How Did It Happen? A Memetic Theory of Interorganizational Information Systems Emergence and Evolution

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Abstract

Interorganizational information systems (IOISs) have become the core platform of today's digital economy. Despite their increasing importance, little is known about how they have emerged, evolved into their current operational form, and coevolved with social institutions that develop, regulate, use, and maintain them. Why certain IOIS features and functions are selected for implementation while others are not; and once implemented, why some features and functions remain in existence while others disappear have yet to be explained. Departing from the current research paradigm on IOIS emergence and evolution that focuses mainly at the macro level, we conceptualize IOIS as complex adaptive systems and look at the smallest elements that constitute their existence, i.e., memes or information, knowledge, and ideas that fuel their implementation and dictate their features and functions. We propose a memetic theory of IS emergence and evolution, and operationalize our theory with four propositions. A 17-year longitudinal case study is used to illustrate our meme-centered view of emergence and evolution.

1. Introduction

Interorganizational information systems (IOISs) are information and communication technology-based systems that support data sharing, coordination, cooperation, and collaboration across time and space [1]. Given that the interchange of information forms a basis of economic, political, and social activities, IOISs become increasingly pervasive in public and private sector. They are no longer a strategic measure for a competitive success but a competitive necessity [2].

IOIS can be seen as a complex adaptive system (CAS). It consists of many interacting and interdependent components working together to yield outcomes that cannot be accomplished if each component works individually [3]. Similar to other types of CAS, the parts that constitute IOIS are governed by their own rules. Each of them is continually revising its rules as it encounters not only a problem posed by its surroundings, but also a changing behavior of the other parts [4].

Research in IOIS to date is mostly concerned with impacts of IOISs on governance over economic transactions, organizational consequences of IOISs, and factors influencing organizational adoption of IOISs [5]. To our knowledge, the current literature provides a rather incomplete and disparate explanation of how an IOIS gets selected for implementation from a large number of possible projects, evolves into its current form, and coevolves with social institutions that develop, regulate, use, and maintain it. Furthermore, the current literature neither explains why certain features and functions of a system are implemented while others are not [6, p. 51]. A possible explanation would be that past empirical studies of IOIS emergence and evolution have primarily looked at IOIS at the macro level (i.e., IOIS of a specific technology, an organization, a community of practice, or an industry).

In this research, we argue that it is at the micro level where IOIS emergence and evolution can be understood. Building on the smallest level of micro analysis, we adopt the memetic concept introduced by Dawkins in evolutionary biology and picked up by researchers in the area of cultural evolution. We argue that IOIS emergence and evolution revolve around meme – information, knowledge, and ideas that can self-replicate, mutate, change as a response to changing environment, and get transmitted.

The remainder of this paper is organized in five sections. First, we provide a brief review of the concepts that serve as a foundation that underpins the alternative theoretical explanation of IOIS emergence and evolution. We then present a synthesis of selected evolution research to provide a seamless explanation of the emergence, evolution and coevolution of any CAS. We next propose a memetic theory of IOIS emergence and evolution. We then briefly use a longitudinal case study of a major IOIS for trade facilitation in Thailand that we conducted to illustrate our theory. We conclude the paper with the implication of our work and a note on opportunities for future research are highlighted.

2. A meme-centered view of emergence and evolution

For the purpose of this research, we define a CAS as one that is composed of a large number of diverse but interconnected components with the ability to continuously adapt to one another and to their

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changing environments. Two ubiquitous features that are common to all CAS are emergence and evolution.

2.1. Emergence

The Oxford American Dictionary defines emergence as a "process of coming into being, or of becoming important or prominent". In the context of CAS, Holland (1992) of the Santa Fe Institute describes emergence of the whole as a phenomenon that occurs as a result of the interaction between the individual parts. These individual parts, known as agents, interact without any direction from a central control. As each part continually revises its rules in response to a problem posed by its surroundings, it triggers a changing behavior of the other parts.

For the emergents within a CAS to occur, CAS must possess a mechanism capable of generating a feedback when the system is operating at a state beyond the equilibrium in a way that anticipates new problems posed by the environment [7]. The emergents are likely to increase rapidly (i) if the flexibility of the interactions between the individual agents increases and (ii) if the individual agents have some capacity for adaptation or learning [8].

