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# Model of multinominal regression logistic of management innovative Thought (TPIG), applied to managers in the construction sector: Case of Sincelejo

## Modelo de regresión multinominal logística de gestión del pensamiento innovador (TPIG), aplicado a los gerentes del sector de la construcción: Caso de Sincelejo

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**Abstract**

**Objective:** To validate an innovative thinking test among the managers of the companies of the construction sector in the municipality of Sincelejo to know to what extent they are creative and innovative. **Methodology:** Corresponds to a study of a correlational nature, which explores the reliability of content and validity of the Management Innovative Thinking Test (MITT), capturing and quantifying the capabilities of entrepreneurs. **Results:** Evidence is valid in the applicability of the Management Innovative Thinking Test (MIIT) and concordance between the observed and predicted variables. **Conclusions:** The Management Innovative Thinking Test (MIIT) allows to measure the capacity of innovation as a measure of realization of creativity among managers of the construction sector in a valid and reliable way.

**Keywords:** Creativity, innovation, test, correlation, construction managers.

**Resumen**

**Objetivo:** Validar una prueba de pensamiento innovador entre los gerentes de las empresas del sector de la construcción en el municipio de Sincelejo para saber en qué medida son creativos e innovadores. **Metodología:** Corresponde a un estudio de naturaleza correlacional, que explora la confiabilidad del contenido y la validez de la Prueba de pensamiento innovador de gestión (MITT), capturando y cuantificando las capacidades de los emprendedores. **Resultados:** La evidencia es válida en la aplicabilidad de la Prueba de pensamiento innovador de gestión (MIIT) y la concordancia entre las variables observadas y predichas. **Conclusiones:** La Prueba de pensamiento innovador de gestión (MIIT) permite medir la capacidad de innovación como medida de realización de la creatividad entre los gerentes del sector de la construcción de una manera válida y confiable.

**Palabras claves:** Creatividad, innovación, prueba, correlación, gerentes de construcción.

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## Introduction

Creativity and innovation as cognitive processes have caught the attention of man, who knows himself creative, but does not understand how those ideas are generated and have allowed to shape a world at his convenience, to the point that concepts such as quality of life and well-being are associated with their inventiveness and how they serve the rest of humanity, housing, health, education, infrastructure, public services, computer media, innovations arising from the creative action of the human being.

Authors such as [1] have pointed out that "innovation and creativity are hallmarks of the human species" and to verify this, you just have to look around to account for the endowments that man has left his mark on in a variety of areas and 'creative and creator' to live in comfortable conditions, giving himself quality of life. This need to create takes on strength in the middle of the era of the knowledge society, having not only expedited access to information to generate new knowledge but by testing the intuitive capabilities of other people to adapt to the environments of recent and growing creation.

Faced with the dilemma that causes man to ignore the form, the cognitive process arises, but at the same time he understands its creative potential, so it has been tried to evaluate this phenomenon and exploit it productively. In this way it is found that the most commonly used way to try to understand people's ability to produce creative ideas are divergent thinking tests or creative thinking [2, 3].

However, it is necessary to clarify that the innovative potential that drives a city to its development depends not only on the creative capacity of the individual but also on the city´s structures and the level of urbanization that it possesses, without neglecting the level of wages and the demands in productivity which are held [4]. Also, the social factors interfere in the cognitive process of the people, therefore, in the creative and innovative capacity [5], also the lack of technological elements in a city or the joint of the technology in the social sub-groups affects the development of the creativity and innovation [6].

For the study presented in this dissertation, it is of interest to evaluate the ability to put creativity into practice, that is, concrete achievements or innovations, which for the field of construction is unfinished subject matter if it is oriented to Research & Development, therefore based on theoretical premises about people's knowing whether or not they are creative (self-knowledge). The present paper presents the application of a test aimed at evaluating the creative and innovative capacity of the managers of the construction sector in Sincelejo, as it is an economic line of remarkable importance for the development and growth of this middle city, with a population growth rate (1.49) above the national average (1.18) [7]. If projective studies are addressed, which warn that by 2050 70% of the world's population will live in cities, it is estimated that solutions in the construction sector have a huge creative challenge concerning the concept of sustainable infrastructure. Therefore, having tools to assess the creative and innovative capacity of those who decide the course of urban development of cities, is a way to contribute to diagnose and to revise the capacity of adaptation and adequacy of the human resource to the needs of the context.

