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Frugal innovation in women-led family businesses in rural communities

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Abstract

Purpose – The purpose of this paper is to identify a useful taxonomy of frugal innovation (FI) applied to women-led family businesses in rural communities in Oaxaca, Mexico when confronted with disruptive situations such as the recent COVID-19 pandemic, thus achieving a greater understanding of FI in this context to provide these businesses with strategies that allow them to face crises more effectively.

Design/methodology/approach – The study was cross-sectional and quantitative. A scale was developed and applied to 160 family businesses run by women and located in four rural communities in Oaxaca, Mexico. A review of the literature from the period of 2018–2024 made it possible to identify the essential characteristics of FI.

Findings – Through an exploratory factorial analysis, four types of FIs were identified: new production and marketing models, new methods of operation, new financing methods and new organizational methods. Using a discriminant analysis to establish the functionality of the identified FIs, the authors found that shifting to new financing and organizational methods was more important for the survival of family businesses in times of crisis.

Originality/value – This study highlights the forms of FI that develop in small family businesses led by women; this is important for the survival of the family and the business. The research highlights innovation challenges and opportunities for women entrepreneurs in the global south.

Keywords Family businesses, Rural communities, Emerging country, Measurement, Frugal innovation

Paper type Research paper

1. Introduction

Although there is extensive literature on the analysis of innovation in small companies in various developed countries (Mahmud *et al.*, 2020; Menter *et al.*, 2023), it is mainly focused on innovation models, which allow the company to develop or improve new products or

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services, implement new processes, use new marketing methods and make changes at the organizational level, giving them a competitive advantage in terms of traditional innovation (Mahmud *et al.*, 2020; Menter *et al.*, 2023).

This does not differ greatly from what happens in emerging countries, especially China (Yang and Xu, 2023; Zhou *et al.*, 2023) and to a lesser extent Mexico (Cuevas-Vargas *et al.*, 2023; Ramírez-Solis *et al.*, 2022; Rodríguez-Espíndola *et al.*, 2022), where much of the research focuses on innovation related to new or modified ideas in terms of products and services, processes, organizational changes and marketing (Cuevas-Vargas *et al.*, 2023; Ramírez-Solis *et al.*, 2022). However, these models, which were mainly developed from the literature to explain innovation, may differ from reality in some cases because there are contextual problems (such as poverty in Mexico) that differentiate the environment in which many small businesses develop, especially for family businesses located in rural areas.

These companies operate informally in a context of resource scarcity and institutional voids (Onsongo *et al.*, 2023) and operate at the base of the pyramid (BoP) in markets with complex institutional environments, poor infrastructure, deep-rooted and traditional sociocultural environments, high illiteracy rates and low disposable income. This type of company's success lies in its survival which has been threatened recently due to the COVID-19 health crisis. The records from this globally significant event show that small businesses were the most affected (Belitski *et al.*, 2022; Engidaw, 2022).

The state of poverty that characterizes the BoP has generated the emergence of a relatively recent term, "frugal innovation" (FI) (Molina-Maturano *et al.*, 2020; Onsongo *et al.*, 2023; Pedroso *et al.*, 2023).

FI serves the BoP population through the redesigning of products, services and business models to reduce complexity and total life cycle costs, combining economic value with environmental and social benefits (Pedroso *et al.*, 2023). FI can provide appropriate solutions at significantly lower costs and with fewer resources, making it suitable for the contexts present in emerging countries (Niroumand *et al.*, 2020; Weber and Huynh, 2022).

In addition to the above, it is essential to consider that in the face of health crises such as those caused by COVID-19 (Sharma *et al.*, 2022), FI represents a valuable tool for combating the negative impacts of crises. Corsini *et al.* (2021) found in a study in India and Italy for example, that the application of FI in digital manufacturing made it possible to face the COVID-19 crisis. Sarkar (2021) found that various measures promoted by the government in Kerala, India, such as solutions based on implementing effective and low-cost technologies, effectively contributed to Kerala's resistance to the COVID-19 pandemic. In a study conducted in the Indian subcontinent and Africa by Dubey *et al.* (2022), FI was adopted by producing innovative solutions for necessary items such as masks, face shields and ventilators, allowing those areas to fight COVID-19 more effectively. Vesci *et al.* (2021) found in a case study in Lombardy, Italy that FI is adequate to face an unexpected and extraordinary situation such as the COVID-19 pandemic.

