

Network analysis and agent-based modeling of micro-businesses

Análisis de redes y modelado de micronegocios basado en agentes

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Abstract

Introduction: The analysis of the structures of social networks and agent-based simulation models allow to know and analyze the behavior of the different actors interacting within a system. **Objective:** To conduct a network analysis and agent-based modeling of microbusinesses to understand, identify and compare the existing relationships and behavior among actors, suppliers, creditors, public and private institutions of microbusinesses in the grocery industry in the central district of Honduras through a simulation model. **Methodology:** This local study was carried out with a descriptive nature, under a mixed approach where data were collected through interviews with managers of the The data were collected through interviews with managers of micro-businesses that represent the entire population of the study unit. **Results:** Pajek software was used for the elaboration of the network systems and NetLogo was used for the development of the simulation model. **Conclusions:** The centrality and density of the actors in a network, together with the modeling through simulation, allows us to know the approximations and behavior of the agents that approaches and behavior of the agents that guarantee the sustainability and productivity of micro-businesses.

Keywords: Small business; Financing; Consumption; Private company; Public company; Simulation model.

Resumen

Introducción: El análisis de las estructuras de las redes sociales y modelos de simulación basados en agentes permiten conocer y analizar el comportamiento de los diferentes actores que interactúan dentro de un sistema. **Objetivo:** es realizar un análisis de redes y modelado de micronegocios basados en agentes para conocer, identificar y comparar las relaciones existentes y el comportamiento entre los actores, proveedores, acreedores, instituciones públicas y privadas de los micronegocios del rubro de abarrotería en el distrito central de Honduras a través de un modelo de simulación. **Metodología:** Este estudio de alcance local fue realizado con una naturaleza descriptiva, bajo el enfoque mixto donde se recolectaron datos a través de entrevistas con gerentes de los micronegocios que representan la totalidad de la población de la unidad de estudio. **Resultados:** En la elaboración de los sistemas de redes se empleó el software Pajek y para el desarrollo del modelo de simulación se utilizó NetLogo. **Conclusiones:** la centralidad y densidad de los actores de una red junto con el modelado a través de la simulación, permite conocer las aproximaciones y comportamiento de los agentes que garantizan la sostenibilidad y productividad de los micronegocios.

Palabras Clave: Pequeña empresa; Financiación; Consumo; Empresa privada; Empresa pública; Modelo de simulación.

Códigos JEL (Ciencias Económicas y Administrativas): D01, D12, E17, E27



Introduction

In the field of Network Analysis (NSA), the relational structures that emerge when different actors interact, communicate, coincide, establish links and collaborate with each other are explored and characterized. These interactions may manifest themselves through various processes or agreements, whether between two or more actors, which may be individuals or organizations, and the resulting inter-connection of these actors gives rise to a social network (Sanz Menéndez, 2003). ARS appeared in the 1970s with the foundation of the International Network for Social Network Analysis (INSNA) located in the city of Florida, United States, with the purpose of analyzing and understanding the behavior of diverse social systems. This analysis has found application particularly in the field of social work and intervention, the tool is useful because it facilitates the understanding of the interactions between the different actors that make up a system (Rúa, 2008).

The application of models allows the creation of simulations, which are defined as the interconnection of two entities, so that, from one of them, an influence or action is exerted on the other (Ojeda et al., 2017). On the other hand, Nigel and Klaus, (2005) cited by Vélez Torres, (2019) indicate that the construction of a model is a tool that allows us to understand the world, since it represents the less detailed and complex simplicity of reality. In other words, a model serves to predict and project the future of an event or phenomenon before they occur, thus allowing to anticipate in decision making.

Microbusinesses, as a result of entrepreneurship, are defined as activities that are generated by an idea that culminates in the commercialization of a good or service; however, evidence from previous studies reflects that certain circumstances limit or potentiate microbusinesses under the same conditions, which allows for their disparity according to the line of business, purchasing power, access to financing and geographic location (Zambra- no-Vargas & Vázquez-García, 2019). Access to financing provided by governmental and private institutions and creditors boosts their growth, and in addition, training allows the generation of new competencies for those who acquire them in strategic decision making.

Suppliers play a vitally important role in promoting microenterprises, since they provide credit that enables these businesses to obtain the necessary inputs and products. They are especially relevant considering the characteristics of developing countries, where access to financing for microenterprises is a primary need. Microenterprises are a fundamental pillar of economic development in Honduras; according to data provided by the Central Bank of Honduras (BCH), they generate the majority of jobs in the country. In this context, the Banco Hondureño para la Producción y la Vivienda (BANHPROVI) assumes a role of considerable importance, as does private banking. Both actors play a fundamental role in providing financial support to microentrepreneurs, acting as financial pillars, both state and private, that drive and support this crucial sector of the national economy (Banco Central de Honduras [BCH], 2022).