# Methodology

## Participants

The research participants correspond to a representative sample of the construction sector focused in the municipality of Sincelejo in Colombia, composed of 80 entrepreneurs, 64 men and 16 women, determined by simple sampling for a level of confidence of 95% and 5% error. According to records of the Chamber of Commerce of this locality, are recorded 60 companies in the sector, 25 of which serve the strata 4, 5 and 6, remain only four of these companies that lead the construction market in the city, namely: Atlantis Constructora Ltda., Promoter Villas of the Mediterranean Ltda., Isaac and Duran Ltda., and Dorian Lastre Construelite [8].

## Instruments

The innovative thinking managerial test was applied which is composed of nine levels of self-evaluation of creativity and innovation: 1) level of conscience to be creative and innovative; 2) Self-knowledge; 3) implementation of logical thinking lateral thinking; 4) Ease for the formulation of problems and the concretion of creative hotbeds; 5) constant search of ideas; 6) Creative Leadership; 7) thought and ingenuity applied; 8) Knowledge of creative and innovative methods; 9) Knowledge of innovation processes. Each one of these levels contains three subcategories responsible for measuring each level through a Likert-type scale with ratings of 1 to 5, where: 1 Bad, 2 Regular, 3 Acceptable, 4 Good and 5 Excellent.

**Table 1.** describes the levels of self-evaluation and valuation scale of the creativity-innovation domain:

| Level | Levels of creativity and innovation | Evaluation | | | | |
|---|---|---|---|---|---|---|
| | | 1 = BAD | 2 = REGULAR | 3 = ACCEPTABLE | 4 = GOOD | 5 = EXCELLENT |
| 1 | Level of consciousness of being creative and innovative | | | | | |
| 2 | Self-knowledge | | | | | |
| 3 | Implementation of logical thinking + lateral thinking | | | | | |
| 4 | Ease for the formulation of problems and the concretion of hotbeds creative | | | | | |
| 5 | Constant search for ideas | | | | | |
| 6 | Creative Leadership | | | | | |
| 7 | Thought and ingenuity applied | | | | | |
| 8 | Knowledge of creative and innovative methods | | | | | |
| 9 | Knowledge of innovation processes | | | | | |

**Source:** Own production

## Software used

For the organization, tabulation and analysis of the data, the IBM software SPSS Statistics 23 for Windows was used.

## Statistical model

For the realization of model estimates in the parameters of the multinomial logistics model, the link function of the multinomial distribution to the exponential family is used, which called logit transformation [9]:

$$\mathbf{1\ E\ Yi} = \log\left(\frac{p_{ij}}{p_{ig}}\right) \quad (1)$$

Where $p_{ij}$ is the probability of individual i belongs to category j, $p_{ig}$ corresponds to the probability of the same individual in category g, which is defined as reference category, of the variable with multinomial distribution Y.

$$\mathbf{1E\ Yi} = \log\left(\frac{p_{ij}}{p_{ig}}\right) = \boldsymbol{\beta oj} + \boldsymbol{\beta 1jxi1} + \cdots + \boldsymbol{\beta pjxip} \quad (2)$$


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Now, by applying the exponential both sides of the linear equation, the following is obtained:

$$\frac{\mathrm{Pij}}{\mathrm{Pig}} = e^{\beta oj+ \beta 1jxi1+\cdots+\beta pjxip} \tag{3}$$

$$pij = pige^{\beta oj+ \beta 1jxi1+\cdots+\beta pjxip} \tag{4}$$

$$\sum_{j=1}^{g} pij = Pi1 + \cdots + Pi(g-1) + Pig = 1 \tag{5}$$

$$\text{e } \mathrm{Pig} = 1 - Pi1 - \cdots - Pi(g-1) = 1 - \sum_{j=1}^{g-1} Pij \tag{6}$$

