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La sottoscritta **Pisano Paola**
(cognome) (nome)

codice fiscale **PSNPLA77A44L219G** nato a **TORINO** prov. (**TO**) il **4/1/1977**

residente a **TORINO** prov. (**TO**) in **CORSO MARCONI** n. **20** c.a.p. **10125**

telefono: **3357243792** e-mail paola.pisano@unito.it

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Open Organization Model Diffusion : The Main Field Analysis Approach

Paola Pisano[1], Daniele Manini[1], Marco Gribaudo[2] and Marco Pironti[1]
[1]Computer Science Department, University of Torino, Torino, Italy
[2]Electronic and Information Department, Polytechnic of Milano, Milano, Italy
pisano@di.unito.it
manini@di.unito.it
gribaudo@elet.polimi.it
pironti@di.unito.it

Abstract The objective of this research is to show a new methodology for modeling phenomena present in complex economic systems. The case study we analyzed is the adoption of open organization model among firms operating in a particular industry. A firm with an open system model creates and captures value taking advantage not only from the internal resource but also from external. The organization could approach to open model acquisition using different focus: external focus namely looking out of its boundary, acting and reacting to competitor innovation, costumers' changing, demand growth, or internal focus remaining inside its boundary improving its best capabilities ignoring what happened outside (Vagnani 2010). The actors involved are firms, customers and suppliers linked together thought a business to business model. The methodology is based on an Object-Oriented Analysis Field Model that allows to intuitively describe systems characterized by a large number of objects that interact, as in this case of a system composed by different organizational entities. The system simulation allows to analyze how the actors influence the acquisition and diffusion of the open organization model. This approach permits, for the generation of different classes of objects, to represent all actors involved in the evolution of the system and to define the dynamics that determine their interaction. The solution of the model can be approximated using the Mean-Field analysis technique (Kurtz 1978), following the results proposed in (Bobbio 2008). A qualitative result is illustrated in order to show the applicability of the proposed methodology and to emphasize its relevant features: flexible modeling approach, capacity of solving complex systems and output management facilities. The presented model is comprehensive and its scope is wide; it could be used to study the behavior of enterprises changing model in many different scenarios and situations. In future works quantitative results will be given, and different situations will be analyzed.

Keywords: diffusion, open organization model, internal focus, external focus, mean field analysis.

1. Introduction

In the modern economy the organizations have to respond in efficient and rapid way to the environment variation or rather to the global competition of firms, new or different needs of customers and change in the law and rule of the industry in which the business is developed. The organization could approach to strategic problem using different focus: external focus namely looking out of its boundary, acting and reacting to competitor innovation, costumers' changing, demand growth, or internal focus remaining inside its boundary improving its best capabilities ignoring what happened outside (Vagnani 2010). The diffusion of organization business model is influenced by the organizational internal or external focus: firms with an internal focus will absorb business model more slowly and rarely than organization with external focus.

In our work the actors propensity to acquire a business model is described using the mean field analysis approach (Kurtz 1978). The Mean Field Analysis methodology allows to intuitively describe systems characterized by a large number of objects that interact, as in this case of a system composed by different organizational entities. This approach permits, for the generation of different classes of objects, to represent all actors involved in the evolution of the system and to define the dynamics that determine the entities' interaction. After a literature overview (Section 2) on the basic (open organization, organization diffusion, and market orientation: internal or external focus) the paper will describe a new methodology approach (Section 3) for studying phenomena like business model diffusion (Section 4). The qualitative results (Section 5) shows the behavior of internal and external organization in the presence of a changing of leader organization.

