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ENTERPRISE DIMENSION OF THE E-GOVERNMENT: BACKGROUND OF A GENETIC ALGORITHM TO COLLABORATE WITH LOCAL ECONOMIC DEVELOPMENT

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ABSTRACT

Intelligent computing has evolved in recent decades, which means that its application and growth in several sectors have proven results. In this sense, genetic algorithms are a clear application of this evolution, practical to everyday aspects of life. In this research, we discuss how to improve the decision making of government for economic development, through a genetic algorithm, which has the capacity to identify Micro Small Medium Enterprises (MSMEs) with potential for growth and economic development for one socioeconomic region at northwest of Mexico, and that through collaboration with the constant identification of internal and external variables that will guarantee the correct decision-making. Main results of proposed GA show are possible to identify percentage of success of Medium Enterprises (35%) very close to figures of official Government institutions like National Institute of Statistic and Geography - INEGI (34.6%).

Keywords: *Genetic Algorithms, Strategic, Decision making, Economic Development, Entrepreneurship*

1. PROBLEMATIC

Decision-making in local economic development around the world has experienced challenges, in which, although the creation of companies is not the only path of development, they represent a determining factor. In this sense, local governments require alternatives that allow them to identify internal and external variables that support the birth, growth, development and permanence of companies, but unfortunately a greater percentage 90% of them have the need to close or merge with others in less than 3 years of its appearance, with which the economic development of the region is diminished (INEGI, 2009). In addition, in the Latin American countries, the Total Entrepreneurial Activity Index (TEA) has an important effect on the Gross Domestic Product (GDP) and the Wealth Distribution Indicator (GINI), with correlations of up to 95% according to the indicators indicated from 2009 to 2013 (Vallejo-Trujillo, Hernández-Aguilar, Perez-Mayo, 20, P. 1256). Hence the importance of generating alternatives for government decision-making, which will satisfactorily increase the percentage of micro, small, and medium-sized enterprises that achieve their permanence in market. In this sense, through genetic algorithms it is intended to identify on one hand the internal and external variables that favor companies in their evolutionary stages, and on the other hand, an algorithm that determines the ideal conditions of the region where companies can be created with a certain degree of certainty, and from this, the government authorities take the decisions to encourage the creation of companies with the characteristics of the region and profile of the company suggested by the Genetic Algorithms. Therefore, the work is justified because it will contribute to the successful creation of MSMEs, with the objective of contributing to local and regional development, as well as serving as a source of information for the decision-making of entrepreneurs and interest groups.

2. RELATED WORK

The studies that precede this are two, the first of them discusses municipal public services, in which it was identified that the business line is poorly attended, and where only administrative

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processes are taken care of like opening of companies, attention of public services like lighting, drinking water, among others, but lacks of strategic vision to collaborate with the economic development [2].The second study is about intelligent computing applied in educational environments, it is relating to the present, with the application of genetic algorithms which made projections of students' academic performance by subject, school grade and group, in public schools of the basic level with the objective of providing information to teachers for the application of corrective measures to students with low academic performance and from both of them, the vision of applying these researches to the local public administration sector[3]

3. RESEARCH METHODOLOGIES

Given the characteristic of the research, the methodology of analysis and synthesis will be used, which will start from the identification and separation of the variables for their analysis, in order to identify their specific qualities and later unite the previously divided variables, to discover their relationships, characteristics and how they interact (synthesis). The causal method can also be used, which will consist in proposing a model that identifies the characteristics of the variables, establishing their relationships to obtain the causes and effects. Once the variables that will serve as input for the project are determined, concepts can be elaborated that will allow reframing alternatives for the improvement of the Genetic Algorithm, which, although this will carry out several executions before reaching the ideal, requires refinements (improvements) before having the final version. Finally, and given that the research will allow the appearance of ideas with the identification of inputs, algorithm design and improvement, the systemic method will be used, which based on these ideas, connection of concepts, and linked to models and strategies (created in the research) will allow to improve the research project in a constant and integral way [4], [5].

4. THEORETICAL FRAMEWORK

The theoretical framework is integrated by the concepts that facilitate the understanding of the topic of interest, which in this case focuses on intelligent systems, as well as regional economic development through SMEs, in which genetic algorithms play an important role.