Based on the above, it is evident that although the literature on FI is constantly growing, there are still gaps to be addressed as pointed out by Hossain *et al.* (2023) and Pedroso *et al.* (2023) regarding the fact that there is a lack of knowledge about the interpretation and implementation of FI in rural areas of emerging countries that face resource limitations (Niroumand *et al.*, 2021). Furthermore, there is a dearth of literature that examines FI as an essential tool for dealing with disruptions such as those caused by the COVID-19 pandemic (Dubey *et al.*, 2022; Bughin, 2023). In addition, a gap is observed regarding current ambiguity about the types of FI (Winkler *et al.*, 2020). In this sense, Rossetto *et al.* (2017) and Farooq (2017) argue that there is a lack of instruments that allow a clear and precise measurement of FI, or that identify the existing types of FI effectively.

The above reveals that more needs to be done to identify the key components of the FI measure to address the needs of people experiencing poverty. Therefore, conventional measures could be insufficient to clearly explain the reality of many family businesses run by women, and more particularly in rural communities (Chhabra *et al.*, 2020; Sajjad *et al.*, 2020).

The approach in this research consists of providing new methods and models to women in small family businesses in a country with an emerging economy. These new methods and models allow these business leaders to face unexpected crises such as the COVID-19 pandemic. An advantage of FI for places with limited resources is to offer women entrepreneurs new means or sales, operational and production strategies to innovate and reduce costs, and to offer sustainable and relevant solutions for their communities. The theoretical contribution of the FI given in this study is the survival of businesses in times of crisis by proposing new financing or organizational methods.

The purpose of this article is to delve deeper into the existing information gap to identify a useful taxonomy of FI applied to family businesses in rural communities in Oaxaca, Mexico when they face disruptive situations such as the recent COVID-19 pandemic, and thus achieve a greater understanding of FI in this type of context to provide women business leaders with strategies that allow them to face these crises. To do this, we start with the following questions: What concept best describes FI in the rural communities studied? What are the types of FI identified in these rural communities? A model is suggested based on identifying the types of FI that exist in these communities, and the usefulness of these types of FI in times of crisis is explored.

The rest of the article is organized as follows: Section 2 is based on literature related to FI, addressing definitions and types of FI in different contexts, particularly emphasizing the background of the study; Section 3 addresses the research methodology; Section 4 focuses on the results obtained from principal component analysis (PCA) and discriminant analysis; and Sections 5 and 6 address the discussion, conclusions, limitations and implications of the results.

2. Literature review

FI is a new concept stemming from the creativity of achieving more with less. In a global scenario of resource scarcity and competition based on optimization and cost reduction, developing this style of innovation is necessary to help marginalized communities find solutions to their unresolved needs. The literature review is addressed in two sections: definitions and analysis of FI measurement.

2.1 Definitions of frugal innovation

FI encompasses various disciplines such as economics, administration and engineering, among others and has therefore been defined differently depending on the field (Niroumand *et al.*, 2020; Ploeg *et al.*, 2020). Because this concept is transdisciplinary in and of itself, it describes various aspects of innovation but focuses mainly on three: the drivers who emerge to innovate as a search for a solution to a problem; the characteristics of the result obtained, which may be a new accessible, efficient and frugal product, service or process; and the innovation methods, which are characterized by combining innovation and development (Brem and Wolfram, 2014; Niroumand *et al.*, 2021).

The development of FI is based on three basic principles: simplification, use and accessibility. The first principle is characterized by the design of products that have ease of use, essential functions and high benefits for the consumer (Weyrauch and Herstatt, 2016) since this allows for conserving resources, reducing environmental impact and meeting

specific requirements for the consumer (Hindocha *et al.*, 2021). The second seeks to use the minimum possible resources available and accessible in the company's environment (Radjou and Prabhu, 2015). The third principle is cost reduction; the cost is significantly lower, at least a third of the value compared to similar products for the consumer (Weyrauch and Herstatt, 2016; Hindocha *et al.*, 2021). All of the aspects described above have led to various definitions of FI.

Hossain (2017) states that FI focuses on offering a better product or service to the greatest number of people or beneficiaries using the fewest resources possible. Prabhu (2017) defines FI as the search for maximization of the value resource relationship by increasing value for customers, shareholders and society while reducing the use of resources such as energy, capital and time. Martin (2019) conceives FI as a continuous search process to remodel, design, configure or change products, goods, processes, technologies, services or business models.

