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THE SEMIOTIC STRUCTURES OF INFORMATION SYSTEMS

James J. Lee, Seattle University, leej@seattleu.edu
Bandula Jayatilaka, SUNY-Binghamton, bandula@binghamton.edu
Ben B. Kim, Seattle University, 900 Broadway, bkim@seattleu.edu
Pairin Katerattanakul, Western Michigan University, pairin@wmich.edu

ABSTRACT

Often conceptualization of IS field has emerged from past research or from design and developer side. A conceptualization that is not ex-ante as such can benefit the field by providing new conceptual foundations, as well as social and technical innovation or at least enrich the dialog in the field. Our attempt is to contribute towards such a conceptual development and we postulate that a useful conceptualization can emerge by researching on the use side of IS. As we have observed for more than two decades, the applications and technologies that have emerged primarily from the use side has drastically changed, if not revolutionized, IS.

Keywords: Conceptualization of IS, syntactic, semantic, pragmatic, intention, institution, interaction, physical structure, deep structuvre, surface structure, functionalism, adoption, metamorphism

IS EVOLUTIONS

Expansion of organizational boundaries has necessitated the expansion of Information systems (IS) and its roles. These changing boundaries have immensely helped in redefining business organizations. As a result of advanced technology, IS evolved into organizational business structures and has even moved organizations into new directions, for example, pure e-business players like amazon.com. These developments lead to huge changes in society as IS has spread out gradually in social systems. For example, people use IS to manage their routine or personal data even companies apply IS to manage their customers (customer relationship management). Therefore, IS plays an increasingly indispensable role in our world. To cope with its various roles, researchers have conceptualized the field of IS in many ways in terms of human behaviors, data modeling, process modeling, data, information, knowledge management, etc. (21, 19).

IS has evolved from a data processing system to a more socially diffused web based system, changing its roles as needed (12). The basic assumption of IS identity, of course, has been mostly in a category of technological wonders. However, the early assumptions and conceptualizations have been transformed from technical to social in nature as we have advanced IS to the point that we can program more and more complex social phenomena. It is difficult to define what kind of product an IS is capable of due to the complex environment combined with high-tech and network technologies.

Because of its field name, information systems, it is natural that we conceptualize IS as a group of devices or artificial objects of an organization for distributing and serving information. Though it has had leading roles in shaping social structure via information, information systems has never given any core concepts that could drive people in computer science and hardware/software industries into certain directions. Rather, technological advances create new opportunities in the world of business. As new technologies come into our daily life, our business practices evolve into the new dimension. This unstructured nature of IS conceptualization has dominated so far, which makes it difficult to have a solid IS conceptualization due to the technology driven environment.

The best strategy to lead industry is to provide it with a conceptual framework that vendors can put into their products**.** Those can be 1) rules and policies of organizations, 2) what users want to deal with, or 3) institutions between users and users or users and systems. There is much research arguing that norms and culture be embedded in forms of work practices (7, 17, 28, 33, 35, 36, 38) In this study, we focus on the clarification of the use side of IS rather than the design side of IS. Much traditional IS research has investigated more on the design side of IS. The

key activities are business requirements analysis and systems design. Contrarily, IS research on the use side is based on actor's institutionalization at actual work sites. The use side of institutionalization occurs through work practices of users. In other words, this is the process of building institutions in actors' minds. Thus, intentions of IS design on the design side and institutions on the use side are amalgamated, conceptualizing information systems. Our quest starts from a question, "Is IS a social product or just simply a technological product?" From this question, we investigate institutions of actors then conceptualize them into three different structures: physical, deep, and surface structures.

SEMIOTIC STRUCTURES

Because the IS field has been developed at the intersection of disciplines (12), the views of IS are transformed as the nature and characteristics of IS have evolved. In an effort to clarify the field, we propose three structures as views of the field in this study. A conceptualization of structure can be found in the notion of 'deep structure' (41). This theory was pioneered by Noam Chomsky in linguistics, and was introduced in IS by Wand and Weber (43). The theory of deep structure consists of three structures: physical, deep, and surface structures (41). Though Wand and Weber only apply the notion of deep structure into IS ontology, we will examine three structures with Semiotic Theory (45). Semiotic theory is the starting point for emergence of a behavioral frame of reference in linguistics. Thus, it explains how we can build mental maps between semiotic theory and theory of deep structure through IS conceptualization.

