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## **Presentation of Content**

In a first article we present, *Application of logistic regression in industrial maintenance management* by HERRERA-SÁNCHEZ, Gustavo, SILVA-JUÁREZ, Alejandro, MORÁN-BRAVO, Luz del Carmen and DESAMPEDRO-POBLANO, Héctor Manuel, with adscription in the Universidad Tecnológica de Puebla, as the next article we present, *Social Work intervention in health conditions and promotion of family integration in a walker in Poza Rica* by HERNÁNDEZ-MAQUEDA, Martha Soledad, MERCADO-MOJICA, Alin Jannet, PACHECO- ARENAS, Noelia and HERNÁNDEZ -MAR Sandra Luz, with adscription in the Universidad Veracruzana, as the next article we present, *Changes in control of supplies, production processes and advertising of Acámbaro companies; Gto. derived from the pandemic* by BARRERA-FIGUEROA, Mayra Verónica, RODRÍGUEZ-RODRÍGUEZ, Graciela and UGALDE-ZAMUDIO, Giovanni, with adscription in the Universidad Tecnológica de León, as the last article we present, *AST for the Development of Professional Competencies in Software Engineering* by ZAMORA-RAMOS, Víctor Manuel, OSORIO-ÁNGEL, Sonia, BECERRA-VELÁZQUEZ, Violeta del Rocío and MACÍAS-BRAMBILA, Hassem Rubén, with adscription in the Universidad de Guadalajara.

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## Application of logistic regression in industrial maintenance management

### Aplicación de la regresión logística en la gestión de mantenimiento industrial

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#### Abstract

In the area of industrial maintenance, the application of statistical methods is essential, in that sense, the purpose of this analysis is to explore logistic regression as an element of industrial maintenance management. By means of logistic regression, a predictor equation for the response variable, machine failure, is obtained by correlating it with categorical and continuous predictor variables. The continuous explanatory variables are machine age, mean time between failures, mean time to repair and the categorical ones are application of preventive and corrective maintenance. The results obtained indicate that only the explanatory variable preventive maintenance is significant to the response variable by applying the Wald test and this result was also validated with goodness-of-fit tests. Logistic regression is more used in other areas, such as health, however, in maintenance categorical variables are used such as machine with autonomous maintenance whose result is yes/no, therefore, it is important to incorporate a regression model that considers different types of independent variables, in addition to the use of emerging technologies of Industry 4.0 such as Machine Learning for the prediction of scenarios for efficient maintenance management.

**Correlating, Logistic Regression, Predictor, Preventive, Corrective**

#### Resumen

En el área de mantenimiento industrial es primordial la aplicación de métodos estadísticos, en ese sentido, el propósito de este análisis es explorar la regresión logística como un elemento de la gestión del mantenimiento industrial. Mediante la regresión logística se obtiene una ecuación predictora para la variable de respuesta, máquina falla correlacionándola con variables predictoras categóricas y continuas. Las variables explicativas continuas son edad de la máquina, tiempo medio entre fallas, tiempo medio para reparar y las categóricas son aplicación de mantenimiento preventivo y correctivo. Los resultados obtenidos indican que únicamente la variable explicativa mantenimiento preventivo es significativa a la variable de respuesta mediante la prueba de Wald y también se validó este resultado con pruebas de bondad de ajuste. La regresión logística es más utilizada en el otras área, como de la salud, sin embargo, en mantenimiento se utilizan varias variables categóricas como máquina con mantenimiento autónomo cuyo resultado es si/no, por ello, es importante incorporar un modelo de regresión que considera a diferentes tipos de variables independientes, además de la utilización de las tecnologías emergentes de la Industria 4.0 como Machine Learning para la predicción de escenarios para una eficiente gestión del mantenimiento.

**Correlación, Regresión Logística, Predictor, Preventivo, Correctivo**

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## Introduction

Logistic regression is a technique that allows us to establish a relationship between a discrete, mainly dichotomous variable with possible outcomes of accepted or not accepted and predictor variables, which can be quantitative or qualitative in a probability of occurrence of the particular phenomenon. Logistic regression has been used in predictive maintenance for machine failure analysis (Battifarano et al, 2019; Yongyi et al, 2019; Yugapriya et al, 2022), in machine efficiency assessment through Overall Equipment Effectiveness (OEE) (Borucka, Grzelak, 2019), its main use has been in the areas of medicine and psychology (Alzen et al, 2018; Oyekale, 2022; Zabor et al, 2022).

The purpose of this research is to apply a logistic regression model of the state of failure and state of function of machines for maintenance management using logistic regression, thus, to analyse and evaluate how dichotomous independent variables influence the probability of occurrence of the states of a machine, i.e., in the state of operation (State of Functioning, SoFu) and in the state of failure (State of Failure, SoFa).

## Materials and methods

To predict when a machine is in SoFu or SoFa, there are different regression methods such as simple linear (Le, T at al, 2014; Teng, et al, 2016), multiple linear regression (Bicharra et al, 2014), non-linear regression (Mosallam et al, 2011), Monte Carlo simulation (Srivastava et al, 2020), determination of reliability, maintainability and availability indicators using continuous probability distributions (Mora, 2009; Ramesh, Krishnan, 2017).

However, there are situations where the random variables of study are discrete and dichotomous in the area of maintenance, for example, if the machine failed, if the machine was applied preventive maintenance, if the machine has an autonomous maintenance routine.

Therefore, the statistical regression models mentioned above are not suitable for the prediction of the operating status as a mathematical model involving discrete variables and continuous variables is required.

Logistic regression does not require a linear relationship between the response and predictor variables nor does it emphasise the assumptions of linearity, normality, homoscedasticity and level of measurement.

## Logistic Regression Model

The mathematical model of a logistic regression allows to observe the possible correlations between independent variable  $X_1, X_2, X_3, \dots, X_n$ , which can be continuous or discrete with a discrete and dichotomous dependent variable  $Y$ , usually taking the values of 0 and 1. Also the predictor variables can be qualitative or quantitative. The logistic regression model is based on the logistic or sigmoid function, equation 1.:

$$f(x) = \frac{e^x}{1+e^x} = \frac{1}{1+e^{-x}} \quad (1)$$

The sigmoid function fulfils  $\lim_{x \rightarrow \infty} f(x) = 0$  y  $\lim_{x \rightarrow -\infty} f(x) = 1$ , the transformation from logistic regression to linear regression  $Y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n$ , substituting in the sigmoid function the  $x$  by the linear function  $\beta_0 + \beta_1 x_1 + \dots + \beta_n x_n$ , is obtained (equation 2):

$$P(Y) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\dots+\beta_n x_n)}} = \frac{e^{\beta_0+\beta_1 x_1+\dots+\beta_n x_n}}{1+e^{\beta_0+\beta_1 x_1+\dots+\beta_n x_n}} \quad (2)$$

Through this equation, the possible values of  $Y$  are 1 and 0, which is interpreted as the probability of occurrence of  $Y$ , the closer the value of  $P(Y)$  is to 1, the more likely it is that  $Y$  will occur.

On the other hand, if we have a dependent variable  $Y$  which is dichotomous with values of 1 or 0 and  $n$  independent variables  $X=(X_1, X_2, X_3, \dots, X_n)'$ , the generalised model for the logistic regression is (equation 3):

$$P(Y = 1|X = x) = px = \frac{e^{\beta_0+\sum_{i=1}^n x_i}}{1+e^{\beta_0+\sum_{i=1}^n x_i}} \quad (3)$$

For maintenance management (Eagle Technology, 2020; MaintainX, 2021; Sellitto, 2020), logistic regression is considered appropriate, since we have continuous and discrete predictor variables, for example, continuous variables can be the cost of maintenance.

The age of the machine, the Mean Time Between Failures (MTBF), Mean Time To Failure (MTTF), Mean Time To Repair (MTTR), among others. For discrete and dichotomous variables, one can start by asking what happens if corrective maintenance, preventive maintenance, predictive maintenance, the technician who performed the maintenance, etc., was applied.

The data for this test are shown in table 1. Where the response variable is and machine failure takes the value of yes and no when the machine is available for its function, with the following predictor variables being: machine age (ME), MTBF, MTTR, preventive maintenance (PM) and corrective maintenance (CM).

Machine failure	EM	MTBF	MTTR	MP	MC
Si	7	9652	9	0	0
No	3	612	3	1	0
Si	6	6769	6	0	0
No	4	7344	8	0	0
Si	3	1198	8	0	1
No	4	9572	7	1	0
Si	2	8212	6	0	1
No	7	8498	7	1	1
No	5	5475	7	0	0
No	9	1272	8	0	1
No	6	9790	7	1	1
No	7	2469	4	0	0
No	3	7132	2	1	0
Si	10	6254	2	0	0
Si	7	6054	3	0	0
Si	4	9815	2	0	1
Si	2	9367	9	0	0
Si	5	408	4	1	1
Si	7	883	8	1	0
No	9	1534	6	1	1
No	11	4745	11	1	0
No	13	899	15	0	1
Si	3	3752	20	0	0
Si	10	5194	17	0	0
No	9	939	10	1	1
No	20	2657	4	0	1
Si	17	9918	15	1	1
Si	11	7324	17	0	1
No	18	6689	8	0	1
Si	15	743	8	0	1
Si	2	1200	2	0	1
No	5	4001	1	1	0
No	3	2500	5	1	0
No	8	2356	6	1	0

**Table 1** Data for logistic regression  
Source: Own Elaboration

**Results and discussion**

Using minitab software, the regression is solved by the logistic regression method with the Logit link function, see equation 4.

$$Y' = 0.15 - 0.125EM + 0.00008MTBF + 0.1015MTTF - 1.928MP_{si} + 0.597MC_{si} \tag{4}$$

The equations for the discrete variables are shown in table 2. The positive coefficients of the predictor equations indicate that the machine is likely to fail as the value of the predictor increases, on the other hand, the negative coefficients indicate that the event of machine failure is less likely as the value of the predictor increases.