It is important to define the central concepts of the research before approaching the contextual framework of the proposal

Economic Development is an integral, socioeconomic process that implies the continuous expansion of the economic potential, the self-sustaining of that expansion in the total improvement of society. It is also known as the process of transformation of society or process of successive increases in the living conditions of all people or families in a country or community[6]. However, this development is increasingly demanding and complex, adding to the competitiveness and the global market, in which large companies concentrate the greatest wealth at the regional, national and global levels, leaving micro, small and medium enterprises with less than 20% percent of wealth, despite the fact that this sector collaborates with more than 90% in the concentration of labor according to World bank[7], OECD[8], ECLAC[9]. As a result, MSMEs became a strategic sector a few decades ago, little used, in addition to the adversities to which they face major problems. Where few of them manage to stay, grow and develop, to the extent that more than 50% of these enterprises in a period not exceeding 3 years are extinguished, broken or closed for different reasons such as poor planning, insufficient market studies, competition, interaction with the environment, lack of knowledge and skills in administrative issues and decision making of those who lead them, among other variables.

In this sense, the United Nations - UN [10] suggests fostering innovation, industry and economic growth, with initiatives and methodologies to enhance the growth and development of the regions, strategic sectors and the promotion of the SME. Therefore, an alternative solution to this problem is through intelligent systems which deal with solving everyday problems of the human beings, which imply understanding, knowledge, experience, interpretation and reasoning capacity through of disciplines like [11]:

- ✓ Data mining, which consists of a process of scrutiny of information contained in large volumes of data in order to analyze its characteristics for decision making. Among the solutions offered by data mining we have: problems of diagnosis, classification, search of

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associations, definition of typologies, detection of temporal cycles and prediction [12].

- ✓ Genetic algorithms are search algorithms inspired by natural selection processes, based on Darwin's theory of evolution, in which an analogy is established between the set of solutions of a problem and the set of individuals of a natural population. They are mainly applied in optimization problems [13]. Genetic algorithms emulate natural selection over a group of individuals to find the best solution to a given problem. The "genetic information" of each individual is a possible solution to the problem; by analogy, there is a "gene" for each variable or parameter of the problem on which you want to run the optimization process. To emulate natural selection, a population or group of individuals is created and evolved so that the best adapted, that is, those that are the best solution to the problem, reproduce more likely and little by little individuals will emerge better adapted to the problem; in other words, better solutions [14].
- ✓ Artificial neural networks, according to [15], is a system of parallel processors connected to each other in the form of a directed graph. Schematically, each processing element (neurons) of the network is represented as a node. These connections establish a hierarchical structure that, trying to emulate the physiology of the brain, looks for new processing models to solve concrete problems of the real world. The problems that most often resolve neural networks are: Adaptive learning, Self-organization, Fault tolerance, Real-time operation, Easy insertion in existing technology, such as the study by Hajek & Henriques [16], whom developed a model for evaluate the innovation performance of European regions using multi-output networks.

In this case, the research focuses on the genetic algorithms given the solutions they provide, as well as the experience in their use. On the other hand, in relation to Darwin's theory of evolution, it is based on four basic principles that explain how to population's features change over time.

First, individuals in a population show differences or variations. Second, variations can be inherited, which means that they pass from father to son. Third, organisms have more offspring than can survive with available resources. Finally, the variations that increase reproductive success will have a greater chance of being transmitted, than those that do not increase it [17].

In order to exemplify the biological relation and its corresponding with the genetic algorithms (See *Table 1*).

Table 1. Comparison of biological concepts with genetic algorithms

Concept	Biological meaning (descriptive)	Meaning of genetic algorithms
Chromosomes	They have the function of being a kind of pre-projects of the organism of which they are part	It refers to a candidate to solve the problem
Genes	Functional DNA blocks that encode a protein. Determine the traits of the individual	They are a bit like short blocks of adjacent bits that code a particular element of the candidate for solution
Alleles	Different possibilities of choosing a trait	In a bit string it will be a 0 or 1.
Genotype	Set of genes contained in a genome (complete collection of genetic material).	Bit configuration of that individual's chromosome
Phenotype	Physical and mental characteristics of each individual	It does not appear in the GA
* Selection	* Individual selection mechanism (chain) for reproduction according to the fitness function (value of the objective function)	* The selection algorithms will be responsible for choosing which individuals will have opportunities to reproduce and which will not. The basic idea of selection is associated with the fitness function and the original system
Crossing	It consists in a genetic exchange between two chromosomes of 2 parents. * Method of fusion on the genetic information of	Exchange of bits (genes) between two chromosomes

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	two individuals; if the coding is chosen properly, two healthy parents will produce healthy descendants	
Mutation	Change a gene of an individual for better or for worse * In real evolution, the genetic material can be altered in a random way due to an error in the reproduction or the deformation of genes	It is a permutation in a bit in a random place * In genetic algorithms, the mutation is, very likely, a random deformation of the chains. Produce random incremental changes in offspring, making random changes in allele values in some genes
* Replacement	* Procedure to calculate (create) a new generation of the previous one and its descendants	* A space is created for offspring in the population by eliminating parents