Semiotics is the study of sign processes. It describes the complex and elaborate sign behavior found in human speech and writing. Semiosis, the sign process itself, involves three factors (46). The factors are: that which acts as a sign, that which the sign refers to, and that effect on some interpreter in virtue of which the thing in question is a sign to that interpreter. There are three sub-disciplines within semiotics; syntactics, semantics, and pragmatics.

Syntactics is the formal relation of one sign to another. Physical structure belongs here. It refers to the technologies used to implement information systems. Thus, it determines the protocols that apply to the perceptions of social interaction as collectives by observers. Information systems provide such categories and terms to be used in actual work places. *Semantics* is the relations of signs to the objects which the sign represents. Deep structure describes this category. It explains the intention of information systems to be modeled by real world systems. It implicitly means value, beliefs, and norms that are important to organizations and IS. Thus, deep structure has rules that govern individual behavior and interactions. *Pragmatics* is the relation of signs to interpreters. Surface structure applies to this relation. It is something conceived in the mind, thought, notion, or an abstract or generic idea generalized from particular instances. The generalization process occurs from interactivity between users. For IS concepts, actors interact with IS. Thus, institutions built by actors through interactions can be formalized to concepts. Surface structure is an interface between the IS and its users' organizational environments. Table 1 summarizes the three conceptualizations of IS structure.

Table 1. Semiotic Structures of IS

Semiotic	Relation	Structure	Definition	Meaning
Syntactics	Formal	Physical	Interaction	Categories, Terms, Practices
Semantics	Applicable	Deep	Intention	Rules, Values, Beliefs, Norms
Pragmatics	Interfacial	Surface	Institution	Mind, Thought, Notion, Abstract

The purpose of this study is to conceptualize three structures in the use side of IS. It is not easy to build physical, deep, and surface structure because of the subjectivity of relation types. Thus, we decided to use a grounded theory approach because it is a research method to build theoretical explanation in the social context from human subjects (15). To access the conceptualization of human subjects, we asked them whether they perceived IS as either 1) social products or 2) technical products. Once they chose one of them, they were asked to discuss why they chose that option. Dividing IS by either a social or technical conceptualization shows a simplistic dichotomy. Answering

this question makes subjects reveal their basic conceptualizations of IS. Thus, the data from subjects can be grounded as a theory.

PROCEDURES OF GROUNDED THEORY

Grounded theory is a qualitative analytic method conducted throughout an intense or prolonged qualitative research. The phrase "grounded theory" refers to theory that is developed inductively from a corpus of data. This means that the resulting theory fits, at least, one data set perfectly (15). The core of grounded theory is a conceptual framework and researchers can analyze any social topic through research cycles based on the conceptual framework. Miles and Huberman (29) describe a conceptual framework as follows:

> "A conceptual framework explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships between them."

Researchers may form a conceptual framework from different aspects, such as personal experiences, general observations, or real world facts. After forming the conceptual framework, they can incorporate knowledge or even build a theory via research cycles. There are four stages in a research cycle which includes planning, collecting data, analysis, and reflection (8). From the conceptual framework, researchers can plan their research sequence and clarify the research topics. Then they must define the data source and collect data. Due to the result of the analysis, they might need to collect different data or extend the data source. Finally, the outcome of the analysis should reflect the original conceptual framework.

The responses from the qualitative data we collected for this study have two viewpoints and each of them is supported for various reasons. We used the open, axial, and selective coding methods to analyze these reasons (15, 39). Open coding is the part of the analysis concerned with identifying, naming, categorizing, and describing phenomena found in the text (15). This technique is used to analyze the content of the data, which are read and categorized into concepts rather than imposing concepts taken from outside. Therefore, in our research, each line, sentence, paragraph, etc. is read in search for the answer to our question "Is IS a social product or just simply a technological product?"

After open coding, axial coding was performed. Axial coding is the process of finding the relationships among the codes (categories and properties) in open coding via a combination of inductive and deductive thinking (15). The relationship between a category and a property is a kind of dynamic channel referred to as dimensions in axial coding. Axial coding relies on a technique of making connections between categories to construct a more comprehensive scheme (32).

The last stage of our research cycle was to reflect, making core categories – *selective coding*. We needed to compare the results of open and axial coding with our conceptual framework. Thus, selective coding is the process of integrating and refining categories. We reflect on the information obtained from open and axial coding steps in our research cycle and plan another research cycle. This procedure may repeat several times until we are satisfied with the conclusion, known as "theoretical saturation" (15).

