexity" [14]. Modules in a system represent separate subcomponents of the larger, more complex system. The purpose of splitting a larger system in smaller subcomponents (modules) is to reduce systems complexity. Apart from reducing complexity, modularity (as a concept) also enhances systems agility. The modularity concept is now regarded by both academics and practitioners as an important concept which helps in controlling complexity, reducing combinatorial effects, and enhancing agility. It is used in various disciplines such as management, IS, software architecture, psychology, biology, engineering, and mathematics [15]. A trend towards increasing modularity is also observed in contemporary business practices, such as contract manufacturing and outsourcing, including IS outsourcing [16-22].

The next paragraphs of this section further explore the concept of modularity in the context of outsourcing. It particular aims at answering the following call: "*to assess what we know about modularity, much more empirical research in this field is needed*" [23]. In fact, five important dimensions are associated with the study of modularity. These dimensions are: interfaces, degree of coupling, components and systems, commonality sharing, and platform [24]. Campagnolo & Camuffo (2010) conducted a literature review on modularity and listed 125 papers, of which 56 papers are related to product design, 49 papers are related to production systems, and 35 papers are related to organizational design [25]. Tiwana & Konynski (2010) defined IT architecture modularity as "*the degree of decomposition of an organization's IT portfolio into loosely coupled subsystems that communicate through standardized interfaces*" and identified standardization and loose coupling (a high degree of independence between modules) as two key constructs of IT architecture modularity [26].

3.1   Modular organization

Modular organization design is a new paradigm which addresses the need for a flexible and learning organization that continuously changes and solves problems through an interconnected coordinated

self-organizing process [25, 27]. In modular organization, functional components are separated from one another. Techniques to separate components are borrowed from the field of software engineering. Recent research also examined the application of modularity to the concept of organizational structure [19, 20, 22, 25, 28-32]. Schilling and Steensma (2001) pointed out that due to the popularity of outsourcing among organizations, organizational structures are becoming increasingly modular [22]. Both authors also asserted that firms use three primary ways to establish loose coupling; these three ways are: contract manufacturing, alternative work arrangements, and alliances. Nadler and Tushman (1999) already predicted that the rapidly changing environment will drive firms to use more modular organizational forms [31].

Baldwin & Clark (1997) asserted that in order to compete in a modular world, frequently redesigning the internal organization is necessary [32]. Obviously, this call is of a descriptive rather than a prescriptive nature. To date, neither a prescriptive methodology nor a sound theory have been proposed as to how one may design organizations which can deal adequately with change and complexity (i.e., evolvable organizations). McKinsey's industry survey concluded that organizations often have great difficulties to adapt their IT applications such that they can keep up with changing market needs [33]. A modular organization structure may help out. The concept modular organization can be redefined in two ways: one based on network modularity and the other based on organizational modularity [25]. Network modularity refers to modularity in relation to the organization's external environment, such as the position of the boundaries of the organization (i.e., make, buy, and/or ally decisions) and the outsourcing networks. Organizational modularity refers to an organizational architecture which allows splitting and recombining parts of the organization to work in a more efficient and agile way. The key lies in the ability to identify which modules of the organization are effective and which can be outsourced to attain economies of scale.

Modifying an organization such that it can adequately respond to contemporary business imperatives is an important challenge for most business leaders. By optimizing the modular design an agile, flexible, and evolvable organization may be designed and maintained over a relatively long time horizon. Unlike unanticipated changes (note:

these changes are always troublesome), anticipated changes in the business environment should not affect the stability of the organization. The modular organization is quite robust against changes in the (business) environment, as modular design minimizes the number of changes required as a response to a change in the external environment (i.e., combinatorial effects). Technically speaking, a combinatorial effect may be interpreted as a form of entropy. As entropy is a measure of disorder, combinatorial effects are most undesirable in an organizational architecture [34].