Thus, the need arises to conduct research on this topic in order to perform a network analysis and modeling of agent-based microbusinesses to identify and compare the existing relationships on the behavior between actors such as: suppliers, creditors, public and private institutions of microbusinesses in the grocery business at the local level in the Municipality of the Central District, Department of Francisco Morazán, Honduras, through a proposed simulation model.

THEORETICAL FRAMEWORK

2.1 Social Network Analysis (SNA)

The study of social networks makes it possible to recognize how different entities or individuals interact within a social system, which helps to understand evolving events and processes (Aguirre, 2011; Kuz et al., 2016). On the other hand, Avila-Toscano (2012) points out that Social Network Analysis (SNA) focuses on the quantitative examination of social structures, investigating the regularities in the connections between people, groups or organizations that form the units of society.

The set of interrelationships or networks are used to interpret social structures and understand the behavior between actors, which can be measured with respect to centrality, intermediation, groups, clusters, communities, density, cohesion and strength of links or frequency of interactions, among others. Networks connect actors within a social system by nodes that can be represented through the use of graphs or network system figures that show these relationships; according to Kuz et al. (2016) to understand them and determine the role and importance of each actor within the system, metrics or measures that facilitate the organization and analysis of data are used.

In the context of Social Network Analysis (SNA), technological tools play an essential role as visual and descriptive instruments that represent networks through systems in the form of figures, which facilitate the analysis of interconnections between individuals or organizations, allowing the identification of the usual structure of the network, the identification of sets, as well as the relative position of the actors in the network. This enables a better understanding of the social structures underlying phenomena such as knowledge diffusion, reciprocities and power in the studied environment (Sanz Menéndez, 2003).

In line with the perspective of Sanz Menéndez (2003), a network is fundamentally characterized by two primary elements: the actors who establish relationships with each other, presented as points or nodes in the network, and the relationships between these actors themselves, symbolized by lines or connections.

The application of graph theory has been highly beneficial for the analysis of social structures in the framework of Social Network Analysis (SNA). This theory has a len-

specialized software that facilitates the exploration of multiple properties of social networks. It also provides mathematical tools to measure and analyze these properties. In addition, graph theory enables the formulation and proof of theorems related to networks, which makes it possible to deduce and test various assertions (Sanz Menéndez, 2003).

According to Aguirre, (2011) the place occupied by the actors within the network shapes their behavior, determines their capacity and scope of action, as well as regulates their access and the degree to which they can influence the resources and information circulating within the network. The ARS aims to examine in a quantifiable way each perspective of each actor in the network, in turn the processes, movements, exchanges and resilience capacity in the network (Fernández Fernández & Díaz Varela, 2018).

2.2 Agent-Based Simulation Models

According to Belda and Grande (2009), the value of simulation models lies in their ability to define multiple potential scenarios related to a company's core activities. In this sense, companies can anticipate, compare and improve the performance of their simulated processes quickly and efficiently, avoiding the risks associated with practical implementation. This approach enables the dynamic representation of processes, resources, raw materials and services in a modeled environment.

In accordance with the above, González Campo (2007) mentions that for the organizational area, simulation processes invite the elaboration of tests that allow examining and appreciating the dynamics of the actors without incurring in costs and time, while the progress of technology allows simulations to obtain more exhaustive results.

2.3 Microbusinesses

Micro-businesses are defined as the economic unit composed of a minimum number of collaborators from different industries, according to the National Institute of Statistical and Geographic Information of Mexico, micro-businesses are composed of six to 16 people and that in 2009 in Mexico there were five million companies, 95% of which correspond to micro-businesses. This type of business requires initial capital, which represents a restricting factor for the microbusiness system due to the lack of characteristics requested by financial institutions (Sosa Valdés, 2014). This type of business influences the market of the local economies in which they develop and must make the necessary modifications to adapt to external and internal inertial changes.

In Honduras, entrepreneurship has experienced exponential growth over time at the national level. This phenomenon has been supported by the rates of support received by visionaries, both from state authorities and organizations dedicated to promoting national investment.

In recent decades, the study of microbusinesses has been widely addressed in the literature.

However, in order for microenterprises to be a growth factor with a greater participation in the economies, it is necessary to find timely sources of micro-financing (Espinosa Atoche et al., 2018). In this sense, the least favored and most neglected sectors have been precisely the small businesses, which in most actions are not subject to credit from private banks, which is why the state must intervene with policies and programs to create opportunities for microbusinesses so that they can be better inserted into the formal economy. Similarly, microbusinesses are of significant importance not only because of the economic development that their investments promote, but also because of the number of jobs they generate, thus causing an economic spillover to the population (Guatzozón Maldonado et al., 2020).

