Influence of franchise governance mechanisms on franchisee's local decisions about the environmental practices use: An NK simulation model

A1[1[]], A2 [2[]], and A3 [3[]]

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2

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Abstract. In this research, we find franchises a favorable field to contribute to the improvement of the environmental effects of human production and consumption. We focus on the analysis of the governance mechanisms present in the franchises and we carry out an NK model, where we generate an environmental landscape determined by the interdependencies (K) of the environmental practices (N) for different types of franchises according to the implementation of these practices. Thus, lagging franchises, followers, and leaders, each configure an environmental landscape, wherein a framework defined by the configuration of formal and informal governance mechanisms, four modes of governance are determined. We want to find out under which modes of governance, a greater exploration capacity is developed, where the local decisions of the franchisees influence the use of environmental practices and achieve higher values of environmental performance. After developing the NK model and running the simulations for each governance mode, we found that in governance modes where both types of mechanisms are combined, the exploration capacity is greater, allowing franchisees to explore and involve the use of practices. environmental in the franchise. We also find that, to achieve higher levels of environmental performance, for each level of implementation of environmental practices, it depends on the modes of governance, thus, for lagging franchises, where the use of environmental practices is lower, the formal governance mode reflects better performance, while for franchises that have more environmental practices in use, the more formal governance mode is more appropriate to achieve higher performance.

Keywords: Franchises, Governance Mechanisms, Environmental Practices, NK Model, Complexity.

1 Introduction

Climate change is one of the biggest environmental challenges facing humanity today. The increase in greenhouse gas emissions due to human activity is causing an increase

in global temperature, which in turn is having a significant impact on the planet's climate and ecosystems. Franchises can help address climate change by adopting sustainable environmental practices and encouraging their franchisees to do the same or vice versa.

Franchisors can set specific environmental goals in their franchise agreements, such as reducing greenhouse gas emissions and promoting more sustainable practices in their operations. Likewise, franchisees can propose changes and improvements in the franchise's environmental practices to help reduce their environmental impact. For example, they may suggest adopting more energy-efficient technologies, reducing food and material waste, and promoting sustainable transportation.

By implementing sustainable environmental practices, franchisees can not only contribute to addressing the problem of climate change but also improve their reputation and attract consumers who are increasingly sensitive to environmental issues. In addition, the implementation of sustainable practices can have long-term economic benefits, such as reduced operating costs and improved efficiency in the use of resources.

Now, the phenomenon described above, can be explained from the literature, and with the construction of an NK simulation model, it can be used as an instrument to answer the question: Can franchise governance mechanisms influence local decisions of franchisees on the use of environmental practices? To answer this question, first, the theoretical framework on which the NK model of this research has been built is developed. We begin with the term governance both in franchises and in environmental sustainability. It then focuses on the NK landscape, as a model that meets the conditions for this research. In addition, we define the environmental practices that will be part of the decisions that the franchisor can make in the structure of the NK model. In a later section the methodology applied for the NK model, the results and analysis, and finally the conclusions are developed.

1.1 Governance, environmental sustainability, and franchises

In the literature, the term "governance", seen as the interaction processes between strategic actors (Prats, 2003), is represented, among others, through structures and modes; and it is described from the implementation of formal and informal governance mechanisms. In the context of franchising, some authors describe governance through how power is distributed in the franchisee-franchisor relationship depending on various characteristics of the franchise (Jell-Ojobor & Windsperger, 2014). Other authors such as Windsperger (2013) describe a governance structure between own points and franchised points. From the Transaction Cost Theory approach, Williamson (1991) defines it as forms or structures of governance within the framework of institutions, which depend on the specification of transaction costs. Thus, Williamson (1991) defines three forms of governance: market, hybrid or hierarchical. Within this framework, franchises are defined as hybrid organizations and within this type of institution, four modes of

governance are described that Ménard (2004) defines as Trust, Relational Network, Leadership, and Formal Governance.

On franchise governance mechanisms, the literature (Zheng et al, 2019; Antia et al, 2017; Matinheikki et al, 2022; and Iddy 2019) describes formal mechanisms that generally associate them with "complete contracts" and informal governance mechanisms. to "socialization in franchises" (Antia et al, 2017) or "franchisor services" (Zheng et al, 2019) [1]. To operationalize these mechanisms, modeling variables are used that are characteristics of the franchises and that determine how the franchisors and franchisees are going to relate. Within these characteristics of franchises and for this model, the modeling variables that have been chosen are decision rights and the exchange of information, which depending on each mode of governance will specify how they behave in the franchisor-franchisee relationship (see section 2).