MP.	MC.	Ecuacion
No	No	$Y' = 0.147 - 0.1246EM + 0.00008MTBF + 0.1015 MTTR$
No	Yes	$Y' = 0.743 - 0.1246EM + 0.00008MTBF + 0.1015MTTR$
Yes	No	$Y' = -1.781 - 0.1246EM + 0.00008MTBF + 0.1015MTTR$
Yes	Yes	$Y' = -1.184 - 0.1246EM + 0.00008MTBF + 0.1015MTTR$

**Table 2** Model equations  
Source: Own Elaboration based on minitab

Analysing the variance table, see table 3, it is observed that the explanatory variable of predictive maintenance is statistically significant to the response variable with a confidence level of 95%, therefore, this categorical factor significantly influences the dependent variable and the machine failure.

Source	GL	Chi square	Value - p
Regression	5	7.43	0.190
Machine age	1	1.65	0.199
MTBF	1	0.42	0.516
MTTR	1	1.06	0.302
M. Preventive	1	5.22	0.022
M. Corrective	1	0.46	0.499

**Table 3** Analysis of Variance  
Source: Own elaboration based on minitab: Own elaboration based on minitab

The other p-values of the predictor variables are not statistically significant, indicating that the regression model can be reduced without these terms.

Verifying that the logistic regression predictor equation fits the data, the following goodness-of-fit tests were performed:

- Deviance with value -  $p = 0.112$ .
- Pearson's test  $p = 0.232$
- Hosmer - Lemeshow test  $p = 0.873$

With these results, the p-values are greater than the significance level of the investigation, therefore, there is no significant statistical evidence to conclude that the model does not fit the data.

Using the Normit link function instead of Logit, the goodness of fit test results do not show a significant change:

- Deviation with value -  $p = 0.114$ .
- Pearson's test  $p = 0.238$
- Hosmer - Lemeshow test  $p = 0.733$

With the Normit link function, the Wald test, no significant change is observed in the ANOVA table, the preventive maintenance variable remains statistically significant with  $p = 0.017$  at the 95% significance level.

In relation to multicollinearity, the results obtained from the coefficients of the predictor equation are not severe, see table 4. The variance inflation factors are close to unity (Del Valle and Guerra, 2012), which indicates that there is no correlation between the predictor variables, therefore, the model is reliable to forecast

Term	Coefficient		
	Coef	EE coef	FIV
Constant	0.15	1.20	
Machine age	-0.1246	0.0971	1.33
MTBF	0.00008	0.000124	1.05
MTTR	0.1015	0.0984	1.14
M. Prev_Si	-1.928	0.844	1.03
M. Corr_Si	0.597	0.884	1.22

**Table 4** Variance inflation factors  
Source: Elaboration based on minitab

In table 5, the odds ratio (ODDS) for continuous predictors reveals that the variable age of the machine has a value of 0.8828, which indicates that the event the machine fails is unlikely to occur because there is a negative association. If we perform the inverse operation  $1/0.8828 = 1.13$  it indicates that there is a probability of 1.13 times that the machine will work. For MTTR and MTBF values are greater than unity (Salas, 1996), i.e. there is a positive association between the event and the machine is less likely to fail, however, for the explanatory variable MTBF its ODD is practically 1 showing no association.

The MTTR denotes a positive association, since, there is a 1.1 times probability of machine failure considering all other constant values.

	Odds ratio	IC de 95%
Machine age	0.8828	(0.7299, 1.0679)
MTBF	1.0001	(0.9998, 1.0003)
MTTR	1.1069	(0.9127, 1.3423)

**Table 5** Likelihood ratios for continuous predictors  
Source: Elaboration based on minitab

With respect to the odds ratio of the categorical predictors, table 6, the preventive maintenance variable is 0.1454 times more likely that the machine fails, if we obtain its inverse  $1/0.1454 = 6.88$  times that the machine does not fail if we apply preventive maintenance keeping the other explanatory variables constant. The association is positive for corrective maintenance, when corrective maintenance increases, the machine is more likely to fail.

Level A	Level B	Odds	IC de 95%
Preventive maintenance			
Yes	No	0.1454	(0.0278, 0.7599)
Corrective maintenance			
Yes	No	1.8171	(0.3215, 10.2691)

**Table 6** Odds ratios for categorical predictors  
Source: Elaboration based on minitab

Figure 1 shows an area under the curve of 0.8021, according to Sweest's (1988) criteria, the area under the curve, known as ROC, is in the range of 0.7 to 0.9 and this indicates that it has an acceptable discriminant capacity for when the machine fails or does not fail. On the other hand, according to Hilbe (2015), values from 0.5 to 0.65 have low predictive ability, values from 0.65 to 0.80 have moderate ability, values between 0.8 and 0.90 indicate strong predictive ability and values greater than 0.9 indicate high predictive ability, but this last relationship almost never happens. It is desirable that it is greater than 0.9 in order to have a higher sensitivity and specificity and thus obtain few erroneous results in the variable y'.

The most usual is to find a curve between 0.7 and 0.9 (del Valle, n.d.) with an overlap between the sensitivity or true positive rate, TPR, and the specificity or false positive rate, FPR. For our study it means that the sensitivity has an acceptable discrimination in predicting when the machine fails and when it does not fail.



**Figure 1** ROC curve for the study

On the other hand, according to the results of the analysis of variance in table 3, the logistic regression is solved with the machine failure versus preventive maintenance, resulting in the following equation:

$$y' = 0.619 - 1.918 MP_{si} \quad (5)$$

Comparing equations 4 and 5, there is no big difference in the coefficient of the preventive maintenance variable, as well as in the goodness of fit tests: for deviation, the p-value is 0.184 and for Pearson the p-value is 0.371.

For the ODD with respect to the preventive maintenance variable there is no significant difference, see table 6 and 7.

Level A	Level B	Odds	IC de 95%
Preventive maintenance			
Yes	No	0.1469	(0.0305, 0.7099)

**Table 7** Probability relationships for machine failure vs. Preventive Maintenance

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## Conclusions

With logistic regression applied to maintenance management, we have a statistical tool that allows us to make predictions of whether a machine is in its functional state or in a state of failure using categorical variables, not only with continuous variables. Goodness-of-fit tests were performed to test the suitability of the model in different scenarios with the Logit and Normit link functions, with no significant differences.

On the other hand, two predictor equations were obtained, one model with all the variables of the initial analysis and another one only with the significant variable without having a relevant difference. With respect to the ROC curve, the model is adequate for the prediction of the response variable.

Like any process, it can be improved, as other predictor variables can be incorporated, such as the cost of total maintenance, corrective, preventive, predictive, maintenance policies with respect to the machines, criticality, all with the aim of strengthening the prediction model for a relevant industrial maintenance management.

Finally, incorporating the disruptive technologies of Industry 4.0, since companies tend to be cyber-physical systems that have vertical and horizontal integration, and data collection, in accordance with the ISA - 95 standard, with sensors on the machines will lead to the use of data in the cloud, the analysis of big data through Machine Learning and real-time decision making. This leads to a new maintenance management 4.0. Logistic regression will then use sensitive data to predict machine failure through the use of Machine Learning with real-time data collection for increased productivity and competitiveness in industrial maintenance.

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## Social Work intervention in health conditions and promotion of family integration in a walker in Poza Rica

### Intervención de Trabajo Social en las condiciones de salud y promoción de la integración familiar en un andador en Poza Rica

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#### Abstract

The Social Work intervention strengthens the promotion of health, education and the adoption of self-care practices, for which a professional intervention was carried out in a walker, with the objectives of promoting comprehensive health in families and promoting the training of students. The methodology used was participatory action research: 1) Diagnosis and 2) Intervention. The results of the diagnosis indicated that the age of the attendees between 45 and 71 years, 91% come to exercise for physical health, the main activities carried out are walking and jogging, 50% suffer from some chronic disease; Finally, they expressed interest in conferences, talks, size and weight controls, and activities for the family. The Professional intervention had as results: socio-educational activities that favor family integration, healthy coexistence, strengthening of values and physical activities for the benefit of health, with 150 people; a cycle of conferences on self-esteem, stress management and eating habits with 75 people; Likewise, 6 students participated in the design and execution of the project, developing skills for working with groups and families, as well as in the application of techniques for social intervention, strengthening professional training as social workers in real settings.

#### Diagnosis, Intervention, Execution

#### Resumen

La intervención de Trabajo Social fortalece la promoción de la salud, la educación y la adopción de prácticas de autocuidado, para ello se realizó una intervención profesional en un Andador, con los objetivos de Promover la salud integral en las familias e Impulsar la formación de estudiantes. La metodología utilizada fue la investigación acción participativa: 1) Diagnóstico y 2) Intervención. Los resultados del diagnóstico indicaron que la edad de los asistentes entre 45 y 71 años, 91% acuden a hacer ejercicio por salud física, las principales actividades realizadas son caminar y trotar, 50% padece alguna enfermedad crónica; finalmente manifestaron interés en conferencias, pláticas, controles de talla y peso y actividades para la familia. La intervención Profesional tuvo como resultados: actividades socioeducativas que favorecen la integración familiar, sana convivencia, fortalecimiento de valores y actividades físicas en beneficio de la salud, con 150 personas; un ciclo de conferencias sobre autoestima, manejo de estrés y hábitos alimenticios con 75 personas; así mismo 6 estudiantes participaron en el diseño y ejecución del proyecto, desarrollando competencias para el trabajo con grupos y familias, así como en la aplicación de técnicas para la intervención social, fortaleciendo la formación profesional como trabajadores sociales en escenarios reales.

