Organisational Responsiveness Through Signs

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Abstract. Organisational Semiotics is a discipline that studies signs of organisations, and how these signs aid an analysis and design of technical information systems. The responsiveness of organisations has been discussed as a key feature to adapt the organisational behaviour in turbulent environments, but there are not studies about the implication of these capabilities on Information Systems. Organisational Semiotics can be used as a good approach to understand relationships between living things and organisations in order to develop their responses to the organisation. The purpose of this paper is the proposition of a preliminary model of organisations as living systems, using the concept of organisations as information systems. This paper articulates the information interactions between the border of the system, the environment and the activities of the organisation that maintain this border by methods of organisational semiotics. The future study will focus on the implementation of the proposed framework.

Keywords: Organisational Semiotics, Autopoiesis, Responsiveness

1 Introduction

Small and Medium Enterprises (SMEs) are facing constant changes in consumer preferences. A number of competitors and a market size are some factors which impact on how SMEs should respond to changes in the competitive environment [1]. The definition of responsiveness has been used in a wide range of fields as quality to react positively and quickly [2], and responsiveness of organisations has been seen as the ability to recognise changes and act on them [3]. However, the current approaches of responsiveness have been focused on reactions to certain changes, such as customer needs [4], suppliers [5, 6] and supply chain [7], without providing a holistic understanding of which degree of the organisation can support these changes and why. Although responsiveness of organisations is not seen as a competitive advantage like agility, which included the speed of change and the flexibility of infrastructure to change [3], responsiveness should be seen as a basic capability of organisations that allows adaptations and modifications without affecting their current strengths. Autopoiesis as an explanation of life in living systems reveal why living things

maintain their inner-organisations in spite of the environment's changes, and provide a basic explanation of which kind of responsiveness can be expected from living systems in order to survive. Current studies about autopoiesis in Information Systems (IS) point out some challenges of preservation of an identity after several changes [8] where the organisational image can play a significant role in the definition of the main features of the IS [9, 10]. These definitions explained some properties of an autopoietic system that can be applied to technical IS, e.g. avoiding a concrete analysis of the concept of production of signs and information to maintain an organisational border that response to the environment with components of IS. This paper provides a preliminary model of organisation based on the definition of autopoiesis to understand why organisations can be seen as living systems, and how their responsiveness should be analysed and designed in order to maintain the autopoietic relationships and structure.

This paper starts with the definition of responsiveness for organisations and living systems, using the definition of autopoiesis as the main engine of responsiveness in Section 2. Section 3 analyses the semiosis of organisation as an autopoietic process, followed by the proposition of the preliminary model of organisation in Section 4, using the cell-structure as a functional basis. Section 5 discusses the application of this theory, and followed by conclusions and future work in Section 6.

2 Responsiveness from Living Systems

Responsiveness of living systems can be defined as the ability of a living-thing to undergo a response [11]. This reaction must maintain the network of processes that allows the life or the autopoiesis of the living system [12]. Autopoiesis can explain why living systems define a set of thresholds to maintain this network of processes. For example, in the case of a cell, its autopoiesis needs a membrane to perform this network, which at the same time produces lipids and proteins to maintain the membrane [13]. The responsiveness of a cell could be defined as the threshold of an external stimulus until the cell reacts to maintain the autopoiesis. An example of this threshold is the Heat shock response to avoid protein damage, which is a biochemical response of cells to mild heat stress. In this case, the cell response is the production of the protein HSF1 that repair some protein damage, developing thermos-tolerance [14]. This reaction cannot be explained without the principle of autopoiesis to maintain the membrane. Thus, the definition of autopoiesis in the organisation can help the development of thresholds and capabilities to improve the responsiveness of organisations.

2.1 Kinds of Autopoietic Systems

According to [15], depending on a level of autonomy and dynamic, autopoietic systems can be classified in first, second and third order. First order autopoietic systems are basic forms of life like a prokaryote or eukaryote cell [13]. They possess the main features of autopoietic systems, which is the capability to produce their components (self-production) as a result of a network of processes. Some features of this kind of systems such as the maintenance of border and the relationship of their

components can be found in the autopoietic test proposed by [16]. Second-order autopoietic systems are meta-cellular organisms that are multicellular systems with the same lineage and structural couplings among them. This is possible if the regular interactions among autopoietic systems are sources of perturbations and compensations, where the participated systems do not lose their identity, creating a new unity. Examples of this kind of systems are human beings, animals and plants, which possess their own form of autopoiesis. Meta-cellular organism with nervous systems shows new forms of interactions such as abstract interactions and new inner-states as a result of their self-conscious, which at the same time is able to represent the world with abstract representations. Third-order autopoietic systems are societies of second-order autopoietic systems, which coordinate their acts by language. Communication makes the social coupling by means of linguistic perturbations and compensations among individuals, creating inner-regular interactions in the form of cultural acts [15].