2. Literature overview: open organization diffusion among different focus's firms

2.1 Open organization

An open system model is a model in which the firm creates and captures value taking advantage not only from the internal resource but also from external. For defining open organization model Chesbrough (2006) identified some organizational characteristics. First of all in open organization model, firms commercialize external (as well as internal) ideas by deploying outside (as well as in-house) pathways to the market. Specifically, companies can commercialize internal ideas through channels outside of their current businesses in order to generate value for the organization. In addition, ideas can also originate outside the firm's own labs and bring inside for commercialization: “valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well” (Chesbrough 2006a) Second, the companies have to be able to screen their ideas: in any R&D process, researchers and their managers must separate the bad proposals from the good ones so that they can discard the former while pursuing and commercializing the latter. Both the closed and open models are adept at weeding out "false positives" (that is, bad ideas that initially look promising), but open model also incorporates the ability to rescue "false negatives" (projects that initially seem to lack promise but turn out to be surprisingly valuable). Third, the firm’s value is contingent upon its ability to create and lay claim to knowledge derived from participation in various kinds of collaborations with other actors. Scholars writing along these lines have developed important findings in terms of how certain network structures influence firms behavior and performance (Ahuja 2000, Baum 2000, Gulati 2000). Relationships with other actors help firms to absorb technology (Ahuja 2000), improve survival rates (Baum 1991) increase innovativeness (Baum 2000), improve performance (Hagedoorn 1994; Shan 1994) and grow faster (Pawell 1996, Stuart 2000). Creating and sustaining ties with other actors constitutes a relational capability and creates benefits for firms that master it (Lorenzoni 1999).

2.2 Organization diffusion

The diffusion of the open organization model among the companies could be compared to the innovation process diffusion, in fact process innovation is defined as new elements introduced into an organization’s production or service operation to create a product or render a service (Ettlei 1992, Knight 1967, Hutterback 1975). The diffusion of open organization model shows as the spread of a set of process innovation, is difficult and slowly compare to product innovation’s diffusion. Myers and Marquis (1969) reported that industrial firms adopt approximately three times more product than process innovations, and in a survey of executives. Strebel (1987) supported (1969) results and reported that firms adopt more product than process innovations in every stage of their life cycle. Process innovations, on the other hand, tend to be more systemic in their impact and their adoption is often more disruptive than product innovations because they usually involve larger aggregate of tools, machines, people, and social systems (Tornastzky 1990) as well as changing in organization. In their meta-analytic review, (Tornastzky 1982) reported that innovation complexity has a negative relationship to innovation adoption. Successful applications of process innovations depend upon more widespread changes in organizational structure and administrative systems (Ettlei 1992) while product innovations are more specific to the industry and less specific to the adopting organization; thus, competitors can reverse engineer product innovations more quickly than process innovations. The perception of the advantage of process innovations’ acquisition could depend on the degree of market orientation of the firm: more the firms is interest in what happen out of his boundary more could perceive the advantage of a new business model.

2.3 Market orientation: internal and external focus

Many researcher consider the market orientation from the first years of 1990 until now (Jaworski 1990, Narver 1990, Jaworski 1993, Day 1983) There are two most frequently administered market orientation scales, both of which have three components. The MARKOR scale (Kohli 1993) assesses the extent to which firms acquire, disseminate and respond to customer and market information. Narver and Slater (1990) scale assess the extent to which firms are customer oriented, competitor oriented, and interfunctionally coordinated. The measures in both scales are broad in scope and are designed to truly capture an ‘‘orientation’’ rather than specific processes, systems, and procedures. For Hunt and Morgan (1995) market orientation is a resource and like every resources are usually tacit, socially complex, and non substitutable. Capabilities are bundles of more specific skills, procedures, and processes that can leverage resources into competitive advantage. Resources alone are insufficient to create competitive advantage. It is the combination of resources and matching capabilities that leads to competitive advantage. Day (1983) suggested that the degree of market orientation possessed by an organization is positively correlated with its capabilities to support and sustain behavior conducive to the development of this orientation (Narver 1990). Many scholars start to analyze the marketing orientation focalizing more on costumer orientation or competitor orientation. A customer-oriented firm that closely monitors customers’ needs tends to improve creativity enhancing organizational innovations through the firm’s entire business system (Deshpandè 1993, Gatignon 1997, Han 1998). A competitor-oriented firm tends to monitor progress against rival firms continuously, which can lead to opportunities to create products or programs that are differentiated from those of competitors. Vagnani and Simoni (2010) made one step more in the research of market orientation, costumer and competitor orientation moving to external and internal focus: an organization has an internal focus when makes action and reaction moving by improving internal (e.g. cost reduction, quality improvement, new product development) or external parameter (e.g. sales, profitability, growth, value creation). An organization has external focus when make action and reaction moving by the change of external environment (eg: competitor, new costumers need, shareholder, shareholders, suppliers).