#### Diagnóstico, Intervención, Ejecución

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## Introduction

Integral health "is not the mere absence of alterations and diseases, but a positive concept that implies different degrees of vitality and adaptive functioning" (Vera, 2010).

Participating in health care makes it possible to adopt a healthy lifestyle and to anticipate situations that may damage it. In this sense, the intervention of Social Work professionals strengthens health promotion, education and the adoption of self-care practices, in order to raise awareness among families about the need for care and physical activity to reduce the risk of suffering from chronic degenerative diseases such as diabetes and hypertension, among others.

From the articulation of the analysis of the family structure and the family life cycle with the study of changes in family models, academics and students of the Faculty of Social Work Poza Rica campus developed the Project "Professional Intervention of Social Work with families in the Metropolitan Area of Poza Rica (ZMPR)" which was carried out with people who go walking to a walker in the city of Poza Rica, Veracruz, To promote the professional training of students of Social Work through the promotion of health to families of the walker and the general population and 2. To strengthen the development of skills and attitudes for social intervention with families in the Metropolitan Area of Poza Rica through socio-educational activities in the walker and the general population.

The development of the project involved the participation of academics and students of the educational experiences (or subjects) of Planning for Social Intervention and Social Intervention Techniques, as well as external guests. The application of the theoretical, heuristic and axiological knowledge generated by these educational experiences favoured the professional training of students by carrying out a professional intervention based on real problems and/or needs, demanded by the families participating in the walkway of the 27 de septiembre neighbourhood, also allowing in the process of execution the application of social intervention techniques, to promote integration, participation and development of significant learning to improve the living conditions of the participants.

This project helped to promote the professional training of Social Work students through the development of professional competencies in social intervention in response to a real and high-impact problem, through the interaction of practising social workers, teaching staff and experts, who promoted integral health in the families of the walker.

Considering that, from a critical point of view, social workers can intervene in the social sphere to enable the exercise of a socio-educational action that contributes to the consolidation of an active citizenship, in relation to health awareness and family integration.

## 1. Development

### 1.1 Health

Health has been considered as a key point in lifestyle, it is the main condition for human development, it is the state of ideal well-being and it is only achieved when there is a balance between physical, biological, emotional, mental, spiritual and social factors. These factors allow for adequate growth and development in all areas of life. This concept is very similar to that of general health established by the World Health Organisation (1948) which states that "health is the state of physical, emotional and social well-being of an individual".

On the other hand, San Martín (1981) points out that "the concept of health is dynamic, historical, it changes according to the time, the culture and the living conditions of the population. The idea that people have of their health is always limited by the social framework in which they act". Thus, in the society in which we live, health is a fundamental aspect in the life of the human being, the concepts that are handled about it are varied and have considerable repercussions, since it means different visions of one's own life, actions and planning (Sánchez González, 1998).

Therefore, the actions that each person carries out for physical and mental health, such as eating habits, daily routines, exercises, among others, help to favour a better quality of life as one gets older.

These habits and actions are called self-care; In this regard, the World Health Organisation (WHO, 1983) defines for the first time the concept of self-care as "the ability of individuals, families and communities to promote health, prevent disease, maintain health and cope with illness and disability with or without the support of a health care provider", so that self-care is a responsibility of each person with their own physical and mental integrity, of each family and even more, this self-care should be considered as a co-responsible and collaborative work that encourages a community practice that stimulates the promotion of comprehensive health.

In this sense, promoting health from the family context acquires relevance in order to contribute to improving the quality of life of individuals, families and, therefore, society. From a social work perspective, it is important to establish a clear link in the triad of health intervention: doctor-social worker-family.

As mentioned by Rapa, Hanna, Pollar, Santos-Paulo, Gogay, Ambler and Dalton (2023) "Establishing a family's cultural, spiritual and religious understanding of the use of other (traditional) treatment methods alongside Western medicine may help to promote a mutually respectful relationship between the physician and the family. Health professionals need to recognise how, in some cases, stigma can influence family-centred care within a family and its community".

In this context, the social worker, from a holistic vision, articulates the professional intervention of health personnel with families within the framework of public policies and the socio-cultural conditions of the subjects from processes of education, training, management, channelling focused on the promotion of health from an integral perspective.

It is through education and information that one learns to take care of one's health, giving rise to the generation of healthy habits and the prevention of illnesses. This is achieved through non-formal education processes, which involve a practice that promotes processes of reflection on the importance of health and integral wellbeing.

Participating in health care makes it possible to adopt a healthy lifestyle and to anticipate situations that could damage it. In this sense, the intervention of Social Work professionals strengthens health promotion, education and the adoption of self-care practices, by raising awareness among families about the need for care and physical activity to reduce the risk of suffering from chronic degenerative diseases such as diabetes and hypertension, among others, and, if necessary, to contribute to better control of the health conditions of those who already suffer from one or more of these diseases.

## 1.2 Social work and the health of families

As Donini (2005) points out "... the family is the first and most important agent for the transmission of ethical and social values, habits, customs, norms, roles, relationships and expectations aimed at preserving the cultural heritage for future generations" (p. 23). (p. 23)

In this sense, Social Work from its origins has been linked to work with families, from an approach centred on family relationships, fundamentally because it is this social institution that is difficult to replace as a context that generates identity and models of relationships for people.

For this reason, Social Work with families articulates the analysis of family structure and the family life cycle with the study of changes in family models. It also offers the framework for the evaluation of family structure where the general objective is to understand relationship patterns, taking into account the influence of the family system itself to promote pattern change.

All families, regardless of the structure to which they belong, go through different stages as they grow. This growth brings with it various changes, creating crises and tensions that mobilise all members, not only individually but collectively, to optimise resources in order to contribute to the development of the family nucleus. This whole process of evolution is called the life cycle and consists of different moments experienced by all family members who will share a common history. At each stage, the family must deal effectively with the challenges it faces, applying resilience processes to adapt and grow.

According to WHO (2015) it is important to know the family life cycle because it allows:

- It helps to understand the stages a family goes through and the needs that arise in each of them.
- It allows the identification of risk and protective factors at each stage, which facilitates prevention and addressing family problems.
- It facilitates the planning of interventions and support programmes for families, adapted to their specific needs.
- Promotes understanding and respect for different types of families and their dynamics.

It is in the family context where the foundations of health are formed and good health is the best resource for personal, family and social progress. Health promotion is a global political and social process that encompasses actions aimed at modifying social, environmental and economic conditions in order to favour their positive impact on individual and collective health. Ottawa Charter (WHO, 2019).

The current health promotion mandate for the Americas region, the Strategy and Plan of Action on health promotion in the context of the Sustainable Development Goals (SDGs) 2019-2030 approved at the 57th Directing Council (2019), proposes 4 essential strategic lines of action to promote health:

1. Strengthen healthy environments.
2. Facilitating community participation and empowerment. 3.
3. Strengthen governance and intersectional action and address the social determinants of health. 4.
4. Strengthen health systems and services.

With this frame of reference, it is important to specify that health promotion is a key element in strengthening health systems and their capacity to respond to the health needs of individuals, families and communities, focusing on ensuring health at the highest possible level with solidarity and equity.

Each contact with an individual can be an opportunity not only to provide a clinical service, but also to assess the conditions in which they live and work, learn about their family and social context, and connect with community assets. It also provides an opportunity to coordinate with other services such as social protection and housing to address the identified needs of individuals.

The health sector must achieve more relevant and concrete advocacy in collaboration with communities to create healthy living conditions, based on primary health care.

According to the Pan American Health Federation (PAHO, 2023), health promotion is an essential public health function, which should be included in the processes of evaluation, policy development, resource allocation and in the dimensions of access to health services.

It is precisely social work that is responsible for understanding and interpreting reality in a holistic way, with the implications and complications of different social structures and changes.

From the perspective of the field of health and family care, the social worker takes up the field of community leadership and management, from which social processes of community organisation are influenced, whose primary objective is to make the population aware of the importance of health, in all the dimensions involved.

Therefore, the professional intervention of the social worker is necessary from a multi- and transdisciplinary work, generating synergies that promote the development of the communities and the well-being of the people, in which through their actions it is possible to perceive the ethical sense of the same, that moral values and ethical principles are made visible, which tend to promote family integration.

Family integration is understood as the degree of health, harmony and balance existing in the relationships maintained within the members of a family, including and valuing the person and his or her role within the family nucleus.

Maintaining it requires efforts, activities and actions carried out that allow a strong, structured and coherent relationship and bonding of each and every one of the members of the family nucleus, so that the family functions in an organised and functional way and generates wellbeing for each of its members. The aim is to achieve a healthy family environment that allows the development of the family as a whole, with special interest in generating harmony and relationships of trust and union among its components.

Generally, when we speak of family integration we are referring to efforts to maintain a strong and respectful bond within the family, in which adults can be involved in the lives of their children, allowing all family members to maintain a quality bond and act as reference figures.

Good family integration can foster positive values and ensure quality education by dedicating sufficient time and effort to joint activities and fostering good relationships between family members. For this, it is necessary that the members of the family group share quality time, assertive communication that allows the free expression of ways of thinking, fears, doubts, emotions, joys and values.

Another important aspect is the process of linking the family, society and the environment, which includes work, friendships and leisure activities, among others.