Grocery microbusinesses are characterized by their family nature and source of self-employment; the way they manage resources and capital creates a fragility in their competencies and sometimes does not allow them to achieve differentiation in the market to compete with more structured and developed businesses such as convenience stores, supermarkets and national chains; the size of the population represents a limitation since the geographic influence does not exceed a few streets and depends on the relationship with the client (González Samaniego, 2006). In the Republic of Honduras, in the second decade of the 21st century, a total of 127,330 micro-businesses were registered in urban and rural sectors, with characteristics that define a micro-business in that country as a productive enterprise of a maximum of people, covering industrial, micro-business and service areas. According to data from the Inter-American Development Bank (IDB) for 2014, these businesses contributed significantly to employment generation in the cities of Tegucigalpa and Comayagüela, totaling 577,343 jobs. In that same year, 26,521 of these micro-businesses were operating, representing an impressive 49% contribution to the local economy (Barahona Alonzo, 2017). In the same vein, according to a report from a soft drink company in the sector in Honduras, at the beginning of 2022, 58,887 enterprises were registered at the country level, focusing on the Central District in the cities of Tegucigalpa, Comayagüela and its surroundings, of which a total of 16,977 microbusinesses of grocery stores are registered; these types of businesses compete in the market with the different scourges, such as crime, economic crises and political situations.

METHODOLOGY

This is a descriptive research, under a mixed approach, which includes information obtained through the bibliographic review of scientific articles and the knowledge and experience of the actors involved in the network system, through the application of semi-structured interviews with the five managers of a chain of micro-businesses in the grocery industry and the administrator in charge of the Central Office, which represent the totality of the object of study.

In this research, a Social Network Analysis - SNA was carried out, focusing on the structural characteristics of the actors within the network with a local level approach. It was

considered that the unit of study is composed of the five micro-businesses of a grocery chain whose branches are located in different areas of the Municipality of the Central District, Francisco Morazán, Honduras during the months of November and December 2022, and the managers of the five micro-businesses were interviewed. According to Leskovec & Faloutsos, (2006) the type of sample used in the ARS can be in three ways:

a) random selection of nodes, b) random selection of links, and c) exploration technique that simulates random steps. A sample with random selection of nodes was used to carry out this research, which represents the total of the five nodes of the population and connections of the network.

In this study, Pajek software was used for the analysis and visualization of social networks; the choice of software was based on its accessibility and availability, the clarity of the interface and the capacity to graph the networks. In addition, the platform has a wide range of algorithms for network analysis and offers the capacity to export the results to a variety of formats (Navarro Sánchez and Salazar Fernández, 2007).

Understanding networks and their members is based on the use of various metrics that allow the relevance and function of each actor within the network to be established. According to Hanneman and Riddle (2005), the most frequently used measures are divided into two groups: centrality metrics and power metrics. The notion of an actor's power is related to the extent and pendency it has with the other actors in the network. This parameter can be evaluated using the term centrality, which is a method for quantifying influence, and refers to the proximity of an actor in relation to the center of a network, i.e., the locations that confer the greatest dominance and impact.

The measures used in this analysis include the degree of centrality, which corresponds to the count of direct connections, i.e. the number of links that an actor maintains with other members in the network, closeness, which represents the average proximity of an actor in relation to the other members of the network, and intermediation, quantified as the proportion of occasions in which an actor is found on the route between different pairs of actors (Navarro Sánchez & Salazar Fernández, 2007).

NetLogo, created by Wilensky in 1999, is a modeling environment that specializes in multi-agent systems. This environment evolved from the Logo programming language, known since 1967 for its focus on "turtle" graphics, and has extended its functionality to handle numerous agents simultaneously. The term "Net" in its name alludes to its ability to simulate phenomena that are multi-agent, decentralized and inter-connected (Rousse et al., 2011).

The existence of highly sophisticated computer tools simplifies and facilitates the process of designing and coding a system dynamics model. In this study, the NetLogo platform is used, which simulates in real time between a model developed from an agent perspective and another from system dynamics, both implemented on the same platform. The resulting results are commonly subjected to analysis through the use of statistics and other computational utilities (Izquierdo et al., 2008).

The population of interest is the area of the Municipality of the Central District in the Department of Francisco Morazán, which belongs to the Republic of Honduras; the microbusinesses in the grocery category located in the areas of Villanueva, Kennedy, Anillo Periférico, La Pradera and Residencial Honduras are considered as the unit of study. It should be noted that, according to data obtained from the sales report of a soft drink distribution company in November 2022, there are 328 micro-businesses that sell grocery products in each of the aforementioned areas, with a total population of 13,750 residents.

In order to know if there is a relationship of cost and consumption with respect to micro-businesses in the grocery industry and a variation with respect to suppliers, creditors and other actors with which it has a relationship, a social network analysis is performed to determine the density and centrality for understanding the productivity of the network and each of the branches of the micro-businesses considered in this study.

