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## **Innovating Family Business Succession: Sustainable Strategies through the Integrative Model in Mexico**

### **Innovando en la sucesión de empresas familiares: estrategias sustentables a través del Modelo Integrativo: Caso México**

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## **ABSTRACT**

**Context.** Most Mexican businesses are family-owned, and their continuity depends on effective generational succession. However, many of these businesses lack formal transition structures, which could jeopardize their continuity and sustainability.

**Problem.** Family-owned businesses (**FOBs**) face the challenge of structuring their succession processes clearly and effectively to ensure continuity and sustainability. This study aims to examine the structuring of succession processes in Mexican family businesses and to identify the factors that influence the clarity and effectiveness of these mechanisms.

**Purpose.** To assess the suitability of Mexican Stock Exchange Funds for generational transition and identify key organizational components for structured succession. The study supports **SDG8** by promoting professionalized succession and sustainable business continuity.

**Methodology.** Empirical research was conducted in Jalisco between 2020 and 2022, collecting data from 337 family businesses. The correlation between the clarity of succession criteria and factors such as governance and company size was evaluated. Classification models were compared using indicators such as precision, recall, accuracy, and **F1** score.

**Theoretical and practical findings.** The results indicate that firms with formal governance structures, such as family protocols, boards of directors, and share transfer plans, have strict succession rules. The K-Nearest Neighbors (**KNN**) model showed the best performance in terms of accuracy (0.8038), **F1** score (0.7044), and precision (0.8038). Logistic regression had the highest **AUC** value (0.8654), indicating a high discrimination ability. The Naive Bayes model had the highest recall value (0.6944), which is relevant for the identification of more positive cases.

**Originality.** This study is original in applying predictive models to succession in family-owned businesses, providing empirical evidence and contributing to **SDG 8**.

**Conclusions and limitations.** Family-owned businesses in Jalisco, Mexico often lack succession planning, which risks their continuity. Strengthening formal mechanisms can improve transitions. The study is limited to Jalisco; further research in other contexts and the institutionalization of succession are recommended.

## RESUMEN

**Contexto.** La mayoría de las empresas mexicanas son de propiedad familiar. Su continuidad depende de una sucesión generacional efectiva. Sin embargo, muchas de estas empresas carecen de estructuras formales de transición, lo que puede amenazar su continuidad y sostenibilidad.

**Problema.** Las empresas familiares (**FOB**) enfrentan el reto de estructurar sus procesos de sucesión de manera clara y efectiva para asegurar su continuidad y sostenibilidad. El propósito de este estudio es examinar la estructuración de los procesos de sucesión en las empresas familiares mexicanas e identificar los factores que influyen en la claridad y efectividad de estos mecanismos.

**Objetivo.** Evaluar la idoneidad de los Fondos de la Bolsa Mexicana de Valores para la transición generacional e identificar los componentes organizacionales clave para una sucesión estructurada. El estudio contribuye al **ODS8** al promover una sucesión profesionalizada y la continuidad empresarial sostenible.

**Metodología.** Investigación empírica en Jalisco (2020 y 2022) recopilando datos de 337 **FOB**. Se evaluó la correlación entre la claridad de los criterios de sucesión y factores como la gobernanza y el tamaño de la empresa. Los modelos de clasificación se compararon utilizando indicadores como la precisión, el recuerdo, la exactitud y la puntuación **F1**.

**Hallazgos teóricos y prácticos.** Las empresas con estructuras formales de gobernanza, como protocolos familiares, juntas directivas y planes de transferencia de acciones, tienen leyes de sucesión estrictas. El modelo **K-Nearest Neighbors (KNN)** mostró el mejor rendimiento en la precisión (0,8038) con puntuación **F1** (0,7044). La regresión logística tuvo el valor más alto de **AUC** (0,8654), lo que indica una alta capacidad discriminativa. El modelo Bayes naïve tuvo el valor de recuerdo más alto (0,6944), lo cual es relevante para la identificación de más casos positivos.

**Originalidad.** El estudio es original por aplicar modelos predictivos a la sucesión en empresas familiares, con evidencia empírica y aporte al **ODS 8**.

**Conclusiones y limitaciones.** Las **FOB** en Jalisco, México carecen de planificación sucesoria, lo que pone en riesgo su continuidad. Fortalecer mecanismos formales puede mejorar la transición. El estudio se limita a Jalisco; se recomienda explorar otros contextos e institucionalizar la sucesión.

## 1. INTRODUCTION

Most companies in Mexico are family-owned. As in other countries (Bennedsen et al., 2006), they have low effectiveness in the intergenerational succession process; that is, most do not survive to a second generation, and a very low percentage manage to pass to a third generation successfully.

Succession has been a priority topic in existing research on family businesses, as shown in recent studies such as those developed by Ribeiro et al. (2023), Ge & Campopiano (2022), Nave et al. (2022) and Ramón (2021), among others.

For their study, several conceptual models have been developed, such as the Organizational implications of three patterns of successions by Le Breton-Miller et al. (2004), as well as the model based on the transfer of knowledge and development of the successor in the family business by Cabrera-Suárez et al. (2001), or the model of transitions in family businesses by Morris et al. (1997). Among them is the Integrative Model for Successful Succession (Le et al., 2004), which breaks down the variables and steps to be followed to achieve successful succession and the aspects that impact the process.

With this research, we intend to determine how prepared Mexican family businesses are to undergo successful succession development. For this purpose, we focus on the first phase of the Integrative Model for Successful Succession by Le Breton-Miller et al. (2004), with the understanding that companies that have already completed the first phase are in a position to advance to the following blocks of the process; similarly, those that have not even covered the first steps will find it challenging to achieve the subsequent stages in the intergenerational succession process successfully.

This study can be linked to the UN Sustainable Development Goal (United Nations, n.d.) named “*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*”, because **FOB** with successful succession can guarantee the economic sustainability of a region and thereby contribute to social development as well as the preservation and growth of decent employment.

In line with this premise, we pose the following question: How influential are Mexican companies in implementing the first phase of Le Breton-Miller et al. (2004), Integrative Model for Successful Succession? In addition, and in order to identify the strongest and weakest common points of Mexican firms, we formulated a second research question: What are the variables of the

first phase of the model that are fulfilled in most Mexican family firms? A questionnaire was designed and applied to 337 Mexican family businesses to address both questions was applied between 2020 and 2022.

The research is presented in this document in the following order: first, it developed the theoretical framework for the succession process in the family business, as well as the Integrative Model for Successful Succession (Le et al., 2004); second, it is broken down each of the points that comprise its first phase; then It is presented the methodology and the descriptive information; we move on to the description of the conclusions drawn from the research, as well as its limitations; finally, we present the section of bibliographical references used.