To address the issue of governance and environmental sustainability in organizations, the Green Supply Chain Management approach is used (Srivastava, 2007; Sarkis, 2012; Green et al., 2012). Within this literature, governance is generally defined through governance models, but also through formal and informal governance mechanisms. This means that some authors use one of the two ways to refer to governance. Thus, authors such as Vurro (2009) group these characteristics into models: Transactional, dictatorial, participatory, and permissive. Tachizawa & Wong (2015) and Giménez & Sierra (2013) work specifically with formal and informal governance mechanisms for environmental sustainability.

Based on these two major frameworks of the literature, to define a structure of governance and environmental sustainability in franchises, it is proposed to use the framework proposed by Ménard (2004) as the basis of the modes of governance for hybrid institutions, thus preserving the relationship that develops Vurro (2009) within the framework of environmental sustainability. The formal mechanisms are described based on the characteristics of "complete contracts"; and the informal ones, through "socialization in the franchises" (see section 2). The way to operationalize these mechanisms in the modes of governance is based on the characteristics of decision rights for complete contracts and information exchange for socialization in franchises. Next, Table 1 illustrates these relationships more precisely:

Table 1. Formal and informal mechanisms relations and governance modes for franchises. The "+" sign indicates how the decision rights are in the franchisee for each mode of governance.

Formal/informal mechanisms (Zheng et al, 2019; Antia et al, 2017;	**Governance modes for hybrid institutions (Ménard (2004))**			
	Trust	Relational network	Leadership	Formal governance

[1] These mechanisms "complete contracts" and "socialization in franchises" or "franchisor services" are developed in section 2. For this work, it has been decided to adopt the term "socialization in franchises".

Matinheikki et al, 2022; and Iddy 2019)				
Complete contracts	++++	+++	++	+
	Decision Rights in the franchisee (+)			
Socialization in the franchises	Information is shared between Franchisees and franchisors freely and randomly		The information that is shared is defined in the contract. There is no margin of freedom for the franchisee to share their information	
	Information sharing			

Table 1 shows the governance modes to be used for the NK model. The four modes of governance have been defined taking into account Ménard (2004) and are used in the model to define how franchisees and franchisors relate and make decisions. The formal mechanisms, which in the case of the model are "complete contracts" and the informal mechanisms which are "socialization in the franchises", are operationalized from two modeling variables, which are characteristics of the franchises: decision rights and information exchange, respectively. These modeling variables are the ones that define the decision rules in each of the governance modes. Later in numeral 3. Decision rules, the formal and informal mechanisms are defined and it is explained how these decisions are made in the NK model using the modeling variables.

1.2 Environmental practices (N), the interdependence of environmental practices (K), and Landscape NK.

As mentioned above, a theoretical framework has been developed in the literature to address environmental sustainability issues in supply chains and from there, the incorporation of governance mechanisms to manage environmental sustainability (Govindan et al, 2016). This environmental sustainability is directly related to the environmental practices that organizations introduce both in operational processes and management processes. The literature (Green et al., 2012; Zhang et al., 2018; and Assumpção et al., 2019) also shows that environmental practices can be internal (in the organization) and external (concerning the actors in Supply Chain). Table 2 shows the practices in each category.

Table 2. Internal and external environmental practices

Environmental practices – literature review	
Internal practices	1. Environmental management
	2. Sustainable product design
External practices	3. Green purchases →Suppliers
	4. Collaboration with clients
	5. Payback

However, depending on the practices that the organization is implementing, an interdependence is created between these practices and in turn a different scenario in each

combination. Several authors develop what these interactions between environmental practices are like (Kang & Hwang, 2017; Zhang et al., 2018; Ahmed et al., 2020; Zhu et al., 2019; Bakshi, 2019; Laari et al., 2015). This is because environmental practices are not isolated, but depend on each other to be implemented. Here the relationship between practices does not imply causation, but rather interdependence. In this way, the more environmental practices are implemented in the organization, the more interdependence is generated between the practices, which makes each scenario different and increasingly complex.

These scenarios are defined based on the environmental practices implemented in the organization, and according to the literature (Moreno-Mantilla et al., 2018; Ciccullo et al., 2020; Winston, 2014; Buysse & Verbeke, 2003; and Sellers, 2009), companies can be classified as laggards, followers and leaders. It is important to clarify that the literature develops different approaches to develop these three levels chosen in the model. On the one hand, there is a pyramid approach described by Ciccullo et al. (2020) which is equivalent to these three levels. On the other hand, there is a capabilities approach developed by Buysse & Verbeke (2003) and Sellers (2009) where they present how GSCM capabilities are built sequentially (it is useful for this model, as it is also related to the three levels mentioned). In the latter, a sequence of implementation of these practices is suggested that can finally be related to each level. Another approach defined by Zhu, Sarkis & Lai (2019) describes that depending on how the product life cycle is and where the company is in the supply chain, the practices that must be implemented are chosen. Based on this literature review and the different approaches, the authors who present an approach with the three scenarios for organizations are chosen: laggards, followers, and leaders.