Then,

$$pig = 1 \sum_{j=1}^{g-1} Pige^{\beta oj+\beta 1jxi1+\cdots+\beta pjxip}$$

$$= 1 - Pig \sum_{j=1}^{g-1} e^{\beta oj+\beta 1xi1+\cdots+\beta pjxip}$$

$$Pig\left(1 + \sum_{j=1}^{g-1} e^{\beta oi+\beta 1ixi1+\cdots+\beta pixip}\right)$$

And on the basis of the probability that the individual i belongs to the category g, which from now on we will detail as a category of reference, is obtained:

$$Pig = \frac{1}{\left(1+\sum_{j=1}^{g=1} e^{\beta oi+\beta 1ixi1+\cdots+\beta pixip}\right)} \tag{7}$$

Finally, the following conditional probabilities are found when replacing:

$$Pij = \frac{e\beta oj+\beta 1jxi1+\cdots+\beta pjxip}{\left(1+\sum_{j=1}^{g=1} e^{\beta oj+\beta 1jxij+\cdots+\beta pjxip}\right)} \tag{8}$$

$$Para\ i = 1, \ldots., n\ y\ j = 1, \ldots., g-1$$

And the expressions used for the calculation of probabilities are defined:

$$pij = P\ (\{Yi = j\ |x1, x2, x3, \ldots., xp\}; j = 1, 2, \ldots, g-1$$

That in essence is interpreted as the probability that the individual i belongs to the category j, given a set of covariates.

The linear regression parameters $\boldsymbol{\beta_{ij}}$ are now estimated using the maximum likelihood estimation method that does not establish any restrictions on the characteristics of predictor variables. This function is defined as follows:

$$L = \prod_{i=1}^{n} P_{i1}^{yi1}\ P_{i2}^{yi2} \ldots P_{ig}^{yig} \tag{9}$$

That when applying the logarithm and replacing the above results is obtained:

$$\ln L = \sum_{i=1}^{n}\sum_{j=1}^{g} yij \quad lnPij = \sum_{i=1}^{n}\left[\!\left[\sum_{j=1}^{g-1} y_{ij\,ln}\left(\frac{e^{xi\beta j}}{1+\sum_{j=1}^{g-1} e^{xi\beta J}}\right) + y_{ig\,\ln}\right.\right.$$
(10)

$$\ln L = \sum_{i=1}^{n}\left[\!\left[\sum_{j=1}^{g-1} y_{ij\,\ln e^{xi\beta}} - \sum_{j=1}^{g} y_{ij\,ln}\left(1 + \sum_{j=1}^{g-1} e^{xi\beta jl}\right)\right.\right. \tag{11}$$

By maximizing the likelihood function, a system of equations that requires numerical methods is obtained to find the best solution.

## Multinomial Logistic Regression

The creative model is conceived as a process until its application or presentation in a market, which can be immersed in a paradigm, without violating the "free process" rule that has no limits or restriction parameters and whose purpose is to promote [10]. Under this approach, the model proposed in this document is raised.

The multinomial logistic regression model is used in cases when the response variable is polynomial, that is, it is represented by more than two modalities that can be of nominal or ordinal type. The objective is to describe the relationship between the response variable and a set of explanatory variables or predictors, which in turn can be quantitative or qualitative. Table 2 shows the first model calculated.