2.2 Minimal Autopoietic Structure

The definition of autopoiesis does not say anything about the components, because autopoiesis emphasises the organisation or the network of processes of production of components over the structure [12]. However, it is possible to describe a basic structure of cells based on the concept of minimal cells, which use the self-production property to define the basic components to self-produce a membrane [17, 18]. The semi-synthetic minimal cell is an extension of this concept that defines the DNA, enzymes, ribosome, RNA, membrane and cytoplasm as basic components for self-maintenance, self-reproduction and possibility to evolve [19].

Additionally, according to [12] there are three kinds of relations of productions that constitute some basic structure. They proposed the following relations:

- Production of constitutive relations: there are components that maintain the topology or physical space. The network of processes of production of these elements constitutes the topology of the autopoietic system
- Production of specificity relations: There are components that specify the creation of other components. The network of processes of production of these elements determines the identity of the components of the autopoietic organisations
- Production of relations of Order: There are components that regulate the points of meeting among processes. The network of processes of production of these elements determines the relations of order among the other processes

These relations describe the following components:

- Topological Components: The main function is the topological deployment of other components. Although membrane is a good example of these components, there are active sites in enzymes that fit with this description
- Creational Components: There are components such as DNA, RNA and enzymes with the capability to produce other components
- Control Components: There are components such as metabolites and enzymes with the capability to control the speed of the production of elements

Thus, there are components such as enzymes with more than one function. Table 1 classifies the components of the minimal cell with the components described from the autopoietic relations, and the function of these components into the cell.

Table 1. Relation between component and their classification

Component	Function	Kind of Component	Specification Relation
DNA	Replication	Creational	Specification
RNA	Message of protein synthesis	Creational	Specification
Enzymes	Catalysis	Creational and Control	Specification and Order
Ribosome	Protein Synthesis (translation of RNA into protein)	Creational	Specification
Membrane	Maintenance of cellular environment	Topological	Constitutive
Cytoplasm	Provide a Solver System and help the movement of food	Topological	Constitutive

Therefore, it is possible to define components based on the three relations of production, where creational and control components can be divided into message, control and production components. The creation of components in an autopoietic system conjugates these three relationships, because it is created a specific component in a specific physical space controlled by components produced by the cell.

3 Information Systems as Organisational Semiosis

3.1 Semiotics Implications of Sign, Data, Information and IS

The understanding of information, data and interpreter can be made with the division of Peirce among interpreter, sign and object [20]. Signs from the perspective of semiotics can be anything determined by an external object and the effect of them upon a person (interpreter). This division defines an object with an independence of the observer and his/her knowledge, where the full understanding of an object can be made with a chain of signs [21]. According to [22], there are intrinsic relations among information, events and signs. Events like objects are independent of an observer, and they can be stored and transmitted as signs by the environment and people. Data of an event can be seen as a collection of signs, which can be stored or transmitted as information. Thus, data is a kind of representation of events. On the other hand, information is a human process of sense making related to semantics, pragmatics and social world, which interprets signs or data as events in the daily life [23]. Fig. 1 shows this relationship among events, data, sign and information, where the process of semiosis in the organisation is the process of sense making or understanding of external events, which are perceived as a collection of signs. The organisation has a role of interpreter of these signs to see the events as objects, which could be an abstract representation of the event or another sign that trigger the process of semiosis again. The organisation as the interpreter is affected by previous knowledge, which can be norms, culture and other events that restrict the behaviour or the possibility for

reaction. This background knowledge can be updated as a result of this process and the information about events can open the possibility to react in the form of action or events that at the same time creates new signs. Examples of previous events that can shape the organisational behaviour could be the membership of people in different positions, the acquisition of new technology, changes in the regulation or changes in the competence. For this reason, the responsiveness of external perturbations is limited to the understanding of events or previous semiosis, which restricts or enables this capability for reaction.