To simulate these complexity scenarios according to the environmental practices implemented and their interdependence (Kang & Hwang, 2017; Zhang et al., 2018; Ahmed et al., 2020; Zhu et al., 2019; Bakshi, 2019 and Laari et al. al., 2015), the NK model is proposed. Various metaphors can be used to explain the NK model, we like to use the following example:

> Imagine that you are climbing a mountain and your goal is to reach the top. As you go up, you encounter higher and higher peaks and you must decide which one to climb to get closer to the top. In terms of the NK model, each peak represents a possible state of a complex system, and each escalation represents the selection of a specific configuration within that state. Each configuration is made up of different variables that interact with each other, and each of them has a degree of influence on the result. Just like on the mountain, there are different paths to take on the NK model. Some paths may lead to optimal results, while others may lead to a suboptimal solution or even a dead end. The key is to find the right path that leads you to the optimal solution.

The NK model proposed by Kauffman (1993) has been used in business strategy and organization studies (Levinthal, 1997; Rivkin, 2000; Gavetti & Levinthal, 2000;

Siggelkow & Rivkin, 2005), where the complexity of the phenomena modeled cannot be approached with conventional strategies that statically assess relationships between variables. In other words, the NK model captures component interdependence, in contrast to the variable dependency/independence structure in statistical models. Several authors have used the NK model to operationally represent different relationships that occur in the organization. These relationships can represent, for example, conditions of power within the organization and with other organizations. They also show how these relationships influence categories such as learning, incentives, coordination, and allocation of decision rights (Marengo & Pascuali, 2012; Dosi & Marengo, 2015). The NK model has also been used in the context of governance in supply chain management (Giannoccaro, 2010). This last study shows a reference for the phenomenon that is modeled in this work since it considers the configuration of the supply chain under different types of governance and configures the search rules in the NK landscape based on the characteristics of the relationships that exist between the actors of the supply chains. Likewise, Siggelkow & Rivkin (2005) also use the NK model where the organizational structure of the company affects the organizational search within the landscape.

The landscape is represented by N, environmental practices; and by K, the interdependence between these environmental practices. The three scenarios define the environmental landscape and the place where the franchisees search for aptitude or *fitness values*. Tables 3, 4, and 5 show the three scenarios proposed based on considering the interdependence between environmental practices. This interdependence, in this case, the "x" that appears in each box and that shows the relationship of one practice with another, will be explained in later paragraphs.

Table 3. Scenario for a *lagging* franchise

	Environmental management	Sustainable product design
Environmental management	x	
Sustainable product design	x	x

Table 4. Scenario for a *follower* franchise

	Environmental management	Sustainable product design	Green purchases → Suppliers
Environmental management	x		
Sustainable product design	x	x	
Green purchases → Suppliers	x	x	x

Table 5. Scenario for a *leading* franchise

	Environmental management	Sustainable product design	Green purchases → Suppliers	Collaboration with clients	Payback
Environmental management	x				
Sustainable product design	x	x			
Green purchases → Suppliers	x	x	x		
Collaboration with clients	x	x		x	
Payback	x	x	x	x	x

In the NK model of this work, environmental sustainability in the organization is conceived as a set of N binary decisions. That is, N can take two values, in the case of the model [0, 1]. A string of N digits represents a specific set of options (environmental practice choice settings) for $N = 5$; $a = (a_1, a_2, a_3, \dots, a_N)$ with $a_i = 0\ o\ 1\ (i = 1, 2, \dots N)$. Every decision a_i affects the overall environmental $P(a)$ *fitness of the organization*. The contribution (C_i) of each decision to *fitness* depends not only on the specific decision but also on how well the other decisions that interact with it (K) are satisfied. *Environmental fitness* has been named in this way, since it is determined by the relationships of environmental practices for each scenario, in other words, it configures the landscape in an environmental context. Thus, the environmental *fitness P(a)* is calculated as an average of each contribution *(C_i)* over the number of practices *N*. Equation 1 describes this relationship:

$$P(a) = \frac{\sum_{i=1}^{N} C_i(a)}{N} \qquad (1)$$

When $K = 0$, the contribution of each decision a_i is independent of the other decisions; when $K = N - 1$, the contribution of each decision a_i depends on all the remaining decisions. A *fitness* value is associated with each configuration option a. For this case, in the NK model, the possible searches can be defined using a^N; if *a* takes 2 values (0, 1) then they would be 2^N possibilities. In the case of leading organizations (see Table 5), N is the number of practices that can be implemented, that is, 5, so the maximum landscape of environmental sustainability would be made up of possible searches in the landscape, in this case, 2^5options $2^5 = 32$. These options are the mapping of the configurations of choice and it is what has been called the fitness landscape or environmental *fitness*. The goal of the search is to reach the highest peak in the landscape, that is, to identify the configuration option that produces the highest fitness value (global peak). Thus, the franchise is committed to an adaptive "hike" across the landscape in search of the global peak. The more rugged and multi-peaked the landscape, the more

difficult the search will be. The roughness of the landscape is determined by the number of interactions between decisions (K): the higher K, the more rugged the landscape (Kauffman, 1993). Furthermore, the higher K is, the average performance decreases, but the value of the global optimum increases (ie, the best performing options are scarcer, but provide a higher return) (Ganco & Hoetker, 2009). We will see later if these conditions are also fulfilled for our model.