Furthermore, Molina-Maturano *et al.* (2020) mention that FI is a type of innovation that reduces costs and focuses on the main functions offered by a good or service, generating optimized performance levels. Ploeg *et al.* (2020) define FI from innovation results, considering that resource limitations function as the drivers that cause FI. Cuevas-Vargas and Parga-Montoya (2022) point out that FI is also when organizations use existing resources to generate new ideas for products or services, prioritizing cost reduction and reducing waste. Finally, Sharma and Kumar (2024) point out that the concept of FI "encompasses the domains of product, process, business model and organization" and emphasize that it can be characterized as those innovations that are "functional and focused on what is essential" or "minimize the use of material and financial resources" or are "easy to use".

2.2 Frugal innovation measurements

This section has been developed from the concentrated research shown in Table 1. It was derived from those studies that contribute to the measurement of FI. The review was carried out with research that covers the years from 2018 to 2024 in emerging countries such as Brazil, China, India, Jordan, Mexico, Pakistan and Vietnam, as well as in countries with developed economies such as the USA, Spain, Italy and Poland.

Most of the authors mentioned in Table 1 have evaluated and named substantial cost reduction as a dimension of FI, defined as the effort to offer innovative solutions of affordable and quality products by reducing production, administration, organization and waste generation costs. This cost reduction is translated into a decrease in the price of the product/service for the customer. Winkler *et al.* (2020) consider that this reduction should be at least one-third of the price of the conventional product, both for the manufacturer and the customer. Mishra (2021), Vesci *et al.* (2021), Levänen *et al.* (2022) and Sharma and Kumar (2024) emphasize that innovative solutions do not have to be sophisticated, although without losing quality or being considered cheap. Likewise, some authors use other terms such as low costs, cost innovation, frugal costs or cost reduction.

Mainly, substantial cost reduction has been measured with items that encompass eight relevant aspects: solutions or introduction of products/services that are cheap, good value and of satisfactory quality (Rossetto *et al.*, 2017; Shehzad *et al.*, 2023; Cai *et al.*, 2019; Rossetto *et al.*, 2023; Lei *et al.*, 2024; Al Omoush *et al.*, 2023); significant cost reduction in the operational process, operation, economical manufacturing, innovation with new ways to reduce raw materials in production, and innovation with new ways to reduce waste in production (Rossetto *et al.*, 2017; Molina-Maturano *et al.*, 2020; Cuevas-Vargas and Parga-Montoya, 2022; Shehzad *et al.*, 2023; Rossetto *et al.*, 2023; Lei *et al.*, 2024; Al Omoush *et al.*, 2023); significant reduction in the final price of the products/services compared to

Table 1. Measurements of frugal innovation from 2018 to 2024

Authors	MEASUREMENTS OF FRUGAL INNOVATION						Context and case study
	Substantial cost reduction	Focus on core features	Optimized performance level	Creating a frugal ecosystem	Renewal of production, services, and/or markets	Development of new production methods and management systems	
Rossetto *et al.*, (2017)	■	■	■	■			Companies in Brazil, India, and the USA
Cai *et al.*, (2019)	■	■					Manufacturing companies in China
Martin (2019)	■	■	■				Countries with emerging economies
Winkler *et al.*, (2020)	■	■	■				Three case studies in developed markets
Molina-Maturano *et al.*, (2020)	■	■	■				Ecological wastewater treatment plant and rainwater collection system in Mexico
Vesci *et al.*, (2021)	■	■		■			Isinnova case in Italy
Mishra (2021)	■	■	■				Indian social entrepreneur focused on menstrual health and hygiene of rural women in India
Corsini *et al.*, (2021)					■	■	Case in a high-income country and case in a lower-middle-income country
Cuevas-Vargas and Parga-Montoya (2022)	■	■		■			Small and medium-sized businesses in Guanajuato
Leväinen *et al.*, (2022)	■	■		■			Case studies on MittiCool, Ksheera Enterprise, and Jayashree Industries from the Asian continent
López-Sánchez and Santos-Vijande (2022)		■			■	■	Spanish manufacturing companies
Shehzad *et al.*, (2023)	■	■		■			Pakistan SMEs
Rossetto *et al.*, (2023)	■	■					Companies in Brazil, India, and the USA
Lei *et al.*, (2024)	■	■	■				Vietnam manufacturing companies
Woźniak and Wereda (2023)	■	■		■		■	Companies in Poland
Al Omoush *et al.*, (2023)	■					■	SMEs in Jordan
Sharma and Kumar (2024)	■	■	■				Construction companies in India

Source: Prepared by the authors

Table 2. Socioeconomic characteristics of the study region

Municipality name	Total population	Population of 15 years old or more, without basic education (percent)	Overcrowded housing (percent)	Employed population with income of up to 2 minimum wages (percent)
Asunción Ixtaltepec	15261	41.89	20.23	68.75
Heroica Ciudad de Juchitán de Zaragoza	113570	39.11	35.05	65.9
Salina Cruz	84438	28.01	26.59	67.06
Santo Domingo Tehuantepec	67739	34.94	29.7	77.19