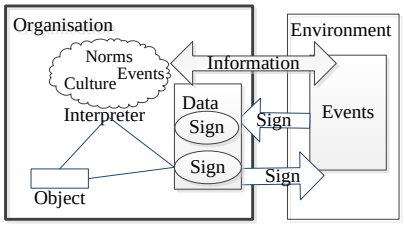

Fig. 1. Organisational Semiosis and the Responsiveness through Signs

According to [20], organisations can be seen as IS, where a set of norms can define the manner of behaving. There are informal, formal and technical norms, where the informal norms are beliefs and goals which are the first definition of the phenomenon named organisation. When a set of clear agreements are made, formal and technical norms formalise the messages of organisations, but in practical terms, they are the understanding and control of this phenomenon. This process of understanding of the organisation as a phenomenon, which starts from the informal layer shapes a set of data from events as formal and technical norms, creating information as a constant process of semiosis.

3.2 First Order Autopoietic System

Responsiveness of organisations depends on capabilities to response through signs, which can be analysed from the biologic perspective of autopoiesis. Organisational onion can simplify the analysis, focusing on the technical and formal layer [23]. The algorithm of six points proposed by [16] can help to analyse systems as an autopoietic system, starting with the analysis of the border and finishing with the analysis of interaction in the network of interactions. Information systems can be seen as autopoietic systems, because the lack of physical boundaries results in a boundary based on the information that is produced by the organisation. Referring to Fig. 1, technical and formal activities are not possible without an understanding (information) of previous events (data). Fig. 2 shows the self-definition of identifiable components such as contracts and inventory that can be used in the activities that interact with the environment. These components lead deterministic interactions from previous data or agreements, which can be connected in specific contexts. For instance, the sale activity as a context contains pre-defined signs such as contracts or inventory (norms, tasks or data) that are linked with components of the border,

resulting in actions that create signs and information (receipt). Finally, the components that are not self-produced by the Information System are directly related to the process of generation of information. For instance, the inventory represents the acquisition event and participates in the sales action as a response to customer needs.

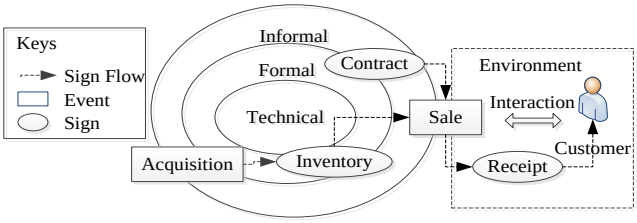

Fig. 2. The Role of Signs in Autopoiesis

Although IS has fitted their features with the autopoietic test, this analysis was made under ideal conditions. For instance, the theoretical division in layers of technical IS can be argued if a technical IS does not have this division. Therefore, the responsiveness of autopoietic systems can be summarised as the capability to maintain its border in spite of environmental perturbations.

4 Preliminary Model of Organisations as Living Systems

Under the assumption that organisation can behave as living systems, Fig. 3 shows an autopoietic model of organisations based on the division of functional components of a minimal cell and the components of an organisation based on organisational semiotics such as the definition substantive, control and communication behaviour.

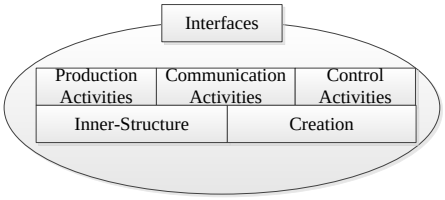

Fig. 3. Autopoietic Model of Organisation

The main components of the model described as follows.

- Interfaces: These components are inspired in the membrane and represent the interactions that the IS must consider with the external environment such as the interchange of matter and energy. The main sources of interactions are customers, suppliers and other stakeholders such as government (i.e. custom and revenues) and partners. Initially, the border of the organisation is defined by the purpose of the organisation, and the activities that interact with the environment with physical and social consequences. The components of the

organisation that participate in the border activity are agents, substantive activity, control and communication.

- Creation Components: These components are inspired on the DNA, and they define the aim of the organisation. Some examples are which product or service is produced, which raw material or organisational product/activity is needed to interact with other stakeholders. It is important to highlight that DNA or creation components control the specification of each component of the organisation and the internal coherence in the form of meta-norms [24]. Meta-norms self-regulate the organisation as a result of the process of adaptation from the environment, because they look the environment in order to prepare or change Meta-norms of organisation for new interactions. For instance, the (re)definition of the strategy is not directly involved in the production, but it would affect the production activities.
- Inner Structure Components: These components are inspired by the Cytoplasm. The inner structure is composed of structural components that define order or hierarchy of the organisation such as hierarchy of communication, the division of departments and the assignation of agents in certain positions. This inner structure is mainly static and defines who the boss of whom is.
- Communication Activities: These activities are inspired by the RNA. These activities are named coordination tasks, because they are not directly involved in the production of product/services, but they are also significant to the organisation. These activities can be basic activities to coordinate processes, but in a complex organisation, there are workflows, which is a composition of communication power and tasks.
- Production Activities: These activities are inspired by the Ribosome. These activities are the substantive tasks that are involved in the creation of product/service of the organisation.
- Control Activities: These activities regulate task and behaviour of the members. There are several classifications of norms, for instance, it is possible to classify according to the control of human behaviour, the effect of execution and the object that is applied [20]. Thus, norms are capable of controlling every aspect of the organisation from their informal conception to their technical application.