*Source: Relationship of biological concepts with Genetic Algorithms López [18], * Includes concepts of [17]*

On the other hand, according to Ponce [17] for the basic structures of a genetic algorithm it is also necessary to know the transition from one generation to another, which consists of four basic elements:

- ✓ Selection: individual selection mechanism (chain) for reproduction according to the fitness function (value of the objective function). The selection algorithms will be responsible for choosing which individuals will have opportunities to reproduce and which will not. The basic idea of selection is associated with the fitness function and the original system; for its implementation it is commonly known as roulette - wheel (RWS); it uses a probability distribution, where the probability of selecting a chain is directly proportional to its ability.
- ✓ Crossing: fusion method on the genetic information of two individuals; if the coding is chosen properly, two healthy parents will produce healthy offspring. It is the main genetic operator; it provides a mechanism to inherit characteristics of their offspring; intervenes in both parents.
- ✓ Mutation: In real evolution, the genetic material can be altered in a random way due to an error in the reproduction or the deformation of genes. In genetic algorithms, the mutation is, very likely, a random deformation of the chains. It produces random incremental changes in offspring, making random changes in allele values in some genes. In the case of binary chromosomes, it corresponds to make the changes of positions in each bit. It does not affect the entire population, but it is likely to harm some. The mutation has the effect of safely disturbing the chromosomes to introduce new features that were not present in any element of the parents.
- ✓ Replacement: procedure to calculate (create) a new generation of the previous one and its descendants. A space is created for offspring in the population by eliminating parents

5. ADVANTAGES AND DISADVANTAGES OF GENETIC ALGORITHMS

Genetic algorithms have advantages and disadvantages when applied, so it would be worth knowing them. According [19] main advantages are:

- ✓ It is optimized with continuous or discrete variables.
- ✓ Does not require derived information.
- ✓ Search simultaneously from a broad sample.
- ✓ Deal with many variables.
- ✓ It is suitable for parallel computers.
- ✓ Provides a list of optimal variables, not just a solution.
- ✓ You can code the variables so that the optimization is done with the variable code.
- ✓ Works with numerically generated data, experimental data or functions.

Other Advantage are [20]:

- ✓ Genetic algorithms are intrinsically parallel, that is, they operate simultaneously with several solutions, instead of working sequentially like traditional techniques.
- ✓ When used for optimization problems are less affected by local maxima (false solutions).
- ✓ They use probabilistic operators, instead of the typical deterministic operators of the other techniques.

Main disadvantages [20] include:

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- ✓ The language used to specify candidate solutions must be robust, must be able to tolerate random changes that do not consistently produce errors.
- ✓ They may take depending on the parameters used in the size of the population, number of generations.

6. PARAMETERS OF GENETIC ALGORITHMS

According to Arranz de la Peña & Parra [20] the parameters that have the genetic algorithms are**:**

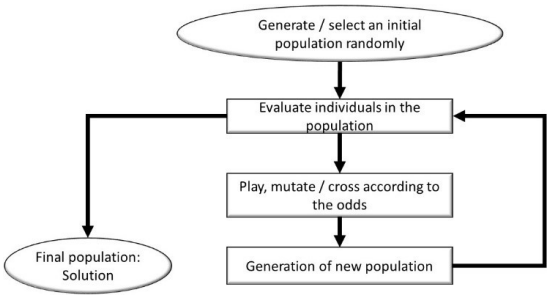
- ✓ Size of the population. It indicates the number of chromosomes that a population of our population has for a given generation. In case this measure is insufficient, the genetic algorithm has few possibilities of reproducing, which would make a search for scarce and less optimal solutions.
- ✓ Probability of crossing. It indicates the frequency with which crosses occur between the parent chromosomes, that is, that there is a probability of reproduction between them. In case there is no chance of reproduction, the crossing will be exact copies of the parents.
- ✓ Probability of mutation. It indicates the frequency with which the genes of a chromosome are mutated. If there is no mutation, the descendants are the same as those after reproduction.

