

# Systems Thinking on the Dynamics of Knowledge Growth - A Proposal of Dynamic SECI Model -

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## Abstract

This paper investigates a dynamic mechanism underlying the process of knowledge creation and evolution with a focus on the SECI model(standing for Socialization, Externalization, Combination, Internalization) as proposed by Nonaka and Takeuchi(1991) and broadly accepted especially among the practitioners in knowledge management field. The SECI model provides with intuitive logic and clear delineation of knowledge types between the tacit and the explicit, and embodies an interaction dynamic. However explanations of the propelling forces for the knowledge transfer over the four quadrants of the model is yet to be made. And the transmission mechanisms are not prescribed though the model mentions knowledge is created and evolved in a spiral process. This paper, therefore attempts first to extend and elaborate it into a dynamic SECI model by identifying those propelling factors and their relationships(linkages) based on the systems thinking.

**Keywords:** SECI Model, Systems Thinking, Knowledge Conversion,  
Information Perspectives

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## I. Introduction

Since the knowledge delineation first espoused in management theory by Polanyi (1958, 1969), a great deal of research has been published in the academic arena and numerous practices have been vigorously made in the industry over the past two decades. Based on what people in this field have been doing thus far, the stream perhaps falls into two tracks of activities pertaining to knowledge management (KM): one is IT-centered and the other is people-oriented (Sveiby 2001).

Whereas researchers and practitioners on the IT-track are mostly involved in the construction of information management systems with a view of knowledge as a static object that can be identified, captured and handled in information systems, those on the people-track are primarily interested in assessing, changing, and improving human skills and/or behaviors, claiming that knowledge is a process in which human skills, know-hows, and even learning and sharing behaviors. Depending on how to understand knowledge, emphasis is placed on either its static or dynamic properties. Simply the management focus of the former is on the 'knowledge capture,' and the latter on the 'knowledge creation'.

This paper focuses primarily on the dynamic properties inherent in the process of knowledge creation and evolution. Regarding this, Ikujiro Nonaka, with his various co-authors Hirotaka Takeuchi, Georg von Krogh and others, created a dynamic model to illustrate organisational knowledge creation in a series of books and articles that began appearing in the early 1990s. The most notable is the SECI (the acronym for Socialization, Externalization, Combination, Internalization) process originally proposed by Nonaka (1991), though was refined (1994) and expanded in the popular book *The Knowledge Creating Company* (Nonaka & Takeuchi 1995).

The SECI model met with broad acceptance, especially among management practitioners, due to its intuitive logic and clear delineation of knowledge types between tacit and explicit knowledge. The model also embodied an interaction dynamic by which knowledge is transferred in a spiral process, allowing the knowledge value to be enhanced through exchange between individuals and groups within the organisation.

Inherent in much of the SECI work is an incorporation of Michael Polanyi's distinction (1969) between tacit and explicit forms of knowledge though the model and its derivatives also incorporate elements of information systems, organizational learning and behavior. The SECI model has implications both for managerial style and organisational structure, and for

the first time emphasised the whole human process of information as an essential component of organisational knowledge management and learning (Rice & Rice 2005). However, relying on the heavy employment of philosophical elements of knowledge, the practicality of SECI framework is inherently difficult to be empirically proved. Furthermore, the fact that explicit and tacit knowledge boundaries are often indistinct, and that this dichotomy is such an important one in the SECI framework, make it difficult to postulate what factors are involved and how they are interrelated in the process of knowledge growth, though it conceptually explains of modal shift and spiral of knowledge.

This paper, therefore looks first to address limitations of the SECI model together with a brief review of modal shift and spiral of knowledge over its four quadrants and summarize the current efforts to complement those limitations. Secondly, attempts to propose an alternative from the perspective of 'mobilization' process of information flows and to elaborate the SECI into a dynamic model by identifying the factors enabling modal shift and their relationships(linkages) which are unexplored so far. Causal loop diagramming (CLD) technique based on the systems thinking is introduced to describe the dynamic process of knowledge proposed in the study. The article closes with key directions for further research elucidated by this work.

## II . Review and Evaluation of the SECI Process

When originally proposed, the SECI model (Nonaka 1991), as previously mentioned, received wide attentions from the KM field for its intuitive logic and clear delineation of knowledge types - tacit and explicit. The core behavioural assumption underlying the model is that knowledge flows between individuals and groups and is transferred between tacit and explicit knowledge. The model was extended by introducing another assumption that knowledge is grown dynamically as it flows through different levels of the organization and between individuals and groups (Nonaka 1994). In 1998 a third, more challenging, cultural assumption was added to the SECI discussion (Nonaka and Konno 1998) by introducing the concept of Ba, a philosophical construct rooted in Japanese society that relates to the physical, relational and spiritual elements of 'place', or perhaps more expansively 'context'. The theory of knowledge creation through the SECI process and ba was further advanced by incorporating