2.2. Evolution

Evolution can be defined as a process of change in systems' properties over time [9, 10]. According to Darwin (1909), Lamarck (1914), and Spencer (1862), evolutionary change can be considered as a transformation toward greater improvement. Nevertheless, the greater improvement is not guaranteed [13]. Parsons (1966) claims that the principle of evolution, whether 'biological' or not, also applies to the world of living things. It is applicable to any cultural system, whether it be a model of the culture of mankind as a whole, or the culture of any people and group of people as it can be regarded as a system, or to those portions of the total cultural system that can be treated as subsystems, such as technology and social organizations [15].

An evolutionary phenomenon tends to migrate from a relatively simpler state to a more complex one [16]. It results in a change from a more diffused state to a more concentrated perceptible state; from a less coherent form to a more coherent form; from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity; and from confusion to order [10].

2.3. Memes as origins of CAS emergence and evolution

It seems convenient to analyze the emergence and evolution of any CASs at the individual level where the characteristics of CASs are shown. However, it is at the micro level the where emergence and evolution arise [4, 7].

In the social/cultural realm, we contend that memes are those micro elements that lie at the origin of CAS emergence and evolution. They are information, knowledge, and idea that form themselves into distinct memorable units [17] and propagate without too much alteration [18]. The units of meme are "the smallest elements [yet remain intact with certain identity of effect] that replicate themselves with reliability and fecundity" [19, p. 344]. The identity of effect reflects not only a purpose or a reason for which a particular meme exists, but also the substantive content embedded in memes themselves.

Memes can be divided into three classes [20]. *Distinction-memes* are memes that distinguish one object or concept from another. *Strategy-memes* are memes that provide instructions for carrying out certain tasks, including practices and routines, with an aim to achieve desired results. *Association-memes* are attitudes about everything in life, which emerge when one attempts to associate existing memes.

Blackmore (1999) notes that changes in phenotypic expression of a cultural artifact, which can also be seen as a CAS, depend on changes in these memes. It is simply because these memes contain information that not only dictates the physical characteristics of a cultural artifact, but also directs its behavior in response to given environmental conditions. Given that meme-centered view provides a useful philosophical perspective for examining the emergence and evolution of cultural artifacts, memes have been used as units of analysis in the study that attempted to explain the emergence and evolution of cultural artifacts such as musical style [22], ideological thought [23], investment strategy [24], international norm [25], regional policy [26], firm [27], and technology [28, 29].

3. From evolutionary biology to IT

Knowledge in evolutionary biology discipline has been used to explain phenomena that happen beyond the biological realm. We believe that it is also applicable to the IT world. It can enhance our understanding about how IOISs emerge, evolve into their current form, and coevolve with social institutions that develop, regulate, use, and maintain them. In this section, we briefly discuss key principles of selected evolutionary theories that underpin the alternative theoretical explanation of IOIS emergence and evolution.

Evolution is a phenomenon that obeys the laws of natural selection in a neutral and algorithmic manner [17]. This evolution process can be applied to any 'system' where there are variations in its units of heredity and where only some variations are selected for reproduction [21]. Due to its degree of generality and abstraction, the laws of natural selection are known

as Generalized Darwinism [30]. Several scholars argue that the principles of Generalized Darwinism can be used to describe the evolution beyond a biological domain (e.g., 19, 29, 31, 32, 33).

The essence of Darwin's theory of natural selection lies in the claim that natural selection is a creative force of evolutionary change [34]. Darwin (1909) argues that variations in individual organic beings must exist for natural selection to operate. These variations serve as raw material for the environment to function. They can be random or planned [35]. Whenever and wherever an opportunity arises, the natural selection preserves all variations that best fit the environment and rejects those that do not. In other words, there must be an environment in which not all the variations can survive and some do better than others.

As units of natural selection, variations can be any kinds of replicating entity that can pass on its structure largely intact in successive replications [36, 37]. In biology, a gene is a well-known example of a replicator [36]. It functions as an instructional unit that dictates physical characteristics of respective organisms and directs their behavior in response to certain given environmental conditions [25]. Analogous to gene, Dawkins (2010) names 'meme' as another type of replicator that conveys the idea of cultural transmission.

Memes are information, knowledge, and ideas that form themselves into distinct memorable units [17] and propagate without too much alteration [18]. The units of meme are the smallest elements that replicate themselves with reliability and fecundity [36]. The identity of effect reflects not only a purpose or a reason for which a particular meme exists, but also the substantive content embedded in memes themselves.