**Table 2.** Multinominal logistic regression

| Description of significance of the explanatory variables | | | | | |
|---|---|---|---|---|---|
| Model | Dependents variables | Explanatory variables | CHI-square Statistic | Degrees of freedom | P-value |
| Model 1 | Y1 | X8 | 39,057 | 4 | <0,000 |
| Model 2 | Y2 | X12 | 24,828 | 4 | <0,000 |
| Model 3 | Y3 | X1 | 7,612 | 2 | 0,022 |
| | | X6 | 7,842 | 2 | 0,02 |
| | | X15 | 17,749 | 4 | 0,001 |
| Model 4 | Y4 | X17 | 35,558 | 4 | <0,000 |
| Model 5 | Y5 | X2 | 19,363 | 4 | 0,001 |
| | | X20 | 7,817 | 4 | 0,099 |
| | | X21 | 8,555 | 4 | 0,073 |
| Model 6 | Y6 | X23 | 24,255 | 4 | <0,000 |
| Model 7 | Y7 | X26 | 13,564 | 4 | 0,009 |
| | | X27 | 18,017 | 4 | 0,001 |
| Model 8 | Y8 | X1 | 3,093 | 2 | 0,213 |

| | | | | | |
|---|---|---|---|---|---|
| | | X7 | 6,628 | 2 | 0,036 |
| | | X30 | 5,538 | 4 | 0,236 |
| | | X31 | 14,506 | 4 | 0,006 |
| Model 9 | Y9 | X2 | 9,226 | 4 | 0,056 |
| | | X6 | 8,23 | 2 | 0,016 |
| | | X32 | 23,985 | 4 | <0,000 |
| | | X33 | 5,769 | 4 | 0,217 |

**Source:** Own production

However, during the development of the adjustment of the models, some modifications were made to both explanatory variables as in the response variables. The sample size number of categories of covariates – explanatory variables – as well as the number of covariates, caused "overfitting" problems in estimating the parameters of the regression models. To fix this problem, it was decided to merge some categories of the variables since in many cases, they showed frequency null.

## The response variables of the models are:

$\boldsymbol{Y_1}$:.I consider myself have a good personal degree to be creative and innovative.

$\boldsymbol{Y_2}$: My level of self-knowledge in creative and innovative thinking

$\boldsymbol{Y_3}$: I constantly develop divergent thoughts on creativity and innovation.

$\boldsymbol{Y_4}$: I am good for project formulation and creative focus and innovation.

$\boldsymbol{Y_5}$: All the time I am in constant search of creative and innovative ideas.

$\boldsymbol{Y_6}$: I consider that I have a personality of creative leadership and innovative.

$\boldsymbol{Y_7}$: My level of ingenuity thinking in new creative and innovative projects.

$\boldsymbol{Y_8}$: I know creative techniques for innovation

$\boldsymbol{Y_9}$: I know creative processes for innovation.

Each variable has three categories which are 1: Acceptable, 2: Good, and 3: Excellent, whose probabilities are estimated through the logistic model.

## Model definition

Consider a vector of explanatory $\boldsymbol{p}$ variables, $\boldsymbol{X}' = (\boldsymbol{X_1}, \boldsymbol{X_2}, \dots, \boldsymbol{X_p})$ for each of the regression models. The research has a total of n = 80 observations, the probability of possible ways in which each of these observations can be divided among the three categories of the response variable is modeled. For this purpose a reference category is taken which in this case is category 3:


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Excellent. In this way, the logit for the categories of the Y response variables is defined as:

$$\boldsymbol{f(\pi_i) = Logit(\pi_i) = log\left(\frac{\pi_i}{\pi_3}\right) = X_i'\beta_i} \quad \text{For } \boldsymbol{i = 1, 2.} \tag{12}$$

More explicitly, for the categories of each response it is possible to find the following:

$$\boldsymbol{f(\pi_1) = log\left(\frac{\pi_{Aceptable}}{\pi_{Excelente}}\right) = \beta_{10} + \beta_{11}X_1 + \beta_{13}X_3 + \cdots + \beta_{1p}X_p} \tag{13}$$

$$\boldsymbol{f(\pi_2) = log\left(\frac{\pi_{Bueno}}{\pi_{Excelente}}\right) = \beta_{20} + \beta_{21}X_1 + \beta_{23}X_3 + \cdots + \beta_{2p}X_p} \tag{14}$$

Where,

$\boldsymbol{\beta_{i0}}$: It is the constant of the model or term independent when it is modeled the category $\boldsymbol{i}$.