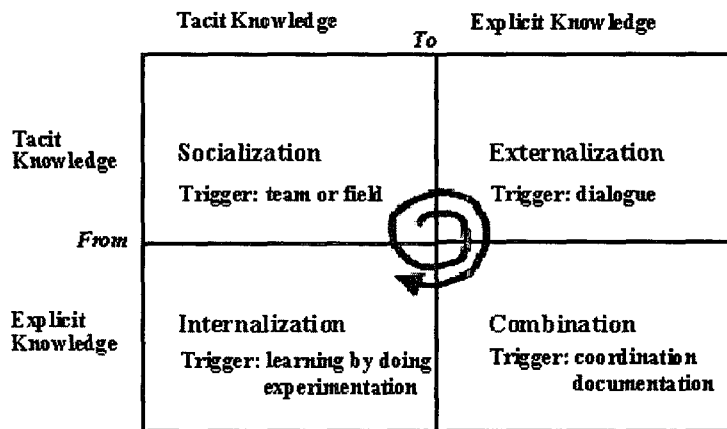
the dialectic thinking (Nonaka and Toyama 2003) by which knowledge creation is conceptualized as a dialectical process.

## 1. The Essence of SECI Process

The SECI process adopts a two-dimensional model to describe the (interacting) processes of knowledge creation and evolution of knowledge (Nonaka and Takeuchi 1995). The first dimension of the model - the epistemological dimension - concerns the nature of knowledge and how new knowledge is created through repeated interactions and conversions between different kinds of knowledge, while the second dimension - the ontological dimension - concerns the organizational level of knowledge creation and expansion.

At the core of the epistemological dimension lies the distinction along the between tacit and explicit knowledge. Tacit knowledge is personal and formed by experience. It is context specific, bound to individual practices and hard to formalise and communicate, but it can be shared with others through collaboration, observation or imitation. Explicit knowledge, on the other hand, is codified or digitized knowledge that is thus transmittable in formal, systematic manner; e.g., defined in written procedures, models, records, manuals, textbooks etc. But an organization cannot rely on tacit knowledge alone, it must create an organizational memory with explicit knowledge sharable among organizational members. Therefore the knowledge creation depends on a series of conversions between tacit and explicit knowledge, where individual knowledge is shared, codified, and used as a basis to build new knowledge.

The four possible conversions between tacit and explicit knowledge results in the four modes of knowledge creation in Figure 1. In the first mode, socialization, is tacit knowledge of the individual shared with others through collaboration, observation or imitation of behaviour. The second mode, externalization, converts tacit knowledge to explicit by building models, descriptions or metaphors, etc. It is a very important in knowledge creation process, since this is where ideas or concepts are formulated. The third mode, combination, integrates explicit knowledge from different sources into into new explicit knowledge. Here knowledge about existing practices, textbook descriptions, models etc. are sorted and reconfigured into new descriptions, procedures etc. Lastly the fourth mode, internalization, feedbacks these to the members of the organization who use the new knowledge in their work, thereby creating new tacit knowledge.