Source: Prepared by the authors, based on Villasana *et al.* (2023)

other products on the market (Cai *et al.*, 2019; Cuevas-Vargas and Parga-Montoya, 2022; Shehzad *et al.*, 2023; Lei *et al.*, 2024); improved and satisfactory quality with reduced costs (Cai *et al.*, 2019; Al Omoush *et al.*, 2023); reduction in the cost of use and/or ownership (Martin, 2019); reduction in investment costs (Molina-Maturano *et al.*, 2020); maintenance (Molina-Maturano *et al.*, 2020); and reorganization of the process (Rossetto *et al.*, 2023).

Another dimension of FI specified in Table 1 is the focus on core functionalities, characterized by "the reduction of necessary functions, the minimization of material resources and ease of use" (Winkler *et al.*, 2020). The systematic identification of core and secondary functions allows us to discard unnecessary functions and use resources more

efficiently with a more sustainable approach (Winkler *et al.*, 2020; Cuevas-Vargas and Parga-Montoya, 2022). According to López-Sánchez and Santos-Vijande (2022), focusing on the most critical functions allows the organization to obtain knowledge that allows them to adapt to constant market changes quickly and proactively. This aspect may include indicators such as usability, ease of use (Winkler *et al.*, 2020; Cuevas-Vargas and Parga-Montoya, 2022; Sharma and Kumar, 2024), product durability (Cuevas-Vargas and Parga-Montoya, 2022; Sharma and Kumar, 2024) or security (Sharma and Kumar, 2024).

The third most studied dimension of FI, according to Table 1, is optimized performance level (Rossetto *et al.*, 2017; Martin, 2019; Winkler *et al.*, 2020; Molina-Maturano *et al.*, 2020; Lei *et al.*, 2024; Sharma and Kumar, 2024). This category measures aspects of FI such as ease of use, reliability, robustness, use of cutting-edge technology, maintenance of quality and meeting or exceeding acceptable quality standards (Weyrauch and Herstatt, 2016; Winkler *et al.*, 2020).

The fourth dimension identified for measuring FI is the creation of a frugal ecosystem; this is characterized by the effort of organizations to seek sustainability, sustainable development and the development of a relationship throughout the entire value chain which in turn creates an environment that generates the ideal conditions to promote FI. According to Rossetto *et al.* (2017), a frugal ecosystem can be measured through the elements of environmental sustainability present in the operational process, alliances with local companies and efficient and effective solutions to clients' social and environmental needs. Various authors shown in Table 1 (Cuevas-Vargas and Parga-Montoya, 2022; Levänen *et al.*, 2022; Shehzad *et al.*, 2023; Woźniak and Wereda, 2023) have adopted the creation of a frugal ecosystem as one of the dimensions for measuring FI.

The dimensions of FI addressed in the previous paragraphs indicate that the evaluation of FI has focused for a considerable time on the results of the measurement of three main characteristics:

(1) substantial cost reduction;

(2) focus on core functions; and

(3) optimized performance level (Weyrauch and Herstatt, 2016).

However, over the years, the way FI has been measured have been strongly influenced by context and are constantly changing or adding new elements leading to new proposals for measuring FI such as a frugal ecosystem (Rossetto *et al.*, 2017); renewal of production, services and/or markets (Corsini *et al.*, 2021; López-Sánchez and Santos-Vijande, 2022); and development of new production methods and management systems (Corsini *et al.*, 2021; López-Sánchez and Santos-Vijande, 2022; Woźniak and Wereda, 2023; Al Omoush *et al.*, 2023), such that the definition no longer focuses precisely on its primary functions.

Table 1 also shows that at a contextual level FI was initially described in emerging economies such as India, Pakistan, Vietnam and Mexico, among others, since companies located or emerging from these countries needed to create affordable products and services for the population. The COVID-19 pandemic accelerated the decision of companies, governments and organizations to innovate frugally since quick responses were required due to pressing needs and the low availability of resources (Sarkar, 2021; López-Sánchez and Santos-Vijande, 2022; Rossetto *et al.*, 2023). For this reason, FI also appeared in developed economies such as the USA, China, Italy, Spain, Poland and Jordan, among others.

One of the challenges companies faced during the COVID-19 pandemic was "aligning their business processes and products so that the price of their products and services was at a level that economically disadvantaged consumers also felt was affordable" (Dubey *et al.*, 2022).

