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Predicting the resilience of hotel companies after the covid-19 health crisis

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Abstract

The tourism industry is a major branch of the service sector contributing to national wealth creation. It is one of the main drivers of employment and foreign exchange drainage in the economies. However, some tragic events affect and slow down its development. Moreover, the epidemiological context of the coronavirus has deeply affected the sector, implying a total halt of all tourism activities at the national and international levels. This paper will analyze a set of resilience determinants, assisting the tourism industry during the covid-19 pandemic specifically the classified hotel units to overcome this health crisis. In an attempt to predict the resilience of hotel businesses, this study will mobilize generalized linear models, specifically the "logit" model using the binary logistic regression method. As a result, the characteristics related to the hotel environment, the strategies implemented, the personal traits of the manager, and the characteristics specific to hotel organizations contribute significantly to overcoming the negative consequences of this epidemic.

Keywords: Resilience determinants, tourism sector, the coronavirus epidemic, binary logistic regression, Generalized Linear Models.

Résumé

L'industrie du tourisme est une branche majeure du secteur des services qui contribue à la création de la richesse nationale. Elle est l'un des principaux moteurs de l'emploi et du drainage des devises étrangères dans les économies. Cependant, certains événements tragiques affectent et ralentissent son développement. De plus, le contexte épidémiologique du coronavirus a profondément affecté le secteur, impliquant un arrêt total de toutes les activités touristiques au niveau national et international. Cet article analysera un ensemble de déterminants de la résilience, aidant l'industrie du tourisme pendant la pandémie de covid-19, en particulier les unités hôtelières classées, à surmonter cette crise sanitaire. Pour tenter de prédire la résilience des entreprises hôtelières, cette étude mobilisera des modèles linéaires généralisés, plus précisément le modèle " Logit " utilisant la méthode de régression logistique binaire. Il en résulte que les caractéristiques liées à l'environnement hôtelier, les stratégies mises en œuvre, les traits personnels du manager et les caractéristiques propres aux organisations hôtelières contribuent significativement à surmonter les conséquences négatives de cette épidémie.

Mots clés: Déterminants de la résilience, secteur du tourisme, épidémie de coronavirus, régression logistique binaire, modèles linéaires généralisés.

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1. Introduction

Despite all the pessimistic scenarios predicting a severe recession for the first quarter (2023), the evaluation of the Moroccan economic fabric has shown that the situation is rather good and is part of a confirmed recovery dynamic (HCP, 2022) [19]. Admittedly, the Moroccan economy was marked in (2020) by an acute recession in its history (-7% according to the HCP and the IMF). Also, everything indicates that the crisis has had a singular effect on the activity of companies, especially those operating in the tourism sector. Even though many of them have had to slow down their activity or even, to a lesser degree, except that a significant number of them have been able to master and overcome the repercussions of the covid-19 health crisis, and adapt to the restrictive measures and diligently seize the opportunities offered in this unfortunate context.

The latest study conducted by Inforisk (a subsidiary of the FinAccess Group: specialist in business intelligence on Moroccan companies) on the situation of Moroccan SMEs, confirmed this finding and reported that the cessations of companies declared in (2020) recorded only 6,612 economic units with a decrease of 21.6% compared to the year (2019). Admittedly, from an academic point of view, this situation seems paradoxical. The reported figures remain biased mainly by the almost continuous cessation of activity of tribunals and commercial courts from March to September (2020). Nevertheless, from an experimental point of view, the indicators relating to the financing of the Moroccan economy in the first half of the year (2021) show globally encouraging developments in the national economy (deceleration of the growth of bank credits at the end of March (2021) to +3.3% after +5.3% one year earlier, continued improvement of the indicators of the Casablanca Stock Exchange at the end of April (2021), a notable increase in exports at the end of March (2021) of 12.7%, etc.) (DEPF, 2021) [9].

These reassuring figures reveal encouraging signals, allowing us to hope for an increase in the economic recovery from (2021) onwards and testifying to the capacity of Moroccan companies, and mainly tourism companies, to overcome the effects of the pandemic and to show resilience and flexibility in the face of the scale of the shock suffered. In this context, the determinants of resilience help to ensure the survival of tourism units and their success in overcoming the negative consequences of the covid-19 health crisis. These determinants of resilience are linked to elements of the context in which the tourism enterprise operates, such as the intrinsic characteristics of the managers, the strategies implemented, the internal and external environment of the tourism units, and the specific features of the enterprise itself.

Several studies have examined the determinants of business resilience and success specifically during and after the covid-19 health crisis. The study by S. Jabraoui and A. Boulahoual (2016) [22] shows that the preparatory elements, the environment, the financial means, and the accompanying actions of the enterprises are the factors that most impact the success and resilience of Moroccan enterprises. However, the results remain mixed, as entrepreneurial success is a complex phenomenon with a polysemic and non-univocal conception (Zotlan J. Acs and László Szerb, 2010) [40]. To this end, given the pandemic context, and the importance of the research topic, we considered it useful to explore and analyze the determinants of resilience and success of tourism businesses during the COVID-19 pandemic in overcoming and managing the health crisis. This exploration will focus on four main dimensions: the characteristics of the leaders, the strategies implemented, the specificities of the enterprises, and their environment. However, our problem will be articulated around the main question we will try to answer throughout our essay by attempting to analyse, from a performance perspective, the endogenous and exogenous determinants that explain the resilience of tourism enterprises in the Rabat-Salé-Kenitra region during a health crisis?

To answer this question, we will begin with an exploratory documentary study which will be supported by a qualitative study through the administration of interview guides to a sample of fifty managers and owners of tourism units in the Rabat-Salé-Kenitra region. This qualitative study will aim to detect and select the exogenous and endogenous determinants of resilience which have a significant impact on tourism units. This selection will mobilize the AFCM method allowing dimension reduction for the statistical exploration of complex qualitative data. Secondly, our study will move towards a quantitative study to quantify the impact of each resilience explanatory variable on the performance of tourism enterprises in overcoming the health crisis. This quantitative approach will focus on the use of generalized linear models, more precisely, the logistic regression method. Our paper will focus exclusively on the quantitative study.

This study aims to explain the different factors that explain the resilience of tourism enterprises, specifically hotel enterprises, in the context of health and economic crisis to highlight the most significant elements. In other words, we will try to predict the resilience of hotel units in the region of Rabat, Salé, and Kénitra, specifically classified hotels, during the epidemic. To respond to the problem raised above, we use the post-positivist epistemological position, based on hypothetico-deductive reasoning, which allows us to extract the primary hypotheses from the literature review and to try to validate or refute them on a chosen field. However, the finalization of this survey will focus on the quantitative method, using the binary logistic regression model to quantify the impact of each explanatory variable on the resilience of classified hotels during covid-19.

2. Literature review, conceptual, and theoretical framework of resilience

Although several research studies have attempted to develop a model of resilience, they offer no unanimous conclusion. Thus, the determinants of resilience, particularly in times of recession or health crisis, remain an intriguing and under-explored area (Staniewski M. W and Awruk K. 2018) [31]. The academic literature offers a multitude of definitions and approaches to business resilience. It is often associated with business performance, survival, or success.

About resilience as a survival issue, Karl E. W., defines the notion of organizational resilience as 'the ability of an organization to maintain a system of organized actions in the face of an unusual situation to preserve the organization's survival' (Karl E. W. 2003) [25]. He adds that resilience involves three mechanisms, the absorptive capacity that allows the company and the organization to cope with crises without collapsing, the renewal capacity that allows it to reinvent itself to adapt to a new situation and build new futures, and the appropriation capacity that allows it to strengthen itself by learning from the crises it experiences. From a performance perspective, Louis Hébert (2009) [20] explains resilience as an entrepreneurial skill that manifests itself in several ways. Firstly, it is financial and concerns the company's indebtedness, its solvency, and the quality of its relations with the various stakeholders. Secondly, resilience is operational, affecting the efficiency of operations and the supply chain. And finally, it is a marketing issue, manifested in the strength of the distribution network and the creditworthiness of customers (African Development Bank (AfDB), International Labour Organisation (ILO) 2021) [1]. In other words, resilience aims to ensure the short-term survival of enterprises without compromising their long-term future, by trying to absorb as much as possible shocks from the environment as.

Translating an act of success, organizational resilience is considered to be the ability to achieve all the objectives that entrepreneurs have set for themselves, whether economic (financial health of the business, increased revenues) or non-economic (personal well-being, territorial legitimacy, etc.) (Josée St-Pierre and Louise Cadieux, 2009) [24]. Resilience is seen as a trigger for the process leading the organization and its leader to success (Witt P. 2004 [39], Tamassy C. 2006 [35]; Lasch F. et al., 2005 [26]; Jean C. Teurlai 2004 [36]). In his aspect of success, Cooper A. (1992) [11] states that "to succeed is not to fail, even if the enterprise remains small and unprofitable". Thus, the concept of success is reduced to that of survival". In general, a heterogeneous range of approaches has addressed the concept of resilience regarding the survival, success, and performance of organizations. These include approaches that focus on the leader of the organization, approaches that focus on the strategy and processes implemented, approaches that focus on the characteristics of the organization, and approaches that focus on the business environment.

The notion of resilience involves several determinants that are endogenous and exogenous to the organization. In other words, the ability of a company to overcome shocks and crises is specifically related to the characteristics of the organization, its leaders, the strategies it has implemented, and its environment. Regarding the characteristics of leaders and their direct impact on the resilience of companies at times of crisis, personality traits explain the extent to which their behavior, reactions, and decisions enable them to overcome economic or health crises. In this context, Cooper A. (2002) [7] explains that the failure or success of the company can be explained by the background of the leader. In other words, the strengths and weaknesses of the company can be the result of the personality traits of its leader. Furthermore, the experience effect of the leader is an important factor in the success of organizations. Cooper A. aligns himself with the view of other authors who argue that entrepreneurial or managerial experience could be an indispensable condition for the success of the firm. In the same vein, the theory of human capital intervenes, which responds to the importance of the human factor in the survival or success of an organization and therefore its resilience in the event of a crisis.

Van Praag C. M. (2003) [37] indicates that there are links between human capital elements, namely the age of the leader, his or her experience and education, and the survival and resilience of the firm. That is, there is a positive correlation between these different leader characteristics and the resilience of organizations. It also includes other determinants related to motivation, to more psychological elements such as religion or family environment to demonstrate to what extent these factors can influence one's behavior and decisions in the shock phase, to overcome them. However, several studies have started to explore the positive relationship between the profile and characteristics of the leader and the resilience of firms (Bouchikhi H., (1993) [4]; Bhidé A., (1994) [3]; Bouchikhi H. and Kimberly J., (1994) [5]; Jabraoui and Boulahoual, (2016)) [22]. These characteristics can be broken down into four dimensions: personality traits, motivation, entrepreneurial skills, and human capital.