Scholars involved in the study of modularity tend to disagree on the significance of the modularity concept. Some scholars emphasize the benefits gained through modular design and use terms such as the 'power' of modularity [35]. Other scholars warn for weaknesses of the modularity concept (e.g., easy to replicate a module by competitors), and some even claim modularity is threatening, a real 'danger'! [36]. This disagreement is legitimate given that, presently, modular systems tend to fall short in delivering on expectations. The underperformance of modular systems strengthens the reasoning underlying the development of Normalized Systems theory. Mannaert & Verelst (2009) indicated that lack of evolvability is the reason as to why modular systems fall short in delivering anticipated benefits [34]. Normalized Systems theory asserts that a truly modular system should be evolvable, reversible, and should be free of combinatorial effects. Actually, avoiding combinatorial effects is the main challenge in designing a modular organization [37].

3.2 Modularity and outsourcing

This section explains how the concepts of modularity and outsourcing are interrelated. Modularity is conceived (in IS) as a critical factor in driving agile organizational change, and in enabling enterprise architecture restructuring. The concept of modularity holds a lot of promise in solving complex problems and to get a full appreciation of these relatively new concepts, economists may reach out for their dusty copies of the books of Adam Smith and Alfred Marshall which emphasize the importance of specialization and creating cost advantages [38]. Modularity is a concept that has been applied in many fields dealing with complex systems [15]. Some quotations have been distracted from the literature, and relate to the existence of a direct relationship between modularity and outsourcing (see Table 2.2).

After two decades of "just in time" (JIT) processes in the supply chain, organizations are now experimenting with modular supply chain systems, while making use of outsourcing. Volkswagen (hereafter VW) applied the "modular consortium" concept to its car assembly in Brazil. VW started by reducing the number of suppliers from 400 to only 8. These 8 suppliers then agreed to invest in installing machineries and to equip them with skilled manpower to create their own module. They also accepted all liabilities and risks relating to their own module. In return, the suppliers were guaranteed long-term contracts. At the Brazilian plant eight modules were sequentially integrated with each partner occupying a section of the plant and accepting full responsibility for the quality of their assemblies. VW took responsibility for quality assurance and distribution of vehicles once the assembly process was completed (see figure 2.1). By outsourcing vehicle assembly, VW not only succeeded in reducing its assembly labor costs, but also enhanced efficiency, agility, and was able to focus on its core competencies (e.g. R&D, logistics, engineering, quality assurance, marketing/branding, and customer service). By making jointly use of modular systems and outsourcing operations the boundaries of almost every organization may be redrawn (frequently).
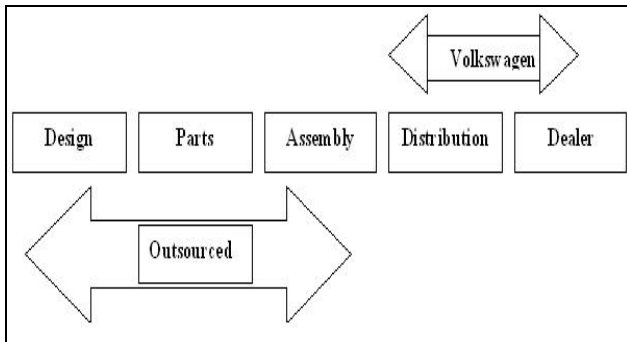

Figure 2.1. "Modular Consortium": VW supply chain. Adapted from Collins, Bechler, & Pires (1997) [39].

Chrysler was also heavily involved with transforming its supply chain to a modular system. Its modular supply chain model was different than that of VW in that it focused on four important elements. These were: (1) rapid and innovative vehicle design; (2) strong reliance on outsourcing using a large number of suppliers; (3) enabling technical support with suppliers for interoperability; and (4) cost reduction through making suppliers (partly) responsible for innovation. These four

elements representing separate modules worked together as a single system; all independent subsystems were developed by autonomous suppliers [38].