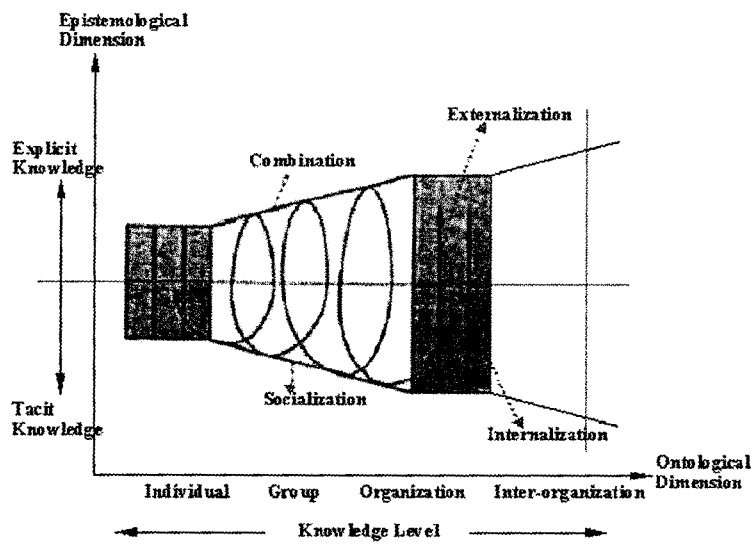
*Adapted from Nonaka, 1994*

[Figure 1] SECI Process : Four Modes of Knowledge Conversion

The ontological dimension is used to describe this "amplification process" and identify the organizational level of knowledge creation; i.e. individual, group or organization. The combination of the two dimensions produces a 'knowledge creation spiral' that cycles through the four modes (see Figure 1). There are various triggers that induce this modal shift in spiral form over the four quadrants of the model. First, the socialization mode usually starts with building a 'team' or 'field' of interaction which facilitates the sharing of members' experiences and perspectives. Second, the externalization mode is triggered by successive rounds of meaningful 'dialogue' where sophisticated use of metaphors enables team members to articulate their own perspectives and thereby reveal hidden tacit knowledge otherwise hard to communicate. Third, the combination mode is facilitated by such triggers as 'coordination' between members and the 'documentation' of knowledge, through which concepts formed by teams can be combined with existing data and external knowledge in a search of more concrete and sharable specifications. Fourth, the internalization mode can be triggered through a process of 'learning by doing' in the field of action where a certain concept is gradually translated through interaction and a process of trial-and-error 'experimentation' into different aspects of tacit knowledge.

While tacit knowledge possessed by individuals may lie at the heart of the knowledge creating process, realizing the practical benefits of that knowledge centers on its externalization and amplification through dynamic interactions between all four modes of knowledge

conversion. Tacit knowledge is thus mobilized through a dynamic entangling of the different modes of knowledge conversion in a process which will be referred to as a 'spiral' model of knowledge creation (see Figure 2). The interactions between tacit and explicit knowledge will tend to become larger in scale and faster in speed as more actors in and around the organization are involved. Thus the typical pattern of knowledge creation can be viewed as an upward spiral process, starting at the individual level moving up to the group level, and to the organizational level, sometimes reaching out to the interorganizational level.



*Adapted from Nonaka 1994, Nonaka et al. 1996*

[Figure 2] Spiral Model of Knowledge Creation

## 2. Emerging Questions

The SECI model essentially describes a "spiral" of dynamic interaction between tacit and explicit knowledge along the epistemological dimension, and characterizes four processes (i.e., socialization, externalization, combination, internalization) that enable individual knowledge to be "amplified" and effect organizational knowledge "crystallization" along the ontological dimension. And its extended model (Nonaka et al. 1996) identifies enabling "triggers" for and provides additional workplace examples of each knowledge conversion process (e.g., the trigger for socialization is building a "field" of interaction).

Since SECI's introduction to KM field, some empirical research has delved into the testable propositions presented in the SECI framework, which tend to be related to the presence or absence of organisational structures to facilitate the knowledge transformation between levels and type (explicit and tacit). Kusunaki et al. (1998) investigated the presence of SECI type systems in organisations as an antecedent to successful product innovation. They found some support for their propositions that elements of SECI systems did support positive product development and innovation outcomes at the firm level within Japanese firms. Recent work by Chou and Te (2004) and Chou and Tsai (2004) has sought to empirically test the roles of knowledge assets in the promotion of SECI outcomes, finding some support for hypotheses asserting that the presence of knowledge assets like organisational routines can have a strong impact on certain SECI outcomes.

Particularly, extended research on the dynamics of the model shift and spiral of knowledge is done by Nissen (2002) who integrates and extends the Nonaka's Spiral model and develops a phenomenological model of knowledge flow. This model makes flow time explicit and supports a multidimensional representational framework that enables a new approach to analysis and visualization of diverse knowledge-flow patterns within the organization. By introducing a new dimension, lifecycle (i.e., time horizon) together with both epistemological and ontological dimensions, Nissen attempts to visualize a diversity of organizational knowledge flows over the three-dimensional representation, which defines a vector space and enables us to plot dynamic trajectories for each flow.

Though there have been notable research publications as above, which seek to better understand the associations and causalities among the different elements of the system, knowledge conversion (or flow) dynamics presented in the SECI model and its extensions are much like a static picture (e.g., camera snapshot). Like the other extant models of knowledge flow, the SECI model is yet to be improved by introducing a dynamic representation of knowledge-flow dynamics. Moreover, throughout this line of research, important dynamic interactions between model elements remain obscured through descriptive models. Some skepticisms inherent in the SECI model, however, still remains and unsolved.

First, explicit and tacit knowledge boundaries are often indistinct, though this dichotomy is such an important one in the SECI framework (Rice & Rice 2005). Though SECI assumes that explicit knowledge and tacit knowledge are distinctive and mutually exclusive, this is not always the case. As Polanyi (1964) put it, "We know a lot more than we can tell," which

implies that explicit knowledge (i.e., what we can tell) is a part of tacit domain (i.e., what we know). Two types of knowledge - explicit and tacit thus are neither distinctive nor separable. Rather, they are on the same continuum. The only difference is determined by whether what we know can be expressed in formal form or not.

Second, another limitation of the SECI model is the hypothesis that knowledge transfer is unidirectional. Inappropriate is the hypothesis that knowledge shift starts from socialization to internalization on the epistemological dimension and from individual level via group to organizational level along the ontological dimension. Considering the fact that knowledge is unevenly distributed through an organization, it can be argued that its transformation is multidirectional rather than unidirectional through linear interactions (Nissen and Levitt 2002).