Table 1 shows the coding and symbols used in the network systems for this study.

Table 1.
Codification of Network Systems

Actores	Símbolo
Micronegocios del rubro de abarrotería Col Villanueva (MC5V)	▲
Micronegocios del rubro de abarrotería Col Kennedy (MC5K)	▲
Micronegocios del rubro de abarrotería Anillo Periférico (MC5A)	▲
Micronegocios del rubro de abarrotería Col Pradera (MC5P)	▲
Micronegocios del rubro de abarrotería Residencial Honduras (MC5H)	▲
Oficina Central	▲
Alianza	▲
Proveedores contados	■
Proveedor Alianza	■
Acreedores	■
Instituciones gubernamentales	●
Instituciones privadas	●
Instituciones financieras	●

Note: This table shows the codes and symbology used in the network systems.

RESULTS AND DISCUSSION

Table 1 establishes the level of relationship between the actors interacting in the network. Based on these data, the connections and approximations have been defined, in order to perform the social network analysis and subsequently run the agent-based simulation model.

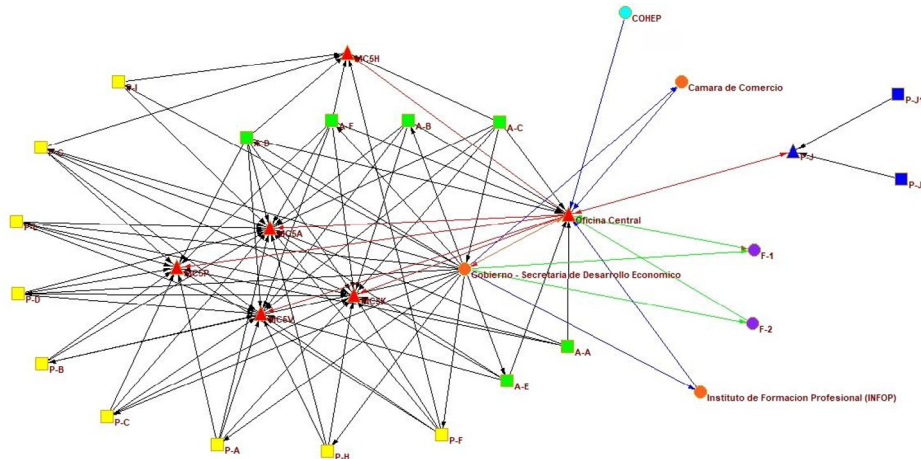
Table 2.*Level of Relationships among Actors for Microbusinesses in the grocery industry*

Descripción	Código	Nivel	Motivo
Proveedores			
Proveedor de refresco 1	P-A	100	Se asignó el rango con relación al volumen de venta
Proveedor de cerveza	P-B	50	Se asignó el rango con relación al volumen de venta
Proveedor de agua	P-C	50	Se asignó el rango con relación al volumen de venta
Proveedor de refresco 2	P-D	10	Se asignó el rango con relación al volumen de venta
Proveedor de refresco 3	P-E	5	Se asignó el rango con relación al volumen de venta
Proveedor de abarrotería 1	P-F	70	Se asignó el rango con relación al volumen de venta
Proveedor de bocadillos	P-G	20	Se asignó el rango con relación al volumen de venta
Proveedor de abarrotería 2	P-H	80	Se asignó el rango con relación al volumen de venta
Proveedor de papelería	P-I	70	Se asignó el rango con relación al volumen de venta
Alianza (Proveedor de abarrotería 3 (P-J1), Proveedor de comida para perros y gatos (P-J2))	P-J P-J1/P-J2	500	Se asignó el rango con relación a que se concentra la compra para las del rubro de abarrotería analizadas
Acreedores			
Acreedor de refresco 1	A-A	180	Se asignó el rango con relación al volumen de venta
Acreedor de embutidos	A-B	150	Se asignó el rango con relación al volumen de venta
Acreedor de pollo	A-C	180	Se asignó el rango con relación al volumen de venta
Acreedor de abarrotería	A-D	110	Se asignó el rango con relación al volumen de venta
Acreedor de helados	A-E	170	Se asignó el rango con relación al volumen de venta
Acreedor de huevo	A-F	200	Se asignó el rango con relación al volumen de venta
Financiamiento			
Fuentes de Financiamiento (BANPROVI, Banca privada)	F-1 /F-2	300	Se asignó el rango con relación a la accesibilidad de financiamiento
Capacitación			
Centro de Capacitación Instituto Nacional de Formación Profesional (INFOP), Consejo Hondureño de la Empresa Privada (COHEP), Cámara de Comercio e Industrias de Tegucigalpa)	Sin Código	150	Se asignó por la importancia y uso de los micronegocios para capacitar su personal.

Note: This table shows the weighting of the relationship of the stakeholders.