Referring to human capital theory, Veronique S. (2003) [32], defines human capital as "the set of skills, qualifications and other abilities that a person possesses for productive purposes. It can be innate or acquired during school, university, or professional experience, through the transmission of knowledge and skills, initial human capital takes forms such as intelligence, physical strength, or knowledge transmitted by the family, it responds more to genetic or family factors than to economic ones, and is supposed to be little changeable over time". From this definition, it is notable that there is a significant influence of the notion of human capital on entrepreneurship research, economics research, and organizational resilience, the subject of our essay. Regarding the theory based on the importance of leader motivation Frank L. and Frederic L. R. (2005) [15] explain that leader motivation and engagement are the secrets to the success and resilience of firms in crisis. This means that the resilience, success, survival, and performance of companies are closely linked to the degree of motivation of leaders.

However, the characteristics related to the organizational structure significantly influence the resilience of firms in crisis. In this sense, Francesca L., Enrico S., And Marco V. (2001) [27] point out that there is a direct link between the characteristics of the firm and its ability to survive and succeed in any market. They point out that the size, age, and growth rate of the firm has a strong impact on its resilience. Also, Rosselier D. et al. (2015) [30] indicated the presence of significant effects of the age of the organization on its survival and resilience. On the other hand, Frank S. Coleman (2004) [8], notifies that new firms have a high failure rate due to the information asymmetry of the market and its environment. Referring to this literature review, it appears that the characteristics of a firm can have a significant impact on firm resilience.

However, the strategies implemented by firms also have an important role in the process of organizational resilience. R. Ettenson and A. Crouch (2000) [13] explain that a strategy of innovation, and modernization of the products and services offered by any firm, ensures survival in its market. They add that innovation can be a way to overcome crises and bad surprises. If we refer to the Covid-19 health crisis, despite the difficulties encountered, several companies were called upon, within a few weeks or even days of the outbreak of the pandemic, to devise entirely new strategies and ways of operating, from teleworking to home delivery to strengthening online sales. These methods have proven to be effective and have become normality and a reliable operating rule that guarantees continued success (Frimousse S. and Peretti J. M., 2020) [14].

African Scientific Journal
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Vol : 3, Numéro 16 , Février 2023

Similarly, the operating environment of the company is also crucial to its resilience. Fotopoulos, G. and Louri, H. (2000) [16] argue that there is a significant impact of the firm's environment on its survivability and resilience. They add that operating in an urban area is very different from operating in a rural area. In other words, location is seen as an important determinant of the future survival and resilience of the firm. However, several other studies have argued for the link between environmental context and resilience. According to Morgan G., (2006) [28], the entrepreneurial context and environment is a factor that influences the survival of firms or, on the contrary, their demise. The Covid-19 crisis, for example, was for many companies an accelerator of transformation and change that structured a new normality and a new way of operating.

Our problematic revolves around the analysis of the endogenous and exogenous determinants that explain the resilience of tourism enterprises, more specifically the classified hotel structures established in the Rabat-Salé-Kenitra area during the Covid-19 health crisis. In other words, this article will attempt to identify and analyze the factors, both direct and indirect, impacting the resilience of hotel units in this geographical area of Morocco, to provide decision-makers and investors with a broad vision of the determinants capable of helping them to overcome the challenges of health or other crises in the future. To address our problem, we have formulated the following basic hypotheses:

Tableau 1: Elementary hypothesis

Hypothesis 1: **Managerial characteristics contribute positively to the resilience of tourism businesses in the Rabat-Salé-Kenitra region.** **H1.1**: The leader's track record in crisis management contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.2**: The accumulated experience of the manager contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.3**: The age of the manager contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.4**: The educational level of the manager contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.5**: The motivation of the manager contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.

H1.6: The religion and beliefs of the manager contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.7**: The environment of the leader contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H1.8**: Personality traits contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.
Hypothesis 2: Organizational characteristics contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H2.1**: Firm size contributes positively to the resilience of tourism firms in the Rabat-Salé-Kenitra region. **H2.2**: The age of the enterprise contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H2.3**: The growth rate of the enterprise contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H2.4**: The experience of the enterprise contributes positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.
Hypothesis 3: **The characteristics of the strategy in place contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.** **H3.1**: The strategy options implemented contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H3.2**: Innovation and modernization of offers contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H3.3**: New operating modes contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region. **H3.4:** the degrees of applicability of the strategic options contribute positively to the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.
Hypothesis 4: Environmental characteristics impact the resilience of tourism businesses in the Rabat-Salé-Kenitra region **H4.1:** Entrepreneurial location impacts the resilience of tourism enterprises in the Rabat-Salé-Kenitra region **H4.2**: The internal environment (strength/weakness) impacts the resilience of tourism enterprises in the Rabat-Salé-Kenitra region

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

H4.3: The external environment (opportunities/threats) impacts the resilience of tourism enterprises in the Rabat-Salé-Kenitra region **H4.4**: Asymmetric market information impacts the resilience of tourism enterprises in the Rabat-Salé-Kenitra region.

Source: Authors

3. Methodology

Being a set of statistical models used to analyze the relationship of a variable to one or more others, the Generalized Linear Models (GLM), usually known by their English initials, operate as adequate tools to estimate the parameters of the model used in the most impartial way possible. These models are understood as a development of the general linear model, where the dependent variable or variable to be explained is linearly related to the independent variables via a precise link function. They cover statistical models such as linear regression for normally distributed responses, logistic models for binary or dichotomous data, log-linear models for headcount data, complementary log-log models for interval-censored survival data, etc. However, they have been used to address the shortcomings of linear models. In other words, the latter is limited to describing the relationship between a variable to be explained and explanatory variables, to test the significance and compare the intensity of the impact of each independent variable on the variability of the dependent variable

The Generalized Linear Model (GLM), is a more flexible device compared to the linear model, agreeing to cross the four assumptions mentioned above, in a process of treatment of the observations, to realize a relevant estimation of the parameters of the model and to test the hypotheses conceived in a motive of exploring the quality of the latter. These models were introduced and defined by Nelder John Ashworth, and Robert Wedderburn (1972) [29] stating that they "allow us to model responses that are not normally distributed, using methods closely analogous to linear methods for normal data. However, Sholom F., and al. (2004) [33], present in detail, the concepts of the density function, the exponential distribution function, the form of the moment generating function, and the specific types of the family of exponential distribution functions such as Gamma, Poisson, Bernoulli, Dirichlet, Exponential, Normal, Chi-square, Beta, and so on}. We explain throughout this article, the generalized linear models, and a brief application of one of its extensions namely, the binary logistic regression.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

A generalized linear model is an extension of the classical general linear model, so linear models are a suitable starting point for the introduction of generalized linear models. The linear regression model is characterized by four essential elements such as the column vector of dimension (*n)* of the dependent random variables (*Y*), a systematic component defined as a matrix of size ($n \times p$), and rank (*p*), called the design matrix $X = X_1, X_2, \dots, X_p$, grouping together the column vectors of the explanatory variables, also known as the control variables endogenous, or independent, where (x_i) is the row vector of these explanatory variables associated with the observation (*i*) such that, *i* = 1, 2, …n, (*β)* the column vector of dimension *p* of the unknown parameters of the model, i.e. the unknown regression coefficients associated with the column vector of the matrix (*X*), and finally, the vector dimension *n* of the errors (ε). The data are assumed to be drawn from observations of a statistical sample of size $n \in \Re^{(p+1)}$(where $n > p+1$). However, linear models seem to be based on a set of assumptions such as (i) ε_i are error terms, of a variable *E*, unobserved, independent, and identically distributed, noting that $E(\varepsilon_i)=0$, (ii) the $V(\varepsilon_i)=\sigma^2$. I, about the character of homoscedasticity, referring to a constant stochastic error variance of the regression, i.e., identical dispersion for each *i*, (iii) the normality of the distribution of the error random variable ε noting: $\varepsilon_i \sim N_n$ $(0, \sigma^2 I_n)$ We can also consider that ε_i is an observation of the random variable *E*, also distributed according to a normal distribution, noting that $\varepsilon_i \sim N$ $(0, \sigma^2$, (iv) the *n* real random variables ε_i are considered independent, i.e. ε_i is independent of ε_j for $i \neq j$, (v) y_i is an observation of *Y* of normal distribution, such that, $Y \sim N_n$ $(\beta X, \sigma^2 I_n)$. The linear regression model is defined by an equation of the form:

$$Y = \beta X + \varepsilon \quad \text{with} \quad \varepsilon \sim N_n\ (0, \sigma^2 I_n)$$

Where,

- $\mathbf{Y} \in \Re^{(n)}$
- $\mathbf{X} \in M_{(n,p)}$ known, deterministic, with rank *p*
- $\boldsymbol{\beta} \in \Re^{(p)}$, unknown
- $\sigma^2 \in \Re^{(*+)}$, unknown

In statistics, generalized linear models is an extraordinarily flexible generalization of ordinary linear regression, which takes into account dependent variables, called responses, that have distribution patterns other than the normal distribution. GLM generalizes linear regression by allowing the linear model to be related to these response variables by a (g) link function. This mechanism was founded by John Nelder and Robert Wedderburn (1972) [29], who were able to formulate generalized linear models to unify various other statistical models, including linear regression, logistic regression, Poisson regression, etc. However, the model's linear predictor or deterministic component is a quantity with the skill and ability to incorporate information about the independent variables into the model. It is linked to the expected value of the data thanks to the linking function (g). This linear predictor noted η is expressed in the form of linear combinations of the unknown parameters β and the matrix of column vectors of the explanatory variables X (see the works of Denuit M. and Charpentier A. (2005) [10], J-J. Droesbeke, Lejeune M., and Saporta G. (2005) [11]. η can thus be expressed as:

$$\eta = \beta X$$

The normality of the response variable Y, such that, $Y \sim N_n$ (β X, $\sigma^2 I_n$), for any observation i, allows us to write, E(Y) = βX, and to note E(Y) = μ for simplification reasons. Thanks to the link function (g), it is possible to establish a non-linear relationship between the expectation of the response variable E(Y) and the explanatory variable(s) and to apprehend observations and responses of diversified natures, such as the example of binary data of failures/successes, frequencies of successes of the treatments, lifetimes, etc., by noting that:

$$g\,(E(Y)) = g(\mu) = \eta = \beta X$$

As mentioned in the work of Esbjörn Ohlsson, and Björn Johansson (2010) [23], we can also write that:

$$E(Y) = \mu = g^{-1}(\eta)$$

The linkage function (g) states the relationship between the linear predictor η and the mean of the distribution function μ. There are many commonly used link functions, and their choice is based on several considerations. There is always a well-defined canonical link function that is derived from the exponential response density function (Y). However, in some cases, it makes sense to try to match the domain of the link function to the range of the mean of the distribution function. A linkage function transforms the probabilities of a category response variable into a continuous unbounded scale. Once the transformation is complete, the relationship between the η predictors and the response can be modeled using linear regression. For example, a dichotomous response variable may have two unique values. Converting these values to probabilities causes the response variable to vary between 0 and 1. When an appropriate linkage function is chosen to be applied to the probabilities, the resulting numbers are between $-\infty$ and $+\infty$. However, any probability law of the random component Y has associated with it a specific function of the expectation called the canonical parameter. For the normal distribution, it is the expectation itself. For the Poisson distribution, the canonical parameter is the logarithm of the expectation. For the binomial distribution, the canonical parameter is the logit of the probability of success. In the family of generalized linear models, the functions using these canonical parameters are called canonical link functions. In most cases, generalized linear models are built using these link functions. Below is a table of several commonly used exponential family distributions, the data for which they are commonly used, and the canonical link functions and their means.