DATA COLLECTION

The subjects of this study were 71 students in MIS courses from a university in North America (Table 2). They were asked to explain why they chose one of two views shown below: (a) Information systems are social products, not simply technological products. IS incorporates social rules, norms, cultures, etc. (b) Information systems are technological products which improves only effectiveness and efficiency.

There were two phases in data collection. First, we collected the data from two classes; course 1 and 2. All data were entered in text file format and analyzed in Atlas.ti software. Atlas.ti provides a variety of tools for accomplishing tasks associated with any systematic approaches to our data, e.g., material which cannot be analyzed by formal, statistical approaches in meaningful ways. After one month, the second data set was collected in course 3 and 4 and analyzed. We did not find any major difference in the results of open coding and axial coding in these two data sets and reached the theoretical saturation point.

Table 2. Results by Item Options

Course Name	Sample Size	# of Option (a)	# of Option (b)
1. Visual Basic	15	12	3
2. Development and Integration in Visual Basic	19	14	5
3. Information systems Analysis and Specification	17	16	1
4. System Analysis and Specification	20	14	6
Total	71 (100%)	56 (78.9%)	15 (21.1%)

CONCEPTUALIZATIONS OF INFORMATION SYSTEMS

With the categories, properties and dimensions from open coding, we built relationships among categories. Initially, all categories were connected based on conditions and consequences. Then, we developed super categories to put similar categories together. The relationships among categories and super categories are shown in Figure 1.

From functional foundation to social adoption, conceptualization of information systems has different roles. The first discussion is about functionalism, in which users of systems approach information systems in order to understand how systems work. Thus, most of the conceptualization has already been done in the stages of systems development and implementation. Post implementation process takes those images into actual work places without screening. The second conceptualization is the adoption and use of information systems at three different levels of categories: person, business, and society. The current business environment is described as integrated and connected (24, 27). The information systems are shared by users in organizations. However, people have different perspectives when they actually work with systems. In fact, a person could have three different levels of adoption processes based on findings above.

There are two conceptualizations that explain how different aspects of information systems are practiced by users of systems cooperatively and collaboratively. Those are isomorphism and polymorphism. Isomorphism provides a common ground of interaction. Isomorphism of information systems provides shared communication channels. A good example is the World Wide Web (WWW). Web browsers provide isomorphism of global information systems where different computers and systems can talk. A second type of metamorphism is polymorphism. Polymorphism means that one concept has multiple shapes or expressions. This explains how a system can serve all people in organizations performing different roles. Although people use the same system, each person uses it differently. Work procedures are all different among people - polymorphism, while the purpose of the work practices is the same for all – isomorphism. Isomorphism and polymorphism coexist. Isomorphism explains how we can use different systems together for the same purpose, while polymorphism shows how we can use the same systems differently with different procedures.