To this end, a social intervention project was developed that involved the participation of academics and students, as well as invited external professionals, who in real scenarios applied the theoretical, heuristic and axiological knowledge that they generated from the subjects of Planning for Social Intervention and Social Intervention Techniques, favouring the professional training of students, by carrying out a professional intervention based on real problems and/or needs, demanded by the participating families in the walkway located in the colonia 27 de septiembre, also allowing in the process of execution the application of social intervention techniques, to promote integration, participation and development of significant learning with the aim of improving the living conditions of the participants.

## Methodology

The methodology used was Participatory Action Research (PAR) or also called Action Research (AR), which, according to Zapata, Florencia and Rondán, Vidal (2016) refers to a set of currents and approaches to research that have in common three pillars:

- I. Research: belief in the value and power of knowledge and respect for its different expressions and ways of producing it;
- II. Participation: emphasising democratic values and the right of people to control their own situations and stressing the importance of a horizontal relationship between researchers and the members of a community; and
- III. Action: as the pursuit of change that improves the situation of the community involved (Greenwood and Levin, 1998).

Therefore, the methodological process begins with a diagnosis that allowed us to evaluate the health needs of the people who attend various physical activities on the walkway of Colonia 27 de septiembre in the city of Poza Rica, Veracruz, with which the social intervention was carried out.

With respect to the techniques used for data collection and to be able to carry out the diagnosis, the techniques of observation and interview were used; the latter carried out with a questionnaire applied to the members of the families separately, with the couple or with all the members of the family depending on whether they attended the walker.

## Diagnostic results

The results of the diagnosis indicated that the age of those attending the walker is between 45 and 71 years, so it is adults and elderly people who show greater interest in the development of some kind of physical activity to promote mobility and prevent diseases that are accelerated or are caused by sedentary lifestyles, for the elderly physical activity is much more important, since their autonomy and independence depends largely on it.

Of the participants, 91% of them go to exercise for physical health, the main activities being walking and jogging, since the main benefits of walking or jogging are, among others, the reduction of the risks of hypertension, diabetes, cholesterol and heart diseases, walking helps the body to burn calories and therefore can be an ally for weight loss. On the other hand, 50% of the participants stated that they suffer from some chronic illness, so doing physical activities not only helps them to burn calories, but also helps them to maintain a series of variables that allow the body to function optimally, benefiting their physical and mental health. Finally, 90% of the attendees expressed interest in conferences, talks that would motivate them to develop actions beneficial to their health, as well as height and weight controls and activities for the family.

Subsequently, the results of the diagnosis led to the development of a project called Professional Intervention of Social Work with families in the Metropolitan Area of Poza Rica (ZMPR), which was carried out with people who attend the 27 September walkway with the aim of contributing to the integration of families through socio-educational activities, as well as promoting the professional training of Social Work students through the promotion of health to families and the general population, to develop skills and attitudes that favour the social intervention of students through activities that encourage the promotion of health, such as:

Socio-educational activities: Family meetings through recreational activities to promote family integration through playful, educational and recreational activities supporting human rights.

- Promotion of sport.
- Conference on Self-esteem.
- Conference: Stress management.
- Conference: Healthy eating habits.

### Results of the intervention

The development of the Project "Professional Intervention of Social Work with families in the Metropolitan Area of Poza Rica (ZMPR)", carried out in the colonia 27 de septiembre generated the participation of 6 students, 8 teachers of the faculty of Social Work, 3 external guests and 3 invited experts in health issues.

As well as 5 members of the patronage of the andador 27 de septiembre of the city of Poza Rica Veracruz during the period of one year, from January 2022 to January 2023.

Socio-educational activities were carried out within the framework of the intervention with families, children, young people, adults and older adults, which favoured family integration and healthy coexistence, as well as the strengthening of values and the development of physical activities that promote health, with the participation of 150 people who took part in the various activities developed, such as: lottery, strengthening of values through games, elaboration of manual activities and physical activation and family integration dynamics. The development of physical and sporting activities was also promoted, encouraging self-care and health.

In order to promote the health of the people participating in the walker and families in the communities of the metropolitan area, a series of conferences were held to promote health. The first conference entitled "Self-esteem" was given by personnel from the Sanitary Jurisdiction No. 3 of the city of Poza Rica. 3 of the city of Poza Rica, Veracruz, by personnel from the Violence Prevention Module, with the participation of 35 people from the "andador", students, academics and guests who developed integration dynamics that allow self-reflection and contribute to the improvement of self-esteem. This enabled them to express actions to improve their own self-perception and their relationship with their families and loved ones who live close to them on a daily basis. It also encouraged a better relationship between those attending the walker and a greater knowledge of their interests and motivations, leading to a better inter-retro-relationship with others to the benefit of the dynamics of the walker.

The conference "Stress management" was held in conjunction with an expert from the psychology department of the Health Jurisdiction Number III, with the participation of 35 people from the walker, students, academics and guests; with the aim of preventing and controlling stress, which can reduce the risk of other medical problems such as heart disease, obesity, high blood pressure and depression, favouring the mental health of families.

The development of the activity was favourable and relaxation and breathing exercises were developed as strategies for the proper management of stress.

Afterwards, a conference was held on the subject of "Healthy eating habits" by a doctor and nutritionist from the National Polytechnic Institute, with the participation of 40 people from the walker, students, academics and guests, allowing them to share information on a complete nutrition that favours feeling healthy and with more energy, There was a very enthusiastic participation through comments to reinforce the theme and questions on the subject of nutrition, eating habits and the importance of proper nutrition in the quality of life of the attendees and their families.

Finally, the project led to the following learning outcomes for the students:

1. To establish contact with practising social workers and learn about the strategies they develop to deal with the different problems presented by the population, enabling them to assess scenarios in the field of professional intervention, in which they can develop their work.
2. Identify possible research topics for future thesis work.
3. To value the importance of the promotion of integral health in the different stages of life.
4. Apply professional intervention techniques.
5. To design and participate in the implementation of a professional intervention project.

As a result of the work carried out, the participating students were able to link the theory and methodology of social project planning, as well as the application of social intervention techniques that responded to the specific problems and needs of the participants, as well as those of their families.

In the educational experience Techniques for Social Intervention: students developed the skills of observing real situations, conducting collaborative processes, exercising leadership with social actors and applying techniques for working with groups, as well as strengthening theoretical knowledge on the proper use of techniques, group work, leadership applied to real situations and attention to specific problems of a sector of the population.

In the educational experience Planning for social intervention: they developed the skills of selecting a problem or real need for the design of a project, drawing up a social project and investigating and analysing the causes and effects of the social problems in which they intervene on the basis of a specific reality. In terms of theoretical knowledge, the project made it possible to establish the structure of a social project at the community level and to develop instruments for planning social actions, determining objectives and strategies for professional intervention, which enabled the participating students to design an intervention project on a problem identified in a community environment based on the methodology of social planning and to participate in the implementation process.

### Conclusions

Clearly explain the results obtained and the possibilities for improvement.

From a critical point of view, social workers can intervene in the social sphere to enable the exercise of a socio-educational action contributing to the consolidation of an active citizenship, in relation to health awareness and family integration.

The development of the Project of Professional Intervention of Social Work with families in the Metropolitan Area of Poza Rica (ZMPR) allowed us to establish the following conclusions:

1. The importance of Social Work with families is considered fundamental, as this is a process of social intervention aimed at the individual, family and social dimension of the person in order to achieve better relational and social functioning, as stated by Richard Jolly (2005), who states that: "...families represent much more than mutual care and support. For many of us it is the space in which we realise our most profound human experiences. Intimacy and passion, identity and individuality, connection to the past and belief about the future, all derive from that small nexus. Because the deepest human feelings have their source in the family...", so the Professional Intervention with families through various techniques that allow us to explore feelings, experiences, reinforce behaviours, etc., in order to promote, stimulate and encourage well-being, in this case starting from family integration and promoting health.
2. The professional training of Social Work students was promoted through the development of professional competencies in social intervention in response to a real and high-impact problem, through the interaction of practising social workers, teaching staff and experts, who promoted integral health in the families of the walker.
3. The development of skills and attitudes for social intervention of the students was strengthened.
4. Promotion of collaborative work and awareness-raising among students in relation to this social problem.
5. Management processes were generated, and institutional linkage with the Sanitary Jurisdiction No. III of the city of Poza Rica.
6. The impact of the project made it possible to establish future proposals for intervention with this sector of the population through the continuity of activities with the families who attend the 27 September walkway.

### Proposals for improvement

- Elaborate a social intervention project with the older adults who attend the andador based on the needs detected.
- Integrate a multidisciplinary team of advisors to promote a culture of integral health promotion in families.
- To manage governmental resources and the participation of organisations related to the subject in order to give continuity to the integral actions.
- Create an integral health promotion group in various public spaces in the city.

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## Changes in control of supplies, production processes and advertising of Acámbaro companies; Gto. derived from the pandemic

### Cambios en control de suministros, procesos productivos y publicidad de las empresas de Acámbaro; Gto. derivado de la pandemia

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#### Abstract

Changes are undoubtedly part of our environment, thus, the COVID 19 pandemic marked a milestone in terms of the way in which companies in the productive sector raise and execute their activities. This article shows how the productive sector has reacted to the new needs that have arisen, as well as the strategies implemented and the acceptance of new methodologies and actions to continue subsisting. With the information presented, it is possible to make conjectures and estimates regarding the changes that are currently used by most companies and that allows them to remain in the competitive market, in addition, the various aspects mainly considered and their comparison of implementation both in the field of supplies, production and advertising are appreciated.