Table 2: Laws of the exponential family and their canonical links

Y distribution	Canonical links	Means
Normal distribution $N(\mu, \sigma^2)$	Identity: $\eta = \mu$	$\mu = \beta X$
Bernoulli distribution $B(\mu)$	Logit: $\eta = \ln(\mu/(1-\mu))$	$\mu = 1/(1 + \exp^{-(\beta X)})$
Poisson distribution $P(\mu)$	Log: $\eta = \ln(\mu)$	$\mu = \exp^{(\beta X)}$
Gamma distribution $G(\mu, v)$	Inverse: $\eta = 1/(\mu)$	$\mu = (\beta X)^{-1}$
Gaussian Inverse distribution $I.G(\mu, \lambda)$	Inverse carré : $\eta = 1/(\mu^2)$	$\mu = (\beta X)^{-2}$

Source: Author

3.1. Probability law of the response variable *Y*

The inadequacy of the so-called classical general linear model, of the laws that it associates with the response variables, leads us to use generalized linear models (GLM), which allow us to connect other laws than the normal law, such as Bernoulli's law, the binomial law, Poisson's law, Gamma law, etc. These laws are part of the exponential family, offering a common framework for estimation and modeling. These laws are part of the exponential family, offering a common framework for estimation and modeling. This natural exponential family has laws

African Scientific Journal
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Vol : 3, Numéro 16 , Février 2023

that are written in exponential form, which allows us to unify the presentation of results. Let f_Y be the probability density of the response variable *Y*. We can admit that f_Y belongs to the natural exponential family if it is written in the form:

$$f(Y/\theta,\varphi,\omega) = \exp\left(\frac{Y\theta-\mathrm{b}(\theta)}{a(\phi)}\,\omega + \mathrm{c}(Y,\varphi,\omega)\right),\ Y \in S$$

With:

- a(.), b(.), c(.): Functions specified according to the type of the exponential family considered.
- θ: Natural parameter, also called canonical parameter or mean parameter.
- φ: Parameter of dispersion. This parameter may not exist for some laws of the exponential family, in particular when the law of Y depends only on one parameter (in these cases $\varphi = 1$). Otherwise, it is a nuisance parameter that must be estimated. As its name indicates, this parameter is related to the variance of the law. It is also a very important parameter in that it controls the variance and therefore the risk. In some cases, a weighting is necessary to grant relative importance to the different observations and the parameter φ is replaced by φ/ω, where ω designates a weight known as a priori.
- S: Subset of R or N
- ω: The weights of the observations.

Moreover, if f_Y , belongs to the natural exponential family, we can deduce the following properties:

- $E[Y] = \mu = \mathrm{b}'(\theta) = \partial \mathrm{b}(\theta)/\partial(\theta)$
- $V[Y] = \mathrm{a}(\varphi) \times \mathrm{b}''(\theta) = \mathrm{a}(\varphi) \times \partial^2 \mathrm{b}(\theta)/\partial(\theta)^2$
- $g(\mu) = \mathrm{g}(\mathrm{b}'(\theta)) = \beta X$

With: $\mathrm{b}'(\theta) = g^{-1}(\beta X)$ and $\theta = \eta = \beta X$

For a probability law to belong to the natural exponential family, it is sufficient to write it as an exponential function and determine its terms. We try below to propose some examples of commonly used probability laws, and explain all their components (See the works of Michel Denuit, and Arthur Charpentier (2005))[10].

-The Gaussian distribution, with mean μ and variance σ^2. $Y \sim N(\mu, \sigma^2)$ belongs to the exponential family, with $\theta = \mu$, $\varphi = \sigma^2$, $\mathrm{a}(\varphi) = \varphi$, $\mathrm{b}(\theta) = \theta^2/2$, and $\mathrm{c}(Y,\varphi,\omega) = -1/2\,(y^2/\sigma^2 + \ln(2\pi\sigma^2))$, where $Y \in \mathbb{R}$.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

-The Bernoulli distribution, with mean π, and variance π(1-π). Y ~ B(π) is catalogued among the exponential family, with θ = ln {π/(1-π)}, φ = 1, a(φ) = 1, b(θ) = ln (1+ exp(θ)), and c (Y,φ,ω) = 0 where $Y \in$ N .

-The Poisson distribution, with mean λ, and variance λ. Y ~ P(λ), is part of the exponential family, with θ = ln(λ), φ = 1, a(φ) = 1, b(θ) = exp(θ) = λ, et c (Y,φ,ω) = −ln(λ!) with $Y \in$ N .

-The Gamma distribution, with mean μ and variance v^{-1}. Y ~ G(μ, v), also joins the exponential family, with $\theta = -1/\mu$, $\varphi = v^{-1}$, a(φ) = φ, b(θ) = − ln(−θ), and c(Y,φ,ω) =((1/φ)-1) ln(Y)- ln(Γ(1/φ)) where Y ∈ R^+.

Table 3: Components of the exponential family of usual probability laws

Y distribution	**θ(μ)**	***φ***	**a(*φ*)**	**b(θ)**	**c (Y,*φ*,ω)**
Normal distribution *N* (*μ*, *σ*²)	μ	σ^2	φ	$\theta^2/2$	− ½ (y^2/σ^2 +ln($2\pi\sigma^2$))
Bernoulli distribution *B(μ)*	ln{μ/(1-μ)}	1	1	ln (1+ exp(θ))	0
Poisson distribution *P(μ)*	ln(μ)	1	1	exp (θ)	− ln (Y !)
Gamma distribution *G(μ, v)*	−1/μ	1/v	φ	−ln(−θ)	((1/ φ) − 1) ln (Y) -ln(Γ(1/ φ))
Gaussian Inverse distribution *I.G* (*μ*, *λ*)	$-1/2\mu^2$	σ^2	φ	$-(-2\theta)^{1/2}$	−1/2 (ln($2\pi\varphi Y^3$) + 1/ φ Y)

Source: Author

Table 4: Expectation and variance of usual probability laws

Y distribution	***μ* = E(Y) =b'(θ)**	**V(Y) = a(φ)b"(θ)**
Normal distribution N(μ, σ2)	θ	σ^2
Bernoulli distribution B(μ)	exp(θ)/((1+exp(θ)	$\mu(1-\mu)$
Poisson distribution P(μ)	exp(θ)	μ
Gamma distribution G(μ, v)	−1/θ	μ^2/v
Gaussian Inverse distribution I.G (μ, λ)	μ	μ^3/λ

Source: Author

African Scientific Journal
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The two tables above summarize respectively, the different components of the exponential family for usual probability laws, as well as their expectation and variance, assuming that the weight ω = 1.

3.2. Parameters estimation

At this stage, it is a question of estimating the column vector β = (β_0, β_1, ⋯, β_p) noted ($\widehat{\beta_0}$, $\widehat{\beta_1}$, ⋯, $\widehat{\beta_p}$) of dimension p of the unknown parameters of the model, i.e. the unknown regression coefficients associated with the column vectors of the matrix (X) representing a set of explanatory variables, by maximizing the natural log-likelihood of the generalized linear model. This estimation applies to all laws with a distribution belonging to the exponential family of the form:

$$f(Y/\theta, \varphi, \omega) = \exp\left(\frac{Y\theta - \mathrm{b}(\theta)}{a(\phi)}\omega + c(Y, \varphi, \omega)\right), \ Y \in S$$

The main idea of the maximum likelihood method is to look for the parameters' value that maximizes the probability of having observed what we observed. Moreover, the standard approach to finding the maximum of any function of several variables consists in canceling its gradient (first derivative) and checking that it's hessian (second derivative) is negative. However, to obtain the maximum likelihood estimator (L), we solve the following system of p unknowns β:

$$\frac{\partial \ln L(\beta)}{\partial \beta_1} = 0$$
$$\vdots$$
$$\frac{\partial \ln L(\beta)}{\partial \beta_p} = 0$$

Let n be independent variables Y_i, with i = 1⋯, n of law belonging to the exponential family, X the design matrix, where are arranged the observations of p column vectors representing the explanatory variables, β the column vector of p parameters of the model, η the linear predictor with n components noted η = βX, g the link function, is supposed to be monotonic and differentiable such that, η = $g(\mu)$, as well as the canonical link function, is expressed by $g(\mu)$ = θ. For n observations assumed to be independent, and taking into account the link between θ and β, the likelihood (L) and the natural logarithm of the likelihood (ℓ) are written as follows:

$$L(Y, \theta, \phi, \omega) = \prod_{i=1}^{n} f(Y_i, \theta_i, \phi, \omega)$$

ℓ (Y, θ, ϕ, ω) = ln (L (Y, θ, ϕ, ω)) = ln ($\prod_{i=1}^{n}$ f (Y_i, θ_i, ϕ, ω))) = $\sum_{i=1}^{n}$ ln (f (Y_i, θ_i, ϕ, ω)) = $\sum_{i=1}^{n} \ell_i(Y_i, \theta_i, \phi, \omega)$

With:

$\ell_i = \frac{Y_i\,\theta_i - b(\theta_i)}{a_i(\phi)}\ \omega + c\,(Y_i, \phi, \omega)$, and $\theta_i = \beta_j . x_i^T$

Indeed, we try this method to reach the maximum likelihood. The logarithm function is strictly increasing, and the likelihood and the natural logarithm of the likelihood reach their maximum at the same point. Moreover, the search for the maximum likelihood generally requires the calculation of the first derivative of the likelihood, and this is much simpler than the natural log-likelihood, in the case of multiple independent observations, since the logarithm of the product of the likelihoods is written as the sum of the logarithms of the likelihoods, and it is easier to derive a sum of terms than a product. However, the derivative of the natural log-likelihood can be realized by solving the following equality:

$$\frac{\partial \ell_i}{\partial \beta_j} = \frac{\partial \ell_i}{\partial \theta_i} \times \frac{\partial \theta_i}{\partial \mu_i} \times \frac{\partial \mu_i}{\partial \eta_i} \times \frac{\partial \eta_i}{\partial \beta_j}$$