## **2.CONTEXT DESCRIPTION**

From a national standpoint, the Mexican Instituto Nacional de Estadística y Geografía (INEGI, 2025) reports there are 7,056,499 established businesses in Mexico. In the state of Jalisco, two years after the COVID-19 pandemic ended, businesses and establishments in Jalisco have improved in sales compared to 2021 (IIEG, 2022). According to this survey, the percentage of companies that expect a sales increase in the second half of 2022 went from 40.7% to 43.5%, while those that expect a decrease fell from 18.6% to 12.5%. However, 81.9% of companies reported increased cost, and 37.9% indicated that the conflict between Russia and Ukraine affected their business, mainly due to higher costs and shortages of inputs.

The study also highlighted that 33.1% of economic units are family businesses, although 56% define themselves as such. Of these companies, 66.4% are run by the first generation, 25.3% by the second, and 4.5% by the third.

From a family business standpoint, *Radiografía de la empresa familiar en México* (San Martín & Durán, 2017,32), points out that the total businesses in the country 95% are small and micro. Of the total business, 83% can be considered family business, and in the state of Jalisco, around 82% are family business (San Martín & Durán, 2017, 29). Given their economic weight and employment capacity, especially in post-pandemic recovery, the role of family and small businesses is directly connected to **SDG 8: Decent Work and Economic Growth**, which emphasizes inclusive and sustainable economic growth, productive employment, and decent work for all.

### 3.LITERATURE REVIEW

Before answering the questions posed in the previous section, it is necessary to examine relevant literature on family business succession and its effectiveness in family businesses. The theoretical framework is organized into two sections: the first deals with family business succession, and the second describes the Le Breton-Miller et al. (2004) Integration and Effectiveness Model.

#### 3.1.Succession in Family Businesses

CEO succession is an issue that affects all firms and has been studied by various authors (Berns & Klarner, 2017; Duckworth-Chambless et al., 2023). Succession, understood as the transmission of ownership and leadership of a company from one generation to another, is not an issue that exclusively affects the coexistence of the family that owns it but also influences the financial performance of the company, as studied by Freidman and Singh (1989), among other authors.

Diverse elements impact the succession process. One of them is the personal factor, since in the appointment of the successor, there is often *"an attachment to the past, its total rejection or an incongruent mixture of past and present"* (Le Breton-Miller et al., 2004). A second circumstance is a dilemma of where to choose a better candidate, whether it will be a family member or an outsider (Ramírez et al., 2021). Thirdly, the leaders of family businesses (**FOBs**) strongly influence the succession process, which sometimes makes the reactions more extreme.

These obstacles sometimes come from a lack of understanding of this dimension. Succession is not a simple occurrence. It should be a strategic process (Gimenez & Novo, 2020; Porfirio et al., 2020). These reactions are mainly those of an immature successor plan due to different factors deeply studied (Picone et al., 2021; Gagne et al., 2019), such as confusion, rebellion, dependence, and excessive changes. These behaviors affect the structure and strategy of the firm (Le Breton-Miller et al. (2004).

The effectiveness of the succession process is fundamental for the company's endurance over time. Fortunately, there are different models of the succession process, such as the one proposed by Le Breton-Miller et al. (2004), where the different phases of the succession process are

presented comprehensively, each one with its multiple factors to be considered, in addition to the external influences that surround the process. This model is related to the need for the development of Human Capital for innovation, as described by Castillo-Esparza et al. (2022).

Given its influence on long-term business continuity, employment generation, and organizational resilience, a well-structured succession process in family firms directly contributes to **SDG8: Decent Work and Economic Growth**, by supporting sustainable business practices and intergenerational productivity (United Nations, n.d.)

### **3.2.Integrative model for successful succession**

This model is not widely implemented in Mexico, but it has been used for analysis and development in various countries, as indicated by the literature review. Therefore, its implementation for the evaluation and development of family businesses would be innovative in terms of Innovation management activities according Oslo Manual (OECD, 2018, 91). Developing the capabilities to innovate and keep the fundamentals for business sustainability is essential to maintain the family business throughout generations (Mejía-Trejo, 2021; OECD, 2018, Chapter 5; Pinzón-Castro & Maldonado-Guzmán, 2023).

The integrative model for successful succession encompasses different levels of information and variables such as the industry, the family business, and, at the other end, the social and family context. These two blocks are interconnected and directly affect the succession process. It starts with a series of rules of the game and the first steps that make up the initial stage; the second is the nurturing or development of successors; the third, the successor selection; and the last is the transition process that includes the transfer of capital. All these interrelated variables are monitored and evaluated in the process.

### **3.3.The design of the final instrument**

Due to the breadth of the model and in line with the research questions posed, we focus this research on the first phase of the succession process, which comprises the rules of the game and the first steps. In subsequent work, measuring the rest of the phases will be helpful. In this first part of the process, the succession plan is founded, which serves as a basis for sharing the vision of the future; relevant variables are included, such as:

- a. Selection criteria and potential successors,
- b. Range of candidates (e.g., family or external),
- c. Governance guide and
- d. The transition and share splitting plan, as well as the period in which it is planned and how all parties will be synchronized (Le et al., 2004).

The following is a synthesized description of the variables mentioned above.

### 3.4.The Conceptual Model

According to Le Breton-Miller et al. (2004), and in line with the UN **SDG8** “*Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*”, the conceptual model is built with the following stages:

#### 3.4.1.Selection criteria for successors

The successor selection begins with the identification of potential candidates. This choice requires generating criteria that are clear to both selectors and applicants. A common criterion is that the successor be a descendant of the **CEO**. Stewart (2003) points out that candidates descended from the **CEO** share a network of family associations and social links with the founder. This would not have impediments to succession effectiveness if proper criteria were in place to help select the best candidate among the descendants; however, the practice of transferring power in family firms to the firstborn is common in many **FOBs** (Ahrens et al., 2015)

The relevance of primogeniture and birth order has been linked to effective leadership in family firms (Schenkel et al., 2016). Nonetheless, this factor carries strong cultural significance and has experienced notable transformations in recent years.

#### 3.4.2.Range of Candidates

The criteria for the selection rank of **CEO** candidates must be clear. The decision on this issue concerns whether the candidate is external or internal to the family. In addition to the observations made by Stewart (2003) in the previous section, internal candidates can align the interests of managers and owners and avoid or ameliorate the principal-agent problem.



Even if the successor rank is determined only internally, there are other points to be defined, such as the issue of primogeniture. In recent years, there has been much criticism of this form of succession (based on primogeniture) and also of those ranges that consider gender and, therefore, leave female members of the family out of the selection range. Once the range of candidates is clear, it should be analyzed to see if there is a solid governance guide.

### **3.4.3. Governance Guide**

Corporate governance is indispensable in a **FOB** to advance its performance (Gedajlovic et al., 2004; Nordqvist et al., 2014); but in addition to having a solid board of directors and management, it is also suggested to have a family council and a family protocol, as shown by several examples where the company's results were beneficial (Arteaga & Méndez-Requejo, 2017). In the succession process, and specifically in the early stages, having solid governance of the company simplifies the task. In addition to having all the governing bodies that control ownership, management, and the family, a transition and stock split plan should be established.