**Companies, Supplies, Production, Advertising, Strategy, Changes, Pandemic, Methodologies**

#### Resumen

Los cambios son parte indudable de nuestro entorno, siendo así, la pandemia de la COVID 19 marcó un hito en cuanto a la manera en que las empresas del sector productivo plantean y ejecutan sus actividades. El presente artículo, muestra cómo el sector productivo ha reaccionado ante las nuevas necesidades que se han suscitado, así como las estrategias implementadas y la aceptación de nuevas metodologías y acciones para continuar subsistiendo. Con la información presentada, es posible realizar conjeturas y estimaciones referente a los cambios que son actualmente utilizados por la mayoría de las empresas y que les permite mantenerse en el mercado competitivo; además, se aprecian los diversos aspectos principalmente considerados y su comparativa de implementación tanto en el ámbito de suministros, producción y publicidad.

**Empresas, Suministros, Producción, Publicidad, Estrategias, Cambios, Pandemia, Metodologías**

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## Introduction

Constant changes are part of everyday life, so the need to make periodic adjustments is evident, in order to remain at the forefront in any aspect in which one is immersed. The COVID 19 pandemic marks a before and after, it will now be a reference due to the great impact it had on the way in which the routine activities of each individual are carried out, and, focusing on the context of the productive sector, companies were forced to break schemes and establish new paradigms in order to be able to react to the mismatch of habitual activities with those that previously operated.

Fortunately, the perception of returning to the "normality" that existed prior to the pandemic seems to be getting closer, and that moment has arrived; however, it will be a priority as part of the evolution, to adopt all the advantages and new activities developed during the period in which most of our actions were modified; that is, to continue to take advantage of the technological advantages, adaptations in communication links, the way of interacting, the way of developing, among others; each person will depend on the willingness to implement the positive effects generated by the pandemic.

## Objectives

- To determine the changes that occurred in the control of supplies in companies in Acámbaro, Gto. as a result of the pandemic.
- To identify the modifications made by the companies in Acámbaro, Gto. as a result of the pandemic in the acquisition of raw materials.
- To establish the modifications that were made in the companies of Acámbaro, Gto. as a result of the pandemic in the production processes.
- To show the changes that took place in advertising in the companies of Acámbaro, Gto. as a result of the pandemic.

## Problem statement

COVID-19 made everyone feel the need to make changes, both in everyday life and in business life; it is therefore necessary to know what changes were made by the companies in Acámbaro, Gto. in terms of supply control, production processes and advertising.

The perception of the changes brought about by the pandemic can be very diverse, so in order to establish reliable parameters that explicitly show the adjustments made in the areas of interest mentioned, it is essential to obtain reliable information that clearly shows the impact on the business sector in Acámbaro, Gto. It is necessary to know the impact of the changes generated and implemented in the companies, and thus to know the actions carried out that contribute and helped the sector to survive, in spite of the changing conditions that have occurred and that are still constantly arising.

## Theoretical framework

In the INEGI website (2020), they mention that Acámbaro; Guanajuato has a population of 108 697 inhabitants, also in the same page; but in the section of economic units, they state that to date there are 6067 economic units considering this term as establishments (from a small shop to a big factory) settled in a place permanently and delimited by constructions and fixed installations, in addition in these places the production and/or commercialisation of goods and/or services is carried out (Cuéntame de México, 2021)

In 2020, economic units as well as the entire country were affected by COVID-19, defining the term as the most recently discovered infectious disease caused by the coronavirus (Secretaría de Salud Gobierno de Baja California Sur, 2022) and due to that disease, on 26 March, non-essential activities determined and adhering to federal government strategies were suspended, except for those related to security, health, energy and cleaning services (National Library of Medicine, 2020). Similarly, Harapko (2021) mentions that the COVID-19 pandemic has posed significant challenges to supply chains around the world. Multiple national closures continue to slow or even temporarily halt the flow of raw materials and finished products, disrupting manufacturing.

Also the Food and Agriculture Organization of the United Nations (2022) explains that at the onset of the crisis, food supply chains collapsed, as many countries had imposed restrictions on the cross-border and intra-country movement of goods and people; Alicke, Ed, & Trautwein (2022), on the other hand, reported that in their survey conducted in the second quarter of 2021, they found that companies originally planned to increase nearby offshoring of suppliers to boost supply chain resilience, but ended up increasing their inventories;

In addition, the majority of respondents mention that they have invested in supply chain technologies since 2020 and plan to continue to do so. In parallel, Corporate Transaction Banking (2021) mentions that due to the pandemic and the resulting health crisis, the supply chains of all companies in different sectors have been impacted to a greater or lesser extent depending on their robustness and that, In addition to the above, in 2021, American Express provides that the supply chain in Mexico and the world has been affected by the health crisis caused by COVID-19, which changed the rules of the game for most of the world's markets from one moment to the next. It must now prepare to face the challenges of the "new normal"; however, Sánchez Suárez, Pérez Castañeira, Sangroni Laguardia, & Medina Nogueira (2021) contribute that the Covid-19 pandemic not only impacted process changes, but has been the great accelerator of digital transformation, and the adoption of innovative technologies and processes.

On the other hand, the market will never be the same again, let alone the way of conquering customers [...] consequently every day we live a new scenario; where companies that handled traditional marketing (advertising) are already adapting to the new scenario, as physical shops are exploring social networks and transfiguring their business model (Labrador, Suárez, & Suárez, 2020); therefore the factors that influence decisions about brands are also changing as the trend to "buy locally" accelerates.

Digital commerce has also experienced a boost as new consumers migrate online to do their grocery shopping, an increase that is likely to continue post-crisis (Accenture, 2020), parallel to the above Nielsen (2020), mentions that our global media ecosystem has encountered a serious and unprecedented threat: marketers have reduced advertising investment due to both the economic impact of the COVID-19 pandemic, furthermore the pandemic led advertisers to cut marketing budgets, deprived sellers of advertising space, such as cinemas, of audiences, and put advertisers out of work (El Economista, 2020).

## Description of the Method

### Methodology to be developed

A quantitative research with a descriptive scope was carried out in Acámbaro, Guanajuato, collecting information on the changes generated in the control of supplies, in the production processes and in the advertising of the companies in this municipality, derived from the COVID 19 pandemic.

The starting point of the methodology was the identification of the problem; consecutively, the structure of a theoretical framework was made; the problem to be solved was posed, and from this, four hypotheses were established, which were duly verified through the research; a probabilistic sample was taken in order to study it, and consequently obtain the results of the research. The information collected was carried out in the city of Acámbaro, Gto., in small and medium-sized companies, with commercial activities, administrative and financial activities, among others, oriented to the changes that took place due to the COVID 19 pandemic, in the control of supplies, in the productive processes and in the publicity of the companies in this municipality.

### Research questions

- What changes occurred in the control of supplies in companies in Acámbaro, Gto. as a result of the pandemic?
- How did the enterprises of Acámbaro, Gto. modify the acquisition of raw materials as a result of the pandemic?
- How did businesses in Acámbaro, Gto. change their production processes as a result of the pandemic?

- What changes were there in advertising in the companies of Acámbaro, Gto. as a result of the pandemic?

### Hypothesis

Ho. The use of computers and the requisitioning of fewer workers are the changes that occurred in the control of supplies in the companies of Acámbaro, Gto. as a result of the pandemic.

H<sub>1</sub>. No computer use and increased worker requisitioning are pandemic-related changes in supply control in firms in Acámbaro, Gto.

Ho. Increase in the quantity of raw material purchases and change of suppliers due to changes in the product/service, are some of the changes that the companies of Acámbaro, Gto. had derived from the pandemic in the acquisition of raw materials.

H<sub>1</sub>. Decrease in the quantity of raw material and no change of suppliers because the same product/service was maintained, are some of the changes that the companies of Acámbaro, Gto. had derived from the pandemic in the acquisition of raw material.

Ho. Processes were reduced due to worker infections and the product/service process was modified, these are some of the modifications that the companies in Acámbaro, Gto. made as a result of the pandemic in the production processes.

H<sub>1</sub>. Processes were not reduced due to worker infections and the product/service process was not modified, these are some of the modifications that the companies in Acámbaro, Gto. carried out as a result of the pandemic in the production processes.

Ho. Use of social networks and updating of the website, are the changes in advertising in the companies of Acámbaro, Gto. as a result of the pandemic.

H<sub>1</sub>. Use of printed media and radio spots, are the changes that occurred in advertising in the companies of Acámbaro; Gto. as a result of the pandemic.

### Justification

We are aware of the inherent changes that are part of life, however, sometimes events out of the ordinary occur, such as the COVID-19 pandemic, and for which neither a procedure nor prior knowledge of how to behave was foreseen or established. For this reason, it is convenient to carry out the study described above, because there is no prior knowledge of the effects that arose from the pandemic in the companies of Acámbaro, Gto.

The changes, adjustments and adaptations made during the pandemic were implemented hastily, with a sense of urgency and without space for prior testing or impact analysis, which led to decisions being made in haste and with considerable room for error, a reason that becomes the focus of analysis and social relevance, as the aim is to identify the significance of the results generated by the pandemic, in order to make them known to the general population.

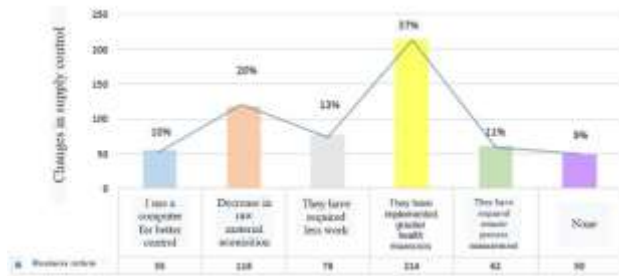
For several companies, the changes implemented allowed them to survive and even helped them to position themselves in a better way, and, on the contrary, many others were victims of the restrictions that were established, unfortunately leading to their demise. In this article, they analyse various actions that were taken in the companies that continue to survive, which indicates that they were the right decisions to allow them to continue in a market as competitive as the business market. For all these reasons, the research fills a gap in knowledge through a methodology established from the beginning of the research, which contributes to the analysis of this social phenomenon that generated multiple impacts and changes, with an important theoretical value.