Figure 1 shows the microbusiness system for grocery stores in a network in which the main actors are identified, including creditors, suppliers, government and other public and private institutions that interact within the network.

Figure 1.
Microbusiness system for the grocery industry.



Note: The figure was created in Pajek software with the data obtained from the microbusinesses analyzed.

In the network system, which is the subject of this research, it can be observed that the financing factor of micro-grocery businesses plays a fundamental role in this area. This factor is composed of key actors such as the private banks and BANPROVI, as well as creditors who provide products and payment facilities. Of course, the selection of financing sources by microenterprises will depend on accessibility according to the characteristics and requirements requested by these institutions, given that for most microenterprises it is difficult to sustain operations with their own resources, obtaining these external resources is a viable alternative for sustainability and competitiveness in the market.

On the other hand, Figure 1 shows the importance for micro-businesses of the alliance formed between two actors acting as suppliers, whose direct relationship with the Central Office guarantees a reduction in the acquisition costs of their merchandise, so a high level of relationship is observed with 100% interaction between suppliers grocery supplier 3, dog and cat food supplier; which manage the negotiation by means of an alliance contract.

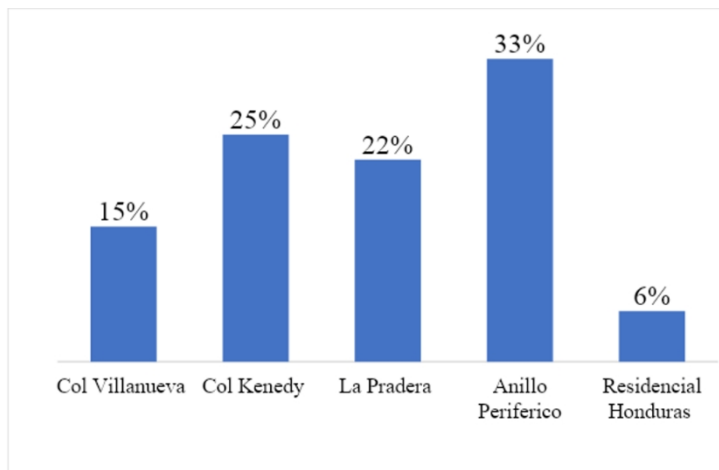
Another aspect to highlight is the training provided by private and public organizations such as the Chamber of Commerce, COHEP and INFOP, coordinated by the Central Office and oriented to topics such as resource management and adaptability to the new demands of the global and digital market, in order to generate competitive strategies, strengthen human resources and increase market share. These relations

The government's role as a regulating actor in the network system and a 100% relationship with the government, which allows the establishment of the necessary conditions for the correct development of the micro-businesses in the sector analyzed, is a high degree of centrality in the network system and a 100% relationship with the government as a regulating actor.

Of course, creditors have a strong relationship and greater density with micro-businesses due to the direct interrelation between them, and finally it is shown that not all micro-businesses have the same suppliers and creditors, being this a marked differentiation between them and this in relation to the discrepancy in demand.

Figure 2 shows the sales volume of the micro-businesses analyzed in this study according to the income level of each branch.

Figura 2.
Volumen de Ventas de los Micronegocios del rubro de abarrotería



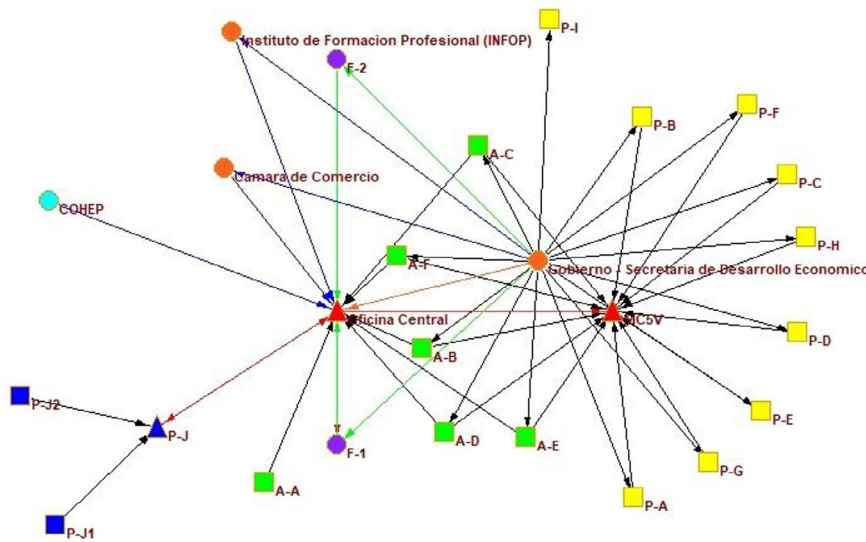
Nota: La gráfica evidencia el volumen de venta de los micronegocios analizados.