Memes act as a guide for human cultural and intellectual development in the same way that genes do in the process of biological evolution [38]. Many different forms of memes include a broad set of values which underpin an existence of a particular cultural artifact, its basic design parameters, design techniques, production processes, production methods, skills tacitly embedded within human agents, and knowledge involved in its use [39, 40].

Using different reasoning approaches, Blackmore (1999) and Aunger (2002) arrive with the same conclusion that memes are not only stored as ideas in human brains, but also embodied in artifacts including prints and technologies. Dawkins (2010) views these forms of meme storage as vehicles for meme propagation. He defines a vehicle as "any unit… which houses a collection of replicators and which works as a unit for the preservation and propagation of those replicators" (p. 114). Hull (1988) refers what Dawkins calls a vehicle to an interactor as its functions go

beyond housing and carrying memes around. To him, any entity that stores memes interacts as a cohesive whole, and the environment causes replication to be differential.

In sum, Generalized Darwinism seems to provide an over-arching framework for explaining how replicators, both biological and social genotypes containing useful information to address particular adaptive problems, are selected, retained, and passed on. This theory also helps inform why replicators differ in their longevity and fecundity. Nevertheless, Generalized Darwinism does not appear to provide details on how replicators and their variations come to life [31, 35, 36]. We claim that this missing theoretical component could be supplemented by Lamarckian perspective.

Lamarck's work sheds light on the role that the environment plays in the emergence of the replicating entities and their variations that make up life [31]. Lamarck posits that the environmental force "induces changes in the need and modes of life of living beings … these changes give rise to modifications or developments in their organs and the shape of their parts" [12, p. 45]. If the problem posted by the environment persists for sufficient time, the acquired characteristics will maintain their constancy and will be codified by heredity [42].

While the environmental forces in the world of the living beings are events such as anthropological, climatic or geological changes [12], those in the context of cultural artifacts mean different things for different scholars. For example, the following are instances of common artifacts that affect CAS: the size and the structure of the industry, the competitors, and government regulations [43]; stabilized, regulated institutionalized practices [44]; the internal dynamics of the industry structure, organization, and individual employees [45].

Although Lamarckian principles had been criticized of being wrong for almost 200 years [27], scientists (e.g., 46, 47, 48) have already found scientific evidence that supports Lamarck's theory. Many prominent organization theorists (e.g., 27, 49, 50, 51, 52) also confirm that instances of socio-economic evolution are in line with Lamarckian's view. The use of combined perspective from Lamarck and Darwin is also present in biological discipline [42].

At the risk of oversimplifying the complexity of evolution theory, we sketch a figure that seeks to provide a literature synthesis on emergence and evolution of CAS. It highlights the key authors in the evolution disciplines – from biologists to social scientists, and their most prominent role in the shaping of our memetic theory to understand the emergence and evolution of CAS.
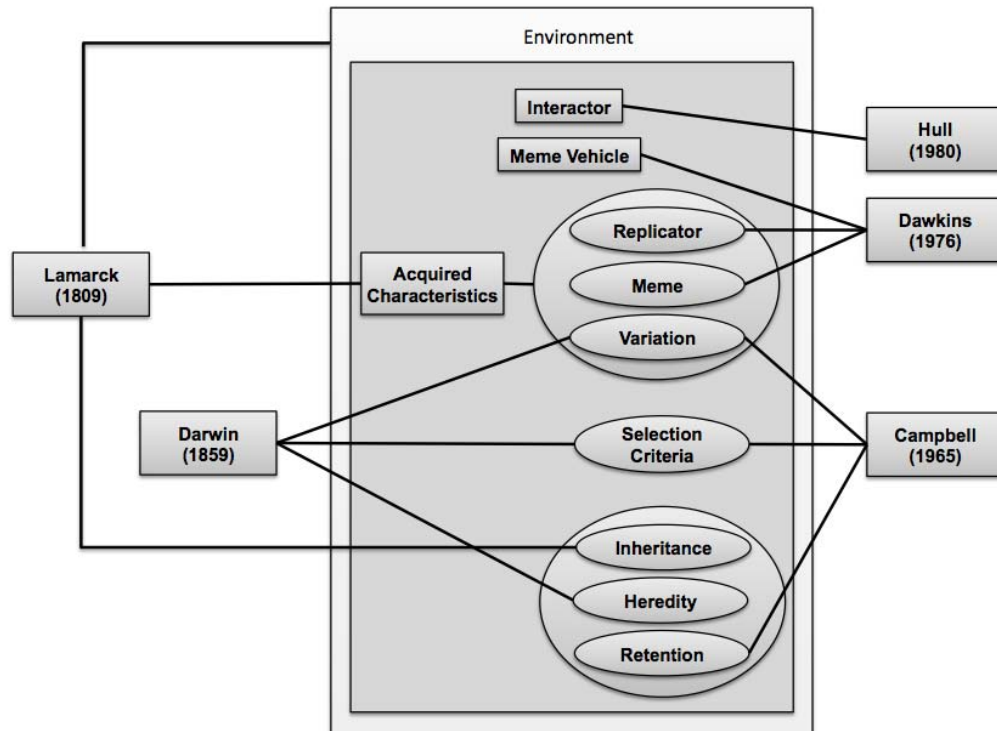
Figure 3-1: Literature synthesis on CAS emergence and evolution