3. Object oriented like mean field analysis

An Object-oriented like Mean Field Model is a representation that describes the behavior of a system as a collection of a large number of interacting objects. Objects are divided into classes: all the objects belonging to a given class have exactly the same behavior characterized by exactly the same parameters. If two objects perform the same actions at different rates, they must belong to different classes. Objects might be influenced by the distribution of the other objects in the system. Each object is modeled by a Continuous Time Markov Chain (CTMC), whose transition rates may depend on the state of the whole system. A CTCM is a mathematical description of a simple Stochastic process, characterized by a state, whose dynamic behavior depends only on its current state. In order to ease the description of complex systems, classes are further grouped into meta-classes. All the classes that derive from the same meta-class are characterized by the same structure, but different rates. The number of objects in every class changes dynamically: new objects might be formed at a given rate (expressed as quantity of new objects created per unit of time), and each object has an exponentially distributed maximum lifetime. More formally, we call an Object-oriented like Mean Field Model M, a tuple:

$$M = (MC, OC) \tag{1}$$

Where $MC = \{\mathrm{mc}^{(1)}, \ldots, \mathrm{mc}^{(k)}\}$ is a set of k meta-classes and $OC = \{\mathrm{oc}^{[1]}, \ldots, \mathrm{oc}^{[m]}\}$ is a set of m object classes. Each meta-class $mc^{(i)}$mc is in turn defined by a tuple:

$$mc^{(i)} = (c^{(i)}, n^{(i)}, L^{(i)}, \Lambda^{(i)}, C^{(i)}, b^{(i)}, D^{(i)}) \tag{2}$$

Where $c^{(i)}$is a label corresponding to the name of the meta-class, $n^{(i)}$is the number of states of the CTMC, $L^{(i)} = \{ \mathrm{l}^{(i)}\}$ is a set of labels (the names of the states) and $\Lambda^{(i)} = \{\lambda_1^{(i)}, \ldots, \lambda_{p_i}^{(k)}\}$ is a set of formal parameters. $C^{(i)} = |c_{ul}^{(i)}|$ is the $n^{(i)} \times n^{(i)}$ infinitesimal generator of the CTMC where $c_{ul}^{(i)}$ is the transition rate from state *u* to state *l*. $b^{(i)} = |b_l^{(i)}|$ is the size $n^{(i)}$ birth vector: its element $b_l^{(i)}$ represents the rate at which new objects are created in state *l*. $\mathrm{D}^{(i)} = \mathrm{diag}(\mathrm{d}_{\mathrm{ll}}^{(i)})$ is a $n^{(i)} \times n^{(i)}$ diagonal matrix, such that $1/\mathrm{d}_{\mathrm{ll}}^{(i)}$represents the mean exponential lifetime of an object in state *l*. The entries of $C^{(i)}$, $b^{(i)}$ and $\mathrm{D}^{(i)}$ may depend on the actual values assigned to the parameters Λ . An object class $\mathrm{oc}^{[j]}$ is also a tuple:

$$oc^{(j)} = (o^{(j)}, c^{(j)}, \Gamma^{(j)}, \mathrm{N}^{(j)}, \pi_0{}^{(j)}) \tag{3}$$