Third, driving forces for the modal shift are not prescribed despite SECI's conceptual embodiment of the interaction dynamics by which knowledge is transferred in a spiral process. Though there is an assumption that tacit knowledge especially requires a degree of proximity for knowledge transfer and exchange (Nonaka 1995), explanations of the propelling forces for the knowledge transfer over the four quadrants of the model is yet to be made.

Fourth, admitting that information is a necessary medium or material for initiating and formalizing knowledge, the SECI model adopts a clear distinction between information and knowledge (Nonaka 1994). It also assumes that tacit knowledge is separable from information and draw a border line between the two domains - information and knowledge. Further, it concentrates only on the semantic aspects of information though there also exists the syntactic aspects.

Although knowledge flow is an inherently dynamic concept, however, the corresponding phenomenon remains poorly understood. We believe that the unresolving problems stated above bear such limitation of the SECI model. And extant approaches to its modeling and description are fundamentally static and largely ambiguous. In this research, therefore, we attempt to tackle those skeptical questions residing in the model and depict a whole picture of integrating four modes of SECI into a single dynamic structure of knowledge flow dynamics from the perspective of 'mobilization' process of information flows.



### III. Dynamic SECI Process: A proposal

There is a clear distinction between information and knowledge, though the two terms are used interchangeably. Information is a flow of messages or meanings which might add to, restructure, or change knowledge (Machlup 1983), while knowledge is created and organized by the flow of information, anchored on the justification and beliefs of its holder (Drestke 1981). Based on this premise, some look to differences between the two and others recognize knowledge as an extension of information. In line with latter view we take on knowledge as a type of information. More strictly speaking, we view knowledge as information with a holder's justification with beliefs. It can be thus argued that knowledge is emerged in the process of information flows.

The word 'information' is derived from Latin *informare* which means "give form to". Chinese letters '情報' corresponding to 'information' is believed to have been derived from '敵情報告' meaning "spying (taking information) on the enemy's situation." Therefore, It could be noticed that the propensity of 'information' is more towards "give" in the west, "take" in the east. No matter what the propensity of 'information' may be, it is clear that information is a flow of message and it is an activity of perceiving and understanding facts, beliefs, truths etc., by matching them with context a receiver has. It, hence, is a verb not a noun. It is something that happens in the field of interaction between minds or objects or other pieces of information.

#### 1. Information Rules and Knowledge Definitions

From the perspective of 'mobilization' process of information flows, four generic characteristics of information (herein called 'information rules') are identified and some analogies to S · E · C · I are possibly drawn from the information rules.

**Rule 1 (Internalization):** *Information is not visible.*

The value of information is subjective. Information is not easily seen unless does arise a certain context which is created by critical mind or curiosity (desire to know). And the value of information is subject to the degree of its fit to the receiver's context. In short information is visible only when intention arise within individual's mind and it is transformed as tacit knowledge through the process of learning-by-doing. The first property of information is

analogous to SECI's internalization mode: conversion of explicit knowledge into tacit.

**Rule 2 (Combination):** *Information is of no value in itself.*

Information has no value unless it is compared and converged with other information. The value of information is synergic through syntheses, which means its value comes out mainly in connection with human interpretation of it combined with other information added. In short information comes to retain its value when pieces of information are interlinked and synthesized together through the process of creative thinking. The second property of information is analogous to SECI's combination mode: conversion of explicit knowledge into explicit.

**Rule 3 (Externalization):** *Information is time-dependent.*

The value of information is perishable over time as situation changes. Its value can be maintained only when it is justified and generalized by the logical structure which is in turn applicable to and reusable for the similar situations. In short the value of information is sustainable when it is transformed into general form. The third property of information is analogous to SECI's externalization mode: conversion of tacit knowledge into explicit.

**Rule 4 (Socialization):** *Information is of culture.*

The value of information can be generated and propagated through the organization only when proper information culture is cultivated within the organization. Because the value of information is renewed or newly created in the following manner: Whenever someone proposes an answer (information externalized in the forms of text, verbal, or numeric formulas), someone else would come up with a new counterexample (counter-information) to shoot it down, which implies, overall, that such societal factors will be effectively handled with rigorous communication culture settled.

Four information rules aforementioned are matched with definitions of knowledge in one to one correspondence. We have to notice how 'information' subtly becomes synonymous with 'knowledge' as if there were no distinction between the two. According to Webster's Dictionary, knowledge is the fact or condition of knowing something with familiarity gained by experience or association. A more workable (practical) definition of knowledge may possibly be derived from the extensive interpretation of 'information rules' in that information is the source of knowledge.