After defining how the interdependencies between environmental practices (N), a pattern is created. This pattern is recorded in an N X N interdependence matrix, where each "x" at position *(i, j)* means that the decision in column *j* affects the contribution of the decision in row *i* to the fitness value. However, to generate the mapping of the options (that is, the landscape), each pattern is defined according to each scenario. For this model, the interdependence matrix or pattern of each scenario is shown in Tables 3, 4, and 5.

Then, a contribution is generated C_i for each possible combination of decisions, drawing it at random from a uniform distribution U [0,1] [2]. As indicated above, the contribution C_i depends not only on the choice of decision i (0 or 1) but also on the choice of K decisions with which it interacts. This means that in the case of K= 0, C_i it assumes only two values: all choice configurations with $a_i = 0$ will have the same C_i and all choice configurations with $a_i = 1$ will share a C_i different. When K=N-1, the contribution of each decision depends on how all other decisions are resolved, so C_i is different for any choice configuration.

The total value of each choice configuration a is calculated by averaging the N contributions (Kauffman, 1993; Ganco & Hoetker, 2009; Levinthal, 1997; and Rivkin, 2000). Therefore, the total *fitness value* is $P(a)$, equation 1.

Next, the explanation of the generation of the mapping will be made (Table 6), using as an example the scenario for a follower franchise (Table 4), where there is an interdependence matrix, for N=3, that is, an N X N = 3 X 3 matrix. Thus, practice a_1: Environmental management is independent, and its contribution C_1 will be independent of the values of the other practices. Then randomly it can be given a value in the uniform distribution and it will only change every time its value i changes from 0 to 1. This is reflected in the first column C_1 (Table 7). Whenever $i = 0$ appears, the contribution C_1 is 0.32, and when it changes to $i = 1$, C_1 =0.71.

For the practice a_2: Sustainable product design, it can be seen in the interdependencies matrix that a_2 interacts with a_1. Thus, the contribution of C_2 is also affected by how

[2]Typically, a uniform distribution over [0, 1] is used, since the focus tends to be on the order of the fitness value, and as N increases, the payoff distribution always converges to the normal one (due to the Central Limit Theorem) (Ganco & Hoetker, 2009). The reason for this is that the fitness value is calculated as an average of the individual values; in terms of the central limit theorem, it is equivalent to having a function of random variables whose distributions can be anything. Random variable functions are normal.

a_1 is resolved. As a result, C_2 is the same in all configuration choices where a_1 and a_2 assume the same value. For example, if 0 is assumed for a_1 and 0 for a_2, the contribution of C_2 will be the same, C_2=0.68. When the *i* value of a_1 or a_2 changes, their contribution also changes but will remain the same as long as they remain the same; thus, a_1=1 and a_2=0, the value will always be 0.43, until either of them changes. For the contribution of C_3, it can be noted that a_3 depends on a_1 and a_2, so the values for C_3 will always be different.

In this case (Table 6) we can see that there are several values of *K* in operation since they depend on the matrix of interdependencies. Thus, for each component a_i that belongs to N, there exists a value *K*. Then the fitness is calculated according to equation 2, considering the value of *K* for each a_i. Where C_i, the contribution of component *i* to the general performance of the system depends on its state and on the states of the K components with which it is interdependent.

$$P(a) = \frac{\sum_{i=1}^{N} C_i(a_i,\ldots,a_{i+k})}{N} \qquad (2)$$

In the NK model, one of the simulation objectives is to find the highest peak (optimal value) reached by the agent. In this case, it would be the combination of a_1 = 0, a_2 = 1, and a_3 = 0, which corresponds to a *P(a)* of 0.70. But other characteristics can also be found in the simulation, such as the degree of exploration (this point is developed further below in section 2). Thus, different search algorithms can be used to find the optimal value and each one will show a degree of exploration.

As an example, one of the algorithms that can be used to perform a search is explained below. First, it starts with a random choice at a point in the landscape, for example [1,0,1] (Table 7) with fitness 0.53 and then it begins to move by varying one of the values of the configuration string, for example, a_1, which goes from 1 to 0, resulting in the setting [0,0,1] with fitness 0.62. So, if the next value is greater than it will move to that value, if not it will stay in place. In this case, the agent would move. The agent is the one who is doing the walk in the landscape, for the model the agent is the franchisee who makes these movements. If the *fitness* were lower it could now vary to a_2 from 0 to 1, resulting in the setting [1,1,1], with *fitness* 0.54, leading to that also moving and so on until the highest value is found.