$\boldsymbol{p}$: number of covariates.

$\boldsymbol{\beta_{ij}}$: coefficient of covariate j when modeling category i.

to take into account that:

$$\boldsymbol{\pi_1 = \pi_{Aceptable}} \;;\; \boldsymbol{\pi_2 = \pi_{Bueno}} \;;\; \boldsymbol{\pi_3 = \pi_{Excelente}}$$

For given values of covariates, the probability that the response variable is in category $\boldsymbol{i}$ is:

$$\boldsymbol{\hat{\pi}_i = \frac{exp(f(\pi_i))}{1+exp(f(\pi_1))+exp(f(\pi_2))}} \tag{15}$$

For the reference category it is

$$\boldsymbol{\hat{\pi}_1 = \frac{1}{1+exp(f(\pi_1))+exp(f(\pi_2))}} \tag{16}$$

The odds ratio:

$$\boldsymbol{\frac{\hat{\pi}_i}{\hat{\pi}_3} = exp(f(\pi_i)) = \mathrm{exp}(\beta_{i0} + \beta_{i1}X_1 + \beta_{i3}X_3 + \cdots + \beta_{ip}X_p)}$$
(17)

Are called Odds of category $\boldsymbol{i}$ of the variable response to the category of reference.

For an explanatory variable that is qualitative with $\boldsymbol{k}$ modalities, suppose, for example, that the last category is the reference category, that is, category $\boldsymbol{k}$. The quotient

$$\boldsymbol{OR = \frac{\frac{\hat{\pi}_{i/m}}{\hat{\pi}_{3/m}}}{\frac{\hat{\pi}_{i/k}}{\hat{\pi}_{3/k}}} = exp(\beta_{im})} \tag{18}$$


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For $\boldsymbol{m} = \mathbf{1}, \mathbf{2}, \dots, \boldsymbol{k} - \mathbf{1}$. Represents the ratio of Odds or the advantage of category $\boldsymbol{Y_i}$of the Y-response variable versus reference category $\boldsymbol{Y_3}$ for category $\boldsymbol{X_m}$ of variable X versus reference category $\boldsymbol{X_k}$.

# Results

## Criteria for adjusting models

Table 3 contains the description of the resulting model for each of the $\boldsymbol{Y_1}, \boldsymbol{Y_2}, \dots \boldsymbol{Y_9}$ response variables and the most significant explanatory variables for the model.

Among the columns in the table is the Chi-square statistic along with the respective degrees of freedom to contrast the hypothesis that the variables are significant in the model. The last column of the table contains the p-value of the Chi-square statistic, the smaller this value, the more influential the variable in the model. The included variables are significant at the level of 5%, 10% and 15%; some variables are less significant, but are included in the model as they affect the significance of other variables.

To measure the degree of quality of the fit of the model is shown in table 2 the calculation of Pseudo $\mathbf{R^2}$ (coefficient of determination) for each of the nine models, the most used are the Mc-Fadden, Cox-Snell and the Nagelkerke.

**Table 3.** Evaluation of adjustment of the models logistical multinomial

| Adjustment assessment of models | | | | | | |
|---|---|---|---|---|---|---|
| Model | MC Fadden | COX y snell | De nagelkerke | CHI-Square Statistic | Degrees of freedom | P-Value |
| Model 1 | 0,271 | 0,386 | 0,463 | 39,057 | 4 | <0,000 |
| Model 2 | 0,161 | 0,267 | 0,312 | 24,828 | 4 | <0,000 |
| Model 3 | 0,161 | 0,285 | 0,325 | 28,826 | 8 | 0,001 |
| Model 4 | 0,208 | 0,359 | 0,407 | 35,558 | 4 | <0,000 |
| Model 5 | 0,203 | 0,342 | 0,392 | 33,462 | 12 | 0,001 |
| Model 6 | 0,145 | 0,262 | 0,298 | 24,255 | 4 | <0,000 |
| Model 7 | 0,191 | 0,323 | 0,371 | 31,185 | 8 | <0,000 |
| Model 8 | 0,208 | 0,34 | 0,393 | 33,243 | 12 | 0,001 |
| Model 9 | 0,353 | 0,512 | 0,589 | 57,44 | 14 | <0,000 |

**Source:** Own production

The theoretical range of the Mc Fadden coefficient is $0 \leq R^2 \leq 1$, although it is not usual that it reaches its maximum value.