From the above equality, we try to give the meaning of each term of the latter as follows:

- $\frac{\partial \ell_i}{\partial \theta_i} = \frac{Y_i - b\prime(\theta_i)}{a_i(\phi)} = \frac{Y_i - (\mu_i)}{a_i(\phi)}$
- $\frac{\partial \mu_i}{\partial \theta_i} = b''(\theta_i) = \frac{V(Y_i)}{a_i(\phi)}$
- $\frac{\partial \eta_i}{\partial \beta_j} = \frac{\partial(\beta X_i)}{\partial \beta_j} = X_{ij}$

And $\frac{\partial \mu_i}{\partial \eta_i}$ depends on the link function $\eta_i = g(\mu_i)$ with $\eta_i = \beta_j \cdot X_{ij}$

The partial differential equations are therefore written in the following form:

$$\frac{\partial \ell_i}{\partial \beta_j} = \frac{Y_i - (\mu_i)}{a_i(\phi)} \times \frac{a_i(\phi)}{V(Y_i)} \times \frac{\partial \mu_i}{\partial \eta_i} \times X_{ij}$$

$$\frac{\partial \ell(Y, \theta(\beta), \phi)}{\partial \beta_j} = \sum_{i=1}^{n} \left(\frac{Y_i - (\mu_i) \times X_{ij}}{V(Y_i)} \times \frac{\partial \mu_i}{\partial \eta_i} \right) = 0, \forall j = 1, \cdots p$$

In the case where the link function used coincides with the canonical link function (η_i=θ_i), these equations are simplified as follows:

$$\frac{\partial \ell_i}{\partial \beta_j} = \frac{\partial \ell_i}{\partial \theta_i} \times \frac{\partial \theta_i}{\partial \mu_i} \times \frac{\partial \mu_i}{\partial \eta_i} \times \frac{\partial \eta_i}{\partial \beta_j} = \frac{\partial \ell_i}{\partial \theta_i} \times \frac{\partial \theta_i}{\partial \eta_i} \times \frac{\partial \eta_i}{\partial \beta_j} = \frac{\partial \ell_i}{\partial \theta_i} \times \frac{\partial \eta_i}{\partial \beta_j}$$

Thus, the partial differential equations can take the following form:

$$\frac{\partial \ell(Y, \theta(\beta), \phi)}{\partial \beta_j} = \sum_{i=1}^{n} \left(\frac{Y_i - (\mu_i)}{a_i(\phi)} \times X_{ij} \right) = 0, \forall j = 1, \cdots p$$

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

However, μ_i is unknown, so it is impossible to obtain an analytical expression of the maximum likelihood estimator of β by canceling the first derivative (gradient): these equations are called transcendental. In other words, they are non-linear β equations whose solution requires iterative optimization methods, such as the Newton-Raphson algorithm referring to the Hessian matrix and the Fisher-scoring algorithm referring to the information matrix, whose approach can be summarized as follows:

a. Choose a starting point β^0
b. Put down $\beta^{k+1} = \beta^k + A_k \times \nabla L(\beta^k)$
c. Shutdown condition : $\beta^{k+1} \approx \beta^k$

Or : $\nabla L(\beta^{k+1}) \approx \nabla L(\beta^k)$

With:

- $A_k = -[\nabla^2 L(\beta^k)]^{-1}$ For Newton-Raphson algorithm
- $A_k = -(E[\nabla^2 L(\beta^k)])^{-1}$ For the iterative Reweighted Least Squares

3.3. Properties of the maximum likelihood estimator and confidence interval

In general, it is insufficient for a statistician to stop in the estimation phase of the value of the regression parameters. However, given that the value of the regression estimator depends closely on the sample on which the modeling is done, it is more legitimate to look at the confidence interval in which it lies, by setting a confidence level beforehand. Thus, the smaller the interval, the more robust the estimate. Let us note $\widehat{\beta_n}$ the maximum likelihood estimator (MLE). This estimator verifies certain properties, under certain classical assumptions of the regularity of the probability density, such as:

- $\widehat{\beta_n}$: Converges in probability to β, which implies that $\widehat{\beta_n}$ is asymptotically unbiased.
- $\widehat{\beta_n}$: Converges to a normal distribution.

Indeed, it is possible to write:

$$\sqrt{n}(\widehat{\beta_n} - \beta) \sim \mathcal{N}(0, \mathbb{I}_n^{-1}(\beta))$$

- $\widehat{\beta_n}$: Estimator of the maximum log-likelihood of $\beta = (\beta_0, \beta_1, \cdots, \beta_p)$
- $\mathbb{I}_n^{-1}(\beta)$: $-(E[\partial \ell^2(Y, (\beta), \phi) / \partial^2 \beta])$ is the Fisher information matrix evaluated in β and ϕ on a sample of size n.

Let $\widehat{\beta_n}$ be the estimator of the parameter β such that $\widehat{\beta_n}$ verifies a central limit theorem, i.e., when n tends to infinity, the random variable of centered reduced Gaussian distribution z tends to the

African Scientific Journal
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Vol : 3, Numéro 16 , Février 2023

value below:

$$\frac{\widehat{\beta_n}-\beta}{\sqrt{V(\widehat{\beta_n})}} \sim z$$

As a way of determining the confidence interval at risk α for $\widehat{\beta_n}$: from the bounds ($z_{1-\alpha/2}$) and ($-z_{1-\alpha/2}$) such that:

$$P\left(-z_{1-\alpha/2} < \frac{\widehat{\beta_n}-\beta}{\sqrt{V(\widehat{\beta_n})}} < z_{1-\alpha/2}\right) = 1-\alpha$$

If n is large enough, we can suppose that $\frac{\widehat{\beta_n}-\beta}{\sqrt{V(\widehat{\beta_n})}}$ follows approximately a Gaussian distribution and *F* the distribution function of the centered reduced Gaussian distribution, so we can write that:

$$P\left(-z_{1-\alpha/2} < \frac{\widehat{\beta_n}-\beta}{\sqrt{V(\widehat{\beta_n})}} < z_{1-\alpha/2}\right)$$

$$= F(z_{1-\alpha/2}) - F(-z_{1-\alpha/2})$$

$$= 2F(z_{1-\alpha/2}) - 1$$

With:

$$F(-z_{1-\alpha/2}) = 1 - F(z_{1-\alpha/2})$$

We can then deduce that:

$$2F(z_{1-\alpha/2}) - 1 = 1-\alpha$$

$$z_{1-\alpha/2} = F^{-1}(1-\alpha/2)$$

So, the bounds of the confidence interval for $\widehat{\beta_n}$ are written as follow:

$$B^{-} = \widehat{\beta_n} - F^{-1}((1-\alpha/2) \times \sqrt{V(\widehat{\beta_n})}$$

$$B^{+} = \widehat{\beta_n} + F^{-1}((1-\alpha/2) \times \sqrt{V(\widehat{\beta_n})}$$

However, an asymptotic confidence interval at the level of 100 ×(1−α) % of the regression coefficients *β* can be designed as follows:

$$I.C_{\beta_n} = [\,\widehat{\beta_n} \pm (z_{1-\alpha/2}) \times \sqrt{V(\widehat{\beta_n})}\,]$$

With:

$z_{1-\alpha/2}$ is the quantile at (1 − α/2) of the standard normal distribution, N (0, 1), and $V(\widehat{\beta_n})$ is the diagonal term of the inverse of the Fisher information matrix.

African Scientific Journal
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Vol : 3, Numéro 16 , Février 2023

3.4 Binary logistic regression, an extension of generalized linear models

The essays of Hosmer D. W., and Lemeshow S. (2000) [21] as well as the work of King G., and Zeng L. (2001) [17], underline that logistic regression is understood as a relevant statistical choice, for situations in which the occurrence of a binary outcome must be predicted. In addition, Burns R. B., Burns R., Burns, R. P. (2008) [6] have offered clarifications of the steps necessary to perform such an analysis using a variety of statistical packages, such as SPSS, R, etc. While the explanation of the phases of performing such analysis in different particular contexts has also been mentioned on many websites, as highlighted in the works of Greenhouse J. B., Bromber, J. A., and Fromm D. A. (1995) [18] as well as the writings of Wuensch D. (2009) [38]

3.4.1 Logit transformation

We consider a population P subdivided into two groups of individuals $G_1,$ and G_2 identifiable by an assortment of quantitative or qualitative explanatory variables $X_1, X_2, \ldots X_p$ and let Y be a dichotomous qualitative variable to be predicted (explained variable), worth (1) if the individual belongs to the group G_1, and (0) if he/she comes from the group G_2. In this context, we wish to explain the binary variable Y from the variables $X_1, X_2, \ldots X_p$.

We have a sample of n independent observations of y_i, with $i = 1, 2, \ldots, n$. y_i denotes a dependent random variable presented as a column vector such that, $y_i = (y_1, y_2, \ldots y_n)$ expressing the value of a qualitative variable known as a dichotomous outcome response, which means that the outcome variable y_i can take on two values 0 or 1, evoking respectively the absence or the presence of the studied characteristic. We also consider a set of p explanatory variables denoted by the design matrix (X) = $(X_1, X_2, \ldots X_p)$ grouping the column vectors of the independent variables, of size $(n \times p)$ and rank (p), where (x_i) is the row vector of these explanatory variables associated with the observation (i) such that, i = 1, 2, …, n, and the column vector (β) of dimension p of the unknown parameters of the model, i.e. the unknown regression coefficients associated with the column vectors of the matrix (X). We consider in this paper that y_i (response variable) is a realization of a random variable y_i that can take the values 1 in the case that corresponds to the probability of tourism companies succeeding in overcoming the health crisis or 0 in the case of the probability of failing to overcome this crisis with probabilities of (π) and (1-π) respectively.