Table 6. Interdependence matrix for the scenario of *follower* franchises (see Table 4 too)

	a_1	a_2	a_3
a_1	x		
a_2	x	x	
a_3	x	x	x

Table 7. The environmental landscape for the *follower* franchises scenario is given by the inter-dependencies between environmental practices.

Configuration of choice			C_1	C_2	C_3	$P(a)$
a_1	a_2	a_3				
0	0	0	0.32	0.68	0.73	0.58
0	0	1	0.32	0.68	0.85	0.62
0	1	0	0.32	0.84	0.94	0.70
0	1	1	0.32	0.84	0.63	0.60
1	0	0	0.71	0.43	0.31	0.48
1	0	1	0.71	0.43	0.44	0.53
1	1	0	0.71	0.35	0.78	0.61
1	1	1	0.71	0.35	0.56	0.54

Depending on the complexity of the problem to be solved, that is, of each scenario (tables 3, 4, and 5), defined by N and K, and likewise, the search algorithm (defined in each governance mode, later Table 9), it may or may not be feasible to find the optimal value for the franchisee.

For the NK model of this work, these search algorithms are defined in each governance mode (Table 1 and Table 9), since the modeling variables determine the search rules in the landscape. These search rules will be defined in the next section.

It is also important to clarify that, to answer the research question of this paper, what must be found is under which governance mode (Table 1 and Table 9) defines the search rules and for each of the considered scenarios of the franchises (stragglers, followers, and leaders), there is *a greater exploration* by the franchisee, who is the one who does the searching in this environmental landscape. For example, it might be found that, under the *trust* governance mode, more exploration occurs for *leading organizations* than for *laggards*. And for the *laggards,* it may be that the greatest exploration lies in the mode of *formal governance*. The contribution of this work to the literature based on these results can indicate to a franchise, depending on its current scenario (whether it is a laggard, a follower, or a leader), which is the most appropriate governance mode to develop a greater exploration capacity. For the model, a greater exploration capacity indicates a tendency toward innovation (March, 1991; Karmeni et al, 2018; Sorenson & Sørensen, 2001). The adoption of environmental practices is the type of innovation studied in this paper.

2 NK model to model decisions on the use of environmental practices through franchise governance.

After the theoretical development that defines the framework for the agent-based model using the NK model, here it is shown how to operationalize the theoretical constructs in the model.

Here we will describe how the modes of governance for franchises according to Ménard (2004) are operationalized in the NK model. The variables in the franchise literature have been described as governance mechanisms that influence the characteristics of the franchises are, level of grouping (Zheng, et al 2019), capacity and motivation (Antia et al, 2017), incentive design and monitoring (Matinheikki et al, 2022), knowledge transfer (Iddy, 2019) and decision rights (Windsperger, 2013), among others, are grouped here into two governance mechanisms. On the one hand, formal or contractual mechanisms and, on the other hand, informal or relational governance mechanisms. The formal mechanisms refer mainly to "complete contracts" and the informal mechanisms to what these authors call "socialization in franchises" or "franchisor services". Each of these mechanisms can be operationalized according to the characteristics of the franchise to be studied and can be modeled as search processes in the environmental landscape.

2.1 Complete contracts

Zheng et al (2019), define complete contracts as the degree to which the relevant clauses are codified in a contract. Although a comprehensive contract guarantees to safeguard interests and coordinate activities, it may also restrict value-enhancing local adaptation. One of the characteristics that are defined in franchise contracts is decision rights. Windsperger (2013) refers to decision rights as the transfer of authority over the use of specific system assets and local market assets through franchise agreements. Decision rights should be delegated to the franchisee when their knowledge of the local market is very specific and therefore the costs of knowledge transfer are very high. In this case, the franchisee's bargaining power is relatively strong because these local market assets cannot be included in the contract (Windsperger & Yurdakul, 2007). Franchisors use contracts to transfer decision rights across company boundaries. For example, they transfer authority to franchisees to make local advertising and training decisions. This authority can be described as the distribution of contractual power according to each mode of governance defined by Ménard (2004). The distribution of contractual power in a similar context has been used in the NK model by Giannoccaro (2011).

Likewise, Windsperger (2013) proposes using the explanation offered by the theory of transaction costs (Williamson, 1991 and Ménard, 2004) on the allocation of decision rights in franchise networks. Thus, under a trust governance mode, where relational risk is reduced and information exchange is increased, the franchisor can reduce formal control over operational decisions and grant more decision rights to the franchisee. The

distribution of contractual power can then be defined according to the decision rights granted in each mode of governance.