### **3.4.4. Transition and stock split plan**

Several factors are involved in succession, such as cultural norms (Sharma & Rao, 2000), birth order (Stewart, 2003; Schenkel et al., 2016), as well as those of a financial nature, specifically of the shareholding partition. In some countries, such as Spain, **FOBs** have family constitutions that establish norms and rules for all their members; among them is the transfer of shares (Arteaga & Mendez-Requejo, 2017). Due to its importance and ability to empower the new leader of the company, it is suggested that this distribution of shares be made immediately after the completion of the succession (Pott et al., 2001b; Farah et al., 2020). Morris et al. (1997) assert that when family members get involved in the transfer of wealth, they have a better relationship.

Control of successor shares provides certainty to non-family shareholders who also do not have controlling shareholding, as sometimes majority shareholders can benefit from the gains made over those who hold fewer shares (Hoffmann et al., 2014; Johnson et al., 2000; Morck et al., 2005).

Gersick et al. (1999) identify three types of ownership transitions: the first type of transition is when there is a change of leaders, but the same ownership structure is maintained; the second is called Devolutionary Transitions, where there is a change to a less complex structure; finally, there

is the Evolutionary Transitions which, contrary to the previous one, changes to a more complex structure.

In this first part of the integrative model for successful succession, the succession plan that serves as a basis for sharing the vision of the future is founded. It includes relevant variables such as:

- a. Selection criteria and potential successors,**
- b. Range of candidates** (e.g., family or external),
- c. Governance guidelines,** and finally,
- d. Transition and sharing plan,** as well as the period in which it is planned and how all parties will be synchronized, period and timing.

Le Breton-Miller et al. (2004) mention that to be established early, it should not only be adjusted based on experiences and feedback but also on communication.

#### **4.METHODOLOGY**

The methodology is mainly based on an empirical study (Bruhn-Jensen, 2014), based on the first phase of the integrative model for successful succession (Le et al., 2004), within the section of succession processes referring to management and ownership and, specifically, on the rules of the game and first steps. Based on the study of 337 surveys, we made a description, in line with Rojas (2008), that helps us to detail our findings.

The questionnaire was applied electronically through the **Questionpro tool** based on the Model described. Thirty-nine questions were submitted to professionals working in family business in the state of Jalisco between 2020 and 2022 and were answered by 337 family members and employees working in the family business. The survey was shared through digital platforms, such as LinkedIn and sent to students, graduates, and parents with family businesses at private universities and business schools. It was controlled by the number of generations currently running the company, assuming that the more advanced the generation in charge of the company, the more likely it is to be aware of the rules of the game and the first steps of the succession process.

We also analyzed several scientific articles and selected the model we considered most complete, such as the Integrative Model for Successful Succession by Le Breton-Miller et al. (2004), to serve as the basis for the development of our study. Finally, we used a criterion based

on hierarchies (Saaty & Vargas, 2012) to order and select the stage that we considered the priority to focus our empirical study: the rules of the game and the first steps. This section presents the analytical approach applied to the data collected from 337 surveyed family businesses. It is structured as follows: first, the generational variable related to current management is addressed (5.1); then, exploratory data analysis is conducted (5.2); followed by the data cleaning process (5.3); and finally, the evaluation of the classification model's performance (5.4).

#### **4.1.Data Analysis**

To control, according to the generation currently managing the company, the information corresponding to each of the 337 surveys was obtained, as shown in **Table 1**. As can be seen, more than half of the responses were given by companies in their first generation, followed by 34% for those in the second, decreasing to 9% for the third and only 3% for the fourth or successive generation. These percentages seem to confirm the normality of the sample because, indeed, most family businesses are first-generation, which decreases as the generation advances.

**Table 1:** Number of generations of family members currently managing the company.

<b>The generation is currently managing the business.</b>	<b>Frequency</b>	<b>Percentage</b>
1st	182	54%
2nd	114	34%
3rd	30	9%
4th or higher	11	3%
<b>Total</b>	<b>337</b>	<b>100%</b>

Note: The table shows a simple distribution of the generation to which the general management of the companies studied corresponds (in number and percentage) according to the survey applied.

Source: own

**Table 2** shows the computation of the percentages obtained from the affirmative answers in the survey regarding the existence and functioning of governance bodies in Mexican family businesses, as well as the establishment of the rules of the game and the first steps for a successful succession.

**Table 2. Percentage of affirmative responses to the survey items according to the generation currently managing the company**

Generation	A	B	C	D	E	F	G	H	I	J
1st	42%	31%	49%	63%	18%	44%	48%	43%	34%	16%
2nd	34%	34%	45%	63%	14%	54%	57%	52%	41%	26%
3rd	43%	47%	70%	60%	37%	67%	70%	57%	50%	37%

**A:** Successor is already chosen ; **B:** Clear rules for succession; **C:** Group of candidates for succession; **D:** Clarity in decision-making; **E:** Defined timeframe for succession; **F:** Board of Directors; **G:** Shareholders meeting; **H:** Stock split plan; **I:** Family Council **J:** Written Family Protocol

**Note:** Table 2 shows, according to the survey applied, the percentages of companies of the total studied that have the existence and functioning of governance bodies in family businesses, establishing the rules and first steps for a successful succession.

Source: own

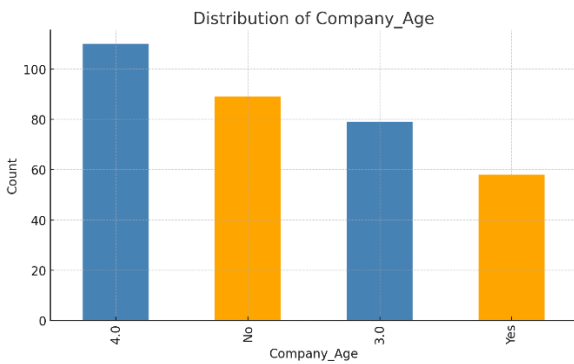
#### 4.2.Data processing. Exploratory data analysis

To ensure the transparency and reproducibility of the research, the underlying data used to build the classification model has been thoroughly analyzed and performance has been assessed alongside exploratory data analysis.

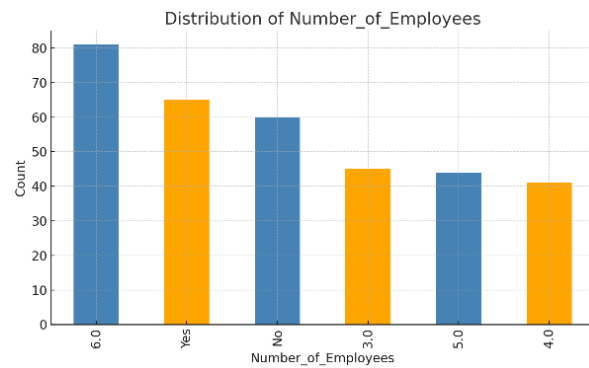
**Panel 1 of Graphs 1 to 15**, developed based on our analysis, shows the generational distribution of family businesses, where most companies are in their first or second generation, indicating younger family businesses dominating the sample. The analysis reveals several critical perspectives regarding current succession planning practices in the context of Mexican family businesses. Most companies do not have a clearly planned succession, which highlights the potential risks to business continuity during generational transitions. In terms of corporate governance structures, there is a balanced distribution of companies that have established a formal board of directors, slightly outnumbering those that have not implemented this governing body. In addition, many companies regularly hold shareholder meetings, demonstrating consolidated practices in the governance of ownership. However, there is evidence of a significant lack of ownership succession planning, as about half of the companies do not have a clearly defined plan for the transfer of shares. This situation points to the need to implement policies that promote more efficient ownership management practices, thus ensuring more fluid and effective transitions.