The distribution of the response variable y_i is called Bernoulli distribution with parameter (π). And we can write $y_i \sim B(1, \pi)$. Let the conditional probability that the outcome is absent be expressed by P(y_i = 0|X) = 1 − π and present, denoted P(y_i = 1|X) = π, where X is the matrix of explanatory variables with p column vectors. The modeling of response variables that have only two possible outcomes, which are the "presence" and "absence" of the event under study, is usually done by logistic regression (Agresti, 1996) [2], which belongs to the large class of generalized linear models introduced by John Nelder and Robert Wedderburn (1972) [29]. The Logit of the logistic regression model is given by the equation:

$$\text{Logit}(\pi) = \ln\left(\frac{\pi}{1-\pi}\right) = \sum_{k=0}^{p} \beta_k x_{ik}, \text{ with } i = 1,\ldots,n \quad (1)$$

By the Logit transformation, we obtain from equation (1) the equation (2)

$$\left(\frac{\pi}{1-\pi}\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \quad (2)$$

We evaluate equation (2) to obtain π et $1-\pi$ as:

$$\pi = \exp\left(\sum_{k=}^{p} \beta_k x_{ik},\right) - \pi \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \quad (3)$$

$$\pi + \pi \exp\left(\sum_{k=0}^{p} \beta_k x_{ik},\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \quad (4)$$

$$\pi\left(1 + \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)\right) = \exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right) \quad (5)$$

$$\pi = \left(\frac{\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right) \quad (6)$$

$$\pi = \left(\frac{1}{1+\exp\left(-\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right) \quad (7)$$

In the same way, we obtain $(1-\pi)$:

$$1 - \pi = 1 - \left(\frac{1}{1+\exp\left(-\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right)$$

$$1 - \pi = \left(\frac{1}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right)$$

$$1 - \pi = \frac{\exp\left(-\sum_{k=0}^{p} \beta_k x_{ik}\right)}{1+\exp\left(-\sum_{k=0}^{p} \beta_k x_{ik}\right)} \quad (8)$$

3.4.2 Estimation of the β parameters of the nonlinear equations of the Bernoulli distribution using the maximum likelihood estimator (MLE).

If y_i takes strictly two values 0 or 1, the expression for π given in equation (7) provides the conditional probability that y_i is equal to 1 given X, and will be reported as P(y_i = 0|X). And the quantity 1-π gives the conditional probability that y_i is equal to 0 given X, and this will be reported as P(y_i = 0|X). Thus, for y_i =1, the contribution to the likelihood function is π, but when y_i =0, the contribution to this function is $1-\pi$. This contribution to the likelihood function will be expressed as follows:

$$\pi^{y_i}\ (1-\pi)^{1-y_i}$$

At this stage, we will estimate the P+1 unknown parameters β, using the maximum likelihood estimator (MLE) as follows:

$L\ (y_1, y_2, \dots y_n,\ \pi) = \prod_{i=1}^{n} \pi^{y_i}\ (1-\pi)^{1-y_i}$

Maximum likelihood is one of the most widely used estimation procedures for determining the values of the unknown β parameters that maximize the probability of obtaining an observed data set. In other words, the maximum likelihood function explains the probability of the observed data based on unknown regression parameters β. This method was developed by the British statistician Ronald Aylmer Fisher between (1912 - 1922) as it was assigned in John Aldrich's book "*R. A. Fisher and the making of maximum likelihood 1912-1922* " published in (1997). This method aims to find estimates of the p explanatory variables to maximize the probability of observation of the response variable *Y*.

$L\ (y_1, y_2, \dots y_n,\ \pi) = \prod_{i=1}^{n} \pi^{y_i}\ (1-\pi)^{1-y_i}$

$= \prod_{i=1}^{n} \left(\frac{\pi}{1-\pi}\right)^{y_i} (1-\pi)$

Substituting equation (2) for the first term and equation (8) for the second term, we obtain:

$L\ (y_1, y_2, \dots y_n,\ \beta_1, \beta_2, \dots \beta_p,\ ) = \prod_{i=1}^{n} \left(\exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik},\right)\right)^{y_i} \left(1 - \frac{\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}{1+\exp\left(\sum_{k=0}^{p} \beta_k x_{ik}\right)}\right)$. So,

$L\ (y_1, y_2, \dots y_n,\ \beta_1, \beta_2, \dots \beta_p) = \prod_{i=1}^{n} \left(\exp\left(y_i\ \sum_{k=0}^{p} \beta_k\, x_{ik},\right)\right) \left(1 + \exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik},\right)\right)^{-1}$

For simplicity, we incorporate the neperian logarithm into the above equation. Since the logarithm is a monotonic function, any maximum in the likelihood function will also be a maximum in the log-likelihood function and vice versa. Thus, considering the natural logarithm of this equation, we obtain the log-likelihood function ℓ expressed as follows:

$\ln\ (L\ (y_1, y_2, \dots y_n,\ \beta_1, \beta_2, \dots \beta_p)) =$
$\ln\left(\prod_{i=1}^{n} \left(\exp\left(y_i\ \sum_{k=0}^{p} \beta_k\, x_{ik}\right)\right) \left(+\exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right)\right)^{-1}\right)$

$\ell\ (y_1, y_2, \dots y_n,\ \beta_1, \beta_2, \dots \beta_p) = \sum_{i=1}^{n} y_i\ \left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right) - \ln\left(1 + \exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right)\right)$

African Scientific Journal
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Deriving the last natural logarithm equation of the likelihood function above, we should write:

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i\ x_{ik} - \frac{1}{1+\exp(\sum_{k=0}^{p} \beta_k x_{ik})} \ \times \frac{\partial}{\partial \beta_k}\left(1+\exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right)\right) \ (9)$$

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i\ x_{ik} - \frac{1}{1+\exp(\sum_{k=0}^{p} \beta_k x_{ik})} \ \times \exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right) \times \frac{\partial}{\partial \beta_k} \sum_{k=0}^{p} \beta_k\, x_{ik} \ (10)$$

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \sum_{i=1}^{n} y_i\ x_{ik} - \frac{x_{ik}}{1+\exp(\sum_{k=0}^{p} \beta_k x_{ik})} \ \times \exp\left(\sum_{k=0}^{p} \beta_k\, x_{ik}\right) \ (11)$$

Knowing that:

$$\frac{\partial}{\partial \beta_k} \sum_{k=0}^{p} \beta_k\, x_{ik} = x_{ik}$$

So,

$$\frac{\partial \ell(\beta)}{\partial \beta_k} = \ell'_{\beta_k} = \sum_{i=1}^{n} y_i\ x_{ik} - \ \pi . x_{ik} \ \ (12)$$

Therefore, the estimation of the parameters $\hat{\beta} = (\widehat{\beta_0}, \widehat{\beta_1},\ \cdots, \widehat{\beta_p})$that maximize the log-likelihood function l can be determined by canceling each of the $P+1$ equations of ℓ' (gradient of ℓ) as mentioned in equation (12), and verify that its Hessian matrix (second derivative) is negative definite, i.e. that each element of the diagonal of this matrix is less than zero (Gene H. Golub and Charles F. Van Loan 1996). The Hessian matrix consists of the second derivative of equation (12). The general form of the second partial derivative matrix (Hessian matrix) can be written as follows:

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k\, \partial \beta_{k'}} = \frac{\partial}{\partial \beta_{k'}}\ \sum_{i=1}^{n} y_i\ x_{ik} - \ \pi . x_{ik} \ (13)$$

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k\, \partial \beta_{k'}} = \frac{\partial}{\partial \beta_{k'}}(-\ \pi . x_{ik}) \ \ (14)$$

$$\frac{\partial^2 \ell(\beta)}{\partial \beta_k\, \partial \beta_{k'}} = -\ x_{ik} \frac{\partial}{\partial \beta_{k'}}\left(\frac{\exp(\sum_{k=0}^{p} \beta_k x_{ik})}{1+\exp\,(\sum_{k=0}^{p} \beta_k x_{ik})}\right)$$

$$\ell''_{\beta_k \beta'_k} = -\ x_{ik}\ \pi(1-\pi)\ x_{ik} \ \ (15)$$

To solve the $(P\ +1)$ nonlinear β equations (12), we use the Newton-Raphson iterative optimization method, referring to the Hessian matrix. Using this method, the estimation of the β parameters starts with the first step of choosing a starting point $\beta^{\,0}$ or $\beta^{\,old}$. The second step consists in mentioning the way the method works by posing: $\beta^{\,k+1} = \beta^{\,k} + A_k \times \nabla L(\beta^{\,k})$, and finally stop when the condition $\beta^{\,k+1} \approx \beta^{\,k}$ or $\nabla L\beta^{\,k+1}) \approx \nabla L(\beta^{\,k})$ is realized. The result of this algorithm in matrix notation is:

$$\beta^{\,new} = \beta^{\,old} + \ [-\ \ell''(\beta^{\,old})]^{\,-1} \times\ \ell'(\beta^{\,old})$$

By putting $\hat{\beta}\ =\ (\widehat{\beta_0}, \widehat{\beta_1},\ \cdots,\ \widehat{\beta_p})^t$ we have:

$$V(\hat{\beta}) = \left(-\frac{\partial^2}{\partial\beta^2}\ln L(\beta, Y)\right)^{-1} \|_{\beta=\hat{\beta}} = (X^t W X)^{-1}$$

To simplify this equation above, we substitute the value of $\ell'(\beta)$, and $\ell''(\beta)$ with another matrix form in the following way:

$$\beta^{new} = \beta^{old} + (X^t W X)^{-1} \times X^t(Y - \mu) \quad (16)$$

$$\beta^{new} = (X^t W X)^{-1} \times X^t W (X\beta^{old} + W^{-1}(Y - \mu)) \; \beta^{new} = (X^t W X)^{-1} X^t W Z \quad (17)$$

Where $Z = (X\beta^{old} + W^{-1}(Y - \mu))$ is a vector, and W is the vector of weights of the values of the diagonal of the inputs $\hat{\pi}_i(1 - \hat{\pi}_i)$. We can also write:

$$\beta^{new} = \beta^{old} + (X^t W X)^{-1} \times X^t(Y - \mu) \quad (18)$$

With:

$$X = \begin{pmatrix} 1 & x_{1,1} & \cdots & x_{1,p} \\ 1 & x_{2,1} & \cdots & x_{2,p} \\ \vdots & \vdots & \vdots & \vdots \\ 1 & x_{n,1} & \cdots & x_{n,p} \end{pmatrix}$$

$$\hat{V} = \begin{pmatrix} \widehat{\pi_1}(1 - \widehat{\pi_1}) & 0 & \cdots & 0 \\ 0 & \widehat{\pi_2}(1 - \widehat{\pi_2}) & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & \widehat{\pi_n}(1 - \widehat{\pi_n}) \end{pmatrix}$$

And:

$$W = \text{Diag } \widehat{\pi_1}(1 - \widehat{\pi_1}), \cdots, \widehat{\pi_n}(1 - \widehat{\pi_n})$$