### Working method

Analysis of quantitative results with descriptive scope

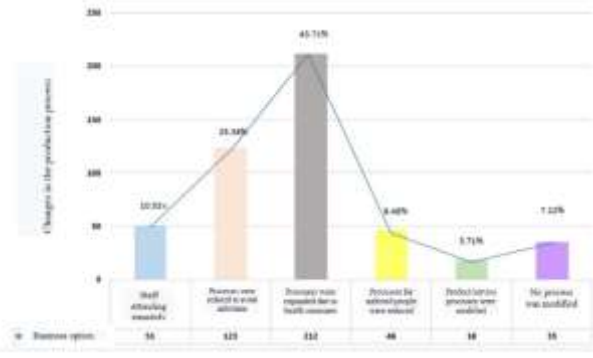
The analysis of results was carried out using the DYANE (Design and Analysis of Surveys) programme, which is an integral computer programme for PC or compatible, carried out in a Windows environment (Santesmases, n.d.), where a database was integrated, which was able to produce graphs expressed by means of basic descriptive statistics.

**Results of the analysis**



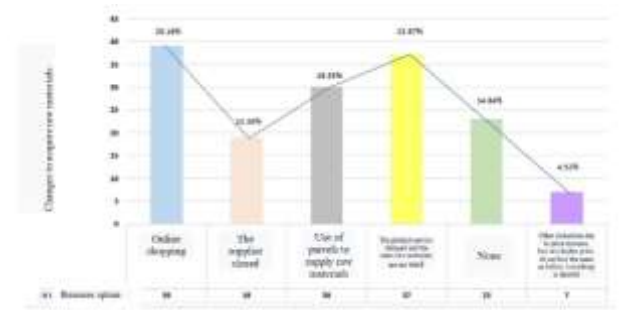
**Graph 1** Changes in supply control

In graph 1, it can be seen that the companies in Acámbaro, Gto. have undergone several changes due to the pandemic, where 37% say that they have implemented more sanitary measures, while 20% explain that they have reduced the acquisition of raw materials, however, 13% have required fewer workers, on the other hand, 11% say that they have required remote process management, and 10% say that they have made use of computers for better control, finally, 9% say that they have not made any changes at all..



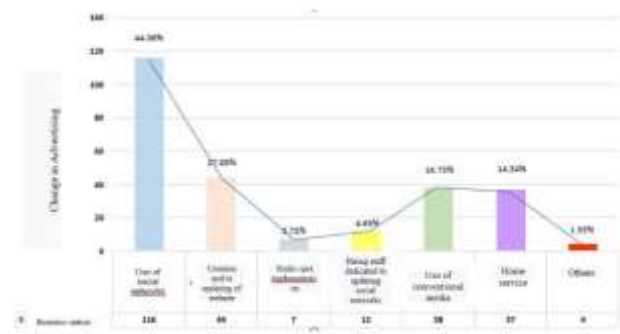
**Graph 3** Changes in the production process

Graph 3 shows the trend in the changes made by the companies in Acámbaro, Gto, 43.71% mentioned that they expanded their processes due to sanitary measures, 25.36% said that they reduced processes to avoid contagion, 10.52% said that they changed personnel to work remotely, 9.48% mentioned that they reduced processes due to infected people, and 7.22% explained that no process was modified; finally, 3.71% said that they modified product/service processes, and 3.71% said that they modified the processes of the product/service, and 7.22% said that they modified the processes of the product/service..



**Graph 2** Changes in the way of acquiring raw materials

Graph 2 shows the trend in the responses of the entrepreneurs in Acámbaro, Gto, regarding the changes they have made as a result of the pandemic in the way they acquire raw materials, where 25.16% said that they now buy online, while 23.87% explained that they changed the product/service, which is why they do not use the same raw materials, and 19.35% now use parcels to supply their raw materials. 35% now make use of parcels to supply their raw material, however 14.84% responded that they have not made any change, on the other hand 12.26% mentioned that the supplier closed down, and the remaining 4.52% expressed that for other reasons they changed, among them price increase, because they buy more quantity, as well as they do not buy the same as before and that now a good amount of operations are at a distance.



**Graph 4** Changes in advertising

Graph 4 shows the changes made by companies in Acámbaro, Gto, In the graph 4, we can see the changes made by the companies in advertising derived from the pandemic, where 44.96% now make use of social networks, on the other hand 17.05% mention that they have created and/or updated their web page; likewise 14.73% make use of conventional media (flyers, newspapers, printed matter, perifoneo); on the other hand 14.34% now implement advertising through their home delivery service, in the same way, 4.65% mentioned they had to hire staff dedicated to updating social networks.

On the other hand 2.72% said they have implemented radio spots, finally 1.55% have implemented other strategies such as avoiding contact with customers, as they are looking for potential customers through sales, i.e. through salespeople they use and take advantage of advertising.

## Discussion

Regarding the changes that have taken place in the control of supplies, they now make use of the computer, they have also required fewer workers, however, within the control of supplies they have implemented sanitary measures to prevent contagion; they have also reduced the purchase of raw materials; in addition to this, the changes they have had to acquire raw materials are directly related to the mandatory change they had to make to their products/services; As a result, they do not use the same raw materials; in addition, with the use of computers, they are now purchasing raw materials via the internet and the use of parcels to supply them has increased; it is worth mentioning that some companies were affected because their suppliers closed down, which shows how difficult the pandemic was for some companies.

On the other hand, production processes were greatly affected because some processes were extended due to the COVID-19 health contingency, and on the other hand, in other companies it was necessary for staff to work remotely and thus reduce processes, which shows the impact on the production of their products/services.

Finally, the companies changed the way of advertising, now resorting to the use of social networks, in addition to hiring a person specifically to fulfil the function of updating social networks, as well as creating and updating their website; this covers more than 50% of the organisations that made changes in the way of advertising with technological tools.

## Conclusions

Based on the results, it is possible to determine that the productive sector had changes in the way it previously operated; some companies to a lesser extent and others with a significant impact, in which they had to forcefully adapt in order to be able to continue and not disappear in the face of the imminent effects generated by the pandemic. Similarly, what can be appreciated considerably is the fact of having implemented strategies to safeguard people's integrity, which establishes health and communicative interaction between individuals that make up a society as a priority, by means of new forms of communication, taking advantage of those currently provided by technology. Finally, there is no doubt about the importance of technology nowadays, and thanks to which it is possible to use it and adapt it to changing circumstances for favourable purposes.

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## AST for the Development of Professional Competencies in Software Engineering

### AST para el Desarrollo de Competencias Profesionales en Ingeniería de Software

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#### Abstract

This work shows the results of the implementation of the Work Situational Analysis, focused on the Computer Engineering Educational Programs of the University of Guadalajara, specifically on the competencies of the Software Engineering learning unit. The main objective is to identify the professional and transversal competences that, according to the industry, the graduates of these programs must comply; as well as to identify to what extent work is being done academically to achieve these competencies. It was found that it is necessary to update the Software Engineering program through collegiate work in order to establish strategies to achieve the development of personal skills and attitudes that, according to industry participants, these skills are as important as the professionals skills.

**Competences, Abilities, Job situation analysis**

#### Resumen

Este trabajo muestra los resultados de la implementación del Análisis Situacional del Trabajo, enfocado en los Programas Educativos de Ingeniería Informática e Ingeniería en Computación de la Universidad de Guadalajara, específicamente en las competencias de la unidad de aprendizaje denominada Ingeniería de Software. El principal objetivo es identificar las competencias profesionales y transversales que de acuerdo con la industria deben cumplir los egresados de estos programas; así como identificar en qué medida se está trabajando académicamente para lograr estas competencias. Se encontró que es necesario actualizar el programa de Ingeniería de Software mediante trabajo colegiado con el fin de establecer las estrategias para lograr el desarrollo de habilidades y actitudes personales que, de acuerdo con los participantes de la industria, estas habilidades son tan importantes como las habilidades profesionales.

**Competencias, Habilidades, Análisis situacional del trabajo**

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## Introduction

According to the Alliance for Training and Research in Infrastructure for the Development of Mexico (2018), sufficient and highly trained professional profiles are required for the demand of the productive sector in engineering disciplines related to Information and Communication Technologies (ICT). Due to the growing and constant technological advancement, as well as the high consumption of products that require efficient software for the increasingly demanded smart devices, there has long been a need to develop in the graduates of ICT areas, indispensable professional skills to face the technological evolution that we live today. However, in spite of the imperative need for graduates in the areas of systems development to have competencies in accordance with the requirements of the different productive sectors, in our country, there is still a significant lack of ICT professional profiles that fully comply with the competencies that solve this problem.

Most employers in Mexico warn about the lack of skills that graduates in this sector have and consider that their training is not sufficient for current labor needs (Gutiérrez Diez et al., 2020). Organizations and business leaders in the IT areas indicate that since 2021, hiring in this field has decreased, not because of a lack of jobs, but because of a lack of specialized talent, since there were a large number of positions available, but few profiles with the competencies required by the industry<sup>1</sup>.