According to Arranz de la Peña & Parra [20], the general operations and the functioning of genetic algorithms, is to find out what parameters the problem depends on, codify them in a chromosome, and applying the methods of evolution: selection and reproduction with exchange of information and mutations that generate diversity and the best possible generation. The most common operations are:

- ✓ Coding of variables. The coding can be done in several ways. The most used is through a string of binary numbers. But coding can also be done by whole numbers or even strings of words. This coding can be: Binary Coding, Numeric Coding, Coding by Direct Value, Tree Coding.
- ✓ Selection. It is necessary to select with the most qualified individuals so that they are the most likely to reproduce in which the most capable are those who must survive and create a new, more empowered offspring. The most common types of selection are: Selection by Roulette Wheel, Selection by Range, Elitist Selection, Selection by Stationary State, Selection by Tournament, Escalation Selection, and Hierarchical Selection.
- ✓ Reproduction. It consists in the exchange of genetic material between two chromosomes. The goal of the crossing is to get the offspring to improve the fitness of their parents. Some of the techniques for crossing are: Crossover 1 Point, Crossover 2 Points, Uniform Crossover, and Arithmetic Crossover.
- ✓ Mutation. The mutation consists of modifying certain genes in a random way, considering the mutation probability established previously. The mutation depends on coding and reproduction. If the mutation is abused, we can fall into the use of the genetic algorithm as a simple random search. The most common technique of mutation is: Simple mutation.

Derived from the above, the general diagram of the functioning of the Genetic Algorithms is shown (*Illustration 1*):

Illustration 1. General functioning of Genetic Algorithms



Source: Operations of the genetic algorithms Manrique [21], Arranz de la Peña & Parra [20]

7. STATE OF ART

After the search for algorithms used to make decisions for economic development, they are limited in the local sphere, where local governments lack this type of solutions to look for alternatives for economic development. However, they found some that are similar in either the technique or the subject related to intelligent computing and genetic algorithms (See *Table 2*).

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Table 2. State of the art related to the subject

Title	Technical	Source	Results
Artificial Intelligence in administrative decision making (Production Management) in the business sector.	Genetic algorithms, neural networks, fuzzy logic.	Bravo, Aguilar-Castro, Ríos, Aguilar-Martin, & Rivas [22]	The results and estimates made by the author is that by 2040 Intelligent Systems (AG, Neural Networks and fuzzy logic) will absorb decision making and autonomous processes in companies, suggesting attention to the transition to ensure that information sources be pure without guidance or gaps.
Model to reduce uncertainty in the decision-making process.	Diffuse Logic / Pichat Algorithm.	Alfaro Calderón, Alfaro García, & Hernández Silva [23]	It was possible to regroup the cluster of companies that make decisions without uncertainty
Prediction of business failure: 50 years of the model of Altman a contrast of its current effectiveness in the business reality of SMEs in Galicia.	Classification algorithms / multivariate analysis.	Rodriguez, Piñeiro, & De llano [24]	The proposal aims to revalidate the original model of Altman contrasted with multivariate models applied to SMEs, the results obtained present an accuracy of 80% in the failure in this sector of companies
Find cluster centers at birth to enhance their use and linkage with other sectors.	Genetic Algorithm.	Khusul Khotimah, Irhamni, & Sundarwati [25]	Locate cluster centers and suggest their link with related sectors
Model of improvement in the potential of organizational improvement in the MSMEs of the industries	Genetic Algorithms.	Arsocski et al. [26]	Predicts that companies (already existing) achieve their permanence to more than 3 years
Flexible work scheduling with double resource constraints to minimize delay through the use of genetic algorithm in a SME	Genetic algorithm.	Paksi & MaRuf[27]	Optimize resources by eliminating duplicity in your application.
Proposal of a model that allows to measure the performance of a portfolio of MSMEs	Genetic algorithm.	Del Pilaret et al. [28]	Genetic algorithms are used to obtain the optimal portfolio that maximizes these metrics.
SME prediction model with the objective of identifying financial difficulties	Genetic Algorithms / Vector Support Machine.	Gordini [29]	Predict companies that will be in bankrupt.
Genetic algorithms to solve programming problems in flexible manufacturing systems (SMF) in SMEs	Genetic Algorithm.	Godinho, Fullin, & Tavares [30]	Identify problems or gaps in programming segments in manufacturing systems of SMEs.
Study understands consumer behavior when buying products to predict purchases	Artificial neural Network.	Agus & Triyoso [31]	Make predictions of product inventory in small and medium enterprises

Source: Own (2019)

As the works in *Table 2* indicate, genetic algorithms provide solutions on prediction, optimization and evolutionary models. Derived from the above, some of these experiences will be taken up to serve as a reference for the present proposal.

On the other hand, within some algorithms are shown to be considered as a basis for the development of the proposal that is in the phase of conceptual and contextual analysis.