3.4.3 Odds and Odds-ratios

The odds ratio (OR) is a statistical procedure used to evaluate the association between two qualitative random variables. This procedure is often used in logistic regression to measure a relative effect. Knowing that we are in a case of a dichotomous response variable y_i (binary logistic regression), the probability of having Y=1 knowing that X= x is noted π_i. We determine the chance (odds) of having (Y =1|X = x) rather than having (Y = 0|X = x) by the ratio {π}/{1-π}. The odds ratio can be expressed as follows:

$$OR = \frac{\pi(x+1)/[1-\pi(x+1)]}{\pi(x)/[1-\pi(x)]}$$

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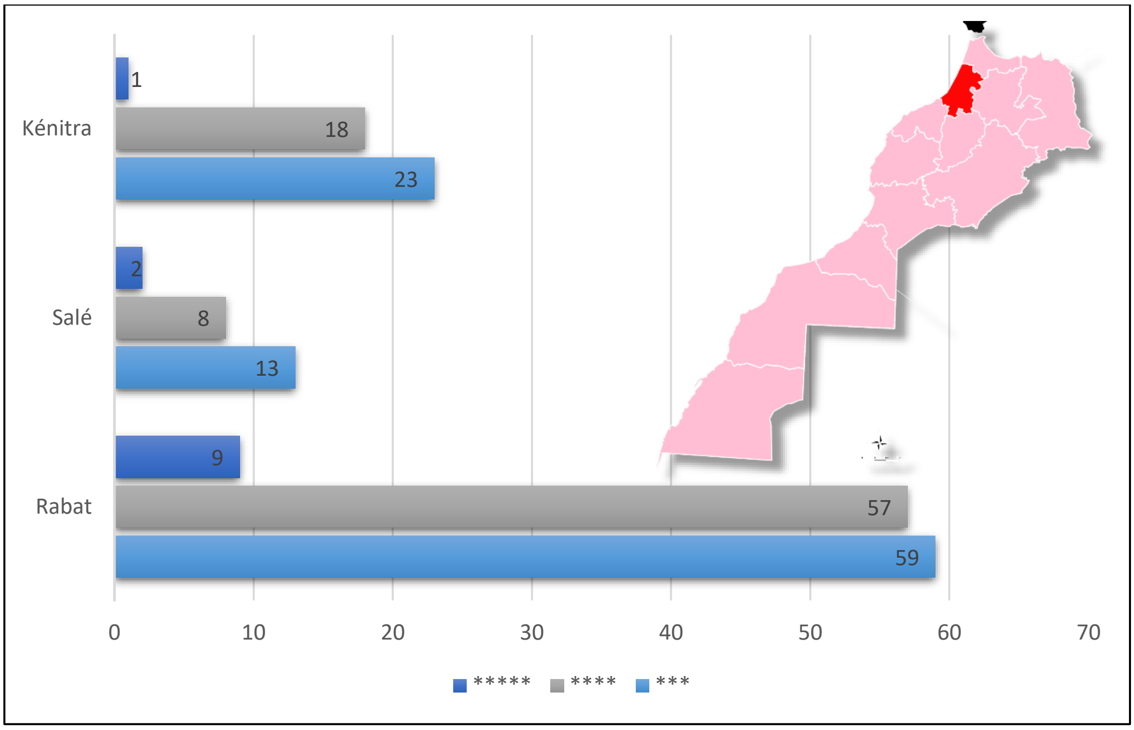
Vol : 3, Numéro 16 , Février 2023

4. Resultat and discussion

The tourism sector represents one of the main foundations of the tertiary sector of the national economy, leading to remarkable economic growth and draining more than 81.4 milliard dirhams from the Moroccan GDP (Mordor Intelligence 2019). Tourism in Morocco not only participates in income generation and job creation but also in developing the country's image and attracting investors in different sectors involving the increase of the Moroccan doing business index. However, the geographical diversity, the favorable climate, the proximity to the main European tourist markets, the massive investments in new infrastructures, such as new airport terminals, roads and railways, safety and security, and the easing of travel procedures, are key factors for the success and development of this sector. Nevertheless, the health crisis due to the covid-19 epidemic has significantly impacted all tourism activities, especially hotel activities. Before starting our empirical study on the prediction of the resilience of classified hotel organizations, we begin by presenting the distribution of hotels in the Rabat-Salé-Kénitra region, according to their classification, which forms the scope of our research project.

Graph 1: Distribution of classified hotels in the region of Rabat-Salé-Kénitra region



Source: Athors

This study focuses on the use of an online questionnaire for data collection. The construction of the questionnaire used in this research is based on the literature of several authors' works. This survey mainly covers two areas of questions. The first one is about the information in the tourism company's identification sheet. The second area includes questions about the impact of resilience determinants on the ability of these tourism units to overcome the covid-19 health crisis. However, the business information is private and would not be disclosed.

We carefully use sampling to control for the representativeness of the sample (simple random sample). The sample consists of 112 tourism units, taking into account the size of the survey population. After reviewing the collected questionnaires, we obtain a total of 100 valid questionnaires. The first introductory part of the questionnaire is devoted to the personal information of the company, such as the range of the realized turnover, number of years of experience, the capacity of the tourist unit, type of tourists accommodated, quality certificate obtained, number of deployed staff, etc. The second part is reserved for answers to multiple-choice questions on the explanatory determinants of resilience using a Likert scale. Finally, the survey is completed with a dichotomous response question concretizing the resilience or failure scenario of these tourism companies interviewed after the covid-19 epidemic. In our study, the response variable "the act of success in overcoming the health crisis" is binary with two modalities that can be coded as 1 if they succeed and 0 if they fail to overcome the health crisis. Let Y be the event "act of success in overcoming the health crisis" representing our variable to be explained, so we have two probabilities:

- $\pi\ (Y = 1)$: Corresponds to the probability of success in overcoming the health crisis.
- $\pi\ (Y = 0)$: Corresponds to the probability of the act of failure to overcome the health crisis.

The resilience variables selected to explain the act of success in overcoming the health crisis are summarized as follows:

Table 5: the explanatory variables and their items introduced into the study

X_1 : Characteristics related to the managers	X_{11}: The leader's track record in crisis management X_{12}: The accumulated experience of the manager X_{13}: The age of the manager X_{14}: The educational level of the manager X_{15}: The motivation of the manager X_{16}: The religion and beliefs of the manager X_{17}: The environment of the leader X_{18}: Personality traits of the manager
X_2 : Organizational characteristics	X_{21}: Firm size X_{22}: The age of the enterprise X_{23}: The growth rate of the enterprise X_{24}: The experience of the enterprise
X_3 : The characteristics of the strategy in place	X_{31}: The strategy options implemented X_{32}: Innovation and modernization of offers X_{33}: New operating modes X_{34}: The degrees of applicability of the strategic options
X_4 : The company's environment	X_{41}: Entrepreneurial location X_{42}: The internal environment (strength/weakness) X_{43}: The external environment (opportunities/threats) X_{44}: Asymmetric market information

Source: Author

The main idea of this study is to model the probabilities of success conditioned by an assortment of explanatory determinants.

$\pi(x) = P(Y = 1|X = x)$ et $1 - \pi(x) = P(Y = 0|X = x)$

Our model is formulated as follows:

$g(\pi(x)) = \beta . X$

The function g represents the link function that one is supposed to define, β the vector of regression coefficients referring to the strength of the explanatory variables on the response variable, and X the vector of explanatory variables. Determining the link function confers focus on the values that $\pi(x)$ can accept (0 or 1) and that $(\beta . X)$ can take any value from the set R. In this context, binary logistic regression consists of modeling the transformation "$logit$" of $\pi(x)$ by a linear function of our (p) explicit variables.

In this study, we attempted to identify predictors of the act of resilience and measure the impact of each on the ability of tourism businesses to overcome the negative fallout of the covid-19

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

health crisis. However, the predictor variables introduced into the logit model to explain the act of resilience are qualitative.

Table 6: Reliability test

Cronbach's Alpha	Cronbach's Alpha based on standardized elements	Number of elements	Confidence interval for Cronbach's Alpha (95%)	
			Inferior	Superior
0.856	0,855	20	0.811	0.891

Source: Author

According to the reliability test, we notice that the value of the coefficient $\hat{\alpha}$ = 0.856 exceeds the conventional minimum threshold of α = 0.70 (Nunnally J. C. 1978), (Darren and Mallery 2008) revealing that we obtain, for this assortment composed of twenty elements, a satisfactory internal consistency.

Table 7: R^2 ajusted

-2 Log of Likelihood	R^2 of Cox and Snell	R^2 of Nagelkerke	$R^2$of the sum of squares	R^2(Adjusted) of the sum of squares
396.009	0.839	0.811	0.848	0.846

Source: Author

The model summary provides the values of (-2LL), Cox and Snell R^2, and Nagelkerke R^2 for the full model. The value of (-2LL) for this model reaches 396.009. This value was compared to that of the base model using the chi-square test to reveal a highly significant decrease between the two (p = 0.000 < 0.05). This degradation justifies that the new model is significantly better fitted than the null model. Furthermore, the R^2 values tell us approximately how much variation in the outcome is explained by the model used. The Cox and Snell R^2 of the full model is 0.839 and indicates that 83.9% variation in the probability that a tourism unit can overcome the negative consequences of the health crisis. In addition, the Nagelkerke R^2, which is an adjusted version of the Cox-Snell R^2 and therefore closer to reality, is 0.811. Thus, we can say that the explanatory variables contribute to explaining 81.1% of the variation in the probability that a tourism business will be able to control for the negative impacts of the covid-19 epidemic. On the other hand, a high value of the fitted or interpolated coefficient of determination refers to a better fit of the model to the data used. In our case the adjusted coefficient of determination

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

R^2(adjusted) = 0.846, i.e. 84.6% of the dispersion is explained by the binary logistic regression model.