"Trust" mode, more decision rights would be assigned to the franchisee and operationalized as part of the search algorithm in the NK model. That is, the franchisee in the environmental landscape and under a trust governance mode, can take the power to decide whether to stay in the chosen place according to the fitness value, since there is no veto power on the part of the *franchisee*. franchisor. But in the *formal governance mode*, the franchisor can veto the franchisee's decision regarding its position in the environmental landscape and not allow its movement.

For the NK model, depending on the governance mode, the veto power is defined by a veto probability *pv* that is distributed in each of the four modes. Thus, for the trust mode there is no veto power on the part of the franchisor and the franchisee will always be able to choose whether to move in the landscape, according to its fitness value. In the relational network mode, the probability of veto power by the franchisor is defined between values of 10-40 %. In leadership mode, this probability increases to 40-80%. Finally, in the formal governance mode, the franchisor will have the final decision, if he considers whether the franchisee's movement is appropriate or not, according to the *fitness value* that he perceives concerning the other franchisees.

2.2 Socialization in Franchises or Franchisor Services

It is an informal or relational governance mechanism that Zheng et al (2019) and Antia et al (2017), among other authors, describe as those continuous services that the franchisor provides to the franchisee and that include activities such as central data processing, central purchasing, field operation, field training, initial store opening, inventory control, information sharing, among others, to "build, maintain, and improve the abilities of the franchisees to provide a uniform quality offer" (Antia et al, 2017, p. 954). As with the franchise agreement, the franchisor's services are generally standardized within a franchise system. The franchisor's services through franchise systems are considered one of the determinants of the competitiveness of franchise systems (Shane, 2001). These services motivate franchisees to act in the collective interest of the company (Ring & Van de Ven, 1992) and spread knowledge through the network (Grace et al., 2013).

In general, the provision of ongoing services to franchisees provides an opportunity for franchisors and franchisees to exchange information face-to-face and jointly solve problems (Antia et al, 2017; Heide & Wathne, 2006). It is precisely the exchange of information that is used in the NK model to operationalize the franchisor's services. Zheng et al (2019) affirms that the continuous support provided by franchisors strengthens the transfer of knowledge within the franchise system. Through such interactions with franchisees, franchisors can learn from franchisees' local operating experiences. In turn, by codifying franchisees' local market knowledge, franchisors can indirectly transmit one franchisee's local market knowledge to other franchisees (Darr, Argote &

Epple, 1995). This indirect knowledge transfer mechanism becomes critical in the high-density stage when franchisees are often less willing to transfer local knowledge to one another (Kalnins & Mayer, 2004).

In the NK model, information sharing is reflected in how franchisors and franchisees share information about the fitness value in each period. For a trust governance mode, information is shared between franchisees and franchisors freely and randomly. In this way, a franchisee can see the fitness value of his colleagues and decide whether to move towards that point or not.

Table 8 shows the coding of the modeling variables used to operationalize the mechanisms of the complete contracts and services of the franchisor:

Table 8. Coding the modeling variables of the NK model

Shaping variable	**Model Choice**	**Modeling variable**	**Options**
Decision Rights	It refers to the distribution of contractual power; if the decision rights are in the franchisee, their decisions may not be vetoed by the franchisor.	Veto Power Chance, *pv*	*pv =0* (confidence) *pv=10%-40%* (relational) *pv=40%-80%* (leadership) *pv =100%* (formal)
Information sharing	It refers to sharing information between franchisees and the franchisor. Information can be shared freely and randomly or, on the contrary, the information that is shared is defined in the contract and there is no margin of freedom for the franchisee to share their information.	Share information, *ci*	Yes/No Yes: The information on the fitness value of each franchisee can be seen by the other franchisees and by the franchisor. No: The franchisor's fitness value information can only be seen by the franchisee.

Table 9 finally shows the modeling of the forms of governance and the modeling variables.

Table 9. Forms of governance modeling

Shaping variables	**Governance modes for hybrid institutions (Ménard (2004))**			
	Trust	Relational network	Leadership	Formal governance

Veto Power Chance, *pv*	*pv = 0*	*pv = 10%-40%*	*pv = 40%-80%*	*pv = 100%*
Share information, *ci*	*ci = Yes*	*ci = Yes*	*ci = Yes*	*ci = No*

3 Results and analysis

For the analysis of the model, some measurements have been developed that correspond to the simulation. A description of these measures is shown here, followed by the results and analysis.

3.1 NK model simulation measurements

The simulation analysis is developed through the design of three types of landscapes that correspond to three scenarios of the adoption of environmental practices characterized by increasing complexity. The simplest scenario is where the franchise exclusively adopts internal environmental practices characterized by the interdependence of one environmental practice over another. Full environmental sustainability occurs in organizations where the 5 environmental practices are adopted and the interdependencies between environmental practices show a higher level of complexity.