Algorithm 1. Genetic Algorithms

```
Algorithm Greedy(a,n)
{
    a [1.. n] contains the n inputs.
    solution : = Æ;
    For i := 1to n do
        { X = select(a);
          if  feasible (solution , x) then
                solution : = union(solution, x);
        } return solution; }
```

Source: Introduction to Design & Analysis of Algorithms - In Simple Way, Rao [35]

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As can be seen in *Algorithm 1*, it takes as inputs the selection of the samples, to later enter the cycle and conditioning statement to evaluate and reproduce or mutate the population *n* times, until it finds the new population. While this is a general algorithm, you can appreciate the general operations (See *Algorithm 2*).

Algorithm 2. Structure of the Genetic Algorithms

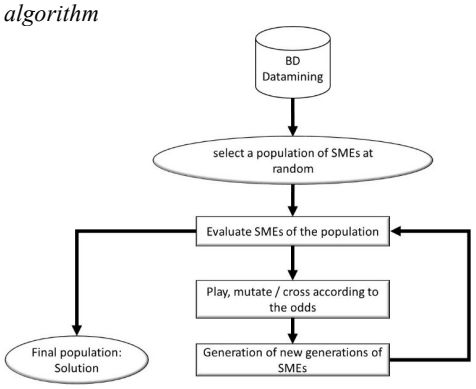
```
B0 5 = (b1,0 , b2,0 , . . . , bm,0);
While condition
Begin
    FOR i:n  to m DO
      Selection an individual bi,t11 from Bt;
      FOR i:n to  m-1 step 2 DO
                IF Random [0, 1]#pc THEN
                        Crossing  bi,t11  with
bi,t11, t11;
      FOR i:n to  m DO
                Muting
                offspring are created by crossing
individuals;
                eventually they mutate bi, tn;
                an increment t is made: 5tn
End
```

Source: Artificial intelligence with applications to engineering, Ponce [17]

8. GENETIC ALGORITHM TO COLLABORATE WITH THE LOCAL ECONOMIC DEVELOPMENT

This research is in the phase of conceptual and contextual development of the proposal, however, the general diagram of the proposal has been identified, it shows how the development of the algorithm will be directed, which will depend on the start of the inputs that are generated in a previous process for the design of the algorithms (See *Illustration 2*).

Illustration 2. General diagram of the proposed genetic algorithm



Source: Own source (2018), Adapted of Manrique [21] and Arranz de la Peña & Parra [20]

Illustration 2, initial sample that inputs will be obtained by a database and data mining, to be able to have the initial population of MSMEs, later will start with the execution of the genetic algorithm. In this stage the core part begins, where through the reproduction and crossing of probabilities with their respective characteristics which will enter a process to iterate n number of evolutions until obtaining the most appropriate MSME for its creation and development (success). While this is the core of the research, this will serve as collaboration for local e-governments to make decisions about the economic development of the regions. This proposal will allow any entrepreneur to complement the information available to know the probability of success of the MSME that he has in mind to create. The design of the genetic algorithm to suggest the creation of MSMEs of the transformation industry with potential for economic development in the State of Sonora, Mexico is presented below.

Algorithm 3. General design of the Genetic Algorithm to suggest the creation of MiPyMEs of the transformation industry

1. Begin
2. Declaration of variables
3. Obtaining indicators of business plan, socioeconomic and business success
4. Calculating the fitness function
5. Cycle while any chromosome is less than or equal to 96% and greater than 1%
6. Begin Cycle
7. Obtaining the genes of each generation, by the proportion method
8. Cycle for (up to the maximum number of companies)
9. Begin
10. Converting the Type of Company to bits in octets
11. Generating the random decimal number between 0 and 1
12. End
13. Getting the best individuals and their conversion to bits
14. Cycle for N (maximum number of companies)
15. Begin
16. Finding and replacing the best individual
17. Converting bits into octets the Best individual
18. End
19. Generating the crossing and mutation of genes
20. Cycle up to N (maximum number of companies)

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21. Begin
22. Random crossover is generated by gene pairs
23. Generating random mutation for each gene
24. The resulting generation is stored and replaced
25. End
26. End
27. Converting the value in bits of the mutated gene to a decimal numerical value
28. The number of crosses, mutation and iterations is counted and accumulated
29. The result is evaluated, if it exceeds the fitness function, the previous value is assigned
30. Printing results
31. End

Source: own (2019), taking as a reference the similar investigations of Arsocski et al. [26], [29], and the methodological contributions of Manrique [21] and Arranz de la Peña & Parra [20]

For the design of the genetic algorithm (See *Algorithm 3*), state of the art information was consulted and analyzed, identifying similar research, techniques used, and the results obtained, to be taken as reference in the present investigation. Additionally, the type of genetic algorithm to be used was discussed, for which the objective of the research and the complexity of the problem to be correlated was considered. Based on the above, it was decided to use the basic genetic algorithm, applying the selection, crossing and mutation of the individuals (company) that the entrepreneur selects. Another element to consider was the effectiveness of the Genetic Algorithms for the optimization of functions, translated into the prediction of successful companies, whose advantage places them in one of the most useful techniques for this type of problems.