These components can create a structure of the organisation, which is based on the minimal components to perform the autopoiesis of a cell. Although, the autopoiesis of organisations have been explained from the perspective of Information Systems and the generation of information, the self-description of these components are the image of the organisation, and their relationships can define a new form of autopoiesis from an abstract perspective. For instance, goals are related to tasks, and the strategy can define new goals. These cycles that generate new organisational signs and new information can be seen as a new perspective of autopoiesis.

5 Discussion

The autopoietic model represents an abstract level of the organisation, but its general features can be applied to any organisations. Companies with several changes during their life can be experimented to study the activity change after different states. An example of this kind of company is Rolls-Royce, which has changed its border activities from a good-dominant (GD) logic to a service-dominant (SD) logic due to the decreasing of the original equipment market. The competitive market with high investment in technology and R&D has pushed to Rolls-Royce into the implementation of the total customer's care system, which means that the business is also focused on the services of aftermarket such as maintenance and repairs of jet-engines [25]. The autopoietic components of Rolls-Royce are:

- Interfaces of Rolls-Royce: Every division of Rolls-Royce provides contracts that include the maintenance, repair and overhaul of their products, making the 50% of the revenue of the company [26]. The customer's activities are related to the selling of product and services, which are focused on the creation of customer solutions in the form of product and service such as flight hours. The strategy of suppliers of Rolls-Royce is more complex than the procurement of products, but this activity can be seen as a key activity of the border.
- Production Activities: The production of engines is the main activity of civil aerospace division, but also they need goods from the suppliers. For the procurement activity, the supplier selection and segmentation are the activities that can provide new suppliers to maintain this dynamic. The maintenance activity as the border needs the data and strategy from engine health monitoring.
- Control Activities: Part of the control activities are the management of portfolio products, Inventory Management, Inventory Management for Aftermarket service parts and Production Management [26]. All processes of Rolls-Royce are controlled by the flow of cash and financial indicators [27]. Additionally, Rolls-Royce works with several quality standards such as six Sigma, robust design and optimization [28] that measure the production activities.
- Communication Activities: Communication activities can be seen as a part of production and controls activities. For example, production activities are connected with a central ERP system, which spread the current state of inventory [27].
- Inner-Structure: The inner-structure of Rolls-Royce is the division of business units. There is a strong relationship among the production of engines and the maintenance or after service activities.
- Meta-Norms: The meta-norms of the organisation can be seen in the strategy that is focused on the customers, innovation and growth [29]. An example of this application is the innovation, which is reflected in all activities like the collaborative product development.

The autopoietic capabilities of Rolls-Royce are reflected from 1) their management of the suppliers, including the selection and segmentation of new suppliers, in order to maintain this dynamic; and 2) the application of meta-norms, like innovation, to

govern their collaboration with the suppliers. Therefore, it is possible to find some behaviour of cells into organisations, and organisations with good practices like Rolls-Royce shows internal activities that maintain the border of the organisation.

6 Conclusion and Future Work

Autopoiesis can explain why living-things have responsiveness, and the definition of autopoiesis from the organisational semiotics can be useful to describe the elements of organisations that are essential in the maintenance of border through the change. The definition of interfaces as the core activities that interchange matter and energy, the set of activities to control, communicate and produce the elements of the border can be seen as an approach to review and understand organisations, their elements and relationships that allow the adaptation. The role of signs is the understanding of organisations as autopoietic systems, which create signs, depending on the current sign structure. Under these conditions, the responsiveness of organisations can be improved with the analysis of the impact of signs and their changes between technical and formal layers, and also among the signs in the interfaces with other kinds of activities in the autopoietic model of organisation. The next stage of this work is the identification of the relationship among these components, and the application of these elements in the analysis of signs of organisations. One of the problems in the design of technical information systems and the analysis of the capability to change is how the connections in the formal layer can be reflected into the technical layer. It is accepted that technical information systems can promote the adaptation, which can be seen in the communication activities, but there are several technical solutions such as three layers architecture or service oriented architecture that promote the flexibility of technical IS, without considering the real capability of the organisation. This work is the first attempt of this understanding.

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