4. A memetic theory of IOIS emergence and evolution

To explain IOIS emergence and evolution, we advocate for a conceptualization of an IOIS as CAS and the recognition of information, knowledge, and ideas that prescribe features and functions of IOIS as memes. Based on our prior knowledge and insights from Darwin and Lamarck, we operationalize our theory with four propositions.

4.1. Interorganizational information systems (IOIS) as a complex adaptive system (CAS)

IOISs are information and communication technology-based systems that support organizational coordination, cooperation, and collaboration across time and space [1]. IOISs involve the sharing of massive information resources between two or more independent organizations [53]. The information resources may include hardware, software, transmission facilities, rules and procedures, business applications, data/database, and expertise.

Stakeholders of an IOIS, however, are not just organizations participating in the cooperative ventures of an IOIS. They also include organizations in the interorganizational networks that extend beyond a particular industry environment. Social actors involving with those organizations are professionally engaged in a set of affiliations that connect them to other members of the industry, national and international networks [44]. Through affiliations, decisions regarding the design, development, use, and maintenance of a particular IOIS are not only influenced by organizations participating in an IOIS but also by other social institutions and communities in an organizational field where those organizations reside. These decisions are derived from a defined set of legitimate options determined by organizations that constitute the organizational field [54].

By its very nature, a typical IOIS exhibits properties of complexity characterized by diversity, connectedness, interdependence, and adaptability. IOIS may contain more than one information systems [55]. Each has its own structure, technologies, strategies, and goals [55]. Lyytinen and Damsgaard (2011) describe an IOIS as a collection of conceptually independent but integrated components that operate together to serve a common goal. To them, the constellation of distinct components is not a simple aggregation of individual behaviors, but a set of emergent behaviors that differ from the sum of the parts. The interactions and interdependencies among these elements are a primary factor that determines the developmental trajectory of an IOIS [56].

4.2. Memetic theory in action

We argue that memes are drivers of IOIS emergence and evolution. They provide raw materials

necessary for an IOIS to emerge and evolve. For this reason, we consider the meme – a replicator – as a major unit of analysis for our study of IOIS emergence and evolution.
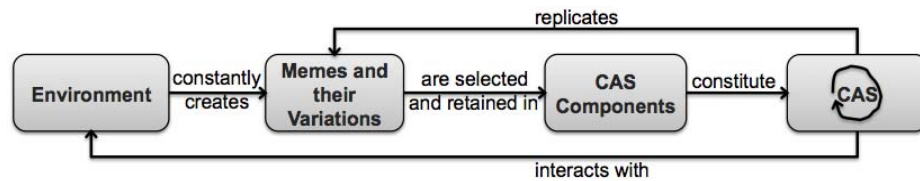

Figure 4.2-1: A memetic theory of CAS emergence and evolution

Proposition 1: IOIS emergence and evolution revolve around memes and their variations.

Memes that define an IOIS can be those that Lyytinen and Damsgaard (2011) consider as the elements that constitute the adopter configuration, the very unit of IOIS adoption. They include organizing visions, key functionalities, structure, mode of interaction, and mode of appropriation for organizations participating in IOIS. In their different forms and variations, these memes provide a broad set of basic design parameters, design techniques, production processes, production methods, skills tacitly embedded within human agents, and knowledge underpinning IOIS existence. Given that the realization of the technologies is achieved by implementing these elements of adopter configuration, which we now conceptualize as memes, a solid understanding about these elements and their interactions is required to understand the emergence of an IOIS and its evolution over time [57].