For a better understanding of the network, different network systems were developed that analyze separately each of the micro-businesses and their actors, explaining specifically the behavior and density of each one.

Figure 3 shows the actors' network for the Villanueva's grocery microbusiness. This network shows the non-existent relationships between the actors soda supplier 3 and soda creditor 1, who are suppliers and creditors respectively, with a total relationship of 80%, which is justified because this branch does not distribute this type of product.

The population of this zone is composed of 2,599 inhabitants in sector 1-2 and 65 businesses that distribute groceries, with a percentage of sales volume of 15%, in relation to the total sales of the micro-business in the grocery sector.

Figure 3.
Microbusiness in the grocery business in Colonia Villanueva.

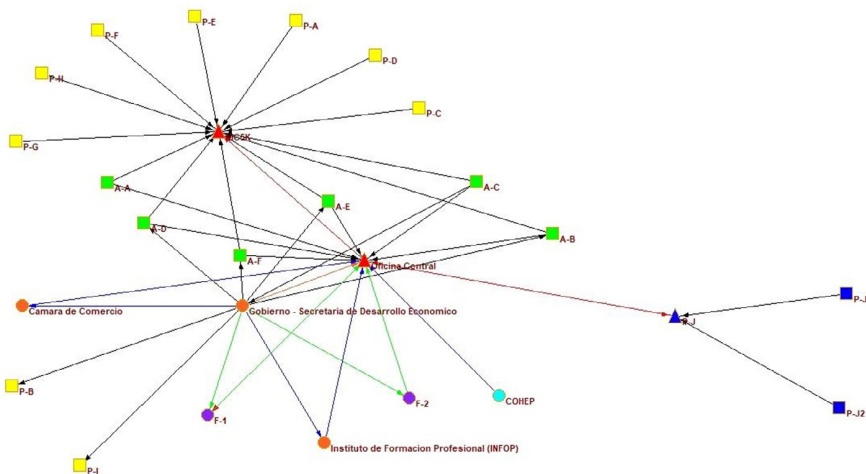


Note: The figure was created in the Pajek software with the data obtained from the microbusinesses analyzed.

Figure 4 shows the network of the branch located in Colonia Kennedy, which presents the same relationship with the same nodes as the network of Colonia Villanueva, but without connection with the beer suppliers and stationery supplier, which represent 80% of the relationship with the actors.

Colonia Kennedy has a population of 5,511 inhabitants in the third and fourth avenue zones, with 64 micro-businesses with a 25% share of sales.

Figure 4.
Microbusiness of the grocery store in the Kennedy neighborhood.



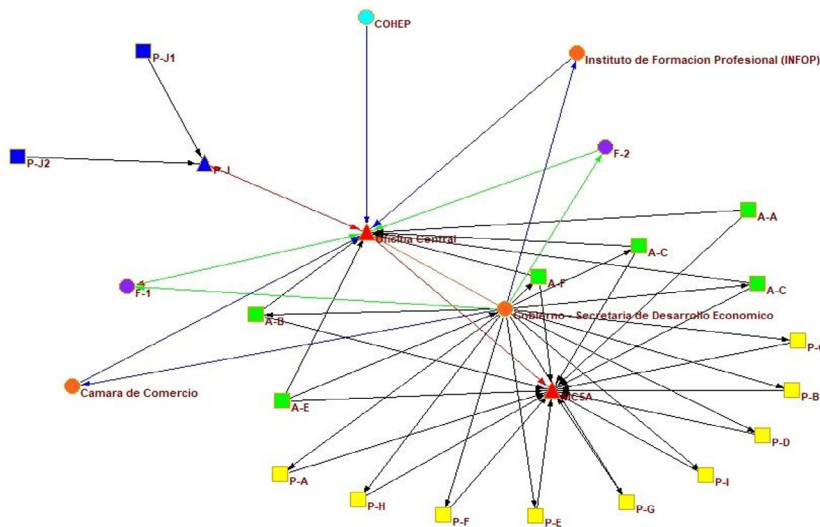
Note: The figure was created in the Pajek software with the data obtained from the microbusinesses analyzed.

The network shown in Figure 5, unlike the previous branches, due to its geographic location in an industrial zone, lacks the population residing in the area; however, the competition is around nine other grocery micro-businesses that account for 33% of the sales volume based on the total number of micro-businesses analyzed.

This branch has the best relationship with suppliers and creditors at 100%; unlike the previous ones, it has a differentiated discount in the commercialization of beer. This branch is also the main office and stores the product received from the alliance formed by the suppliers; grocery supplier 3, dog and cat food supplier. For this reason, this is the store with the greatest commercialization of the products of the actors that belong to the alliance.

Figure 5.

Microbusinesses in the grocery industry in the area of the Peripheral Ring Road.