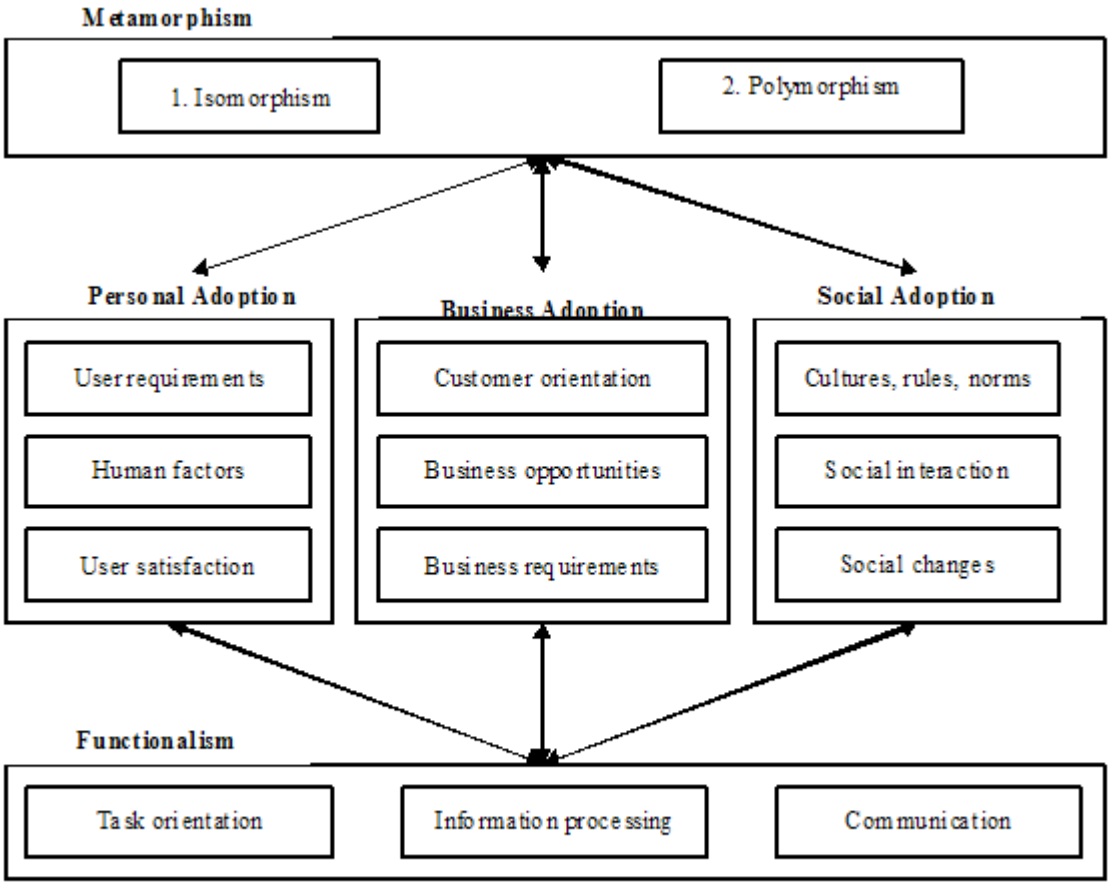

Figure 1. Conceptualizations of IS

Personal Adoption

We find that user requirements often determine the different functions of IS. Users may have different backgrounds. However, some of them share cultures, rules, and norms, thus they require some common, typical functions in IS. Besides, more and more users participate in the design process of IS. Therefore, the final design of systems often incorporates users' requirements and fits users' needs.

Information systems have three different levels of structures: deep, surface, and physical structures (41). The surface structure of information systems is the public interface. The public interface is the interface that connects users and systems. Thus, the public interface is a part of systems that is open to public access. Deep structure of systems, however, contains the main logics of systems and is hidden from users' accesses. This structure is maintained by system administrators or developers. Work practices at work sites explain the physical structure of IS. As systems have different levels of structure, organizations have different types of users, for example, systems administrators, database designers, department end users, etc. Though different levels of users have different intentions, they still share the same systems. Every day, they face and use the same systems fulfilling their specific job descriptions differently.

In the situation where information systems are not integrated or networked, the sole value of systems is evaluated by actual users who use the systems. In many cases, users have many alternatives to perform their jobs either with or without information systems. That's why personal satisfaction also affects the value of IS because the value of IS in personal adoption depends on people's evaluations.

People's satisfaction often plays an important role in deciding whether new IS can exist continuously. The technology acceptance model (TAM) (11, 42) shows this perspective well. Only an appropriate IS can survive when people are satisfied with its function and outcome. However, information systems not only have users' dimension but also possess organizational or societal dimension. Today's systems are integrated with different hardware and software architectures in networked environments. Businesses are streamlined internally in an organization and extended externally with other organizations. This collective use of IS makes IS a must in modern business.

Business Adoption

We find there is a strong interaction between IS adoption and business goals in organizational settings. Because most businesses intend to minimize costs and maximize profits, IS is viewed as goal-oriented (10, 30). We already discussed that IS are implemented to enhance organizational performance. For example, new IS can contribute to improved speed and accuracy of routine work. As information systems have advanced, organizations seek to resolve more and more complex work with IS. For example, companies provide better customer service from customer relationship management systems (CRM) or human resource management.

Traditionally, machines have substituted routine work. With programming capability, machines are getting smarter. Programming is a basic transferring process in which business logics are embedded into software applications (22). Complex business logics, therefore, are now transferred to information systems. This phenomenon becomes obvious as we use more and more database management systems. Building database systems not only means implementing information systems, but also restructuring business concepts explicitly, and making business process explicit knowledge format (44) For example, building entity-relationship diagram (ERD) for database conceptual model analyzes tacit business process to explicit one. Thus, the separation of data from process makes it easier to map business processes to systems' logics.