Proposition 2: Environmental forces, such as social, political, economic, or catastrophic happenings, induce the emergence and evolution of memes that leads to the emergence and evolution of IOIS.

From Lamarck's perspective, memes emerge and evolve in response to problems posed by environmental forces. In the context of an IOIS, these forces are social, political, economic, or catastrophic happenings that trigger or induce perceived needs for new memes including their variations to emerge. They can be events that, for example, involve human aggregates (social), the generation of demands for resources (political), the mobilization of support for generated demands (political), the conflict of interests (political), the inefficiency and ineffectiveness in organizational operation (economic), and natural or man-made disaster (catastrophic).

In an attempt to underscore the importance of environmental forces in the shaping of an IOIS, Schellhammer (2011) suggests that the adaptation to an environment is regarded as the primary factor to explain the development and change of an IOIS over large timescales. As an example, the 9/11 disaster lead to the need to secure and facilitate a global supply chain, which in turn, lead to the emergence of the WCO SAFE Framework of Standards. Schellhammer (2011) also notes that structural changes in an IOIS—as a structurally coupled system—are also determined by the internal dynamics of the industry structure, organization, and individual employee. This view of environmental forces is very much in line with the external environmental variables investigated by many IOIS researchers [5].

Proposition 3: Only memes that fall into one or more than one of the following selection criteria are incorporated into and preserved in IOIS components.

- Memes that are mostly advantageous to system survival and thus bring the most rewarding outcomes;
- Memes that are mostly replicated in population of a selective system;
- Memes that are recognized as conforming to norms, rules, and regulations;
- Memes that are remembered as fulfilling expectations and needs of users; and
- Memes that by chance come to be known right when desperately needed.

Like genes, memes serving as raw materials for national selection are used selectively. Dawkins (2010) contends that some memes are more successful than others. He argues that successful memes are ones that get copied with minimal change, spread rapidly to relevant populations, and last very long in the meme pool. He summarizes the quality of successful memes in three properties: *copying-fidelity, fecundity,* and *longevity*.

Both Darwin and Campbell identify selection criteria that help explain why certain variations of meme are selectively incorporated into a system. In IOIS context, only memes that fall into one or more than one selection criteria outlined above would likely be selected to be incorporated into and preserved in IOIS components. Features and functions of IOIS components specified by memes enable IOIS components to work together. Through the interaction of IOIS components, IOIS emerges.

A particular type of IOIS can have several variations. It is simply due to the operation of the selection criteria on different environmental context. In other words, different locations that circumscribe organizational actions are subject to different environmental forces.

Proposition 4: IOIS and social institutions/ communities participating in its development, operation, regulation, and use coevolve by adapting and modifying themselves in a manner that is harmonious to each other.

CASs do not simply evolve, but coevolve and mutually operate at the edge of chaos [58]. Coevolution refers to a reciprocal evolutionary change between interacting living organisms driven by natural selection [59]. It is a logical extension of Darwin's concept of co-adaptation [60] which posits that two different living organisms modify and adapt in the most perfect manner to each other, by continued preservation of individuals seeking mutual and slightly favorable deviations of structure [11].

For the interaction between two organisms to be called coevolved interaction, there must be "an evolutionary change in a trait of the individuals in one population in response to a trait of the individuals of a second population, followed by an evolutionary response by the second population to the change in the first" [61 p. 611]. From this conceptualization of coevolution, raw materials for the evolution of interactions are from (i) variation in traits in populations involved in the coevolution process and (ii) variation in the outcome of the evolutionary changes [62].

Technological evolution is part of a broad coevolutionary set of processes occurring at different levels of adaptation [63]. As CAS, technological artifacts cohabit and coevolve with other CAS in an ecosystem. One of the relatively well-documented examples of coevolution would be the extension of WCO (World Customs Organization)'s vision to address supply chain security concern in trade facilitation. The extensive discussion within the WTO (World Trade Organization) and the US DHS (Department of Homeland Security) on the need to take a broader approach in improving border management has driven the reconfiguration of IOIS for international trade. Changes were recorded in the way traders, freight forwarders, logistics service providers, and government agencies operate. The effort that members of several social institutions have spent to address security concerns and fulfill security requirements, in turn, made organizations like WCO and WTO realize the importance of carefully balancing the goals of security and trade facilitation.