Price affordability is one of FI's fundamental characteristics and the foremost criterion for meeting the needs of people experiencing poverty (Shibin *et al.*, 2018). Marketing during the pandemic made greater use of social networks when considering aspects of the product (Sarkar, 2021; Sharma *et al.*, 2022).

3. Methodology

Data from four municipalities located on the Isthmus of Tehuantepec were analyzed. These municipalities are considered rural because agriculture continues to be a primary economic activity. However, other activities have been developed to supplement income. It is important to highlight that Zapotec is spoken in these communities and they are classified as marginalized due to the population's low educational level, overcrowding and low income. Table 2 details the socioeconomic characteristics of the localities studied.

The data were collected through a structured questionnaire designed to be administered to women at the head of a family business. This is due to the prevailing culture in the study area where women are typically the ones in charge of the family business. The questionnaire was conducted in Spanish through face-to-face interviews from March to September 2023.

The context of small family businesses in the rural communities analyzed was considered to measure FI and the frequency with which the business resorted to different changes during the COVID-19 pandemic was investigated. The time period taken into consideration went from 2020 to 2022. Responses were obtained on a five-point Likert-type scale where 1 =← never and 5 = very frequently.

Since no formal database records the total number of family businesses run by women in the communities served, a convenience sample was used with the "snowball" technique. A total of 160 questionnaires were collected. Table 3 describes the characteristics of the sample.

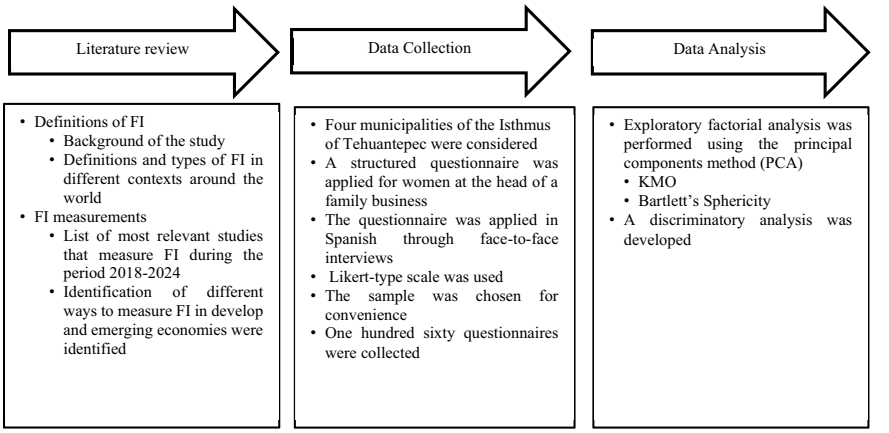
Figure 1 shows the stages of research; for data analysis, a factor analysis (FA) and discriminant analysis were performed. According to Mulaik (1987), FA is a technique that allows for discovering and describing latent variables through the covariances among a set of indicators. It is a technique widely used in those studies related to measurements (Kline, 2016) and is therefore suitable since this study seeks to propose a taxonomy of FI based on its measurement. Shrestha (2021:1) argues that:

> Factor analysis is applied to a single set of variables when the investigator is interested in determining which variables in the set form logical subsets that are relatively independent of one other.

Table 3. Sample characteristics

Owner's age	%	Years of schooling	%
< 30	10	No schooling	10
30–40	33	Grade school	15
41–50	26	Junior high	34
>50	31	High school	31
		College	10
Economic sector		*Years in operation*	
Food industry	52	0–5	19
Retail trade	25	6–10	32
Rental services	1	11–15	16
Temporary accommodation services	18	15–20	11
Other services	4	>20	22

Source: Prepared by the authors



Source: Prepared by the authors based on Asamoah *et al.,* (2024)

Figure 1. Research method diagram

This technique is therefore suitable since this research seeks to explain FI in communities through the logical interpretation of the various factors from which it is composed.

There are two kinds of factor analysis, exploratory (EFA) and confirmatory (CFA), the difference between them is that EFA does not require *a priori* specification of the number of factors, while CFA requires that the exact number of factors always be confirmed. In addition, EFA could theoretically generate all possible solutions (Kline, 2016). This study uses an EFA with the intention of having various possible solutions for FI in the context studied in addition to taking into consideration the lack of clarity in the literature regarding the exact number of factors of which it can be composed.