**Panel 1. Graphs 1 to 15: Distribution of organizational and succession-related variables.**

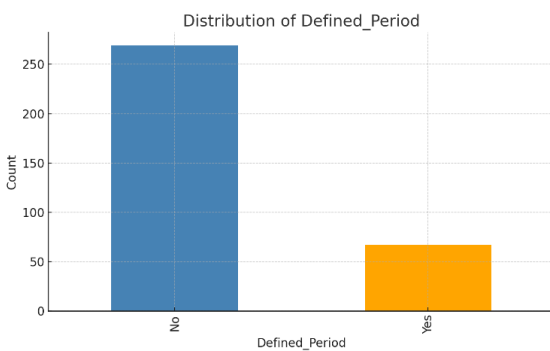
**Graph 1**



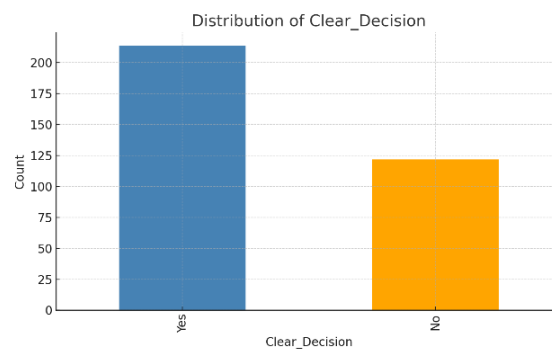
**Graph 2**



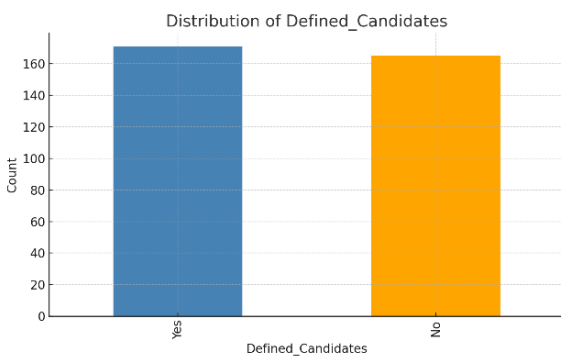
**Graph 3**



**Graph 4**



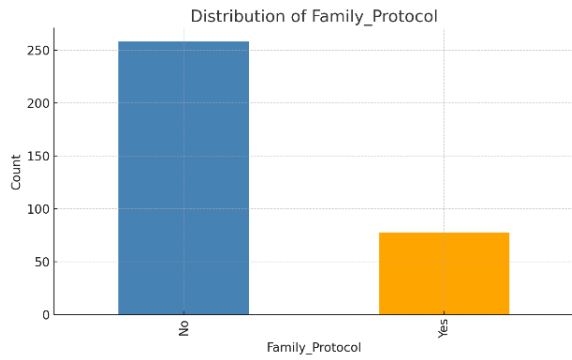
**Graph 5**



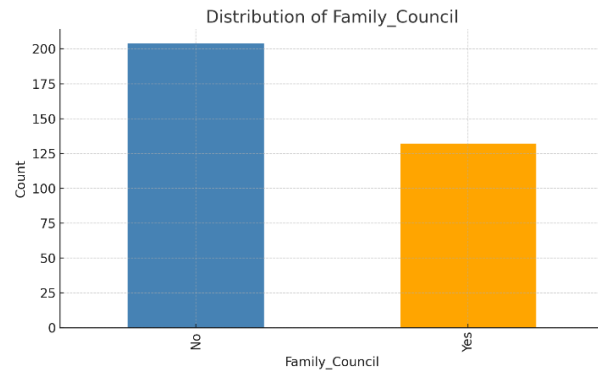
**Graph 6**



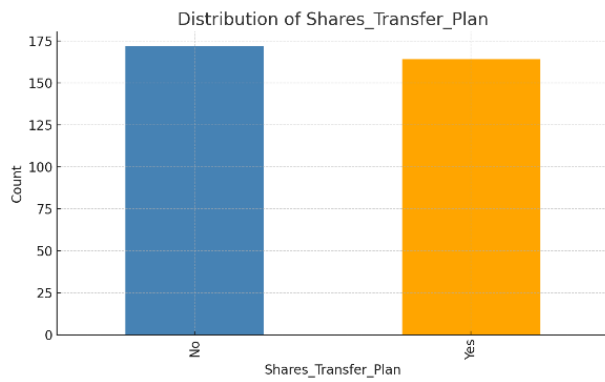
**Graph 7**



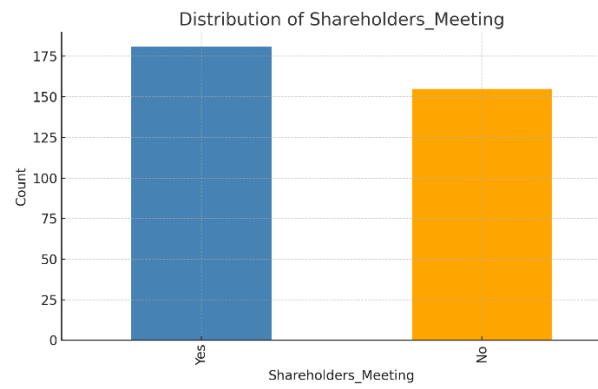
**Graph 8**



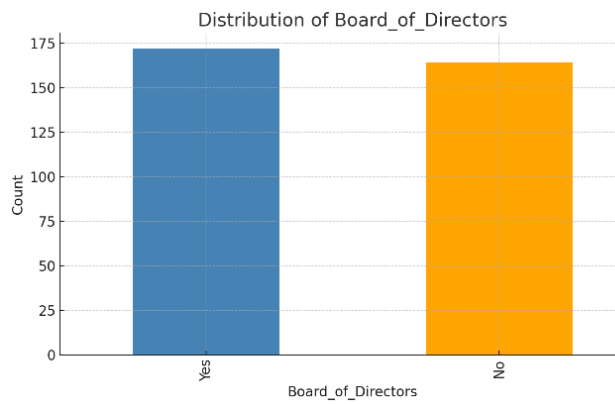
**Graph 9**



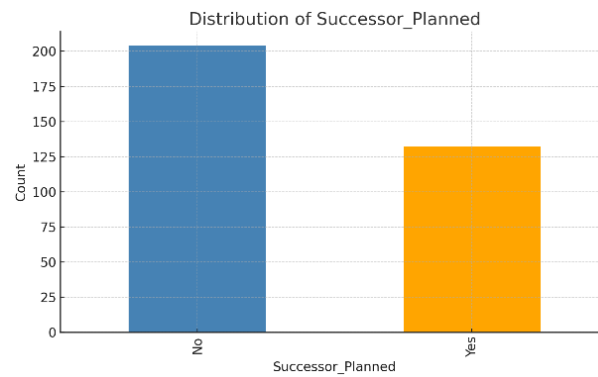
**Graph 10**



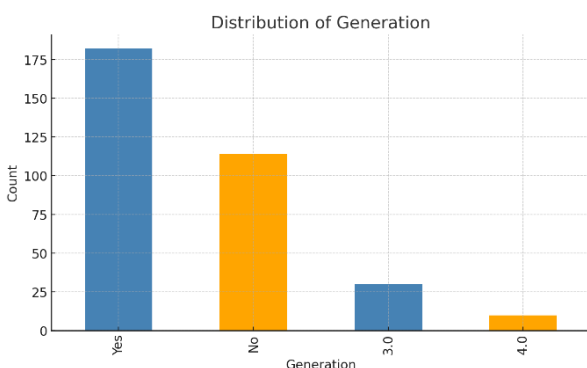
**Graph 11**



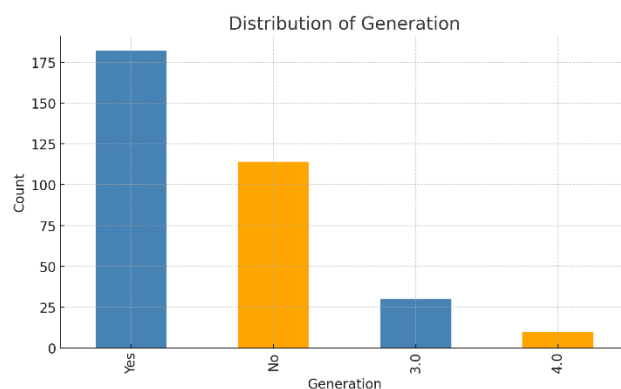
**Graph 12**



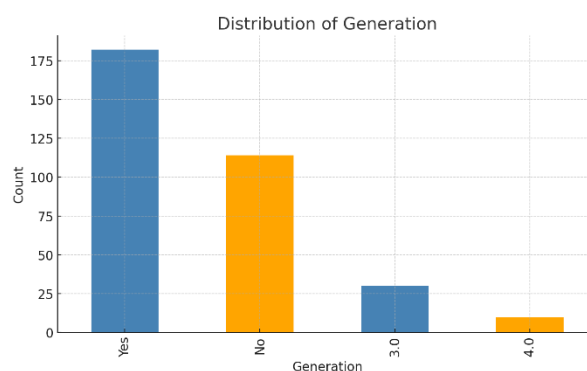
**Graph 13**



**Graph 14**



**Graph 15**



Source: own elaboration based on survey data (n = 337), visualized using PyCaret and Python libraries (Seaborn and Matplotlib).

There are notable deficiencies in family governance structures, with many companies lacking a formal family council and a written family protocol, which could hinder transparent decision-making and effective communication during succession processes. In fact, many companies report that they do not have clearly established succession rules, highlighting an important area for improvement.

Although a slight majority have identified potential succession candidates, many companies have not adequately addressed this issue. Paradoxically, despite the lack of formal succession rules, most companies reported clarity in their succession decision-making processes. However, the exact timing of succession remains uncertain, as the vast majority have not defined a specific time frame for this transition.

Regarding the size and life cycle of the companies, the analysis shows that many companies are small or medium-sized, with a limited number of employees and, in general, a relatively short

life cycle. This demographic characteristic may explain why structured succession planning is not prioritized in the early stages, although it remains crucial for future continuity and stability.

Analysis of the correlation matrix provided additional information, showing moderate positive relationships between variables associated with governance structures, such as the existence of a family protocol, clear rules and regular shareholder meetings. These relationships suggest that companies implementing one aspect of governance tend to adopt several governance practices simultaneously. In addition, a moderate correlation has been observed between the size and age of the company, suggesting that, over time, companies tend to expand in terms of size and complexity, which could increase the need for structured succession planning. **See Graph 16.**

#### 4.3.Data Cleaning

**PyCaret** was utilized to execute the data cleaning process, which entailed the identification, correction, and elimination of errors, inconsistencies, and redundant data from the dataset. This procedure was implemented to ensure the accuracy and reliability of the results.

**PyCaret**, a **Python** library designed to facilitate data preparation for model training, offers specific functions for data cleaning, outlier handling, missing value imputation, and categorical variable encoding. In certain instances, more specialized techniques were necessary for categorical variable encoding, including one-hot encoding and label encoding.