5. A longitudinal case study: An IOIS for trade facilitation

To illustrate the theory, we conducted a 17-year long longitudinal case study on Thailand's National Single Window (ThaiNSW). This case was purposefully selected not only because of the researchers' in-depth familiarity with the project, but also because this type of community-wide IOIS has not been studied much in the past.

5.1. Research settings and method

ThaiNSW is a set of information systems that facilitates the G2G, G2B, B2G, and B2B information sharing and exchange between stakeholders of international supply chains. It emerged in 1998 as a customs automation system. It has evolved over time through a process of what Holland (1992) calls "much coming from little" (p. 2), to incorporate new functions and features, as well as to upgrade underlying technologies to enable more affordable service and greater coverage. Currently, ThaiNSW is also capable of facilitating electronic communication between Thai Customs and dozens of government agencies responsible for administering the international trade. International interconnectivity between ThaiNSW and Single Windows of ASEAN member countries has been established such that Thai Customs can electronically exchange trade documents with relevant government agencies from ASEAN member countries.

To demonstrate our theoretical statements, we collected longitudinal data that spanned over 1995-2012 period from various kinds of documents and in-depth interviews with nine experts. The interviewees were (i) a senior officer from the national think-tank – a champion in driving the interagency collaboration in the ThaiNSW endeavor; (ii) a senior officer from Thai Customs who was involved in the implementation of ThaiNSW at the decision making level from EDI to ebXML era; (iii) four consultants who assisted other government agencies in implementing different components of ThaiNSW; (iv) two change agents from the academia; and (v) an officer one of the United Nations agencies who provided insights on how a particular meme emerged and evolved over time. Data analysis was conducted as we collected data. In addition to the triangulated design, respondent validation was employed to ensure accurate interpretation of the data.

5.2. Findings and discussion

The extensive review of documents and in-depth interviews with the experts enabled us to conduct a multi-level analysis of ThaiNSW emergence, evolution and coevolution. The macro-level analysis

helped us (i) construct the narrative that informed the origin and the evolutionary path of ThaiNSW from 1995 to 2012; (ii) identify memes associated with the identified ThaiNSW evolutionary path, i.e., those that dictated features and functions of ThaiNSW's components and those that fueled their implementation; (iii) pinpoint various types of happenings that induce perceived needs for the emergence and evolution of memes; and (iv) describe how ThaiNSW has coevolved with social institutions and communities involving in its development, operation, regulation, and use. The meso-level analysis uncovered the path in which important ThaiNSW-related memes propagated and the roles of key vehicles or interactors who introduced them to Thailand and embedded them in local practices. The micro-level analysis revealed why certain memes were selected while others were not. The findings not only confirmed our main theoretical propositions, but also led us to the discovery of new knowledge that we were not previously anticipated.

5.2.1. The roles of memes on the emergence and evolution of ThaiNSW (Proposition 1)

In our study, 142 memes were selected and analyzed. Among those memes, 28 of which are what Brodie (1996) categorized as distinction memes, 82 strategy memes, and 32 association memes. Following a configuration analysis approach to study IOIS adoption proposed by Lyytinen and Damsgaard (2011), most of these memes fall into one or more than one of the five dimensions, i.e. *organizing vision, key functionality, mode of interaction, structure, and mode of appropriation*. Based on the collected data, technology is the only dimension that Lyytinen and Damsgaard's approach does not account for.

Table 5.2.1-1: Examples of ThaiNSW-related memes

M1: Thailand's total logistics cost in 2001 was equivalent to 19% of GDP whereas those of EU, USA, and Japan were equivalent to 7%, 10%, and 11% of GDP respectively.
M2: Typical trade transaction involves 27-30 different parties, 40 documents, 200 data elements (30 of which are repeated at least 30 times).
M3: Redundant documentary requirements means non-value added cost to businesses.
M4: The reduction of logistics cost by 5% of GDP would save the country approximately 7.5 billion USD.
M5: The system must comply with the ebXML framework defined by UN/CEFACT and OASIS.
M6: "They [Customs] said we're going to send you [Dept of Land Transport] everything [updated Customs Declaration] and you do what you have to do to get the data you want."