This study also used a factor analysis with principal components (PCA) to examine whether the statements represent identifiable factors. To measure the adequacy of PCA two parameters are used, the KMO and Bartlett's sphericity (Moreta-Herrera *et al.*, 2019). The KMO statistical tests the adequacy of the sample size. The values identified for this parameter in the literature are from 0 to 1, values between 0.8 and 1.0 indicate the sampling is adequate. KMO values between 0.7 and 0.79 are middling and values between 0.6 and 0.69 are mediocre (Shrestha, 2021). Bartlett's test of sphericity tests the null hypothesis and allows us to evaluate how much the variables in the sample are sufficiently correlated with each other (Lu *et al.*, 2020).

Discriminant analysis is a classification technique useful for building predictive models that indicate the group to which a given observation belongs based on certain observed characteristics that delimit its profile (Ramayah *et al.*, 2010; Valderrey, 2010). Since the intention of this study was to classify the functionality of the detected FI with respect to business survival in times of crisis, discriminant analysis is useful to determine this classification.

4. Results

First, PCA analysis was used to generate various factors from the analyzed data and identify those that would best explain FI in times of crisis. This method established the internal structure of FI for the family businesses studied.

As seen in Table 4 and according to the results obtained in the Bartlett's sphericity test, there is some degree of statistically significant correlation between the items or variables analyzed. Furthermore, according to the KMO index, the adequacy of the sample data set to the factor analysis shows a value of 0.739, which, according to Méndez and Rondón (2012), represents a regular value. Therefore, these results justify the application of PCA.

Based on the varimax rotation and as seen in Table 4, the PCA generated a model with four factors, representing 73.07% of the total explained variance. According to Rubio-Andrés and Abril (2024), the factorial solution for this rotation type resulted in uncorrelated factors.

For each factor, those items or variables with a factorial loading >0.5 were considered and only explained by that single factor; thus, seven items that did not meet these characteristics were eliminated. Four factors were obtained with Cronbach's alpha coefficients above the threshold of 0.60 for the EFA (Hair *et al.*, 2006). Each item was sought to be consistent with the factor and the literature. Considering these two aspects, factors were obtained such as new production and marketing models, focused mainly on those innovations that impact the way of selling, but also on production through the development or modification of products and services; new operating methods related to changes that impact the way the business operates and that involve readjustment and adaptation of activities; new financing methods, which are changes made due to the pressing need for business survival in times of crisis; and new organizational methods, focused on changes in the organizational structure of the business that provoke new ways of distributing responsibilities and encourage the involvement of business members.

After the PCA, a discriminant analysis was carried out to classify the business's survival in the face of crisis such as the COVID-19 pandemic based on FIs. For this, step-by-step methods such as Lambda and Wilks's Fisher were used. After eliminating 39 cases, 121 were classified as having 100% explained variance. The classified cases are divided into two groups depending on whether the FIs made by the business during the pandemic allowed them to remain in the market. Tables 5 and 6 show the statistics corresponding to this analysis.

From the results obtained, two types of FI stand out as being significant for the permanence or lack thereof of businesses in times of crisis: those related to new financing methods and those focused on new organizational methods.

5. Discussion

The present research in rural communities identifies the FIs implemented during the COVID-19 pandemic that allowed many family businesses to survive. According to the results obtained, four types of FI are identified, focusing on new production and marketing models, new operating methods, new financing methods and new organizational methods. For family businesses, these types of FI represented adaptations to their conditions during the COVID-19 pandemic. Under these conditions, the availability of resources was minimal and the need to adapt to new forms of production, sales, marketing and organization, among others, was pressing due to the reality that family businesses were experiencing in the studied rural communities at that time.

The new production and marketing models are a type of FI that focuses mainly on changes made in the way of selling, acquiring materials and creating or modifying products and services, which coincides with Corsini *et al.* (2021) and López-Sánchez and Santos-Vijande (2022), who argue that new FI models in times of crisis allow for the development of new sales modalities, ways of operating and readjustment and adaptation of activities within each company. The businesses studied during the COVID-19 pandemic had to use the available resources to continue selling; they used the internet to promote themselves and buy