Can be considered a good quality of adjustment when takes values between 0.2 and 0.4 and excellent for higher values. The Pseudo R-squared of Cox and


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Snell does not have a higher dimension, and Nagelkerke's takes values between zero and one. Considering the type of variable of the models, these values of $R^2$ can be considered as good, because it is not very common in social studies to find these large values.

The chi-square statistic contrasts the hypothesis that none of the model variables significantly explains the response, which can be corroborated with the p-value; values below 0.05 indicate that the variables are significant in the model and therefore a good fit is obtained.

## Model adjustment results

The results of the model adjustment in SPSS are shown each in its respective table. The Wald statistic along with its respective p-value (Sig.) tests the hypothesis that the parameter $\hat{\beta}_{im}$ is equal to zero, this is:

$$H_0: \hat{\beta}_{im} = 0 \quad vs \quad H_1: \hat{\beta}_{im} \neq 0$$

The $H_0$ hypothesis will be rejected at the 95% confidence level if Sig.< 0,05

The $H_0$ hypothesis will be rejected at the 90% confidence level if Sig.< 0,10

The $H_0$ hypothesis will be rejected at the 85% confidence level if Sig.< 0,15

The results are interpreted in terms of the column "Exp(B)", which represents the ratio of odds, $OR = exp\ (\beta_{im})$.

## Parameters that have zero value in the table belong to the category of reference of the explanatory variables

## Interpretation of Model 1

### Response variable:

$Y_1$: I consider myself have a good personal degree to be creative and innovative.

### Modalities:

1: Acceptable, 2: Good, and 3: Excellent

Explanatory variables:

$X_8$: I consider myself a creative and innovative person.

### Modalities:

1: Acceptable, 2: Good, and 3: Excellent

**Table 4.** Multinomial logistic adjustment model

| Parameter estimates | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Y1 | | B | Tip. error | Wald | gl | Sig. | Exp(B) | 95% confidence interval for Exp(B) | |
| | | | | | | | | Lower limit | Upper limit |
| ACCEPTABLE | Intersection | -2,639 | 1,035 | 6,5 | 1 | 0,011 | | | |
| | [X8=Acceptable] | 4,585 | 1,488 | 9,494 | 1 | 0,002 | 98 | 5,304 | 1810,733 |
| | [X8=Good] | 1,723 | 1,331 | 1,675 | 1 | 0,196 | 5,6 | 0,412 | 76,049 |
| | [X8=Excellent] | 0 | | | 0 | | | | |
| GOOD | Intersection | -1,03 | 0,521 | 3,906 | 1 | 0,048 | | | |
| | [X8=Acceptable] | 3,109 | 1,182 | 6,922 | 1 | 0,009 | 22,4 | 2,21 | 227,048 |
| | [X8=Good] | 3,031 | 0,706 | 18,432 | 1 | 0 | 20,72 | 5,193 | 82,67 |
| | [X8=Excellent] | 0 | | | 0 | | | | |

a. The reference category is: EXCELLENT.

b. This parameter is set to zero because it is redundant.

**Source:** Own production

Model 1 developed in Table 4, shows that when is modeled the category "acceptable" of the response variable, it is found that is significant at the 95% Category 1: acceptable of the variable X8. The odds ratio for this parameter is 98.0; this indicates that almost always those who have an "acceptable" personal degree of being creative and innovative, are considered a creative and innovative person "acceptable".

When modeling the "Good" category of the response variable, categories 1: Acceptable and 2: Good of the X8 variable are significant.