Each scenario is generated 300 times for each governance mode and each one is run for 50 periods [3]. A franchise network is simulated, which corresponds to a franchisee with several franchisors, in this case, there will be 7 franchisors. Only franchisees will move on the landscape. Its movement will depend on the configuration in each governance mode, given by the modeling variables. The goal is to find the highest peak according to the fitness value.

The simulation analysis aims to identify under which governance mode (trust, relational, leadership, and formal) and depending on each scenario defined by the configuration of environmental practices (laggards, followers, and leaders) the best performance is offered and more specifically in which one better develops the exploration capacity of the franchisors.

To assess how well the governance mode fits each environmental landscape, three measures are constructed to evaluate the model simulation results. These three measures are *effectiveness, efficiency, and stability*. These measures were proposed by Giannoccaro (2011) for a governance context that solves the problem of integration of a supply chain, but which bears similarities to the model used in this work.

[3]These simulation values are defined according to the sensitivity analysis performed on the model. In general, it is found that for 50 periods, the model reaches points where its state remains constant.

The first measure is the capacity of the mode of governance to deliver the highest performance or *Effectiveness*. That is, the highest yield refers to finding and occupying the highest peak in the landscape. To calculate the *fitness value* that the franchise obtains at the end of each simulation, it will be the average of the *fitness values* reached by all the franchisees in the franchise in the last simulation period. As a measure of *Efficiency*, the percentage of landscapes over which the highest peak is reached is calculated.

the efficiency of the governance mode can also be measured, that is, how far the final fitness of the franchise is from the best one obtained for each landscape. The index is calculated for each landscape and then averaged over the 300 landscapes in each scenario:

$$efficiency = 1 - \frac{Max\ fitness - Last\ update\ fitness}{Max\ fitess} \quad (3)$$

Where *Max fitness* is the highest fitness calculated for the landscape and *the Last update fitness* is the fitness at the end of the simulation. The higher the value, the higher the search efficiency value.

A third measure can be used to measure exploratory capacity, governance mode *stability, that is, the ability to achieve and maintain a* configuration from which the franchisee will not move (in the literature this configuration is known as the *sticking point*). Stability shows how long the franchise remains at a fitness value point, with no further movement in the environmental landscape. High stability can backfire as it can prematurely force the franchise into a fitness low point and not explore the landscape for better fitness values. Two indicators are calculated here: (i) the percentage of landscapes in which franchisees are still looking after more than 80% of a period units; (ii) the percentage of landscapes in which the franchisee has already reached a sticking point within a 10% period units[4]. A high value of the first indicator shows that the franchise cannot yet reach a stable configuration, therefore, the exploration continues. Instead, a high value of the second indicator means that the franchise tends to reach a sticking point too quickly, without adequately searching through the landscape.

3.2 Results

To answer the research question, these measures will be analyzed, focusing attention on the third measure of *stability*. The first indicator of stability describes the property that is sought in the model, the *explorability* (March, 1991). For the model, a greater

[4]These are data proposed by Giannoccaro (2011) and are related to the time window chosen for each run.

exploration capacity indicates a tendency toward innovation. Jell-Ojobor & Windsperger (2014) highlight the importance of developing exploration capacity in franchises, since innovations can be generated through this. The adoption of environmental practices in organizations is the innovation that is studied in this paper. So, with this indicator, it seeks to find for each landscape, which mode of governance is the one that promotes exploration and thus the search for environmental practices in the landscape, whether or not to obtain higher fitness values.

Table 10 shows the simulation results considering both the modes of governance and the scenarios/environmental landscape.

Table 10. Comparison of simulation measures between governance modes for each environmental landscape.

Simulation measurements	**Governance modes for hybrid institutions (Ménard, 2004)**			
	Trust	**relational network**	**Leadership**	**formal governance**
Effectiveness				
stragglers	53.2%	83.7%	65.2%	89.4%
Followers	51.4%	53.2%	30.8%	18.3%
leaders	43.5%	21.7%	10.7%	31.6%
Efficiency				
stragglers	0.85	0.99	0.89	0.99
Followers	0.93	0.94	0.84	0.91
leaders	0.92	0.81	0.85	0.86
Stability	% environmental landscapes that continue the search after 80% of the total period (Exploration)			
stragglers	9.2%	10.8%	10.6%	8.3%
Followers	9.4%	19.6%	58.5%	0.5%
leaders	20.3%	61.4%	52.7%	19.4%
stragglers	% environmental landscapes that stop their search before 10% of the total period (Exploitation)			
Followers	90.8%	89.2%	89.4%	91.7%
leaders	90.6%	80.4%	41.5%	99.5%
	79.7%	38.6	47.3%	80.6%

3.3 Analysis

Regarding the measure of *efficiency*, where the scenario in which the highest peaks are reached is measured, according to the results it can be noted that in the formal Governance mode, for lagging franchises, it is where the highest peaks are reached, with an 89.4% Likewise, the lowest is for the leading organizations in the Leadership scenario, with 10.7%. If analyzed in a general way, the lagging franchises present the highest values achieved. But it is important to highlight that in this scenario, it is the internal

environmental practices that would be in the scenario. The landscapes are less rugged, but the highest peaks do not develop in these landscapes.