Where $oc^{(j)}$is a label representing the name of the class; $c^{(j)}$is name of the meta-class from which the class derives; $\Gamma^{(j)} = \{\gamma_1^{[j]}, \ldots, \gamma_{p_i}^{[j]}\}$ is the set of actual parameters assigned to each of the formal parameters of the meta-class defined by $\Lambda^{(i)}$; $\mathrm{N}^{[j]}$ is the initial number of objects; $\pi_0^{[j]}$ is a probability vector of size $n^{[j]}$ that defines the initial state probability for the objects belonging to this class. We define $n^{[j]}$ as the number of states of class j inherited from its meta-class, that is $n^{[j]} = n^{(\text{meta-class of j})}$. Note that we use round brackets in superscripts for elements corresponding to meta-classes and square brackets to denote elements belonging to classes. The value of each actual parameters can depend on the distribution of the number of objects among the states of all the classes that compose the model. The state space growths exponentially in conventional compositional approaches whereas our mean filed based methodology provides approximations of the system that scales linearly with respect to the number of objects.

Thanks to the previous assumptions, the solution of the model can be approximated using the Mean-Field analysis technique (Kurtz 1978), following the results proposed in (Bobbio 2008). In particular the counts of the number of objects in each state are approximated by continuous variables, that are expressed by means of a set of ordinary differential equations. The solution of such equations, which is obtained using a suitable numerical algorithm, describes the evolution of the model.

4. Modeling the open organization diffusion by object-oriented like methodology based mean field analysis

In this section we first describe how we define the open organization diffusion phenomenon and then we provide the process we adopted to develop the corresponding mean-field based model.

4.1 The open organization diffusion model

The Open Organization’s diffusion considers different types of organization that have singular behavior

regarding the assumption or not of the open model by the actors. Organization with external focus (namely external organization) takes into account the business model of the competitor, market leader, supplier and costumer in the develop of new business model. If the number of open organization actors is high, then the external organization moves the business model from non-open organization to open organization. Vice versa an internal organization shifts its business model regardless of other organizations. It is obvious that the leader's behavior has an important impact on the assumption of the open organization model. If leader has an open organization model, the external organization moves faster to open organization model than if other organizations assuming the same model. Beside, the organizations with internal focus (namely internal organization) changes business model with a very low rate due to their market orientation or rather making action or reaction moving by internal (e.g. profit increase or cost reduction) or external (e.g. market share growth) parameters but never by the change of the environment. Different traceability has leader behavior that assumes an open or not open model independently from the environment and it mainly focuses on the internal best assets. Customers and suppliers decide to switch to the open model looking not only the behavior of other similar organizations (costumer and suppliers) but also external or internal organizations behavior. In fact, the importance of changing organization model can be underlined through the impact on the supplier and costumer's capacity to do their business (buying or selling service or products).
The mean field methodology used for outline the open organization diffusion model can be summarized in three steps. First, we identify the different types of entities that compose the system and we abstract their behavior into meta-classes. Second, we define the Markov chains and the formal parameters of the meta-classes. Finally, we define a class for each type of entity. Each class is derived from a meta-class by assigning appropriate rates to the formal parameters. The class objects represent the actors of our model.

4.2 A First-Step: classes and meta-classes identification

We first identify the entities (classes) that characterize this phenomenon, and we look for similarities to abstract their behavior and to define an appropriate number of meta-classes. We decide to define our model through five actors grouped in two meta-classes*: Leader* and *Organization* (see Table 1).

CLASS	META-CLASS
Organization Leader	Leader
Internal Organization	Organization
External Organization	Organization
Costumer	Organization
Supplier	Organization

Table 1: The model classification.

The meta-class *Leader* has just one class that is the *Leader Organization* assuming that its behavior does not acquire external or internal focus. The organization has four classes that are: *Internal-Organization, External-Organization, Supplier* and *Costumer.* The difference between *Internal* and *External-Organization* depends on the market focus oriented approach where as the *Costumer* and *Supplier* belong to business to business organization. Every classes include an initial number of objects that defines the amount of the actors at time instant t=0.