**Definition 1:** *Knowledge is the awareness and understanding of facts, truths or information*

gained in the form of experience or learning. According to this definition, desire to know (with a critical mind, curiosity, etc., included) is also regarded as knowledge, which corresponds to Information Rule 1 (Internalization).

**Definition 2:** *Knowledge is appreciation of the possession of interconnected details* which, in isolation, are of lesser value. Based on this definition some scholars like Polanyi (1964) contends that knowing or a process of knowing is also knowledge, which corresponds to Information Rule 2 (Combination).

**Definition 3:** *Knowledge is equivalent to justified true belief (JTB)*. This JTB account as a definition of knowledge puts an emphasis of justification of what one knows and/or believes in which inner details are recorded in structured manner and expressed in logical forms. This definition stays in line with Information Rule 3 (Externalization).

**Definition 4:** *Knowledge is a combination of JTB account plus a societal factor, X* as such  $\text{knowledge} = \text{belief} + \text{truth} + \text{justification} + X$ . In this equation X is called Gettier Problem because Gettier published his article regarding this in 1963. Right after that, for a good decade or more, there was an enormous number of articles trying to supply the missing fourth condition of knowledge- to try to figure out the "X" in the equation above. It is believed that organizational knowledge grows through interactions via communication. That's why X in the equation is regarded as a societal factor by which knowledge is getting closer towards literally the 'truth.' It implies, overall, that rigorous communication culture in the organization is a very important issue for KM. This definition corresponds to Information Rule 4 (Socialization).

Figure 3 presents an at-a-glance picture to show how four information rules are matching with four modes (SECI) for knowledge growth. Solid lines indicate SECI's unidirectional process in spiral form proposed by Nonaka's work and its extensions. And dotted lines, missing in the previous models, indicate those we are going to explore in the name of 'Dynamic SECI' model from the perspective of 'mobilization' process of information flows based on 'systems thinking.'

<i>Information Rules</i>	<i>Four Modes</i>			
	<i>Internalization</i>	<i>Combination</i>	<i>Externalization</i>	<i>Socialization</i>
<p><i>Rule 1:</i> Information is invisible. (The value of information is subjective)</p>	<ul style="list-style-type: none"> <li>• Key attribute: <i>Critical sense</i></li> <li>• Trigger: <i>Learning-by-doing</i></li> <li>• Organization culture: <i>Participation</i></li> </ul>			
<p><i>Rule 2:</i> Information is of no value in itself. (The value of information is synergic)</p>		<ul style="list-style-type: none"> <li>• Key attribute: <i>Creativity/Synthesis</i></li> <li>• Trigger: <i>Coordination</i></li> <li>• Organization culture: <i>Flexibility</i></li> </ul>		
<p><i>Rule 3:</i> Information is context-specific. (The value of information is perishable)</p>			<ul style="list-style-type: none"> <li>• Key attribute: <i>Rational mind</i></li> <li>• Trigger: <i>Documentation</i></li> <li>• Organization culture: <i>Justification</i></li> </ul>	
<p><i>Rule 4:</i> Information is of culture. (The value of information is diffused)</p>				<ul style="list-style-type: none"> <li>• Key attribute: <i>Communication</i></li> <li>• Trigger: <i>Teambuilding</i></li> <li>• Organization culture: <i>Openness</i></li> </ul>

[Figure 3] Information Rules and SECI Process

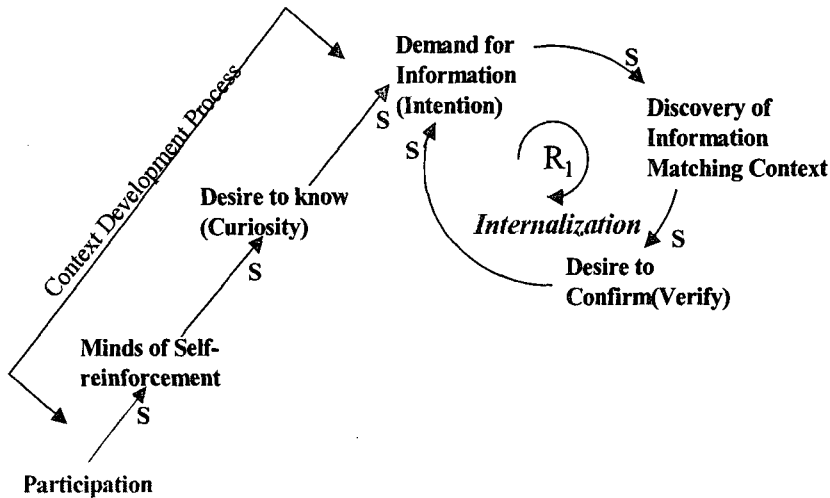
## 2. Dynamic Structure of SECI

Based on the definitions of knowledge, dynamics of knowledge growth is perhaps depicted with causal loop diagram (CLD) as below by introducing systems thinking.