Technology also drives new opportunities. We have been using database management systems (DBMS) for decades. If we have a considerably large volume of digitized data, there are new technologies available to use, such as data warehouse and data mining. With new technologies, customer relationship management (CRM) is very viable. An existing business may have new life cycle extending its business, new business models can be created, and new market ought to be absorbed.

Companies have certain restrictions on IS implementations. For example, most companies have budget constraints on applying or updating IS.

With budgeting factors, organizations identify business requirements. Not like user requirements, business requirements reflect missions, goals, and strategies of organizations. This is a bigger picture of current business because organizations integrate their business processes together to create competitive values to customers.

Social Adoption

We live in a society and so do business organizations. No IS can become successful without taking social factors into account. First, culture transcends people's interactions through social rules and norms. IS has organizational intentions as we discussed in the above section. Organizational intentions are formed based on different cultures, rules, and norms.

Information systems is tailored to fit into social needs in a variety of ways in which the same IS can be used for very different purposes. This is on the same line that a hammer can be a house building tool or a war weapon. This perspective shows multiple intentions of social use of same systems. People can create their own images of information systems in their minds (2, 23, 25). This institution process follows their actual use and adoption of systems (4, 13, 31). Thus, requirements from users and businesses are embedded in the systems. However, institutions such as culture, rules, and norms are established in actual work practice (7, 17, 35).

People believe information systems are gradually changed to fit the social rules and norms as versions of software are upgraded. But what developers focus on in the stage of development are functions, data, and processes. Once systems are developed, these are like stones. Users, who use the stones, decide how to use them without worrying about how to alter the inside of stones. They only look at the surface of stones and gradually build institutions, by interpreting and interacting with stones and other people (4). Due to this reason, programmers or designers of IS should understand and investigate cultures and norms to build surface structure where social rules play important roles in any organizations.

The second belief is that IS is a product of social rules, norms and cultures. This view reflects the governance of social factors. As evidences, human information and human resources now can be mediated through information systems. Thus, IS has a role as facilitator of human interactions. Gradually, we are communicating more complex and sophisticated social interactions via information systems. That is why people perceive social institutions embedded in information systems as shown in the below statements. Rather, social institutions are virtually structured when users perform with IS at their actual work sites (28, 33, 35, 36, 38):

There are social barriers in building institutions of information systems. The way of doing business face-to-face to have a higher level of trust cannot be easily substituted, for example. With better abstractions of data and processes, information systems can help this type of constraints, but it will take time to change social traditions.

By the different levels of adoption of information systems, the social shaping process of information systems is institutionalized in different ways, regardless of surface and deep structure of information systems. We refer to this process as metamorphism.

Functionalism

To understand why IS is in such demand, we should find out why people need IS and what IS provides to people. For example, people easily think a word processor is a better tool than a type writer. It is easy to map between the needs of people and value provided by IS. Functionalities of IS - what IS processes and provides - basically determine the values that fulfill needs. These types of needs are very explicit and can be formulated with ease. In other words, the problems are normally approached by structured ways of thinking. People, who seek these kinds of solutions, view IS as a-technological product. Interviewees think two main reasons cause the popularity of IS. First, IS can be applied to various fields due to their functionalities. There are many different types of systems, such as enterprise resource planning (ERP), supply chain management (SCM), customer relationship management (CRM), database management systems (DBMS), etc. This view mainly focuses on the ontological foundation of IS. IS consists of software and hardware, emphasizing the basic roles of computing systems to fulfill business logics of organizations.

The second reason is the power of information processing. Most legacy information systems are used to store data for faster and more accurate data processing. Eventually, advanced information systems now can maximize their output by even faster data handling, but more importantly, can provide meaningful information. This view expands the basic role above to the advanced role of IS, underlining the efficiency of IS.
As we use IS more often, information processing power increases rapidly. In other words, we can manage a bigger scope of resources with IS. New opportunities are often discovered in technology-driven business.

With basic and advanced roles as stated above, organizations can manage bigger and more complex structures. One good example is the revolutionary business practice from business process reengineering (BPR). It promises one business process across different functional departments (16). With this concept, companies were able to restructure their organizational hierarchies, removing redundant and time-consuming resources. Is BPR possible without IS? The answer, of course, is yes. However, the practical side of BPR strongly recommends the use of IS to expedite communications (9). IS, with basic and advanced roles together, provides a new structure of communications. This enables conceptualizing organizational resources and activities.