We witnessed memes that drove the uptake and guided the implementation of this large-scale IOIS project. Like genes tell a cell to make a certain protein that has a specific job or function in the body, examples of memes listed in Table 5.2.1-1 convinced the country's top-level management to provide commitment, institutional support, and financial support for the implementation of ThaiNSW. They motivated all the stakeholders from both public and private sectors at the middle management level and operational level to participate. They also provided basic design parameters and raw materials necessary for the existence of ThaiNSW in its current form.

5.2.2. The origin of ThaiNSW-related memes (Proposition 2)

Analogous to the biological world where the emergence of new characters and structures of living organisms are controlled by the environment and their interaction with the environment [12], memes also emerge in response to environmental forces and evolve into different variations through refinement and adaptation to new situations and problems.

In the context of ThaiNSW, the environmental forces that caused memes to emerge and evolve were in multiple forms. In line with the past studies that investigated how variables in the external environment, including competitive pressure, government pressure, business partner power, and support from the initiator, forced or facilitated IOIS adoption [5], our findings suggested that social, economic, and political happenings play a crucial role in the emergence and evolution of memes that drove the emergence and evolution of ThaiNSW. The role of catastrophic happenings was not found significant in ThaiNSW case as we speculated.

Table 5.2.2-1: Examples of environmental forces that drove the emergence and evolution of ThaiNSW-related memes, thus ThaiNSW

Social happenings Any phenomena that entail human aggregates and their behavior	Corruption, the upgrade of customs operation to the world standard, the lawsuit against Thai Customs when it attempted to make the use of the customs automation system mandatory
Economic happenings Any situations that deal with the allocation of resources and their use in terms of efficiency and effectiveness	Redundant paperwork, operational inefficiency, high cost of system maintenance, resource scarcity
Political happenings Any events that occur to generate demands for the uptake of certain values and to mobilize support for the demands generated	The need to secure stakeholders commitment and support, the need to get users to use the system
Catastrophic happenings Accidental, intentional, or unintentional man-made or natural disasters	N/A

Like an organic life that originated from series of chemical events [64], the historical analysis of the life of a Single Window concept, which could be traced back to 1963 where the concept of Layout Key was discussed, suggested that the emergence and

evolution of a meme could be driven by a continuous series of various environmental forces. The ongoing changes in the economic, social, and political landscape, as well as the advent in technology were shown to have significant influence on how this particular meme was developed into its current form.

5.2.3. Selection – A determinant of successful memes (Proposition 3)

The analysis of memes collected from the ThaiNSW case suggests that those memes have lived very long and have spread to relevant populations rather fast with relatively a high degree of copying-fidelity. We also found that the rate in which memes spread to their relevant populations were highly time-dependent. The spread of Single Window concept, for example, was slow after it was conceived and spiked after it was promoted as one of UN/CEFACT work programs. After the concept was repetitively discussed at local and international events, it became saturated.

The Single Window concept is an example of a meme that got copied with minimal change, spread rapidly to relevant populations, stayed viral for a very long period of time, and still has its place in the meme pool. In Thailand, this particular meme appeared in various ThaiNSW-related project documents. It had been rehearsed word by word in many occasions. Yet, a trait of "a single entry point… for traders to submit information to governments so as to fulfill import- or export-related regulatory requirements" which constitutes most part of the Single Window concept has not been phenotypically expressed in ThaiNSW. This finding let us to conclude that a successful meme is not just a meme with copying-fidelity, fecundity, and longevity. Rather, it is a meme that is activated. It is a meme that is selected for implementation.

The close examination of memes that were implemented in ThaiNSW case suggested that all of them were:

- Memes that were perceived as mostly advantageous either to the environment or to the existence of ThaiNSW and its components and
- Memes that were in the human capacity to implement.

Yet, the data suggested that not all memes that satisfied the two primary selection criteria got activated. Among those memes, we found that memes that were implemented also met one of the secondary selection criteria. They included:

- Memes that were perceived as conveniently realizable;
- Memes that were perceived as mostly replicated in population of a selective system;
- Memes that were recognized as conforming to government policies, rules, and regulations;
- Memes that were remembered as fulfilling expectations and needs of users;

- Memes that by chance came to be known right when desperately needed; and
- Memes that served as responses to provocation.