The odds ratio for "Acceptable" is 22.40; this indicates that the consideration of having a "Good" personal degree of being creative and innovative versus being "Excellent" is 22.4 times more likely for those who consider theself a creative and innovative "Acceptable" person than those who consider theself a person creative and innovative "Excellent".

The odds ratio for "Good" is 20.72; this indicates that the consideration of having a "Good" personal degree of being creative and innovative versus being considered "Excellent" is almost 23 times more likely for those who consider theself a creative and innovative person "Well" than those who consider theself a person creative and innovative "Excellent".

**Table 5.** Observed and predicted frequencies

| X8 | Y1 | Porcentaje | |
|---|---|---|---|
| | | Observada | Pronosticada |
| Acceptable | Acceptable | 43,80% | 43,80% |
| | Good | 50,00% | 50,00% |
| | Excellent | 6,30% | 6,30% |
| Good | Acceptable | 4,50% | 4,50% |
| | Good | 84,10% | 84,10% |
| | Excellent | 11,40% | 11,40% |
| Excellent | Acceptable | 5,00% | 5,00% |
| | Good | 25,00% | 25,00% |
| | Excellent | 70,00% | 70,00% |

Percentages are based on the total observed frequencies of each subpopulation

**Source:** Own production

On the other hand, you have the probabilities of boxes of the crosses of the categories in Table 5:

- For a creative and innovative person at the "Acceptable" level, the probability of being considered with an "Acceptable" personal degree of being creative and innovative is 43.8%.
- For a creative and innovative person at the "Acceptable" level, the likelihood of being considered with a good personal degree of being creative and innovative is 50%
- For a creative and innovative person at the "Acceptable" level, the probability of being considered with an "Excellent" personal degree of being creative and innovative is 6.3%.
- For a creative and innovative person at the "Good" level, the probability of being considered with an "Acceptable" personal degree of being creative and innovative is 4.5%.
- For a creative and innovative person at the "Good" level, the probability that he will be considered with a good personal degree of being creative and innovative is 84.1%.
- For a creative and innovative person at the "Good" level, the probability of being considered with an "Excellent" personal degree of being creative and innovative is 11.4%.

## Conclusion

Creativity plays an important role in today's world, it is believed to be important for the adaptation of demand to technological environments [11]as could be seen in the showcase of innovation, where the technological application in the innovation case could be evident construction in terms of software application, energy efficiency, automation and construction systems [12].

Concerning the construction, creativity as in all aspects, comes from a cognitive process influenced by the evolutionary, training and social experience, by which cannot be thought of as particular characteristics of an individual [13]. In the case of cities, innovation must contribute to generate new products to satisfy the needs of the population, maintaining the appropriate size and deconcentrating all efforts in the search for competitiveness, rather than concentrate to minimize the costs that should be assumed by the expansion, leaving aside to optimize the benefits [14].

The Management Innovative Thinking Test (TPIG) was created with an instrument in mind that can measure the capacity for innovation as a measure of creativeness among managers In the construction sector in a valid and reliable way, capturing and quantifying these capabilities from self-assessment.

To validate it, the multinomial logistic regression model allows to know the variables that most affect the Test and whether they are in line with the very perception of the entrepreneur since nine variables were analyzed response Y of the perception of the entrepreneur against his creativity and innovation for an explanatory variable X that determines whether or not it is creative and innovative under the modalities of 1: Acceptable, 2: Well, 3: Excellent. In short, it is found that for a creative and innovative person at the "Acceptable" level, the likelihood that he will be considered with a personal "Good" degree of being creative and innovative is 50% higher than for the other categories and for a creative and innovative person in level "Good", the likelihood that it will be considered with a personal "Good" degree of being creative and innovative is 84.1%, higher than the other categories.

The instrument was applied to a sample of 80 entrepreneurs, shows that it also confers validity on the data being representative of the total formally constituted companies, dedicated to the construction in the municipality of Sincelejo, therefore the design of the study is transectional, descriptive and correlational in nature. In this way, a test is validated to make it available to the managers of the construction sector of Sincelejo, which will serve as a tool to measure their capacity for innovation.

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