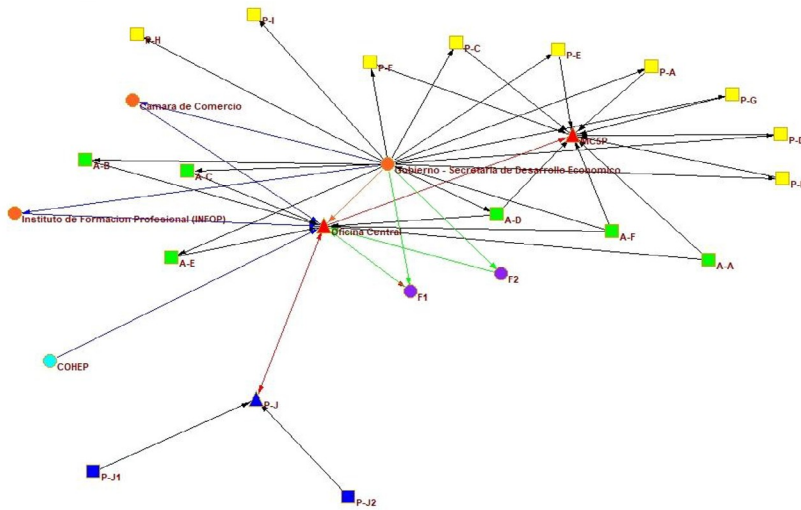


Note: The figure was created in the Pajek software with the data obtained from the microbusinesses analyzed.

The microbusiness branch of the grocery store located in the area of La Pradera, with a population of 1,370, which generates 22% of the sales volume of the total analyzed, is shown in the network system in Figure 6.

This micro-business in La Pradera competes with 20 businesses that belong to the same category; the business has a 66% relationship with suppliers and creditors, excluding actors such as the chicken supplier, ice cream supplier, grocery supplier 2, stationery supplier and sausage supplier, which are important connections that can increase sales volume.

Figure 6.
Microbusiness in the grocery business in the La Pradera neighborhood.

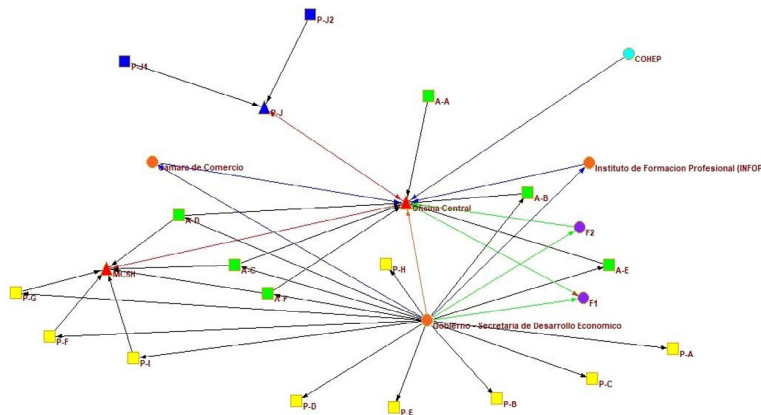


Note: The figure was created in the Pajek software with the data obtained from the microbusinesses analyzed.

The network of micro-businesses in the grocery industry located in Residencial Honduras, shown in Figure 7, has a population of 4,262 inhabitants and 50 businesses with a volume share of 6% of the total.

The network shows that the micro-business has a relationship with the suppliers; the snacks supplier, the grocery supplier 1 and the stationery supplier and with the creditors, the police creditor, the egg creditor and the grocery creditor. This represents 40% of connections with the actors. The network also shows that it is one of the few micro-businesses that distributes stationery supplies, with a high degree of centralization with the central office in terms of alliances and training.

Figure 7.
Microbusiness of the grocery store in Residencial Honduras.



Note: The figure was created in the Pajek software with the data obtained from the microbusinesses analyzed.

In the networks, the most important actors are the creditors and the alliance, due to the significant impact that access to financing provides for the operation of the business. On the other hand, centrality is located in the main office in charge of managing the alliance and negotiations.

Density was calculated through the following formula $n(n-1)/2$ where n is the number of nodes in the network. For the micro-businesses of Villanueva and Kennedy, a total density of 11.5% was obtained with a centrality of 86%; however, the connections of the actors in the network are different.