Table 8 : Interelement correlation matrix

	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{21}	X_{22}	X_{23}	X_{24}	X_{31}	X_{32}	X_{33}	X_{34}	X_{41}	X_{42}	X_{43}	X_{44}
X_{11}	1	0.1	0.3	0.2	0.2	0.7	0.6	0.7	0.4	0.5	0.4	0.4	0.7	0.6	0.5	0.1	0.1	0.2	0.7	0.7
X_{12}	0.1	1	0.1	0.5	0.1	0.6	0.5	0.5	0.6	0.6	0.7	0.3	0.6	0.3	0.6	0.5	0.4	0.6	0.5	0.4
X_{13}	0.3	0.1	1	0.6	0.7	0.3	0.2	0.4	0.4	0.5	0.6	0.7	0.7	0.1	0.1	0.2	0.1	0.3	0.5	0.5
X_{14}	0.2	0.5	0.6	1	0.2	0.3	0.7	0.6	0.6	0.5	0.6	0.7	0.5	0.2	0.5	0.3	0.7	0.7	0.6	0.6
X_{15}	0.2	0.1	0.7	0.2	1	0.4	0.4	0.6	0.7	0.3	0.3	0.2	0.5	0.1	0.4	0.6	0.6	0.3	0.1	0.2
X_{16}	0.7	0.6	0.7	0.3	0.4	1	0.6	0.5	0.3	0.4	0.1	0.1	0.6	0.7	0.4	0.3	0.4	0.4	0.5	0.7
X_{17}	0.6	0.5	0.3	0.7	0.4	0.6	1	0.3	0.5	0.7	0.6	0.4	0.4	0.3	0.2	0.1	0.1	0.3	0.6	0.7
X_{18}	0.7	0.6	0.2	0.6	0.6	0.5	0.3	1	0.3	0.5	0.2	0.7	0.6	0.2	0.4	0.5	0.2	0.7	0.5	0.1
X_{21}	0.4	0.6	0.4	0.6	0.7	0.3	0.5	0.3	1	0.4	0.4	0.1	0.2	0.1	0.5	0.3	0.3	0.5	0.6	0.6
X_{22}	0.5	0.7	0.4	0.5	0.3	0.4	0.7	0.5	0.4	1	0.3	0.4	0.6	0.7	0.1	0.1	0.2	0.2	0.4	0.5
X_{23}	0.4	0.3	0.5	0.6	0.3	0.1	0.6	0.2	0.4	0.3	1	0.2	0.5	0.6	0.2	0.5	0.6	0.7	0.7	0.5
X_{24}	0.4	0.6	0.6	0.7	0.2	0.1	0.4	0.7	0.1	0.4	0.2	1	0.1	0.1	0.4	0.3	0.5	0.2	0.1	0.4
X_{31}	0.7	0.3	0.7	0.5	0.5	0.6	0.4	0.6	0.2	0.6	0.5	0.1	1	0.2	0.3	0.6	0.7	0.6	0.1	0.5
X_{32}	0.6	0.6	0.7	0.2	0.1	0.7	0.3	0.2	0.1	0.7	0.6	0.1	0.1	1	0.6	0.7	0.1	0.3	0.2	0.2
X_{33}	0.5	0.5	0.1	0.5	0.4	0.4	0.2	0.4	0.5	0.1	0.2	0.4	0.4	0.2	1	0.5	0.3	0.2	0.4	0.7
X_{34}	0.1	0.4	0.1	0.3	0.6	0.3	0.1	0.5	0.3	0.1	0.5	0.3	0.3	0.3	0.6	1	0.3	0.2	0.4	0.6
X_{41}	0.1	0.4	0.2	0.7	0.6	0.4	0.1	0.2	0.3	0.2	0.6	0.5	0.5	0.6	0.3	0.3	1	0.2	0.7	0.2
X_{42}	0.2	0.6	0.1	0.7	0.3	0.4	0.3	0.7	0.5	0.2	0.7	0.2	0.2	0.7	0.2	0.2	0.4	1	0.1	0.3
X_{43}	0.7	0.5	0.3	0.6	0.1	0.5	0.6	0.5	0.6	0.4	0.7	0.1	0.1	0.1	0.2	0.1	0.7	0.2	1	0.2
X_{44}	0.7	0.4	0.5	0.6	0.2	0.7	0.7	0.1	0.6	0.5	0.5	0.5	0.4	0.5	0.2	0.7	0.6	0.3	0.2	1

Source: Author

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

The matrix of inter-element correlations is a matrix of statistical correlation coefficients calculated from several variables taken two by two. It allows for quick detect the links between the introduced variables by providing several studies and statistical explanations beforehand. However, the correlation matrix is symmetrical, and its diagonal is composed of 1 since the correlation of a variable with itself is perfect. The correlation matrix based on the responses of our study shows that all the variable items used are sufficiently correlated, with a correlation coefficient varying between r = 0.171 and r = 0.717 noting that: 0.171 ≤ r ≤ 0.717, further confirming the result of Cronbach's Alpha reliability coefficient.

Table 9: Chi-square test

	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{21}	X_{22}	X_{23}	X_{24}	X_{31}	X_{32}	X_{33}	X_{34}	X_{41}	X_{42}	X_{43}	X_{44}
χ^2	*6.1*	*7.2*	*8.8*	*9.2*	*6.9*	*7.3*	*8.1*	*8.3*	*9.5*	*7.5*	*9.2*	*7.8*	*9.4*	*8.5*	*8.2*	*8.7*	*8.1*	*7.4*	*5.9*	*5.9*
p	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*

Source: Author

The chi-square test shows the relationship between the items of explanatory variables such as characteristics related to leaders, characteristics of enterprises, strategies decided by the enterprise and the environment of the enterprise, and the response variable "the act of success of tourism enterprises to overcome the health crisis" is highly significant, and an asymptotic significance of $p = 0.000 < 0.05$. These results refer to the rejection of the null hypothesis H_0. In other words, the explanatory variables selected in this study have a significant relationship with the response variable, that is, a significant influence on the ability of tourism units to overcome the health and economic crisis produced by the covid-19 epidemic.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

Table 10: Cramer test

		Value	Approximate significance
Cramer's V	X_{11}	*0,416*	*0,000*
	X_{12}	*0,581*	*0,000*
	X_{13}	*0,526*	*0,000*
	X_{14}	*0,488*	*0,000*
	X_{15}	*0.441*	*0,000*
	X_{16}	*0.446*	*0,000*
	X_{17}	*0.411*	*0,000*
	X_{18}	*0.467*	*0,000*
	X_{21}	*0.521*	*0,000*
	X_{22}	*0.510*	*0,000*
	X_{23}	*0.541*	*0,000*
	X_{24}	*0.522*	*0,000*
	X_{31}	*0.333*	*0,000*
	X_{32}	*0.301*	*0,000*
	X_{33}	*0.375*	*0,000*
	X_{34}	*0.398*	*0,000*
	X_{41}	*0.481*	*0,000*
	X_{42}	*0.409*	*0,000*
	X_{43}	*0.398*	*0,000*
	X_{44}	*0.407*	*0,000*

Source: Author

The value of Cramer's V varies in the interval [0,1]. In our case, we find that the twenty items of the explanatory variables, managerial characteristics, company characteristics, strategies decided by the company, and company environment, have a strong relationship with the response variable, "the act of success of tourism companies to overcome the health crisis" (Louis M. Rea and Richard A. Parker (1992)). According to the work of Louis M. Rea and Richard A. Parker, if Cramer's V value is between 0.4 and 0.6, the association between the dependent variable and the independent variables is relatively strong. As shown in the table of Cramer's V test, the set of values is bounded between the values 0.4 and 0.6.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

Table 11: Table of variables in the equation

Source: Author

	$\hat{\beta}$	E. S	Wald	ddl	Sig	Exp($\hat{\beta}$)	Confidence interval for Exp (β) (95%)	
							Inferior	superior
X_{11}	1.615	0.460	11.98	1	0.001	5.030	3.015	7.552
X_{12}	1.871	0.617	9.212	1	0.002	6.490	4.941	9.753
X_{13}	1.558	0.571	7.341	1	0.007	4.751	2.542	6.642
X_{14}	1.344	0.211	6.878	1	0.000	3.834	1.331	5.871
X_{15}	0.934	0.812	6.199	1	0.000	2.546	1.210	5.717
X_{16}	1.571	0.711	7.339	1	0.012	4.811	2.120	6.119
X_{17}	1.347	0.215	5.211	1	0.040	3.845	1.276	5.981
X_{18}	1.901	0.912	6.982	1	0.010	6.692	4.110	8.219
X_{21}	1.114	0.451	10.08	1	0.031	3.046	1.510	6.915
X_{22}	1.016	0.697	5.010	1	0.000	2.762	0.910	5.007
X_{23}	1.710	0.511	8.001	1	0.001	5.528	3,211	7.013
X_{24}	1.721	0.311	6.231	1	0.007	3.590	3.145	7.192
X_{31}	1.101	0.320	7.981	1	0.000	3.007	1.570	5.051
X_{32}	1.005	0.117	9.205	1	0.000	2.731	0.610	4.915
X_{33}	1.207	0.220	6.240	1	0.021	3.343	1.635	6.012
X_{34}	1.009	0.771	7.801	1	0.005	2.742	0.531	4.925
X_{41}	1.330	0.672	9.371	1	0.000	3.781	1.751	6.005
X_{42}	1.772	0.491	4.210	1	0.000	5.882	3.158	7.908
X_{43}	1.725	0.921	2.971	1	0.000	5.612	3.061	7.731
X_{44}	0.919	0.574	9.882	1	0.009	2.506	0.762	4.092
Constante	-8,295	0,950	74,91	1	0.000	0,000	-	-

This table provides the regression coefficients $\hat{\beta}$, the Wald statistic for testing statistical significance, the odds ratio exp ($\hat{\beta}$) for each predictor variable, and finally the confidence interval for each odds ratio (OR). Looking at the results first, there is a highly significant effect of all the predictor variables on the response variable "act of success of tourism businesses in overcoming the health crisis". However, it is easy to interpret the p-meanings, but the question that arises at this point is how to interpret the regression coefficients $\hat{\beta}$. What does this coefficient correspond to, and how can it be interpreted? Nevertheless, the regression coefficient $\hat{\beta}$ can only explain the direction of fluctuation between the explanatory variable and the response variable. That is, a positive sign of the coefficient $\hat{\beta}$ refers to a change in the same direction between the predictor variable and the dependent variable, whereas a negative sign refers to a change in two opposite directions of the two variables. Apart from the coefficient $\hat{\beta}$ is not interpretable. However, the exponential of $\hat{\beta}$ "(exp ($\hat{\beta}$))" has a meaning that is easily interpreted by statisticians. The "exp ($\hat{\beta}$)" also called odds-ratio (OR), odds ratio, or also a close relative

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

risk, designates a relationship to the response variable.

The column exp($\hat{\beta}$) (Odds Ratio) indicates that the different items of the explanatory variables each have a distinct influence on the variable to be predicted. Consistent with our case, we can state that managerial characteristics strongly influence the resilience of tourism companies after the covid-19 health epidemic. However, items describing the characteristics of the tourism company's leader significantly impact the ability of the company to overcome the negative consequences of the covid-19 pandemic on its business. For example, the background of a manager and his experience, introduce five ($OR(X_{11})$ = 5.0 30, $IC^{5\%}$ = [3.015, 7.552]) and six times ($OR(X_{12})$ = 6.490, $IC^{5\%}$ = [4.941, 9.753]) more chances for the tourism units to overcome the difficulties generated by this crisis. Also, the age, level of education, and motivation of the manager, respectively, generate four ($OR(X_{13})$ = 4.751, $IC^{5\%}$ = [2.542, 6.642]), three ($OR(X_{14})$ = 3.834, $IC^{5\%}$ = [1.331, 5.871]), and two times ($OR(X_{15})$ = 2.546, $IC^{5\%}$ = [1.210, 5.717]) more chance to overcome the fallout of this pandemic. In addition, the religion and beliefs, educational environment, and personality traits of the leader offer four ($OR(X_{16})$ = 4.811, $IC^{5\%}$ = [2.120, 6.119]), three ($OR(X_{17})$ = 3.845, $IC^{5\%}$ = [1.276, 5.981]), and six ($OR(X_{18})$ = 6.692, $IC^{5\%}$ = [4.110, 8.219]) times the chance of successful resilience for tourism companies, respectively.