9. ANALYSIS, RESULTS AND DISCUSSION

After the experimentation, testing, execution, validation and optimization of the Genetic Algorithm developed in the present investigation, several contributions were found that were not identified in the similar investigations, which are considered a new contribution to knowledge, these are:

- ✓ Include mutation percentages for small and large populations
- ✓ Experimentation with dynamic populations
- ✓ Focus optimum crossover percentages for small and large populations
- ✓ Contemplate a percentage of uncertainty
- ✓ It is oriented to the creation of new local and regional MSMEs
- ✓ Combines knowledge in administrative sciences with entrepreneurship by identifying those factors of importance in the business plan that can determine the success or failure of an MSMEs.
- ✓ Integrates economic knowledge in the search of socioeconomic indicators that collaborate with the success.

The foregoing can be visualized in detail in *Table 3*

Table 3. Contributions found in the present investigation with respect to similar research and literature consulted

Concept	Contribution
Percentage of uncertainty	Percentage: 10%. Which is reduced due to the readjustment of crossing and mutation percentages, recursion and randomness
Mutation percentage for small and large populations	Population less than 20 individuals: 11% to 20%: Optimal: 20% Population greater than 19 individuals: 5% to 10%: Optimal: 10%
Crossover percentage for small and large populations	Suggested: 60% to 90%: Optimal: 60%
Interaction with administrative and economic sciences	Through the search of factors that collaborate with the suggestion of creation of SMEs: Success of the SMEs: Time in market Economic Profitability Utilities Business plan: Structure of the environment Financial structure Ideological structure Human resources Mechanical structure Executive summary Socio-economic indicators
Economic development	Oriented to the creation of SMEs
Type of experiments	Static and dynamic populations

Source: Own (2019)

This offers an improvement in the testing of Genetic Algorithms which can be applied to any optimization problem, which unlike what exists in the literature consulted offers alternatives for small and large populations which were successfully tested in several experiments. In addition, no similar research was found to assist with the suggestion in the creation of MSMEs by considering supplies that better ensure

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the success of MSMEs, as well as integrating Business Plan factors and indicators to prevent failure and contribute to the success of this business sector. Following six experiments with their respective 40 executions, the mutation and crossover percentages were obtained (see *Table* 4).

Table 4. Experiments to find optimal mutation and crossover values

Concept	1	2	3	4	5	6
Crossing percentage	80%	90%	85%	75%	70%	60%
Mutation percentage	20%	10%	20%	10%	20%	20%

Source: Own (2019)

As can be seen in *Table 4*, optimal values were found in the sixth experiment with a crossover percentage of 60% and a mutation percentage of 20%

In addition to this optimal parameter adjustment, a comparison was made with the MATLAB tool in the module of genetic algorithms, and by assigning the same parameters with which the Genetic algorithm was developed in Transact – SQL Server, the obtained the following results (See *Table 5*).

Table 5. of results between genetic algorithm developed in Transact - SQL Server and MATLAB (sixth experiment)

213119 (ranking 1) - Mining-related services					
Size	Percentage of success by the AG	Clustered MSMEs	Percentage of success by MATLAB	Clustered MSMEs	Absolute difference
Medium	35.00%	80.00%	27.30%	79.50%	7.70%
Small	22.50%		22.70%		0.20%
Micro	22.50%		29.50%		7.00%
Large	20.00%	20.00%	20.50%	20.50%	0.50%
Total / Average	100%	100%	100%	100%	3.85%

Source: Own (2019)

Comparing the same optimal mutation percentages between the TRANSACT SQL Server AG and Matlab, maximum differences of 7.7% and minimums of 0.2% were entered, this means that no company size exceeded more than 8% difference, which gave certainty to the values found, as well as the reliability of the results. The micro and medium-sized enterprises had 7.0% and 7.7% respectively, while the small one a difference of 0.2% and the large company with 0.5%. It is important to note that by grouping MSMEs they obtained the same result as all experiments with a difference of 0.5% (see *Table 6*).