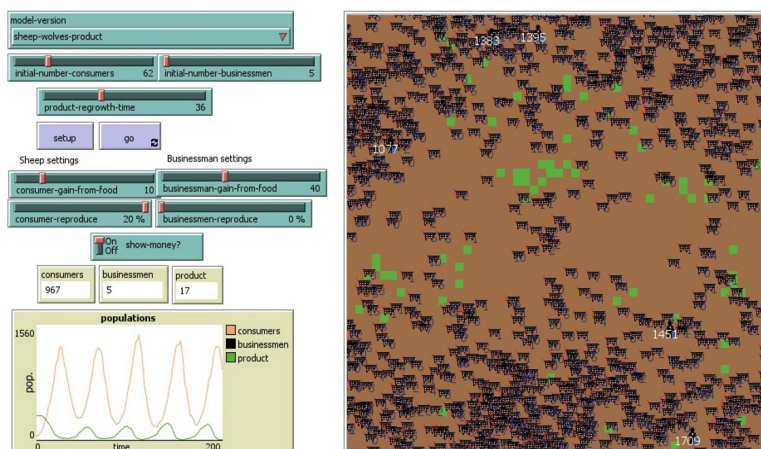
For the Peripheral Ring micro-business, the density is 12.5% with a degree of centrality of 100%, being the most productive network of the system with a maximum use of its relationships with the actors.

The density obtained for the micro-business of La Pradera is 10% with a degree of centrality of 80% and the density obtained for the micro-business of Residencial Honduras is 8% with a degree of centrality of 65%.

Proposed Agent-Based Simulation Model

The proposed Agent-Based Simulation model for micro-businesses in the grocery industry was implemented through the NetLogo program. The model used for this research was the Wolf Sheep Predation developed by Wilensky and Reisman, (2006) this model explores the stability of predator-prey ecosystems. Such a system is called unstable if it tends to lead to the extinction of one or more of the species involved. Conversely, a system is stable if it tends to be maintained over time, despite fluctuations in population size. Under this premise, the supply and demand predation simulation model was developed. Figure 8 shows the model developed.

Figure 8.
Predation Simulation Model Supply Demand



Note: Simulation developed using NetLogo software.

In the model used, it can be observed that the agents called users represent the population of the area in which each microbusiness branch is located, who make up the customers who participate in the process of buying and demanding products (consumer-gain-from-food), which are represented with the number 61 based on a scale of 250 as a result of the number of customers in a period of one month in the general data of the microbusinesses of the grocery category (2,440 customers) in the areas analyzed.

The model is run with the initial number of micro-businesses in the grocery category, which are the agents that represent the productive units of the economy listed as (initial-number-businessmen). For the product-regrowth-time on a scale of 100 the result was 36 with respect to the purchase volume of the suppliers and creditors of the Central District that are the agents that provide various products in the span of a month, with respect to the consumer-gain-from-food it was determined based on the minimum wage according to the scale of the model using an adjustment of 10, in the businessman-gain-from-food it was adjusted based on 40 because it represents 40% of the purchase volume in the agents that personify the creditors of the micro-businesses analyzed. When the simulation model is run, the five branches analyzed are maintained over time and allow us to observe that the model is functional from the logic of the micro-businesses.

CONCLUSIONS

In this research on network analysis and modeling of grocery micro-businesses developed in the Municipality of Distrito Central, Department of Francisco Morazán, Honduras, the main actors in the network were identified as branches of the grocery industry, creditors, suppliers, the Honduran Council of Private Enterprise - COHEP, the Government through the Secretariat of Economic Development, BANHPROVI and private banks, which provide access to financing, and also the Chamber of Commerce and Industry of Tegucigalpa and the Institute of Professional Training - INFOP, which support the system through training for microenterprises.

This study concludes that the relational proximity with creditors is high, which represents a higher density that provides greater flow of information and accessibility to products with ease of payment; however, the alliance enhances group efficiency without affecting the different geographic areas, although it only has two local suppliers negotiating en bloc through the main office, which represents a high degree of centrality.

The main office expedites agreements only with creditors and leaves aside any type of block negotiation benefit for suppliers with cash payment. The direct participation of the main office provides benefits that can be observed in the analysis of the branch located in the peripheral ring road. In addition, the actors with the strongest relationship between them were identified, and those with no relationship were determined. On the other hand, the processes of coordination for each micro-business were coordinated through the main office with the interaction of the Chamber of Commerce and Industry of Tegucigalpa and INFOP.

The Networks and the Supply Demand Depredation Simulation Model allows the a priori understanding to generate a diagnosis of the relationship between the actors and the five grocery micro-businesses, the importance of the relationship between creditors, suppliers, governmental and private institutions that allow guaranteeing productivity and competitiveness in the market to achieve sustainability in a competitive environment and generate strategies to achieve growth.

The behavior of the grocery micro-businesses in the central district of Honduras is oriented to the application of specific strategies and selective collaboration of the different actors with a significant degree of centrality and decision making by the central office of the five grocery micro-businesses. It is important to highlight the contribution offered by digitization, networks and simulation model in micro-businesses, so that it can serve as a basis for replication in other organizational contexts.

Finally, this document has been prepared for academic purposes and is restricted to the information obtained from the interview and scientific documents, so it is not affirmative and does not allow general conceptions to be made, but it does establish a basis for future research.

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