Regarding company characteristics, we find that size, years of experience and seniority, and growth rate make tourism businesses three ($OR(X_{21})$ = 3.046, $IC^{5\%}$ = [1.510, 6.915]) ($OR(X_{24})$ = 3.590, $IC^{5\%}$ = [3.145, 7.192]), two ($OR(X_{22})$ = 2.762, $IC^{5\%}$ = [0.910, 5.007]), and five ($OR(X_{23})$ = 5.528, $IC^{5\%}$ = [3,211, 7.013]) times more likely to overcome the negative effects of the covid-19 health crisis respectively. Furthermore, the characteristics related to the strategies implemented by tourism enterprises also have a highly significant impact on their resilience.

Citing the strategic options put in place ($OR(X_{31})$ = 3.007, $IC^{5\%}$ = [1.570, 5.051]), the continuous innovation introduced in the production process ($OR(X_{32})$ = 2.731, $IC^{5\%}$ = [0.610, 4.915]), the new processes and operating modes ($OR(X_{33})$ = 3.343, $IC^{5\%}$ = [1.635, 6.012]), and the degree of applicability and success of the strategies decided ($OR(X_{34})$ = 2.742, $IC^{5\%}$ = [0.531, 4.925]) upon play an important role in overcoming the consequences of the health crisis.

As for the characteristics related to the environment of the company, such as the entrepreneurial location ($OR(X_{41})$ = 3.781, $IC^{5\%}$ = [1.751, 6.005]), the strengths and weaknesses characterizing the internal environment of the company ($OR(X_{42})$ = 5.882, $IC^{5\%}$ = [3.158, 7.908]), the opportunities and threats describing the external environment of the company ($OR(X_{43})$ = 5.612,

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

$IC^{5\%}$ = [3.061, 7.731]), and the asymmetry of information on the market ($OR(X_{44})$ = 2.506, $IC^{5\%}$ = [0.762, 4.092]) similarly participate in the resilience of tourism units and overcome the fallout of the health crisis of covid-19.

Finally, it can be stated that the items constituting the various determinants of the resilience of companies operating in the tourism industry specifically the hotel industry have highlighted a highly significant impact on the ability of these units to overcome the negative repercussions of the health crisis involving a considerable economic crisis.

Table 12: Area under curve

	AUC	Standard error	Asymptotic Sig.	Asymptotic confidence interval for 95%	
				Inferior	superior
X_{11}	0.718	0.029	0.001	0.693	0.751
X_{12}	0.623	0.028	0.007	0.601	0.676
X_{13}	0.661	0.028	0.003	0.654	0.712
X_{14}	0.720	0.027	0.000	0.702	0.818
X_{15}	0.561	0.020	0.000	0.419	0.835
X_{16}	0.660	0.021	0.000	0.513	0.717
X_{17}	0.531	0.030	0.013	0.406	0.662
X_{18}	0.711	0.001	0.000	0.622	0.813
X_{21}	0.593	0.019	0.017	0.427	0.671
X_{22}	0.612	0.036	0.002	0.581	0.739
X_{23}	0.544	0.016	0.000	0.491	0.683
X_{24}	0.734	0.012	0.000	0.621	0.835
X_{31}	0.611	0.025	0.001	0.542	0.752
X_{32}	0.561	0.017	0.002	0.493	0.679
X_{33}	0.622	0.015	0.003	0.571	0.623
X_{34}	0.582	0.014	0.000	0.471	0.636
X_{41}	0.667	0.001	0.000	0.561	0.729
X_{42}	0.611	0.005	0.010	0.509	0.732
X_{43}	0.553	0.013	0.008	0.433	0.651
X_{44}	0.574	0.014	0.000	0.481	0.683

Source: Author

The AUC (area-under-curve) expresses the probability of placing a positive element in front of a negative element. However, this technique proposes an AUC = 0.5 as a baseline situation that our classifier needs to improve. At first glance, all results are highly significant with a $p = 0.000 \leq 0.05$. On the other hand, the table also reports AUCs that exceed the baseline situation (AUC = 0.5), which means that the explanatory variables used in the model all have a significant impact on the response variable.

However, we can predict that tourism units are likely to overcome the economic crisis caused by the coronavirus epidemic thanks to the characteristics related to the managers at 71.8% ($IC^{5\%}$ = [0.601 - 0.751]). Also, the characteristics related to the companies can help the tourism companies to overcome this crisis at the rate of 62.3% ($IC^{5\%}$ = [0.693 - 0.676]). On the other hand, the strategies implemented during the pandemic can contribute up to 66.1% ($IC^{5\%}$ = [0.654 - 0.712]). to escape the negative effects of this crisis. However, the characteristics of the internal and external environment of the tourism companies participate at the level of 72% ($IC^{5\%}$ = [0.702 - 0.818]). to help them to deviate from the negative consequences of this economic shocks.

African Scientific Journal
ISSN : 2658-9311
Vol : 3, Numéro 16 , Février 2023

5. CONCLUSION

The coronavirus epidemic has greatly exacerbated the difficulties of the tourism industry in Morocco due to the restrictions imposed on the activities associated with it such as the cessation of air and sea transport between countries, the closure of hotel companies, stores, and restaurants, the cessation of handicraft activities, etc., causing significant losses in tourism revenues and thus further increasing the State's budget deficit.

The persistence of the health crisis and the deterioration of the economic context has necessitated the updating of the measures and strategies implemented by tourism companies to preserve continuity and employment. In this pandemic context and the importance of the issue of the sustainability of tourism units, our essay was content to explore and analyze the determinants of resilience during the pandemic of COVID-19 to overcome and manage the health crisis in crisis in tourism enterprises in Morocco, specifically the region of Rabat, Salé, and Kénitra.

This study focused on four main dimensions such as the characteristics related to the leaders, the characteristics related to the companies, the strategies decided by the company, and the environment of the company. These dimensions are introduced in a statistical model of prediction "binary logistic regression" with a motive to explain the ability of the Moroccan tourist companies to overcome the health crisis of covid-19.

However, the analysis of the results obtained demonstrated the existence of a highly significant relationship between the explanatory variables of resilience and the response variable "act of success of tourism companies to overcome the health crisis". In addition, the quantification of the impact of the constituent items of the characteristics related to the leaders of the hotel company on the response variable explained that the experience of the leader in crisis scenarios and his experience in confrontations with similar contexts introduce a means of five ($OR(X_{11})$) = 5, 0 30, = [3.015, 7.552]) and six times ($OR(X_{12})$) = 6.490, = [4.941, 9.753]) more chances that the decisions of the company manager will help the tourism units to overcome the difficulties generated by this crisis.

In the same vein, the maturity of the manager, an advanced level of education and academic training, and the continuous motivation of the manager and his staff introduce respectively four ($OR(X_{13})$) = 4.751, = [2. 542, 6.642]), three ($OR(X_{14})$) = 3.834, = [1.331, 5.871]) and two ($OR(X_{15})$) = 2.546, = [1.210, 5.717]) times more likely to overcome the fallout of this pandemic through guidance from the company manager. However, religion and beliefs, educational environment, and personality traits of the company manager have four (OR(X_{16}) = 4.811, = [2.120, 6.119]), three (OR(X_{17}) = 3.845, = [1.276, 5.981]), and six (OR(X_{18}) = 6.692, = [4.110, 8.219]) times more chance of success of the decisions dictated by the company manager from the perspective of overcoming the fortuitous events of the health crisis respectively.

In an attempt to quantify the impact of the items constituting the characteristics of tourism businesses on the resilience of the latter in the post-crisis phase, we emphasize that the large size of the tourism unit, these years of experience and seniority, the level of annual growth, help it to overcome the economic slippage due to health crises respectively by three (OR(X_{21}) = 3.046, = [1.510, 6.915]) (OR(X_{24}) = 3.590, = [3.145, 7.192]), two (OR(X_{22}) = 2.762, = [0.910, 5.007]), and five (OR(X_{23}) = 5.528, = [3.211, 7.013]) times more than recording failure.

Moreover, the characteristics related to the mechanisms of the strategies implemented by specifically hotel tourism companies also have a highly significant impact on the act of their resilience. Highlighting the strategic options put in place by the general manager during the post-covid19 period (OR(X_{31}) = 3.007, = [1.570, 5.051]), the continuous innovation and creativity introduced into the production process (OR(X_{32}) = 2.731, = [0.610, 4.915]), the new processes and modes of operation in the production chain of the services offered (OR(X_{33}) = 3.343, = [1.635, 6.012]), and the degree of applicability and success of the strategies decided, measured through the gaps observed between expectations and final achievements (OR(X_{34}) = 2.742, = [0.531, 4.925]) play an important role in the process of overcoming the negative consequences of the crisis sanitary.

Concerning the items constituting the environment of the hotel business, such as the entrepreneurial location, exposing the rural or urban operating environment of the business (OR(X41) = 3.781, = [1.751, 6.005]), the strengths and weaknesses characterizing its internal environment OR(X42) = 5.882, = [3.158, 7. 908]), opportunities and threats describing its external environment, outlining political, economic, social, technological, ecological, and legislative determinants (OR(X43) = 5.612, = [3.061, 7. 731]), and the asymmetry of information on the market reflecting the opacity of the game on the tourism sector, especially the hotel industry (OR(X43) = 2.506, = [0.762, 4.092]) significantly contributing to the resilience of tourism units and the correction of their imbalances.

In other words, the post-covid19 period was marked by the emergence of a new trend in rural tourism, i.e. the rural environment was a winning play and a fertile field for attracting tourists to help overcome the losses caused by the health crisis. In the same framework, the internal key success factors and the opportunities presented by the Moroccan context, such as the credit facilities, the easing, and lengthening of tax disbursements, the important number of domestic tourists, etc., have helped the hotel companies to overcome the economic downturn experienced during the health epidemic. Similarly, a clear vision of the game played in the tourism sector by the various market players has allowed the success of the strategies implemented to stimulate tourist activity in Morocco, specifically the Rabat, Salé, and Kénitra area.

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Conflict of interest
The authors have no conflicts of interest

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