"Overall, modularity is believed to help firms manage outsourcing efficiently and effectively thus facilitating the integration of external sources of innovation" [50, p.1].
"Interface standards and modularity, of course, facilitate outsourcing and thereby sharpen requirements for integration" [51, p.23].
"As the relationship between modularity and outsourcing exists although the direction is debated" …..[25, p. 277].
"In the realm of industry organization, however, the value chain elements of lean production that admonished lead firms to ask more from their suppliers dovetailed with other forces in the U.S. that were both driving and enabling increased outsourcing. I will refer to the industrial model that emerged from this process as the modular production system" [52, p. 3-4].
"We conclude that understanding the true complexity of inter-firm relations may lead managers to refrain from outsourcing altogether, we suggest that managers may consider implementing modular organization design to limit complexity and thus facilitate outsourcing" [53, p.2].
"In the past, 'modularity' and 'outsourcing' were investigated predominantly in separate research communities……more recently, however, a research stream has emerged that links these two topics together"[54, p.167].
"On the whole, however, outsourcing, task partitioning, standardization and knowledge encapsulation, although conceptually distinct, remain strictly intertwined in practice, since the evidence coming from the field shows that, especially within global strategies, modularization and outsourcing are becoming increasingly inseparable…" [55, p.8].

Table 2.2. Relationship between modularity and outsourcing.

Personal computer (hereafter pc) maker Dell Inc.'s renowned modular design is a success due to its standardized multi-vendor supply chain. A Dell pc is entirely modular because it is assembled through connecting supplied (i.e., "off-the-shelf") components by standard interfaces. Dell Inc.

outsources component manufacturing to numerous suppliers and keeps them under pressure to reduce cost and improve quality while investing in new technology. Switching to another supplier is always an option! Modular architecture design in product assembly allows Dell to pursue a "built-to-order" strategy, and minimize the risk connected to the product inventory. Another renowned company, Cisco, also outsources most of its product manufacturing to external parties, and takes full responsibility for the integration of the manufacturing system. In addition, a successful brand like 'Nike' never handled its entire shoe production, but outsourced most parts of it. These are all examples of organizations that learned how to integrate systems and managed to be classified among those '*firms who know more than they make*' [41]. In today's hyper competitive business environment, business processes, information systems, and strategies should be planned in an evolvable manner, in order to react adequately to the changing environment. The nature of IS outsourcing is also evolving in this direction and portfolio diversification is becoming the norm (i.e., outsourcing to multiple suppliers) [42, 43].

To avoid the high risk of failure of so-called '*mega deals*' and to take the full advantage of modular technology, organizations now dare to organize outsourcing activities on a smaller scale; this way, they get involved in task-based outsourcing [44]. Increasingly, organizations seek selective, short-term and often multi-vendor outsourcing arrangements [45]. This new mode of outsourcing is referred to as '*out-tasking*' or '*modular outsourcing*' [19, 20, 25]. Modular outsourcing is a relatively new phenomenon which involves deconstructing complexity in business processes and aligning IS artifacts and applications in order to lead and maintain the cycle of design, innovate, and develop. A modular outsourcing strategy affects almost all business and organizational routines. Probably this new mode of outsourcing became a reality due to the prevalence of new technology based on modular systems in software architecture, IS/IT infrastructure and organization design. When using this new mode of outsourcing the success rate is also higher when relying on the traditional mode, '*total*' outsourcing. Many studies reported that too much outsourcing negatively affects the success rate and some literature suggests that '*selective*' outsourcing is more successful than '*total*' outsourcing [46-48].

Modularity positively affects the range of manageable complexity and accommodates uncertainty; modular designs are seen as being (most) evolvable [56]. Sako (2003, p-7) argued that in a 'pure modular' case, interfaces are standardized and reversible [19]. The term "reversible" denotes the possibility of a customer organization (in any anticipated situation), to re-transfer the operations from vendor (supplier) to back in-house. Hence, modular outsourcing practice is conceived as being reversible and may potentially maximize growth, flexibility and agility [45]. From the above discussion a hypothesis is derived:

H1: *Evolvable modular architecture (in technology, the organization, and in business processes) positively correlates with success in outsourcing.*

4 Absorptive Capacity and Outsourcing

The IS outsourcing trend (not restricted to modular outsourcing) is prevalent and is increasing in terms of number of contracts, revenue of the providers, number of experts employed by the providers, and the scope of engagement [57]. Some empirical findings, however, also point to the difficulties to achieve the intended target, and possibly even failures in outsourcing contracts [58-60]. Earls (2004) reported that a fifth of all contracts end prematurely and Deloitte (2005) found that one in four organizations decided to bring outsourced activities back in-house [62, 63]. In 2003, fifty per cent of outsourcing projects were considered unsuccessful by senior executives because they failed to deliver on the anticipated value [64].