Some experts predict that in 2023, these problems will increase, since in a study they found that, in addition to a certain level of experience required by employers, 34% of them said that candidates do not meet the technical skills; while 27% point out the lack of soft skills<sup>2</sup>. Although the problem, is the development of competencies in general, particularly soft skills (*soft skills* in English), result in an object of study with great areas of opportunity for researchers, since the integration of soft skills into the Educational Programs (EP) in higher education is not simple, especially in engineering areas (Schipper & van der Stappen, 2018).

It has been identified that students in STEM (*Science, Technology, Engineering and Math*) areas, excel in technical skills and ability to solve problems autonomously and individually, however, their interpersonal skills are limited, which makes it difficult to achieve collaborative learning compared to students in other areas (Seat et al., 2001).

There are multiple publications that show the lack of soft skills, for example, in Schipper and van der Stappen (2018) the students themselves accept that it is important to develop logical thinking and problem solving, but they do not consider important the skills of writing or debating. Another study shows the perception of engineering students in relation to the soft skills they have acquired (Neri Torres & Hernández Herrera, 2019), and concludes that these are not covered and should be reinforced since there is a lack of social and emotional skills mainly, in addition to problem solving, communication, efficient information processing and creativity are deficient in most cases. This seems to be a global problem, since the first study was done with Dutch students, while the second one is focused on Mexican students.

Probably the lack of soft skills is the design of PE that focus on the knowledge and technical or professional skills of students, without taking into account other types of skills (Boyatzis et al., 2017), training engineers as individual professionals, when the real world requires them to work in multidisciplinary teams and in multicultural contexts.

That is why Higher Education Institutions (HEIs) must identify strategies that contribute to the development of competencies demanded by the industry. It is necessary to find the combination between technical and soft competencies for the adequate development of ICT practice, which can only be achieved with the contribution in the design of the PE, of those who finally evaluate whether these competencies have been fulfilled or not: the employers.

This can only be achieved with the input of those who finally evaluate whether these competencies have been fulfilled or not: the employers.

<sup>1</sup><https://www.eleconomista.com.mx/capitalhumano/Mucho-empleo-y-poco-talento-especializado-el-dilema-del-sector-tecnologico-en-2022-20220127-0106.html>

<sup>2</sup> <https://infochannel.info/se-recrudecera-falta-talento-ti-2023-expertis/#:~:text=Un%20estudio%20de%20la%20firma,carec%C3%ADan%20de%20habilidades%20blandas%20adecuadas>

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It is also important to maintain a constant review of the PE, particularly those related to technology, due to the speed at which it evolves. In this sense, the University of Guadalajara has managed excellent links with the business sector for the creation of the Computer Engineering and Computer Engineering PEs. For their design, Technical Councils were created with the participation of members of the National Chamber of the Electronics, Telecommunications and Information Technology Industry (CANIETI), where programs have been implemented in conjunction with the government and the private sector, with the objective of positioning and generating a high volume of human capital, which is expected to meet the standards required by the global economy, which will allow Mexico to position itself as a reference for the world.

In this context, the Academic Body in Formation (CAEF) UDG-CA-991 "Development of Professional Competences" from the Research Line "Educational Technology in Computer Science", we started with a project to determine the needs of the productive sector with respect to the graduate profile related to software development and the areas of opportunity in the training process of students and graduates of the PE Computer Engineering and Computer Engineering of the University Center of Exact Sciences and Engineering (CUCEI) of the University of Guadalajara.

The project is to contribute to the strengthening of the graduate profile in the area of software development, through the design and implementation of a virtual tutor, thus meeting the demand that the industry requires in the profiles of software development.

## Methodology

The research is developed through a descriptive method by analyzing the employers' points of view to later contrast them with the competencies proposed in the Software Engineering Learning Unit.

The work began in the first semester of the year 2020 with the selection of the methodology for the application of collection instruments that would allow gathering information about the current needs of the competencies required by the industry in the area of software development.

The work began in the first semester of 2020 with the selection of the methodology for the application of collection instruments that would allow gathering information about the current needs of the competencies required by the industry in the area of software development. The CA determined that the Situational Analysis of Work (AST) represents an excellent alternative to know the requirements on competencies that employers are interested in. This method has been implemented by different institutions in order to create, verify relevance and modify their academic<sup>3</sup> programs by identifying the competencies that their students should develop (González Velázquez et al., 2012; González Henández, 2016; Gómez-González et al., 2018, Gutiérrez Muñoz, 2019).

The AST is a method to obtain the maximum information by consensus and thus detect the cognitive, technical, psychomotor and socio-affective skills that allow the execution of productive functions under performance standards (Manjarrez & Bernal, 2020) and thus the graduates of the PE are inserted into the professional labor environment with less difficulty, solving the problems that have the market leaders in their field.

The AST generates information about a specific job position and its productive functions (Ocampo Casados & Martínez Gámez, 2015) and is carried out through a workshop with professionals from the business sector and academics in the area to be analyzed. The AST or IXE method is referred to in the curricula based on labor competencies of the Quebec Ministry of Education (Canada, 1992) and is also based on the guidelines established by the European Higher Education Area for the detection of labor competencies (De Miguel Díaz et al., 2006).

<sup>3</sup>[http://www.utguaymas.edu.mx/utg/es/noticias/events/resources/20190611/4.2%20UT\\_Guaymas\\_I-MT\\_2019.pdf](http://www.utguaymas.edu.mx/utg/es/noticias/events/resources/20190611/4.2%20UT_Guaymas_I-MT_2019.pdf)

Although the AST determines the professional competencies of the graduate of a PE, the CA decided to use it to identify the specific competencies of the Software Developer since it is the object of study of the project, and it is one of the areas in which the graduates of both Computer Engineering and Computer Engineering can perform in their professional practice. Subsequently, the CA will make proposals to the Academy for the modifications of the Software Engineering UA.

**Development**

The AST workshop was held on February 8, 2020, with the participation of the following roles:

- The CA responsible, who acted as the workshop coordinator, supervising that the participants had the necessary equipment and materials; guiding the dynamics among the participants, and applying the collection instruments.
- The members of the CA who guided and clarified the doubts that arose within the work teams of the software development professionals.
- The software development professionals who provided the competencies to be developed by the graduates who will work in this area. In total there were 15 professionals, including 4 graduates from the University of Guadalajara.
- The secretary who was in charge of integrating the information obtained by each of the work teams for their subsequent validation.

At the beginning the coordinator presented to the participants the background that gave rise to the workshop, the CA project and the value chain shown in Table 1, which corresponds to the results from the detection of professional competencies. The first column shows the different areas that will benefit from this workshop, while the second column explains the benefits to be achieved in each of these areas.

Beneficiaries	Benefit
Disciplinary areas of software development	Identification of the characteristics of the graduate profile demanded by the productive sector, solving the problems faced by software development through a curricular updating proposal.
Universidad de Guadalajara	To offer an alternative that improves the formative process of the students of the Software Engineering program, of the different Centers that conform the University Network To have a proposal to standardize the learning process of these students.
Region	Contribute to generate conditions through the training process, for a better integration of graduates in the productive processes. Considering that Jalisco is the capital of innovation and the settlement of the most important national and international companies.
Others	The software industry will rely on quality professional profiles that meet the current challenges and needs. This impacts practically any area.

**Table 1** Value chain of professional competencies

Subsequently, the dynamics of the workshop and the instruments that were applied in each of the work teams were presented. The first work instrument is presented in Table 2, which corresponds to the matrix of functions and sub-functions required to be performed by graduates in the software development area. This matrix was subsequently filled in according to the criteria of the professionals. In the table should be written the functions that software development professionals carry out, as well as the functions that are tasks that allow the function to be carried out.

Functions	Subfunctions			
1.0	1.1	1.2	1.3	1.4
2.0	2.1	2.2	2.3	

**Table 2** Functions and sub-functions in software development

Other instruments used were the tables of transversal competencies, which were designed and used by the General Coordination of Technological and Polytechnic Universities to determine the professional profiles of its academic offerings. Table 3 shows the competencies most valued by employers, according to said Coordination.

Competition	Competition
Analytical skills	Synthesis capacity
Planning capacity	Organizational capacity
Ability to communicate correctly orally and in writing in Spanish	Ability to communicate correctly orally and in writing in another language, which:
Information management capacity	Problem solving
Working in international contexts	Teamwork
Critical reasoning	Ability to relate interpersonally
Ethical commitment	Self-confidence
Autonomy	Adaptation to the environment
Creativity and Innovation	Entrepreneurial spirit
Initiative	Environmental environment
Motivation for quality	Empathy
Vision	Other, Specify:

**Table 3** Most valued transversal competencies

At the beginning, the coordinator presented to the participants the background that gave rise to the workshop, the CA project and the value chain shown in Table 1, which corresponds to the results from the detection of professional competencies. The first column shows the different areas that will benefit from this workshop, while the second column explains the benefits to be achieved in each of these areas.

		A	M	B
Affective	Punctuality			
	Honesty			
	Ethics			
	Responsibility			
	Judgment			
	Identification of values			
	Motivation			
	Patience			
	Initiative			
	Empathy			
		A	M	B
Psychological	Personal mastery			
	Correct use of language			
	Ability to withstand pressure			
	Inductive reasoning			
	Deductive reasoning			
	Hypothetical reasoning			
	Analogical reasoning			
	Holistic attitude			
	Linear attitude			
	Sense of planning			

**Table 4** Personal qualities

Another of the instruments used in the workshop is presented in Table 5, which shows the personal skills that graduates must have in their professional work.

The last three columns indicate the level at which these skills are required High (A), Medium (M) or Low (B).