Table 4. Factor analysis of FI

Items	Factor 1 (New production and marketing models)	Factor 2 (New operation methods)	Factor 3 (New financing methods)	Factor 4 (New organizational methods)	Communalities
Offered home delivery service (9)	*0.568*	*0.079*	*0.130*	*0.467*	*0.564*
Made online purchases *(10)*	*0.675*	0.005	0.169	0.088	0.493
The service/product was promoted online *(11)*	*0.765*	0.105	0.058	0.122	0.614
Development of new products or services *(12)*	*0.824*	0.172	0.030	0.019	0.709
Modified products or services *(13)*	*0.751*	0.338	0.043	0.036	0.682
Sold facilities *(5)*	0.074	*0.916*	0.052	0.097	0.857
Facilities were put up for rent *(6)*	0.104	*0.956*	0.033	0.027	0.926
Change business activity *(7)*	0.212	*0.877*	0.128	0.002	0.831
Change of location *(8)*	0.214	*0.812*	0.013	0.177	0.736
Loans from banks and savings banks *(3)*	0.064	0.061	*0.892*	0.152	0.826
Loans from family *(4)*	0.094	0.022	*0.903*	0.122	0.839
Working hours decreased *(1)*	0.155	0.050	0.144	*0.825*	0.728
Number of workers decreased (*2)*	0.148	0.059	0.177	*0.799*	0.695
Explained variance	*32.44*	*15.85*	*15.59*	*9.17*	*73.07*
Cronbach's alpha	*0.792*	*0.918*	*0.812*	*0.654*	*0.761*
KMO index					*0.739*
Bartlett sphericity					*0.000*

Source: Prepared by the authors

Table 5. Classification of results in family businesses studied

Functionality of FI in the face of COVID-19 original group	Predicted group association 1	2	Total
(1) Functional FI	89	0	89
(2) Not functional FI	0	32	32
Percentage			
1. Functional FI	100.0	0.0	100.0
2. Not functional FI	0.0	100.0	100.0

Note: 100% of the original cases were correctly classified
Source: Prepared by the authors

Table 6. Classification function coefficients for family businesses

Discriminant variable	COVID-19 Functional FI $n = 89$	Not functional FI $n = 32$
X1: New financing methods	1.142	2.511
X2. New organizational methods	1.727	3.317
(Constant)	1.368	3.435

Source: Prepared by the authors

supplies, made home deliveries and modified or developed new products or services. Implementing those changes represented safety for customers during the pandemic as they could access such products or services from their homes. Currently, this continues to be the way of selling for many businesses as the pandemic also represented for some the opportunity to diversify and provide new strategies to expand their market; this coincides with Shehzad *et al.* (2023), Alhakimi and Albashiri (2023) and Al Omoush *et al.* (2023), who argue that the sales strategies implemented during the COVID-19 pandemic continue to be helpful strategies for small businesses in emerging economies.

The new methods of operation are a type of FI aimed at the sale and rental of facilities and the change of line of business or location of businesses in times of the COVID-19 pandemic. During the pandemic, new methods of operation were the mechanism to solve an unexpected problem due to the need to protect most of the population, both at the municipal and international levels (Brem and Wolfram, 2014). Currently, in a post-pandemic stage, it is observed that although this pandemic represented a problematic stage for businesses, it also gave them the opportunity and certainty to make decisions in the short term, which has positively impacted family businesses since many of the changes made during the COVID-19 pandemic remain in place today, such as renting facilities or changing the location of the business to look for alternatives that would increase sales.

The new financing methods refer to loans granted by banks, savings banks or family members. These actions, which some business owners resorted to, allowed them to obtain economic resources and continue operations. No previous studies measure FI through new financing methods within the reviewed literature. Therefore, it is relevant to mention that according to Onsongo *et al.* (2023), FI originates in informality with a shortage of resources

and institutional voids; then, at the contextual level was exacerbated in times of pandemic. So, it is not surprising that the family businesses studied had to change their ways of capitalizing to maintain their survival.

New organizational methods are a type of FI characterized by changes in the business's organizational structure, leading to new ways of dividing its activities and responsibilities. Specifically, the results found in this type of FI focus on reducing the workday and the number of members in the business. These changes made during times of COVID-19 allowed businesses to survive thanks to a reduction in their costs, which has been described by authors such as Sharma and Kumar (2024), who point out the reduction in costs as another element of FI. Likewise, it is worth mentioning that this type of FI is compatible with what has regularly been identified as classic innovation within the literature (Mahmud *et al.*, 2020; Menter *et al.*, 2023). Although they have more differences, in the case of FI in the family businesses studied, the final goal is to achieve subsistence as an indicator of success while in the case of classic innovation, the ultimate goal is mainly to explain the performance or profitability of the business, as expressed by Abdilahi *et al.* (2017).

The results obtained in this research are based on statistical analyses that passed the test of reliability and validity due to the support provided by the reviewed literature on which the questionnaire has been built and in the dimensions that have been found in the factor analysis (Ang and Huan, 2006; Hair *et al.*, 2006). Valid and reliable statistical analysis ensures that the questionnaire can be replicated in other contexts.