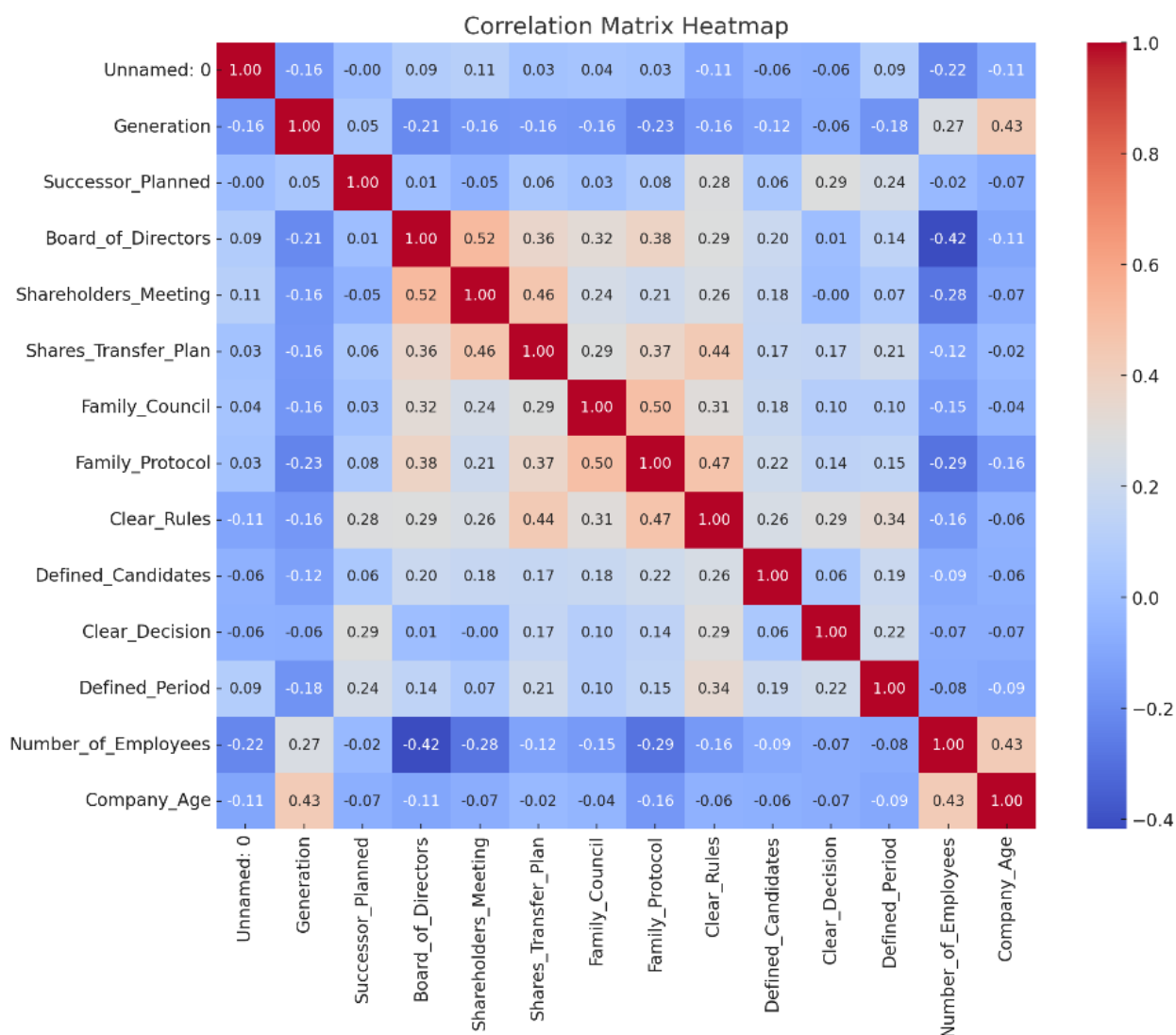
The **PyCaret** classification module was employed to address classification problems in the database columns. This model predicts the possibility of generating new categorical variables from the input values. Following the processing of the data, the dataset was randomly partitioned into two segments: **70%** was allocated for training the algorithms, while the remaining **30%** was set aside for testing. The training dataset was subdivided into ten parts to optimize the outcomes.

The training and comparison of the model were conducted using the *"qualified opportunity"* field as the target variable. Given that **PyCaret** facilitates the comparison of multiple machine learning models, the data were analyzed using various classification algorithms, including Naive Bayes, logistic regression, Ada Boost classifier, Random Forest classifier, Gradient Boosting classifier, Extreme Gradient Boosting, Light Gradient Boosting, Quadratic Discriminant



Analysis, Linear Discriminant Analysis, Decision Tree classifier, K-Neighbor classifier, Sparse Tree classifier, Dummy classifier, Ridge classifier, and SVM.

**Graph 16. Correlation Heatmap of Governance and Succession-Related Variables in Family Businesses**



Source: own elaboration based on survey data (n = 337), visualized using PyCaret and Python libraries (Seaborn and Matplotlib).

#### **4.4. Model Performance Evaluation**

This section will address the evaluation of model performance by describing some of the evaluation metrics used for this purpose. First,

- **Accuracy** is defined as the proportion of correctly predicted sales out of the total number of sales predictions (correct or incorrect).
- **Precision** is defined as the proportion of true positives out of the total number of positive predictions.
- **Recall** (sensitivity or completeness) is the proportion of true positives out of the total number of true positives.
- **The F1 score** is the arithmetic mean of the precision and recall scores. This metric is defined as the percentage of correctly predicted sales out of the total number of actual sales predicted. The range of values that this metric can take is from 0 to 1, with higher values indicating higher classification performance.

To assess the efficacy of the most advanced models, the following analytical instruments were employed: Initially, the confusion matrix was employed, which encapsulates the performance of a classifier in its classification function with respect to a designated set of test data. Receiver operating characteristics (**ROC**) are employed to assess multiple systems, including machine learning systems. This two-dimensional graph enables a balanced assessment of the benefits that would result in true positives and the costs that would result in false positives.

The area under the **ROC** curve (**AUC**) quantifies the model's ability to differentiate between classes. This metric ranges from 0 to 1. A value less than 0.5 indicates an unrealistic classifier, suggesting that the prediction model is unable to differentiate between classes. Conversely, a value above 0.7 indicates that the model performs optimally in differentiating between classes.

**Table 3**, based on our analysis, presents a comparison of various classification models based on different performance metrics, including Accuracy, **AUC** (Area Under the Curve), **Recall**, **Precision**, **F1-score**, **Kappa**, and **MCC** (Matthews Correlation Coefficient). The highlighted values indicate the best-performing models in specific categories.

**Table 3**, based on our analysis, presents a comparison of various classification models based on different performance metrics, including Accuracy, **AUC** (Area Under the Curve), **Recall**, **Precision**, **F1-score**, **Kappa**, and **MCC** (Matthews Correlation Coefficient). The highlighted values indicate the best-performing models in specific categories.

**Table 3: Model evaluation metrics**

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
knn	K Neighbors Classifier	0.8125	0.8494	0.6569	0.8038	0.7044	0.5712	0.5903
gbc	Gradient Boosting Classifier	0.7953	0.8601	0.6319	0.7770	0.6828	0.5356	0.5511
lda	Linear Discriminant Analysis	0.7953	0.8622	0.6444	0.7774	0.6830	0.5373	0.5537
lightgbm	Light Gradient Boosting Machine	0.7911	0.8418	0.6806	0.7427	0.6903	0.5358	0.5525
ridge	Ridge Classifier	0.7909	0.8607	0.6194	0.7810	0.6601	0.5191	0.5373
ada	Ada Boost Classifier	0.7908	0.8637	0.6569	0.7677	0.6933	0.5383	0.5492
nb	Naive Bayes	0.7830	0.8558	0.6944	0.7296	0.7010	0.5339	0.5408
xgboost	Extreme Gradient Boosting	0.7826	0.8346	0.6569	0.7409	0.6748	0.5158	0.5332
lr	Logistic Regression	0.7784	0.8654	0.6444	0.7506	0.6780	0.5130	0.5244
et	Extra Trees Classifier	0.7784	0.7528	0.6069	0.7522	0.6470	0.4930	0.5129
qda	Quadratic Discriminant Analysis	0.7741	0.8412	0.6444	0.7228	0.6585	0.4946	0.5088
rf	Random Forest Classifier	0.7524	0.8202	0.6069	0.6820	0.6267	0.4462	0.4570
dt	Decision Tree Classifier	0.7489	0.7234	0.5597	0.7101	0.6090	0.4299	0.4480
svm	SVM - Linear Kernel	0.7147	0.8334	0.6167	0.6695	0.5871	0.3814	0.4115
dummy	Dummy Classifier	0.6511	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: own elaboration using PyCaret's compare models function within a Python environment.