**Internalization Mode:** By Information Rule 1 and Knowledge Definition 1, 'intention' is perhaps a key factor to mobilize internalization of knowledge. According to Nonaka (1994), intention is concerned with how individuals form their approach to the world and try to make sense of their environment, which implies intention arises, endures, and disappears with subject's commitment to an object - i.e., desire to know and/or curiosity. Further curiosity may be strongly influenced by degree of self-reinforcement. Weick (1979) explains such 'entactment' of the environment as 'self-fulfilling prophecy' which may be a projection of strong will for self-actualization.

In essence, the first mobilizer of internalization process, 'intention' is triggered by curiosity which is in turn propelled by 'self-fulfilling prophecy' as in Figure 4. Individual autonomy widens the possibility of motivating individual's mind of self-reinforcement, which is by and large created by the culture of participation in organizational context. As intention increases so does the chance of discovering information matching context, which in turn stimulates desire

to confirm and verify the information obtained. And 'desire to confirm' bears new demand for another information. Such internalization process is depicted in causal loop diagram in Figure 4.1)



[Figure 4] Dynamic Structure for Internalization of Knowledge

**Combination Mode:** By Information Rule 2 and Knowledge Definition 2, 'justification' is perhaps a key factor for combination of knowledge. A common definition of knowledge is that it consists of justified true belief, which means knowledge without justification is not 'knowledge,' as justification with evidence is an epistemic feature of belief. An activity of authentication through justification is at least a necessary condition for some information to

1) Variables are related by causal links, shown by arrows and each link is assigned a polarity (called link polarity), either positive or negative to indicate how dependent variable changes when independent variable changes.

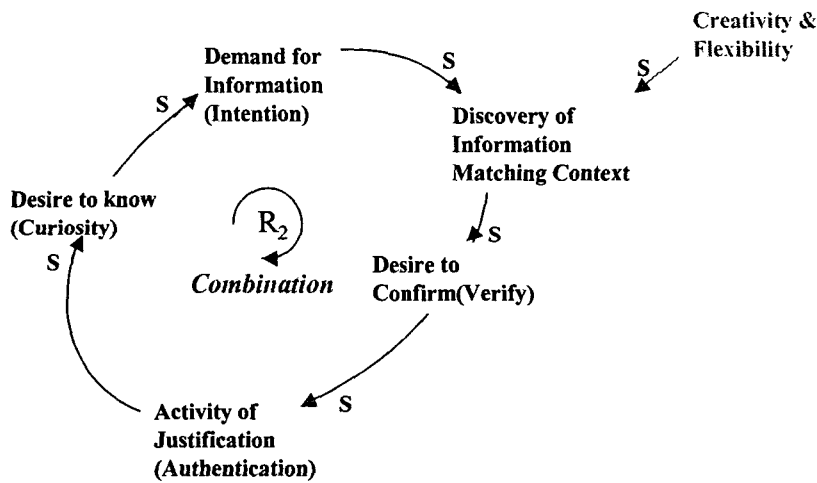
A positive link with 's' on the arrow-head means that the cause and the effect move in the same direction. If the cause increases, the effect increases above what it would otherwise have been, and if the cause decreases, the effect decreases below what it would otherwise have been.

A negative link with 'o' on the arrow-head means that the cause and the effect move in the opposite direction. If the cause increases, the effect decreases below what it would otherwise have been, and if the cause decreases, the effect increases above what it would otherwise have been.

A Feedback loops formed by a set of links and its polarity is determined by the number of positive links involved in the loop. If the number of positive links is even, polarity of the loop is terms as 'reinforcing' (explosive) denoted by a + or 'R.' If the number of positive links is odd, polarity of the loop is terms as 'balancing' (goal seeking) denoted by a - or 'B.'

count as knowledge. Internalized knowledge has to be justified and expressed in formal form so that it can be observed and experimented by others. The rationale underlying 'justification' may be found in scientific skepticism, which is the practical stance that one should not accept the veracity of claims until solid evidence is produced.

As shown in Figure 5, as desire to confirm increases so does activity of justification which in turn influences desire to know in the same direction. In combination mode, creativity and flexibility at both individual and organizational levels play important roles as exogenous variables. Also, what has to be noted here is that unlike Nonaka's SECI model, combination mode is not separable and instead it is an extension of internalization process.