Investigating upon successes and failures, Carmel & Beulen (2005) argued that unsuccessful knowledge transfer is one of the main causes of failure in the first few years of offshore outsourcing [65]. Knowledge transfer is defined as "*the process through which one unit (e.g., group, department, or division) is affected by the experience of another*" [66]. Most organizations that failed initially paid much more attention on knowledge transfer processes in their second attempt to outsource specific activities [67]. Formal knowledge sharing practice is, without any doubt, a key to superior organizational performance, agility and success [68]. Empirical research findings suggest that organizations which succeed in transferring knowledge effectively between and among business units are more productive, and are more likely to survive than organizations which have a hard time

in transferring knowledge [69-72]. Effective knowledge transfer is dependent on both the sender's and the recipient's motivations as well as the recipient's absorptive, retentive and adaptive capacities [73]. The concepts absorptive, retentive and adaptive capacities are well-defined by the theory of "*absorptive capacity*". These concepts are jointly defined as a "firm's ability to re*cognize the value of new, external knowledge, assimilate it, and apply it to commercial ends*" [9]. Customer organizations with a high level of absorptive capacity (when processing input from vendors) enjoy real benefits from outsourcing [74, 75]. So, from above discussion, a second hypothesis is drawn. It states that:

H2: *Level of absorptive capacity in a customer organization positively correlates with success in outsourcing.*

5   Modularity, Absorptive Capacity, and Outsourcing

Some authors who suggest that modularity and outsourcing are tightly connected have also demonstrated that different paths towards product modularity and module outsourcing exist [19, 20]. Sako (2003) distinguishes between three main pathways; what is different between these pathways is the combination of direction and choice made [19]. In the case of a vertically integrated firm with a non-modular product design (left quadrant in Figure 4.1.), Sako outlines the three possible pathways as acd, abd, ad (Figure 4.1.). In the first pathway (acd), the firm defines modular product architecture before outsourcing one or more modules. In the second pathway (abd), the firm starts to outsource some product components before moving towards a modular design. In the third pathway (ad), the firm simultaneously implements product modularity and outsourcing.

The model proposed by Sako (2003), later modified by Campagnolo & Camuffo (2010), describes optimal and sub-optimal pathways to successful outsourcing, depending on whether modular outsourcing is relied upon [19, 25]. Although both Sako and Campagnolo & Camuffo presented their model in the context of product modularity, there is absolutely no reason to believe that (potentially) their model cannot be extended to the context of modularity in technological and/or organizational architecture.
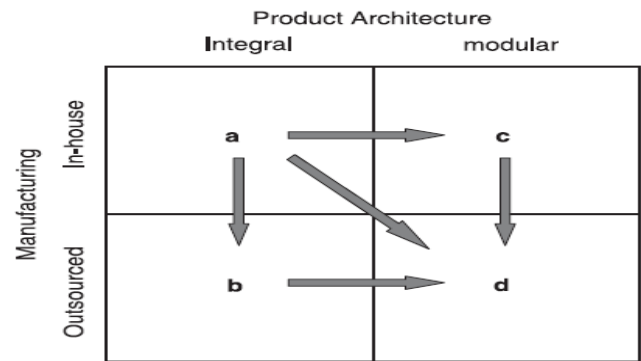

Figure 4.1. Paths towards module outsourcing
Source: Campagnolo & Camuffo (2010).
Adapted from Sako (2003).

One major strength of the model presented by these authors is that it clarifies the relationship between modularity and outsourcing through three specific pathways. Each pathway starts from the in house-integral (non-modular) point (upper left quadrant in Figure 4.1.) and ends up at the outsource-modular point (bottom right quadrant).