### **Key Observations:**

- 1. Best Accuracy:** The **K-Nearest Neighbors (KNN)** classifier has the highest accuracy (0.8125), making it the most overall accurate model in this comparison.
- 2. Best AUC:** Logistic Regression (**LR**) achieves the highest **AUC** (0.8654), meaning it has the best discriminatory power between classes.
- 3. Best Recall:** The Naïve Bayes (**NB**) classifier has the highest **Recall** (0.6944), meaning it correctly identifies more positive cases than the other models.

4. **Best Precision: KNN** also has the highest Precision (0.8038), indicating that when it predicts a positive case, it is correct more often than other models.
5. **Best F1-score: KNN** (0.7044) balances precision and recall the best.
6. **Best Kappa and MCC: KNN** also leads in **Kappa** (0.5712) and **MCC** (0.5903), which measure agreement and correlation between predicted and actual classifications.

***Interpretation:***

- **KNN** emerges as the best model overall, leading in multiple categories including **Accuracy, Precision, F1-score, Kappa, and MCC**.
- **Logistic Regression** has the best **AUC**, indicating that it may perform well in ranking predictions rather than absolute classifications.
- **Naïve Bayes** has the highest Recall, meaning it is better at detecting positive cases but might have more false positives.
- **Tree-based methods (Random Forest, Decision Tree, Extra Trees)** perform worse than boosting models (Gradient Boosting, AdaBoost, XGBoost), indicating that ensemble boosting techniques improve performance.

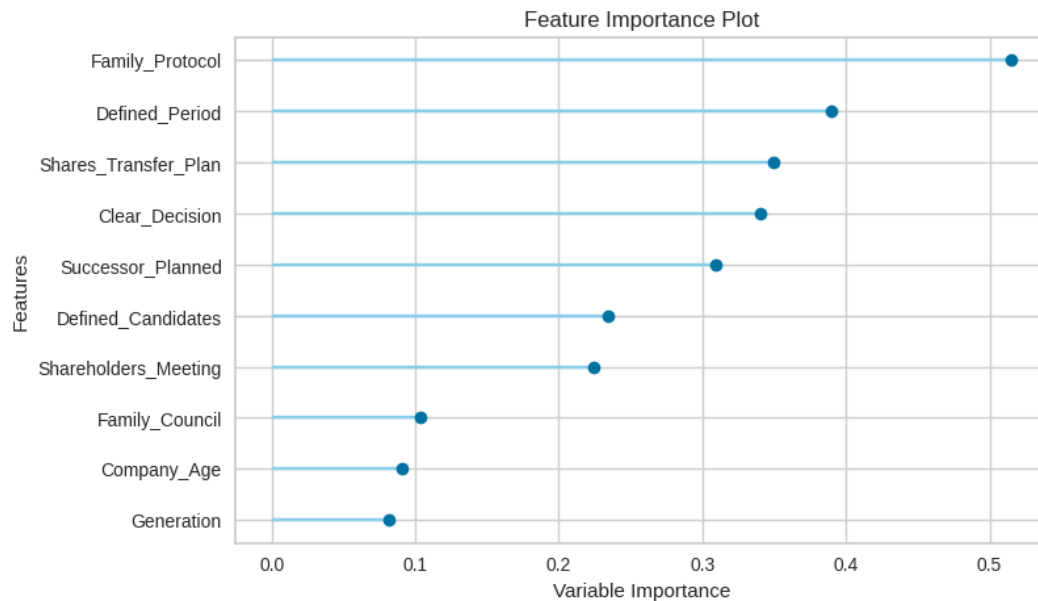
## **5.RESULTS**

The results section presents the key findings derived from the analysis conducted. It begins with an examination of the variables included in the predictive model, highlighting their relative importance in determining the presence of clear succession rules in family businesses. This is followed by inferential statistical analysis aimed to validating the associations between governance-related variables and succession clarity. Categorical variables were tested using chi-square analysis, while quantitative variables were examined through **ANOVA** to explore potential differences based on organizational characteristics. These results provide a comprehensive view of the structural and procedural factors that influence succession planning in the context of family enterprises.

### **5.1.Feature Importance Analysis**

**Graph 17**, based on our analysis, shows the relative importance of various features used in a predictive model, ranked from most to least important.

**Graph 17. Relative Importance of Variables in Predicting Succession Clarity**



Source: own elaboration using PyCaret (classification module), Seaborn, and Matplotlib, based on survey data (n = 337).

Here is the interpretation in detail:

1. **Family\_Protocol** is the most important feature, suggesting that having a family protocol significantly influences the predictive power of the model.
2. **Defined\_Period** is the second most influential factor, highlighting the importance of having clearly defined timelines or periods.
3. **Shares\_Transfer\_Plan** also has a strong influence, emphasizing that having a structured shares transfer plan contributes significantly to the prediction.
4. **Clear\_Decision** shows substantial importance, indicating that clarity in decision-making processes is critical.
5. **Successor\_Planned** is also relevant, emphasizing the importance of succession planning in the predictive context.
6. **Defined\_Candidates** and **Shareholders\_Meeting** have moderate importance, suggesting that defined candidate pools and regular shareholder meetings positively impact the outcomes, but less strongly than the variables listed above.

7. **Family\_Council, Company\_Age, and Generation** have relatively low influence, implying that while these factors are helpful, their impact is minor compared to the higher-ranking variables.

## 5.2. Inferential Statistical Analysis

Two types of inferential statistical analyses were conducted to validate the relationships between variables and assess their relevance to clear succession rules in family businesses. A chi-square ( $\chi^2$ ) test was performed for categorical variables to verify the presence of a statistically significant association between the categorical predictor variables and clear succession rules. As part of this process, contingency tables were developed to tabulate each predictor variable alongside the target variable. Chi-square statistics and corresponding  $p$ -values were calculated to assess the strength and relevance of these associations. The findings indicated significant correlations ( $p - values < 0.05$ ) between key governance structures, such as a family protocol, a board of directors, a family council, clearly defined succession periods, and clearly defined candidates. This underscores that organizations with formal governance structures are more likely to have established clear succession rules.

In **Table 4**, based on our analysis, all categorical variables demonstrate statistically significant associations with the target variable (Clear Rules, clear rules for succession), with  $p$ -values less than 0.05.

**Table 4. Chi-Square Test Results for Categorical Governance Variables and Succession Clarity**

Variable	$\chi^2$ Statistic	$p$ -value
Successor Planned	25.49778	4.43E-07
Board of Directors	26.82297	2.23E-07
Shareholders Meeting	22.11819	2.56E-06
Shares Transfer Plan	62.08005	3.3E-15
Family Council	30.45359	3.42E-08
Family Protocol	72.25231	1.89E-17
Defined Candidates	20.89425	4.85E-06
Clear Decision	27.40024	1.65E-07
Defined Period	36.81187	1.3E-09

Source: own elaboration based on survey data (n = 337), using Python

The most notable variables are:

- a. **Family Protocol** ( $p = 1.89\text{e-}17$ ): This variable demonstrates a highly statistically significant association, indicating that companies that implement a family protocol tend to have clear rules.
- b. **Shares Transfer Plan** ( $p = 3.29\text{e-}15$ ): highly significant, underscoring the significance of a well-defined share transfer plan.
- c. **Defined Period** ( $p = 1.30\text{e-}9$ ) is another salient variable, as companies with a defined period demonstrate a significant degree of clarity in their succession rules.
- d. **Family Council** is also closely linked to succession clarity ( $p = 3.42\text{e-}9$ ). Additionally, a strong correlation was observed between the presence of a **Board of Directors** and clear decision-making processes, with  $p$ -values of  $2.23\text{e-}7$  and  $1.65\text{e-}7$ , respectively.