Finally, a comparison was made including results generated with information from the corresponding INEGI (2017) with mining-related service companies. The results of the Genetic Algorithm developed with Transact SQL Server were similar to the Matlab algorithm and close to the INEGI information, except for the large enterprise, which maintained the same difference in all experiments. It can be observed that there are similarities in the micro, small and medium which do not exceed more than 8%. When comparing large enterprises among Genetic Algorithms they have a difference of less than 0.05%, while with respect to the information obtained from INEGI they have an average variation of just over 12%.

Looking at this difference, this is attributed to the INEGI that large companies generate greater economic profitability, so the weights are higher, and these increase the probability of success in the AGs (see *Table* 6 and *Illustration* 3).

Table 6 Comparison between source information, the algorithm developed in T-SQL Server and MATLAB

213119 (ranking 1) - Mining-related services						
Size	Percentage of success by INEGI (2017)	Clustered MSMEs	Percentage of success by the AG	Clustered MSMEs	Percentage of success by MATLAB	Clustered MSMEs
Medium	34.60	92.30	35.00	80.00	27.30	79.50
Small	30.80		22.50		22.70	
Micro	26.90		22.50		29.50	
Large	7.70	7.70	20.00	20.00	20.50	20.50
Total / Average	100	100	100	100	------	100

Source: Own (2019)

Illustration 3 Differences between success rates between algorithms and information taken of the INEGI

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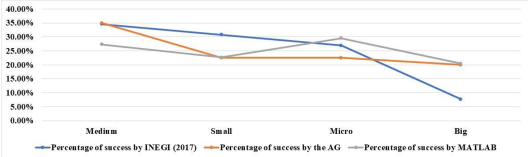

Source: Own (2019) taken of Table 6

According to the results shown in Illustration 3, the micro, small and medium-sized business sector represents about 80% success and the large companies the remaining 20%, however, it is important to consider that in Mexican companies the size The end of the company is not determined by access to initial capital [36], which makes it difficult for this sector of the SMS to create, develop, grow in the medium and long term. What causes more than 75% to extinguish or disappear in less than 3 years according National Institute of entrepreneur [37]. This coupled with the fact that these companies lack a solid and sustainable business plan, adding to the lack of financing that allows them to remain in the market [38], [39]. Derived from the above, the proposal emphasizes integrating variables associated with the business plan and socioeconomic indicators, including as configuration parameters of the Genetic Algorithm, for the entrepreneur to consider them in the formulation, design and decision making in the creation of an MSM Companies. Finally, according to the data presented in Table 7, the results derived from the Genetic Algorithm collaborate with the integration of information that the entrepreneur must consider, analyze and interpret to ensure as much as possible the success of his entrepreneurship initiative at the moment. if implemented operatively and administratively.

The main findings entered are this technological research is considered intervention, since it takes up previous research on Genetic Algorithms, adding the following:

- ✓ It uses relational DB schemes contained in DBMS as a source of information of the AG; for a problem identified in which case it can be applied from the particular to the general.
- ✓ Add algorithms for automatic selection of relevant information, contained in the DBMS, based on previously established configurations
- ✓ Integrates programming languages to encode the genetic algorithm and allow its evaluation, evaluation of results and comparison with other intelligent systems techniques. With which the proposal is checked and applied from theory to practice in a real context.
- ✓ It will allow to know and refine the parameters of entry of the AG from its results and comparisons with successful companies. Which infers the increase in the probability of success in their results

10. COMPARISON WITH PREVIOUS WORK

According to *Table 7*, in the review of the state of the art several similar research to the present one were located, two of them being the closest ones in objective and technique used, the first of them related to the prediction of the probability of bankruptcy of companies in the manufacturing sector [29] and the second research by the author *Arsovski et al.* [26] whose objective is to assess the organizational resilience oriented to MSMEs.

According to *Table 2*, both investigations are using Genetic Algorithms, comparing these investigations with the present one, they achieved their objective, using populations of individuals according to the research with percentages of mutation and crossing within the suggested parameter. As can be seen in Table 7, The three investigations reach the optimization function achieving in all cases the scope of the objective. Another similarity is that the three investigations are aimed at ensuring that MSMEs can continue to collaborate with the economic development of a region, given the importance of this sector in the economy for the generation of jobs, the generation of cash flow, the reduction of poverty and the hiring of human resources.

A difference found is that the present investigation performs several experiments with a small population of four individuals and a dynamic experiment with *"n"* number of individuals, and based on the size of the population are assigned optimal mutation and crossover percentages for each population within the parameters suggested, in both cases the results of the experiment were satisfactory. In addition to this difference, in the first two investigations is limited to perform the experiment and achieve the stated goal. However, its application was not identified in any tool for those interested to use it,

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an issue that is present if the knowledge generated through a web application is applied where entrepreneurs and interested actors can use the tool to suggest the creation of a MSME using Genetic.