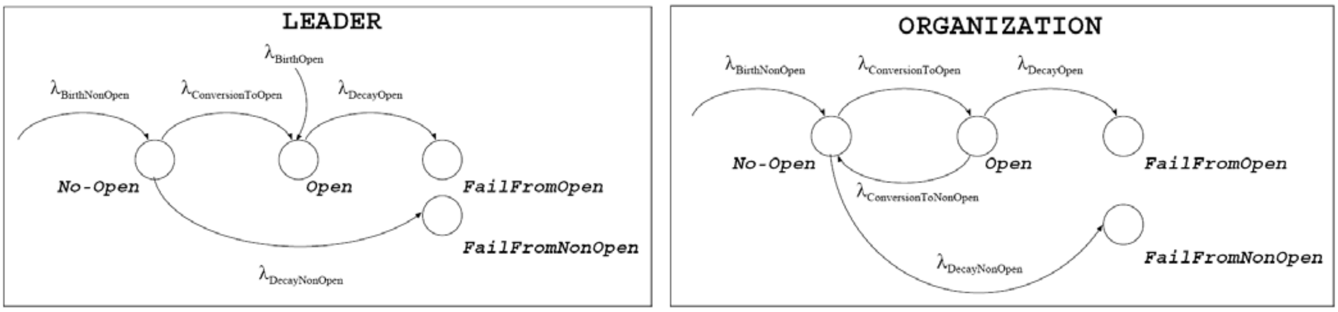

Figure 1: The CTMCs of leader and organization metaclasses.

4.3 Second-Step: meta-classes specification

Afterwards we define the Markov chains (depicted in Figure 1) corresponding to the meta-classes identified before. *Leader* can be in the following states. *NonOpen* (if it has a non-open organization model), *Open* (if it has ad open organization model), *FailureFromOpen* (if the leader fails after assuming open organization) and *FailureFromNonOpen*: (if the leader fails with non-open organization). The transition among the states depend on the rates λ influenced by a set of variables and constants. The presence in the Open Class occurs with *λBirthOpen* while the presence in the *NonOpen* state depends on rate *λBirthNonOpen*. The switch from *NonOpen to Open* occurs with rate λ*ConversionToOpen.* Moreover the switch from *Open* to *FailFromOpen* happens with rate *λDecayOpen.* The switch from *NonOpen* to *FailFromNonOpen* occurs with rate *λDecayNonOpen*.

In this type of process the leader switch between open or not open organization depends on an exogenous variable. The exogenous variable can be the culture of the organization, the attitude to one or other model, the time that helps the organization to acquire one model and, in case of strategic result less than expectation, to change it (the conversion from *nonOpen* to *Open*). In order to simplify the proposed model the only variable that we consider it is the time.

Organization can be in the following states *NonOpen* (if has a non-open organization model), *Open* (if has ad open organization model), *FailureFromOpen* (if the organization fails after assuming open organization) and *FailureFromNonOpen*: (if the organization fail with non-open organization). The transition among the states depend on the rates λ influenced by a set of variables and constants. The presence in the *NonOpen* state depends on the rate *λBirthNonOpen*. The switch from *NonOpen to Open* occurs with rate λ*conversionToOpen.* Moreover the switch from *Open* to *FailFromOpen* happens with rate *λDecayOpen.* The switch from *NonOpen* to *FailFromNonOpen* occurs with rate *λDecayNonOpen*. Beside the transition from *Open* to *NonOpen* occurs thanks to λ*ConvertionToNonOpen.*

In this case the switch between the open or not open status depends on the organization strategy. The organization can decide not only to move from *NonOpen* to *Open* (changing the business model) but also to return from *Open* to *NonOpen* in case of unsustainability of the model.