5.1 Theoretical implication

On the theoretical side, this research has made an important contribution to the field of FI, by generating a taxonomy that empirically shows how FI can be understood. Specially in the context of rural businesses led by women, elucidating the different dimensions of FI will allow for generating interpretative advances in moving toward a theoretical framework that explains FI.

5.2 Managerial implication

In managerial terms, understanding FI in women-led organizations can provide better decision-making in identifying strategic and timely changes in production, marketing, operation and financing that are appropriate and not detrimental to family businesses.

5.3 Public policy implication

In terms of public policy formulation, understanding the importance of FI for those primarily responsible for generating and carrying them out can provide special incentives or adequate and accessible sources of financing for small family businesses in rural areas in poverty, giving women entrepreneurs better conditions in terms of interest and payment time compared to private funds and/or family loans. Another implementation of FI in public policies can be done through specialized training workshops on "doing more with less" in terms of business strategies adapted to business's particular needs.

For public policymakers, research points to actions that benefit small businesswomen; to do so it is necessary to promote innovation processes. As the results show, it will be necessary to generate financing sources and accessible platforms for training in business, information technology, marketing and logistics, among others. The support of decision-makers in the field of public policy is of vital importance to leverage processes that women business leaders are operating empirically, with their own resources and without the support of key actors.

6. Conclusions

Faced with the COVID-19 crisis, family businesses have deployed different solutions to face the threat. Known as FIs, these solutions are characterized by being developed from the BoP and for their accessibility to organizations that operate with limited resources. Different innovations in production and marketing, operation, financing and organizational methods were identified.

These results constitute and demonstrate a new measurement scale that allows a better understanding of FIs that develop in a rural context and that allow businesses to better face crises such as the one recently caused by COVID-19.

Regarding production, the development or modification of products or services was observed. In marketing however, options for acquiring supplies online and implementing home delivery were highlighted. It should be noted that in an environment in which the transit of people and goods was limited, small businesses found forms of mobility both to supply raw materials and to overcome physical distances with their customers while trying to reduce the risk of infections.

The most critical options were presented in the methods of operation since businesses had to resort to temporary closure of operations, sale and rental of some facilities, and change of location to operate. These options show the severity of the crisis and the need for family survival, which even put the temporary continuity of the business at risk.

Businesses sought financing in the form of personal loans and savings banks. It was noted that family capital is precious since it is precisely from the family network that the money needed in an emergency is obtained. Another viable option was the acquisition of debt in savings banks. Compared to traditional banking, these financial institutions have a large number of branches, fewer requirements and respond quickly to grant loans. They have therefore become an accessible financing option for small organizations.

Regarding organizational methods, the reduction in work hours and the number of workers was evident. These options were a response to declining income. On the one hand, efforts were made to retain staff by reducing their hours. However, external staff were laid off, and some family members had to look for other occupations outside the family business and at times even outside of the community. Based on the results, FIs in small rural family businesses at the BoP consisted of strategic changes in production, marketing, financing, organization methods and operation methods developed to achieve survival in the face of the COVID-19 health crisis.

Although a wide range of FI generated in response to the COVID-19 pandemic is shown, two differentiated strategies were identified. The first was a financial capital accumulation strategy, where the small family business was recapitalized through loans and cash outflow was reduced by reducing payment for labor. This course of action can be explained given the previous and continuous experiences of economic difficulties suffered by small organizations which have enabled them to activate cash accumulation mechanisms quickly in the face of crises. Our results show that this strategy allowed businesses to survive and remain in the market in a post-pandemic stage.

A second novel strategy involved developing and modifying products and services, searching for new suppliers and using technological options for promotion and sales. This course of action requires a longer time horizon to make its benefits visible. Furthermore, it is a risky bet in a critical environment such as the pandemic.

6.1 Research limitations and future agenda

This research is an exploratory study of FI in small family businesses. Future research may analyze the benefits of FI in larger and nonfamily businesses, and/or in longitudinal and transversal studies to understand the benefits of innovation in products and services.

Qualitatively, it will be interesting to know what innovative experiences arise from the interaction between family and business at the BoP.

A future area of research is to investigate the antecedent and consequent variables of FI to generate a complete analysis framework; this would require both advances in theory and in methodologies applicable to different contexts. This would allow FI to become a true line of research for explaining innovation and encouraging its deployment for the survival of firms.

Finally, the analyses used in this research are useful for their objectives, however, for future research it is recommended that causal analyses that explain the firm's performance through the implementation of FI also be carried out.

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