Our findings indicated that perception played an important role in meme selection. Perception is determined by individual preferences which is usually tied to other memes, i.e., the values, beliefs, and practices embedded in the social setting in which memes were propagated. The findings from ThaiNSW case also showed that perception often varied from person to person. It can change over time. From social construction of technology theory's point of view, different perception on a particular meme is basically an outcome of the interpretative flexibility where the particular meme is open to more than one interpretation. It was the perception of the 'predominant agent,' e.g., Thai Customs – ThaiNSW lead implementer, that counted.

5.2.4. Coevolution between ThaiNSW and social institutions/communities participating in its development, operation, regulation, and use (Proposition 4)

The evolution of ThaiNSW was also the outcome of its coevolution with other CASs, i.e., social institutions and communities that took part in developing, regulating, maintaining, and using it. There were three types of coevolution between these two species of CASs that we unveiled.

First, we found pairwise coevolution where the traits of a particular social institution (i.e., Thai Customs) created pressure that drove evolutionary changes in the traits of ThaiNSW and the new traits manifested in ThaiNSW, in turn, altered the way members of that social institution ran their business. We speculated that pairwise coevolution could also occur in the opposite direction where a particular social institution modified its traits in response to the traits of ThaiNSW and where the new traits manifested in that particular social institution created pressure that drove evolutionary changes in the traits of ThaiNSW. Somehow, we could not spot any instance of this particular pairwise coevolution in ThaiNSW case.

Second, we found instances of coevolution that involved the reciprocal evolutionary changes between ThaiNSW, Thai Customs, community of traders, and community of customs brokers. In the biological domain, this type of coevolution is known as diffuse coevolution.

The third and more common type of coevolution between ThaiNSW and social institutions/ communities participating in its development, operation, regulation, and use was meme-for-meme coevolution. This is a case where the activation of a meme in one CAS is dependent on the continued activation of a meme in another CAS, and where the interaction between the two memes leads to a single observable characteristic by which the presence or

absence of the relevant meme in either CAS may be recognized. For example, the meme that instructed Thai Customs to adjust the property of tax ID number in the database and relevant message schemas from 10 digits to 13 digits and the meme that instructed value-added service providers to adjust the front-end application accordingly were dependent on the new convention for generating company registration number by Department of Business Development. The presence of 13-digit tax identification number in messages routed through ThaiNSW is an outcome of the interaction between those micro-elements exhibited in two different CASs.

6. Concluding remarks and implications

This research offers an alternative approach to examine the emergence and evolution of IOIS. Through the use of Lamarck's theory of acquired characteristics and inheritance and Darwin's theory of natural selection combined with the conceptualization of IOIS as a complex adaptive system, we postulate meme-centered view with four concrete and propositions.

With the analysis of meme and IOIS as well as the happenings in the scope of an organizational field, we hope that the limitations of the past research have been overcome. The sometime chaotic nature of decisions toward implementing IOIS as well as the rationality of some irrational decisions that do not fit organizational strategies are explained.

Given the size limitation of this paper, we can only use our longitudinal case to briefly illustrate the proposed theory. We do have however sufficient data to provide more rigorous analysis in future research.

Given the highly context-dependent nature of this research, we also recognize the need to replicate this research in a different setting to improve the generalizability of the theory. Despite such limitation, the knowledge gained from this research remains valid as an input for the collective process of knowledge accumulation in a IOIS emergence and evolution research. With better understanding about the environmental forces that favor the emergence and evolution of memes and the characteristics of memes that are likely to be incorporated into IOIS, researchers and practitioners can better predict the intent to adopt IOIS as well as the intent to incorporate certain features and functions into the system.

Observations from our case study also shed lights on how practitioners should orchestrate their ideas if they want to have their ideas selected for implementation. As one of the interviewees reflected: "Building a nationwide information system is like building a large building. There are many stakeholders that we have to communicate with. Many times, to communicate the same story, we have to use different messages. The messages have to be presented in the way that catches the attention." Different messages can be based on the same meme, i.e., same idea but with the details customized to fit the background of the audience.

More importantly, this research carries methodological implications for studying IOIS emergence and evolution. It calls for the multi-level analysis with a great emphasis on memes as they are units of selection and heredity. As Dawkins (2010) put it, to study the evolution of life, "we must begin at the beginning with the very origin of life itself" (p. 11).

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