All the meta-classes presented above can be formally expressed using the tuple reported in (2).

4.4 Third-Step: classes and parameters specification

The crucial phase of this work is the definition of the rates that determine the relations and the interactions among all class actors of the model. The formal rates (depicted in Figure 1) must be instantiated for each class. In the following we focus on the formalization of class *External Organization* and on the definition of the actual rates that determine the behavior of this class. The class can be formally expressed using the tuple reported in (3):

$$oc^{(3)} = \{EnterpriseExternal, Organization, \\ \{\lambda_{BirthNonOpen}, \lambda_{ConversionToOpen}, \lambda_{ConversionToNonOpen} \\ \lambda_{DecayOpen}, \lambda_{DecayNonOpen}\}, 50, \\ |0.5 \quad 0.4 \quad 0.1 \quad 0.0|\} \tag{4}$$

where $EnterpriseExternal$ is the name of the class, $Organization$ is the name of its meta-class. The third term lists the actual parameters assigned to the formal parameters indicated by the *Organization* meta-class. $N = 50$ indicates the initial number of actors in this class and the last term is the initial state probability vector (in this case the actors are initially split in the four class states).

We now illustrate the criteria adopted to define the rates $\lambda_{BirthNonOpen}$, $\lambda_{ConversionToOpen}$, $\lambda_{ConversionToNonOpen}$, $\lambda_{DecayOpen}$, and $\lambda_{DecayNonOpen}$, and then we show the function used to compute $\lambda_{ConversionToOpen}$. Let us see the Enterprise External parameters:

- $\lambda_{BirthNonOpen}$ depends on the industry stadium. If the industry is in the embryonic stadium the birth rate is less than in the develop stadium. In the maturity no organization is born in the industry and in the decline stadium the organization starts to fail.
- $\lambda_{ConversionToOpen}$ depends on the leader behavior and on the other organizations behavior: if the leader assuming open organization model or the number of open organization is greater than the number of non-open organizations, the rate of change from non-open to open will be high.
- $\lambda_{DecayOpen}$ is a constant in order to focus the attention on the switching between non-open and open states.
- $\lambda_{ConversionToNonOpen}$ depends not only on the number of organizations, costumer, supplier and leader that are in the non-open state but also from the number of organizations that are in the failure from

pen state.

- $\lambda_{DecayNonOpen}$ is a constant in order to focus the attention on the switching between non-open and open states.

For sake of brevity we only show how we calculate the rate $\lambda_{ConversionToOpen}$. Its function, reported in Table 2, is expressed by a meta-language.

if (*Organization Leader* has the open model) **then** *External Organization* actors change to the open model with a high rate **else** *External Organization* actors change to the open model with a lower rate that is function of both the actual percentage of *External* and *Internal Organization* actors with open model and the number of *External* and *Internal Organization actors* failed from non-open status.

Table 2: The function used to define $\lambda_{ConversionToOpen}$.

The functions definition determines the behaviors of the overall model and it is based on a series of assumptions. For instance, the description reported above takes into account the leader status, the percentage of open model organizations and the number of enterprises with non-open model failed. Note that it's possible to chose different functions sets in order to consider different behaviors and interactions.