Through information systems analysis, design, and implementation, user requirements analysis is becoming more important (4). Systems, when they are being implemented within organizations, are customized (coding process where programmers change the codes of systems) and configured (engineering process where implementers set the setting of preferences provided by systems) to fit into adopting organizations. All these activities are based on functional analysis of organizations and their business processes and data. Thus, functional conceptualization is embedded into information systems when they are developed and implemented. There are many ways to implement systems. Generally, we can classify them into three categories (1, 37): 1) off-the-shelf systems, 2) in-house systems, and 3) hybrid systems (mix of both off-the-shelf systems and in-house development). In any case, actual use of systems takes time to conquer the systems beyond systems implementations with functional conceptualization. With actual use of systems, many societal factors are restructuring job roles and descriptions (27). We find systems use and adoption from personal perspective (bottom-up) contrarily to system development (top-down).

CONCLUSION

Conceptualization of IS can be a very powerful tool because it would be helpful to determine how to use IS in practice. Because people at different levels of organizations use IS for different purposes in the various areas of internal and external businesses, conceptualizing IS is not an easy task. The theory of deep structure (41, 43) provides the right lens to clarify the multiple nature of IS. As shown in the Table 2, each structure of the theory – deep, surface, and physical – can be conceptualized into functionalism, adoption, and metamorphism.

From the results of the previous section, *functionalism* (18, 20) is a deep structure of IS conceptualization. IS is developed with intentions of what to process. By this nature, it is task-oriented. Business data and process models are embedded into business applications with rules, values, beliefs, and norms.

Second, a surface structure of IS conceptualization shows the concept of the three levels of *IS* adoption; *personal, business, and social adoption* (4, 13, 31). For example, a manager of a company can have all three different views. As a user, he/she adopts IS from the personal perspective, while as a manager managing subordinators and as a subordinator of his/her boss, he/she adopts IS from the business perspective. Social adoption occurs when he/she treats IS in the context of relational means to communicate with people in society in general. Mind and thought are institutionalized in the personal and business adoptions while generalized notion and abstract are instituted in the social adoption.

Metamorphism (10, 30) explains what a physical structure is in IS. Intention of IS and institution of actors are not compatible. This is the same discussion of objectivity and subjectivity (14, Orlikowsky & Robey, 1991). Humans perceive an object with its objectivity and subjectivity. As an object, IS provides its dual identity in objectivity and subjectivity. Isomorphism (3, 40) can be explained in the strong nature of IS objectivity. Categories and terms are protocols applied to the objective perceptions of social interactions. Polymorphism (6) reflects the subjectivity nature of IS. Work practices are produced, reproduced, and transformed at work sites. Subjective reflection of actors plays a key role here.

Applying conceptualizations of IS in deep, surface, and physical structure has potential in leading industry from academia. As illustrated by Table 2, three structures can provide what information systems is intended, instituted, and interacted on World Wide Web Enterprise Resource Planning (ERP) practices. The two different facets of IS are

design-side and use-side. IS researchers have developed universities' curricula, mostly in the design-side of IS, such as database, systems analysis and design (Burrell & Morgan, 1979; 18, 20). As developers take inputs, such as user requirements and feedback, researchers and practitioners agree that good communication between developers and user is one of critical success factors in systems development. The use side of conceptualization (Jayatilaka et al., 2007) provides much broader views incorporating different levels of structure with the 3Is – intention, institution, and interaction. The terms we used in this study are physical, deep, and surface structure, respectively, to represent the essence of conceptualization process. This study reveals that concepts of human, business, and social factors are elaborated with cores of IS transforming into dichotic framework. This dichotomy proves that billions of people in the globe use IS with same purpose and different procedures.

Table 2. Conceptualizations of IS Structures on WWW and ERP Practices

Structure	Conceptualization	Practices on WWW	Practices on ERP
Physical Structure	Metamorphism	• HTML • XML	• Integrated Business Modules • Central Database
Deep Structure	Functionalism	• Semantic Web • Web 2.0	• Business Process Reengineering • Streamlining Business Process
Surface Structure	Adoptions	• Search Engines • Blogging • Wikipedia	• E-Business • Supply Chain Management • Customer Relationship Management

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