Other difference with the first two investigations is that a degree of uncertainty is not observed, while for the present research a percentage of uncertainty of 10% was considered, which according to the experiments developed by Berzal [32], Bonilla, Sánchez & Caballero [33], Molina, Pandolfi & Villagra [34] must follow good practices, together with the comparative results of the GA developed in Transact vs Matlab. In these experiments, good practices, methodologies and comparisons, in none of the cases it doesn't exceed 10% variation. It is important to mention that the percentage of error is reduced due to the readjustment of crossing and mutation percentages, recursion and randomness, which serve as a mechanism to reduce the percentage of uncertainty.

Table 7. Comparative with research similar

Concept	Research		
Author	Gordini [29]	Arsovski et al. [26]	Proposed in this research
Technique	Genetic Algorithms - Logical Regression and Support Vector Machine	Genetic Algorithms - statistical tools	Genetic algorithms
Objective	Predict the probability of bankruptcy of MSMEs	Evaluate the organizational resilience potential for small and medium-sized enterprises (SMEs)	Suggest the creation of SMEs
Population	3,100 individuals	120 individuals	4 Individuals Dynamic (n individuals)
Mutation percentage	6% to12%	5% to 15%	Population less than 20 individuals from 11% to 20% Population greater than 19 individuals from 5% to 10%
Cross over percentage	50% to 70%	Crossing 1 point	Suggested 60% to 90%
Fitness function	"80 > f(x) < 100 " The function is generated in order to take the values of the inputs	$\sum_{p=1}^{6} ri*,p$	"function y = SucessSME(x) ""0 > x < 4 " "y = (100 - x) "
Supplies	Return on capital (ROE) Return on investment (ROI) Billing Interest charges Cash flow Financial debts Total debts Current ratio	Resilience factors: Planning strategies Capacity of internal and external resources Human factors Quality of the process Security management system Emergency response Follow-up to internal processes	Success of MSMEs: Antiquity Economic profitability Utilities Business plan: Structure of the environment Financial structure Ideological structure Human Resources Mechanical structure Executive Summary Socioeconomic indicators
Economic sector	Manufacture	Process industry	Manufacture
Country	Italy	Serbia	Mexico
Stop criterion	When the population stops improving effectively (achieve fitness function)	When the individual reaches the fitness function	When some individual reaches the fitness function
Results	The results show that the accuracy rate of the prediction of the Genetic Algorithms increases when the model is applied according to size and geographical area, with a notable improvement in smaller companies	Identifies the weakest organizational resilience factors and proposes the potential for improvement in the business process	The algorithm presents the percentage of success of the company that the entrepreneur wishes to create, as well as showing a comparison with other successful companies in the same municipality, state and country
Degree of uncertainty	N/I	N/I	10%

** N/I. Not Identify*

Source: Own (2019), taken of a genetic algorithm approach for the bankruptcy prediction of SMEs: empirical evidence from Italy [29], and Improvement

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of organizational resilience potential in SMEs in the process industry [26]

11. CONCLUSION

Based on the results obtained on the comparisons by company size, and economic sector in relation to the INEGI, as well as the comparisons with the results of the MATLAB AG, it is concluded that the AG provides favorable success rates and in accordance with the behavior of the sectors and classes of companies taken from INEGI, as well as the results obtained with a 10% degree of uncertainty.

Genetic algorithms are very efficient in optimization, prediction in different applications, however, in relation to the scope of local economic developments are little used, hence the importance of implementing this application in its development phase and compare it with other traditional methods as market research and be able to evaluate the results in the short and medium term. In addition to this, although the importance lies in suggesting the creation of a SME to entrepreneurs, it also serves governments, business sector, academic - research, since the information that the algorithm generates can be used to analyze trends, generate targeted government programs, among other advantages. In the same way, the genetic algorithm developed in this research facilitates that business incubators can emulate the optimal conditions in the creation of a value proposal, in the context and under the conditions for which the GA was created.

Although the proposed genetic algorithm aims to provide information that facilitates decision making, it is worth noting that is the man who finally has the last word, when interpreting the internal and external variables that favor companies in their evolutionary stages in that decision making.

The fact that the GA is available as a simulator on the Web, will allow it to be nurtured by genetic material to generate crosses for its constant reproduction and the generation of new descendants. This will allow entrepreneurs and stakeholders to generate simulations to obtain the success percentage of MSMEs, which will serve as input for making decisions, as well as complementing the information with other studies

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