Considering the complexity of the environmental landscape, it is highlighted for leading organizations, in Trust governance mode, to find the highest peaks. This result for franchises is important because it shows that under informal governance mechanisms, it is possible to achieve higher values of environmental *fitness* in more robust landscapes. This mode is characterized by having more decision rights in the franchisees and the exchange of information. For Follower franchises, the best governance mode that allows reaching the highest levels is Relational Network. And finally, for Laggard franchises, the best governance mode is Formal Governance, where the decision rights are with the franchisor. This last result shows that those franchises that are still implementing environmental practices must continue under the decisions of the franchisor if they wish to achieve the highest values of environmental fitness, otherwise, they could not achieve it.

In terms of efficiency, in general, the results were about a similar average, although the franchises in each scenario did not reach the highest values, the final fitness value was very close to the highest value. The results also show that the leading franchises achieve greater efficiency in the Trust governance mode, while the laggard franchises have greater efficiency both in the Relational Network governance mode and in the Formal Governance mode. Regarding the follower franchises, it can be affirmed that they have greater efficiency in the Relational Network governance mode.

Finally, the stability metric, which directly answers the research question on which mode of governance is most explored by franchisees, and which for this work has been taken as an indicator of innovation. This innovation is the one that would finally allow the franchisee to include more environmental practices in franchises. We have concentrated on those that continue the search after 80% of the period for each landscape. The results show that for Laggard franchises, the best governance mode that allows further exploration occurs in the relational network and leadership modes. This is that, if a franchise is in that state, applying internal environmental practices, both formal and informal mechanisms could be strengthened and thus allow franchisees to include other environmental practices.

For Follower franchises, the governance mode where the franchisees' ability to explore is best shown is in the governance mode of leadership and relational network, where formal mechanisms prevail, such as the decision rights found in the franchisor. In this way, if in a Follower franchise, the franchisees want to implement more environmental practices, it is recommended to strengthen the formal mechanisms but not abandon the informal mechanisms, since for the formal governance mode, the followers do not find fertile ground that allows them to explore the environmental landscape.

Finally, for Leading franchises, the governance mode that best encourages exploration so that franchisees can engage in environmental practices is the relational network.

In this mode, informal mechanisms prevail, however, it is recommended to keep both formal and informal, since it is at the extremes where there is less development of the exploration capacity.

4 Conclusions

With this research, the franchise sector contributes to work to improve the environmental effects of human production and consumption. It is interesting to find how, through an NK model, it is possible to simulate the relationships between franchisees and franchisors using their governance structure and in an environmental context. Modeling these complex phenomena requires tools that capture the interdependence of components, as in this case, environmental practices. In addition to being able to simulate different scenarios according to how these interdependencies occur. We consider that the work carried out is relevant to environmental needs and the results can help to open a field of knowledge where it had not been considered to analyze the formal and informal governance mechanisms in franchises and even more so in the context of environmental management. We have found a potential that goes beyond the results presented and that is that franchises, by encouraging their franchisees to explore and involve innovations, in this case, the use of environmental practices, can finally spread throughout the entire franchise chain, as stated. Pohoaţă & Socoliuc (2014). The gains are higher in environmental terms.

It is therefore important to highlight the most important findings, we find that the most central modes of governance, Relational Network and Leadership, where both formal and informal mechanisms are combined, are the ones that most favor exploration for the three franchise scenarios. In terms of Efficiency, we found that franchises that are just beginning to use environmental practices, such as the Laggards, perform better in more formal modes. But for companies that have implemented both internal and external environmental practices, we find that governance modes where more formal mechanisms prevail are those that allow them to achieve higher values in the environmental landscape. By this, we mean that each organization where one or other environmental practices are implemented has different behaviors in each mode of governance. It then remains for the franchise both its franchisees and its franchisors to identify at what level they are in the use of environmental practices and likewise implement or reinforce formal or informal governance mechanisms that allow them to achieve their environmental objectives.

Finally, we want to propose as a continuation of this research work, that this model can be extended to simulate a franchise network for a specific sector, that more members of the supply chain can be involved and why not, show the phenomenon of diffusion of these environmental practices throughout the network. We hope that with this work we can give continuity to this very interesting phenomenon.

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