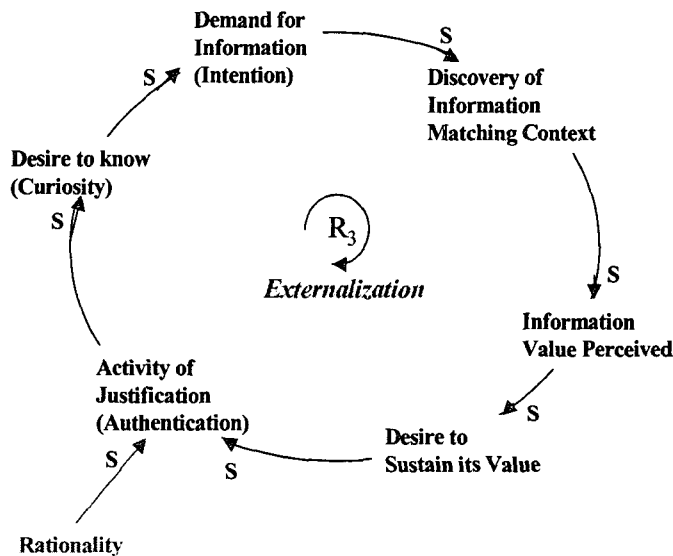


[Figure 5] Dynamic Structure for Combination of Knowledge

**Externalization Mode:** By Information Rule 3 and Knowledge Definition 3, 'desire to sustain' is perhaps a key factor for mobilizing externalization of knowledge. Since information is time-dependent and context-specific, its value is perishable over time and radically diminished as situation terminates. All knowledge of the atom is inferential knowledge as the value of factual knowledge perishes over time. Therefore, factual knowledge gained under a certain context (or situation) has to be converted into a more sustainable form by inferences, so that it can be applied to similar contexts. In general, one can demonstrate know-how (or procedural knowledge) by performing the task in question, but it is harder to demonstrate

propositional knowledge. Therefore, in externalization mode, rationality at both individual and organizational levels play important roles as an exogenous variable. By the account of JTB knowledge has to be supported by rationality which is a quality indicating that the belief is true. Instead of 'justified true belief' or 'true belief with evidence,' thus one can say that knowledge is 'rational true belief.' For our purposes, the whole point is that, to be knowledge, a belief has to have some positive epistemic feature; it can't be arbitrary or random or irrational.

As shown in Figure 6, as desire to sustain increases so does activity of justification which in turn influences desire to know in the same direction. In externalization mode, rationality at both individual and organizational levels play important roles as an exogenous variable. Also, what has to be noted here is that unlike Nonaka's SECI model, externalization is not separable. Instead it is an extension of internalization and combination processes.

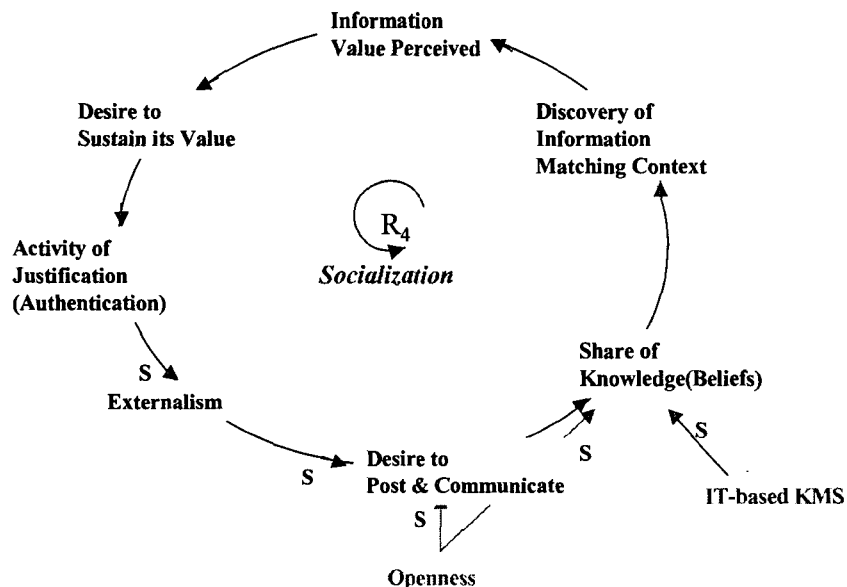


[Figure 6] Dynamic Structure for Externalization of Knowledge

**Socialization Mode:** By Information Rule 4 and Knowledge Definition 4, 'externalism' and 'desire to post and communicate' are key factors for mobilizing socialization of knowledge. As previously discussed, the 'X' in the equation, 'Knowledge = belief + truth + justification + X,' indicates that whenever someone proposed an answer, someone else would come up with a new counterexample to shoot down that definition. Some of the proposed solutions involve

factors external to the agent. These responses are therefore called externalism. For example, one externalist response to the Gettier problem is to say that the justified, true belief must be caused (in the right sort of way) by the relevant facts. In short, X in the equation has a societal attribute by which knowledge is getting closer towards literally the 'truth.' It implies, overall, that openness at both individual and organizational levels play important roles in socialization mode as an exogenous variable, together with IT-based KMS which provides a means to accelerate share of knowledge and/or beliefs among the members of the organization, and even outside the organization.