5. Conclusion and qualitative results

In this section we present a qualitative result to explain the applicability of Mean-Field Analysis Model. The potentiality of this methodology can be resumed in three relevant features: flexible modeling approach, capacity of solving complex system, output management facilities.
The flexibility is obtained thanks to the multilevel model structure (split into meta-class, functions, parameter and model) that supports the execution of experiments for different economic systems. For instance, the meta-classes set proposed in this work permits to describe any economic model whose actors are included in other diffusion phenomena (e.g. product and process ones).
The flexibility of the approach can also be seen from the function and parameter levels. In fact, once the classes of the model have been selected, the use of different sets of functions and/or parameters allows to investigate various dynamics of interactions among actors. Indeed in this work we mainly focus on the change rate of business model from open to not open model, but a further model refinement can be also focused on other important issues such as enterprises birth and decay functions.
The modeling approach supports also different user's points of view. For instance, leaders and organizations can be represented as reported in Figure 1 but also with more detailed structures that account for other intermediate states the actors can reach.
Another potentiality of this methodology regards the capacity of analyzing the interaction among a huge number of organizations structured in a complex system. The intrinsic nature of this approach leads a more precise model when the number of actors grows and it is capable to compute the solution in reasonable time.
Finally the capacity to reproduce the result in a graphical format (the time evolution of the actors, are reported in a web page) helps the user to understand more intuitively the phenomena creation and diffusion as we see in the Figure 2. Furthermore the results are stored in a data file that can be displayed in a customized way.
The qualitative results reported in Figure 2 shows the behavior of internal and external organizations in the presence of a changing of one leader organization. The simulation interval length is equal to 9 time units. The dotted vertical lines indicate the states switching of the leader: the leader birth with non-open model (after 0.5 time units), the acquisition to open model (after 5 time units) and the failure (after 6.5 time units). The figure shows the impact of a leader changing model on both the external and internal organizations, by plotting the number of respective actors (y axis) as function of the time (x axis).
In a presence of one leader with non-open model, organizations with external focus tend to change the model from open to non-open. In fact the number of open organizations decreases from 20 to 4. When the leader changes is business model, the external organizations change model with an high rate moving the number of open organization from 4 to 35. It means that the organization change rate is higher in the presence of a leader with an open model. Finally the leader failure does not impact on the model change.
Otherwise the internal organizations are not affected by the leader status, in fact their number slightly grows regardless to the leader dynamics.
The presented model is comprehensive and its scope is wide; it could be used to study the behavior of

enterprises changing model in many different scenarios and situations. In future works quantitative results will be given, and different situations will be analyzed.

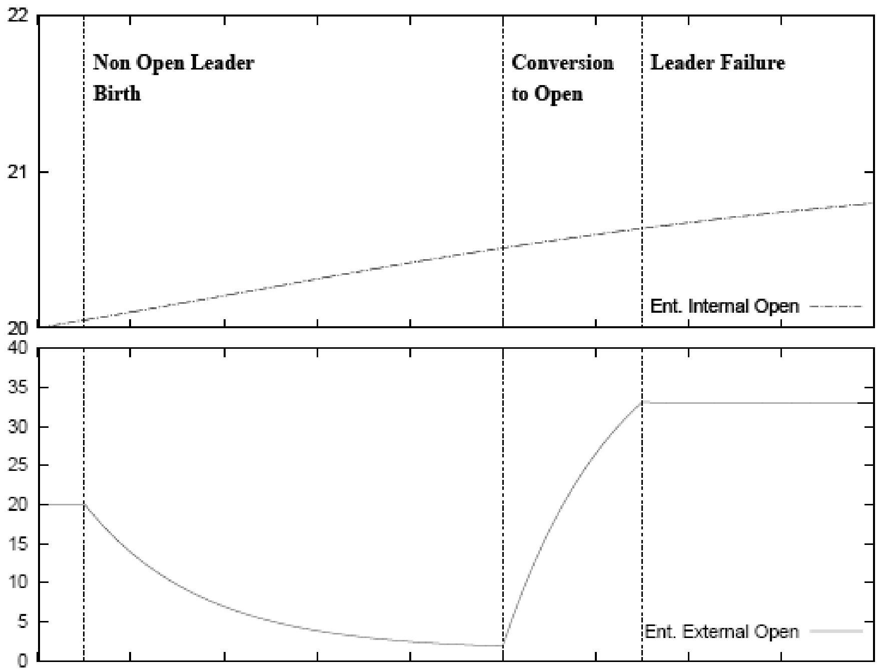

Figure 2: The time evolution of the number of internal (upper) and external (lower) organizations with open model.

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