For the quantitative variables (number of employees and organizational age), an analysis of variance (**ANOVA**) was conducted to determine whether there were statistically significant discrepancies between groups defined by the presence or absence of explicit succession rules. Essentially, the **ANOVA** tests whether the means of these continuous variables differ significantly between the two groups (companies with clear regulations versus those without). The findings indicated that only the number of employees showed significant variations, suggesting that organizational size impacts the clarity of succession planning. In contrast, corporate age was not statistically significant, indicating that corporate maturity does not significantly impact the formalization of succession rules.

**Table 5**, developed in our analysis, shows that the number of employees exhibited statistically significant differences depending on clear succession rules within the company (significant  $F$ ,  $p < 0.05$ ).

**Table 5. ANOVA Results for Quantitative Variables and Succession Clarity**

Variable	F Statistic	$p$ -value
Number of Employees	8.359957	0.004087
Company_Age	1.104867	0.29396

Source: own elaboration based on survey data ( $n = 337$ ), using Python's

This finding suggests that company size may have a bearing on the formalization of the succession process. In contrast, the analysis revealed that company age did not exhibit statistically significant differences ( $p = 0.29$ ), indicating that seniority does not appear to be a determining factor in the establishment of clear succession rules.

## **6.DISCUSSION**

**Critical Analysis of the Results:** The results obtained in this research show that the KNN model was the most accurate, with an accuracy of 81.25%. This suggests that family businesses implementing formal governance structures, such as family protocols and share transfer plans, would have greater clarity in their succession processes. This finding is consistent with previous studies that have highlighted the importance of formalization in business succession.

**Relationship with the State of the Art:** The existing literature on family business succession has emphasized the need for structured succession planning. Studies such as those by Le Breton-Miller et al. (2004) have proposed integrative models that highlight the importance of factors such as governance and share transfer. The results of this research confirm these theories and provide additional empirical evidence that reinforces the relevance of these factors in the Mexican context.

### **6.1.Theoretical Contribution**

This study provides a theoretical contribution by empirically supporting the first phase of the Integrative Model for Successful Succession developed by Le Breton-Miller et al. (2004). The results validate that elements such as the existence of a family protocol, a clearly defined period for succession, and a structured transfer plan are strongly associated with the presence of clear succession rules. These findings reinforce the model's emphasis on early formalization as a critical factor for intergenerational continuity.

The research also complements earlier work by Miller et al. (2003), who analyzed different succession patterns and their organizational implications, highlighting the need to consider both strategic and emotional dynamics in succession planning. Additionally, the inclusion of selection criteria and successor identification in the analysis is aligned with Stewart (2003), who emphasized the relevance of family ties and social capital in choosing future leaders.



Moreover, the study provides a contrasting insight to that of Schenkel et al. (2016), who focused on birth order and identity roles in descendant CEOs. In this research, structural aspects such as company size emerged as more statistically significant than personal or cultural factors like firm age or generational leadership, suggesting new directions for succession theory.

## **6.2. Practical Contribution**

This study offers practical implications for improving succession planning in Mexican family-owned businesses. The results show that firms that adopt **formal governance mechanisms**—such as family protocols, share transfer plans, boards of directors, and shareholder meetings—are significantly more likely to exhibit clarity in their succession rules. This highlights the urgent need to institutionalize these practices, especially in early generational stages, where such structures are often lacking.

Importantly, the study identifies **company size**, measured by the number of employees, as a statistically significant factor influencing succession clarity—more so than company age. This finding suggests that as family businesses grow, they should prioritize the implementation of structured succession processes to ensure long-term continuity.

These findings are especially relevant in the context of **Jalisco** state in Mexico where a high percentage of businesses are family-owned but lack formal succession planning. According to national data, over 66% of family businesses in Jalisco are managed by first-generation leaders (IIEG, 2022), and more broadly, 83% of businesses in Mexico can be classified as family-owned (INEGI, 2025). Strengthening their succession mechanisms is therefore critical to their survival and sustainability.

Finally, this research aligns with the United Nations **SDG8** (United Nations, n.d.), which promotes sustained economic growth and decent work for all. By contributing to business continuity, succession planning in family firms supports employment stability and local economic development.

## 7.CONCLUSION

The main objective of this study is to evaluate the performance of different classification models applied to the prediction of clear succession rules in Mexican family businesses. To this end, several key factors influencing the formalization of the succession process have been identified.

The results of the study highlight that the K-Nearest Neighbors (**KNN**) model performed best in several metrics, including accuracy, **F1 score**, **Kappa** and **MCC**, which positions this model as the most robust option for classifying firms according to the clarity of their succession rules.

However, the logistic regression model had the highest **AUC**, suggesting greater effectiveness in class discrimination. In addition, the Naïve Bayes model stood out in the recall metric, indicating that it is more effective in identifying positive cases, albeit with a higher risk of false positives.

The analysis of the importance of the variables revealed that the existence of a family protocol, a share transfer plan and the definition of a succession period are the most influential factors in the formalization of clear succession rules. Other factors, such as clarity in decision-making, succession planning and the existence of a family council, were also relevant, but with less weight. On the other hand, the age of the firm and the generation of leadership were found to have less significant influence.

Statistically, chi-squared tests confirmed significant associations between different governance structures (family protocol, shareholders' meeting, board of directors, among others) and the existence of clear succession rules. Analysis of variance (ANOVA) showed that the size of the company, measured by the number of employees, has a significant impact on the clarity of succession rules, while the age of the company did not show a relevant effect.

These findings underscore the importance of implementing formalized governance mechanisms to optimize succession planning in family businesses, especially in first- and second-generation businesses, where the lack of preparation is more pronounced. Similarly, the need for a structured approach to leadership transfer is evident, highlighting the role of formal planning in the sustainability and continuity of businesses over time.

As mentioned, based on the UN Sustainable Development Goal (United Nations, n.d.), this study contributes to the **SDG8**: *“Promote sustained, inclusive and sustainable economic growth,*

*full and productive employment and decent work for all*”, because it shows how family business successful succession helps to ensure sustainability in terms of economic growth employment development.

However, it is important to note that the inherent limitation of the study lies in its focus on the Mexican context, which may limit the generalizability of the results to other business cultures. It is recommended that future research deepen the causality of the factors identified and evaluate the implementation of succession strategies in different organizational settings.

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