	A	M	B
Leadership			
Decision making			
Speed of execution			
Manual dexterity			
Teamwork			
Conflict management			
Autonomy			
Innovation			
Promotion of values			
Communicating well			
Self-training			

**Table 5** Personal skills

The workshop participants asked questions about filling out the instruments, which were answered by the coordinator.

The software development professionals were organized into three teams of 5 members each. Each team exchanged their experiences and the shortcomings they identified in the graduates, which were identified in the graduates, at all times they were advised by members of the They were advised at all times by the members of the CA.

The work teams filled out the tables in a digital file, and then presented them to the workshop participants and discussed what was presented. The secretary integrated the three documents, eliminating coincidences or repetitions. Once the contributions of the three work teams had been integrated, the coordinator presented the integrated document for the approval of the participants. To conclude the workshop, the coordinator thanked each of the professionals for their attendance, leaving open the invitation to continue communicating and thus update the competencies required by the software development industry, at least every two years.

**Results**

The AST workshop identified four main functions that a software development professional performs, being the following:

1. Identify the needs of the direct and indirect users who use an information system or who will use it in case it does not exist in the organization.

2. Design, redesign or optimize information management systems that solve the problems of the company, organization, etc., meeting the needs of direct and indirect users.
3. Verify and validate the correct functionality of an information system.
4. Guide, supervise and train the members of multidisciplinary work teams that collaborate in the development of software.

For the fulfillment of the detected functions carried out by software developers, it is essential to describe the sub-functions or tasks; the final conclusions are presented below.

The sub-functions of function 1 are the following:

- Design collection instruments to be applied to direct and indirect users.
- Define the sample size for the application of the collection instruments.
- Synthesize and analyze the information obtained from the collection instruments.
- Define functional and non-functional requirements from the data analysis.

The sub-functions of function 2 are the following:

- Select the tools to be used for the development of the information system.
- Plan the activities of the software development process applying formal methodologies.
- Execute the planning, guiding the development team for its fulfillment in the fulfillment in the established times.

Regarding function 3, the following sub-functions were determined:

- Design and execute test cases that verify compliance with requirements.
- Identify inconsistencies obtained in the test cases.
- Correct the detected inconsistencies.

The sub-functions defined for function 4 are the following:

- Clearly define objectives.

- Identify and take advantage of the strengths of the team members.
- Enhance the capabilities of the team members through training processes.
- Make firm decisions when a conflict arises or planning is not fulfilled.

These functions and subfunctions coincide to a large extent with the competencies established in the Software Engineering AU, in which the three types of knowledge were determined: knowing, knowing how to do and knowing how to be. Table 6 shows the knowledge or skills expected to be achieved in this subject at the end of Software Engineering.

Knowledge	
1.	Identify different software development methodologies.
2.	Identify the characteristics of the main methodologies.
3.	Identify the feasibility process from a technical, economic and operational point of view, with which the aspects of success of a project are measured.
4.	Identify the process of gathering, classifying and prioritizing requirements based on the application domain.
5.	Identify the requirements documentation process based on a quality standard.
6.	Identify requirements validation techniques.
7.	Identify the fundamentals of Unified Modeling Language (UML).
8.	Identify the components of a use case (stakeholders, use case).
9.	Identify the components of a class diagram (class, attributes, methods, relationships).
10.	Identify the interaction of objects and actors of the use cases of the system.
11.	Identify the message passing between the different objects of the system.
12.	Identify the states of the system processes.
13.	Identify the elements of component, implementation, deployment, and activity diagrams.
14.	Identify the concept of software testing and the purpose of software testing.
15.	Identify the elements of a technical manual of an information system.
16.	Identify the installation plan and mechanism.
17.	Identify the elements of the installation manual of an information system.
18.	Knowledge and application of the principles, methodologies and life cycles of software engineering.
19.	Ability to analyze, design, build and maintain applications in a robust, secure and efficient way, choosing the most appropriate paradigm and programming languages.
20.	Knowledge, administration and maintenance of computer systems, services and applications.

**Table 6** Knowledge taken from the UA of Software Engineering. of Software

Table 7 lists the know-how, i.e., the skills that, according to the academy, Software Engineering students are expected to develop.

Know-how (skills)	
1.	To select the appropriate methodology for the development of the application.
2.	To carry out a feasibility study: technical, economic and operational.
3.	Obtain system requirements through the collection techniques.
4.	To elaborate a system requirements specification document using a quality standard.
5.	Check that the requirements are consistent, complete and that they correspond to the application domain.
6.	Elaborate use case diagrams.
7.	Elaborate the class diagram.
8.	To elaborate the sequence diagrams of the system.
9.	To elaborate the collaboration diagrams of the system.
10.	To elaborate the state diagrams of the system.
11.	Elaborate the component, implementation, deployment and activity diagrams.
12.	Design software test cases.
13.	Elaborate a technical manual of an information system.
14.	Elaborate an information system user manual.
15.	To elaborate an information system maintenance manual.
16.	Ability to identify and analyze problems and design, develop, implement, verify and document software solutions on the basis of an adequate knowledge of the current theories, models and techniques current theories, models and techniques.

**Table 7** Know-how (skills) taken from the Software Engineering AU

In this case it was found that these sixteen skills established by the academy do not coincide completely with the personal skills that were handled in the workshop instruments (Table 5), but rather tend to be professional skills or knowledge. The last of the knowledge is knowing how to be, which corresponds to the attitudes and values that the students of this AU are expected to develop. Table 9 shows below the relationship of this type of knowledge, which was established by the professors who are members of the academy to which this AU belongs.

Knowing how to be (attitudes and values)	
1.	Analytical
2.	Skilled in teamwork
3.	Disciplined
4.	Systematic
5.	Organized
6.	Proactive
7.	Ability to communicate orally and in writing.
8.	Generate collaborative work skills.
9.	Ability to solve problems with initiative, decision making, autonomy and creativity.
10.	Ability to communicate assertively and to transmit knowledge, skills and abilities.
11.	To foster an entrepreneurial spirit.

**Table 8** Knowing how to be (attitudes and values) taken from the Software Engineering AU

As can be seen, this table summarizes or synthesizes several of the skills and personal qualities presented in the instruments used in the workshop (Table 4 and Table 5). Table 9 shows the evaluation instruments and/or activities that were defined in the academy, in order to obtain a continuous and formative evaluation.

Type of evaluation
The evaluation of the course must be continuous and formative through the following activities:
Solution of practical cases requested during the activities, as well as their conclusions in written form.
Assignments.
Exhibition.
Class participation.
Project.
Theoretical or practical exams.
Co-evaluation for the deliverables of unit I, in the case of units II, III, IV and V will be evaluated only with the professor giving feedback of all the activities at the end of their evaluation.

**Table 9** Type of evaluation, taken from the Software Engineering AU

In this case, the Software Engineering academy was asked for the evidence of this AU from previous semesters, in order to review them and identify how personal qualities and skills are promoted and, if applicable, how they are evaluated. We found evidence of the Knowledge and Know-how indicated in the AU (Tables 6 and 7) such as assignments, projects, exams, among others. However, there is no evidence of how the Knowing how to be is involved in the learning activities and there is no evidence of evaluation of these skills. Table 10 shows the percentages that the Software Engineering Academy established for the different activities that students must comply with.

Evaluation
Learning Activities 50%.
Consists of evidence, product of class work, homework and activities; delivered in person or through electronic media according to the teacher's selection.
Partial Exams 40%.
Application of two exams during the course with a value of 20 points each, in which the aspects of Knowledge and Know-how described in the document will be evaluated, which may be applied in writing or through the support of a learning environment or virtual platform according to the teacher's selection.
Integrating Activity 10%.
Computer application that must be connected to a database stored in a SBGD, which must have the analysis documentation, architectural design, data model design, maintenance and testing manuals, maintenance and test manuals.

**Table 10** Evaluation Criteria (% per criterion), taken from the Software Engineering UA

It can be observed that in the item of partial exams it is clearly established that this activity, whose percentage is 40% of the total score, must evaluate the aspects of Knowing and Knowing How to Do. However, in no item it is directly stated how the Knowing how to be is evaluated.

## Conclusions

The contributions made by the guests at the Situational Analysis of Work workshop are extremely valuable, since they are the ones who are professionally leaders of information systems development teams for different fields. They are the ones who face technological progress every day and implement it in their developments.

To follow up on the project of the academic body, a workshop will be held with the professors that make up the Software Engineering academy, on the one hand, to inform them of the needs that the software development industry requires regarding our graduates. But, on the other hand, to discuss collegially, the results and findings obtained from this workshop. To raise that it is required to include in the academic activities strategies to develop and evaluate the Know-how of the students, since they are skills that the representatives of the companies consider as important as the professional skills.

The objective of the workshop will be to generate these strategies so that students can develop the required competencies and thus successfully enter the increasingly competitive labor market. To achieve this objective, it will be necessary to establish strategies that involve activities that foster competencies.

For the academic staff, the data collected in both workshops will be the requirements that will be included in the virtual tutor, so the different didactic resources will be sought and/or designed to develop the professional competencies in the students of the PE under study in the project.

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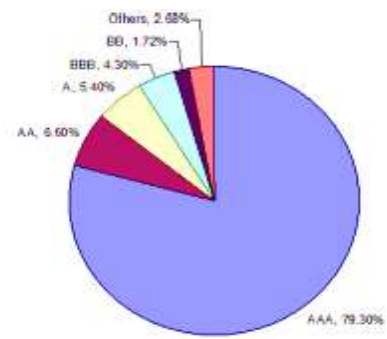
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CC	Borrower is highly vulnerable
C	Borrower may be in bankruptcy but is still paying its obligations
D	Borrower has defaulted on obligations and CRA believes that it will generally default on most or all obligations
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