As shown in Figure 7, as activity of justification increases so does externalism which in turn influences desire to post one's thought and communicate with others in the same direction. Again, what has to be noted here is that unlike Nonaka's SECI model, socialization is not separable. Instead it is an extension of internalization, combination, and externalization processes.



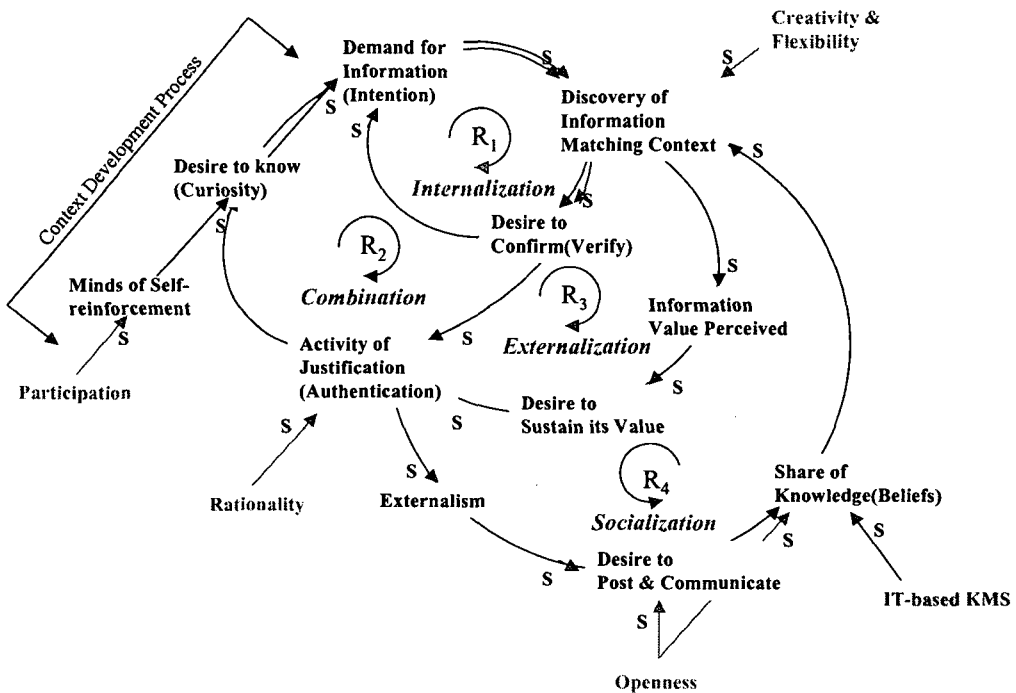
[Figure 7] Dynamic Structure for Socialization of Knowledge

We have, thus far, explored each mode of knowledge conversion process. By integrating them all into a single model, a holistic picture on the dynamics of organizational knowledge growth can be drawn as in Figure 8.



As seen in the integrative causal loop diagram of Figure 8, dynamic interactions between model elements clearly identified and the knowledge conversion (or flow) dynamics are presented in multi-direction which makes more practicable in real world situation. In brief, the model proposed in this study as an alternative to previous SECI model successfully introduces a dynamic representation of knowledge- flow dynamics. Moreover, the missing links in the previous models are identified and included in the 'Dynamic SECI' model, though it is derived from the perspective of 'mobilization' process of information flows and thus partly different interpretation of SECI process.

Notable feature adopted in the 'Dynamic SECI' model is two-folded. First, both explicit knowledge and tacit knowledge are put on the same continuum whereas Nonaka' work assume that they are distinctive and separable. Second, all the four modes of knowledge conversion process are amalgamated with internalization mode as a core of knowledge growth.



[Figure 8] Integrated View of Dynamic Structure for Organizational Knowledge Growth

## IV. Conclusions

The novel contribution of this paper is the exploration of the SECI model and the proposal of new SECI model with dynamic features in it. As the perspective of 'mobilization' process of information flows based on 'systems thinking' is adopted to build a dynamic SECI model, the interpretation of SECI process is inevitably different in part from Nonaka's work.

However, our proposed model as an alternative resolves several pitfalls inherent in the previous SECI models. Above all, linear and unidirectional conversion (or flow) dynamics of knowledge is replaced with nonlinear and multidirectional flows which is closer to the real world. Further, the missing links in the previous models are identified and included in the model. Such dynamic representation of knowledge flows was possible first by aligning both explicit knowledge and tacit knowledge on the same continuum and second by amalgamating the four modes (S · E · C · I) of knowledge conversion processed with internalization mode as its core.

In the near future, we are going to move further for simulating the SECI processes by refining and converting this Dynamic SECI model into stock-flow diagram with empirical tests for each of the links to find magnitudes of causalities. Hopefully some policy leverages would be found from computer simulation runs by a set of scenarios and implications in context of knowledge management would be made all again.

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