Campagnolo and Camuffo (2010, p.15) stated that two pathways (abd and ad) are irreversible and appear to involve higher risks in terms of losing in-house capabilities and control [25]. So, out of three possible pathways, only one pathway is considered as safe (non-risky) whereas the other pathways involve considerable risk. Moreover, Sako (2003, p-7) emphasized that a true modular system is reversible [19]. This argument provides further support for Mannaert, Verelst, & Ven's (2011) assertion that most current modular systems in use are neither truly modular nor reversible because they exhibit only limited evolvability [37].

Campagnolo & Camuffo (2010, p-15) mentioned that in order to control the risk of failure in outsourcing, an organization should posses the required knowledge and capabilities [25]. In the present paper, the required knowledge and capability is considered as "*absorptive capacity*". This paper only focuses on clarifying risks of failure in outsourcing, and emphasizes the importance of knowledge required and capabilities.

The model proposed by Sako (2003), Campagnolo & Camuffo (2010), is limited in that it only involves two variables (see Figure 4.1.: axes) [19, 25]. Bearing the two hypotheses in mind (H1 and H2) a refined model is proposed. This refined model (Figure 4.2.) depicts the relation between three variables, one of which (absorptive capacity) is plotted where the other variables (modularity, outsourcing) comprise the two axes.   Figure 4.2.

may be interpreted as follows: a higher level of modularity combined with a higher level of absorptive capacity may enhance outsourcing as it does no longer involve much risk and it is easily reversible.

As stressed earlier, contemporary modular systems fall short in evolvability. As a consequence, they do not adequately address major drawbacks related to outsourcing, such as vendor lock-in, loss of core competencies, and reversibility. The refined model presented in Figure 4.2. strongly emphasizes the role of absorptive capacity in getting the most out of a modular system. Amongst other factors, absorptive capacity is a catalyst to innovation [9, 76]. As derived from Figure (4.2), modularity is positively correlated to absorptive capacity. Only when modularity is combined with high absorptive capacity an organization may become a system integrator, or an organization which knows more than they make [17, 41].
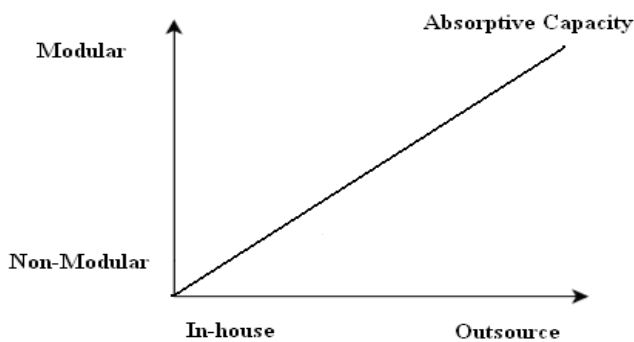

Figure 4.2. Relationship between absorptive capacity, modularity, and outsourcing.

6   Conclusion

From the above discussion, one may conclude that, in today's changing business environment, outsourcing is a very complex maneuver. The failure rate of outsourcing deals is very high. The literature suggested many remedies (e.g., high-quality service level agreements) that may, without any doubt, *help* in reducing the failure rate. However, these remedies treat the symptoms rather than the cause. The purpose of the present paper was to get to the root of the problem by exploring in-depth the reasons for failure. To this end, a thorough literature study was conducted. This paper argued that a solution should come from COMBINING modularization and absorptive capacity. By doing so, the organization can act as a system integrator, and is able to expand its knowledge base. Although based on an in-depth literature review this paper was

clearly a conceptual one describing the relationship between modularity, absorptive capacity and outsourcing. To the best of our knowledge, to date such conceptual piece of work has never been presented before. Nevertheless, getting to the root of the problem (i.e., the high failure rate) is of utmost importance. For this reason we call upon scholars to start from this conceptual paper and conduct those empirical studies which may provide valuable insights in the relevance of the concepts modularity and absorptive capacity (in combination), whenever confronted with a high failure rate in outsourcing.

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