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Predictive Model of Investment in Mexico the Matalurgie Industrie

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Abstract. This paper is one vision of model about predictive at all many situations of investment and production capacity in the mineral – mechanic industry in Mexico. This situation is specific whit study many minerals is an about demanding investment and impacted many activities for example, factoring industry and sector visionaries about automobilist, aeroplanes, machine, hand dispositive and others. The history of Mexico minerals is growing in opportunity optimization problem according database for more eight years in economy for selective maximized. About the model predictive establish in diagnostic the many minerals in Mexico; this is of empirical investment simulation a possible consideration tendency in investment or production of mineral important of investment and costumer in Mexico. The modelling method uses potent to execute genetic algorithm to discovery investment potential across rent and contribution grow national situation about metallurgic industry and historical reason in this industry and empirical situation.
Keywords: Predictive model, genetic algorithm, investment, metallurgic industry, optimization.

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1. Introduction

The investment metallurgy industry in Mexico and word about the continued productive process of sectors in economy, inventory in stay grow investment of equipment machines as equipment in other industries. For historical reasons in this industry and material mineralizes process and other minerals are part-time in finales products. In Mexico does not modeling investment, only is considered the general mining on a case-specific city and not contain specific model, is reference about mathematic technique.

This paper gives the state of predictive model for growth and investment that have developed validity over metallurgy industry of Mexico and across selective in date hart base about genetic algorism execute. The bibliographic review deals with predictive models used, which will allow us to frame the contribution to the optimization and simulation of investment model that we intend to outline in a later article. Said model would allow us to generate higher economic value by optimizing mixtures.

Another objective of this article is the predictive model as establishing about structure analyst what technic identify whit data mining when used many date bases is statistics and possibility in a similar unit in different specific situation in selective actors.

The method of study consists of the formulation of a genetic algorithm for the modelling, which aims to predict the behaviour of the actors, generations under parameters known in order to find solutions to a problem, in this case, the investment predictable in the mining industry - metallurgy in Mexico. The general premise is that investment or enough that there is no application to improvements in the short term due to long processes of renewal of equipment in the industry of Mexico nautical metalwork.

2. Description of the Problem

There are approaches of great interest both in economic theory and the knowledge of engineering in manufacturing and in relation to the mining sector - metallurgical becomes relevant to show the model in this study. The process of investment linked to growth since in Mexico, the manufacturer has presented considerable progress is particularly important, however, currently presents a decline in their rates of investment. In most of the countries of the OECD, that year, Organization for co-operation and economic development – OECD [1], the slowdown during the year of 2015 was present in almost all sectors, affecting companies large and small alike, although it is especially noticeable in the industries where it was expected that the digital innovations and technology to generate dividends in productivity and have currently insufficiently passed the course.

The study according to National Chamber of the industry of steel - CANACERO [2] presents the importance of the steel as activity provider where metallurgy is the first links of the productive chain of an infinite number of uses. Production mining metallurgical is obtained in the activities of extraction, benefit, smelting and refining of metallic and non-metallic mineral mines extracted and processed at metallurgical plants of the country. These activities are catalysts of growth in other sectors that must move on par with the challenges of growth at the national level. This is required of certain about investment less or more according of provability in this regard, the problem can be identified as a maximum problem in investment with maximum fitness and rent with the following characteristics and restrictions.

The problem can be identified as maximizing the profits obtained from investment on equipment and machine. Some authors describe this problem only about production, but not as one of maximum contribution and rent with the characteristics and restrictions is use another character. The other necessity was in specific investment in the mining industry for continued process grows in Mexico.

3. State of the art

In the review of several current publications is that the industry in general and in particular the metallurgical industry has represented in Mexico key to the growth of the country by what is shown is an activity traditionally for Mexico and with challenges to the opportunity in certain minerals. National Institute of statistics geography and Informatics - INEGI [3] is considered as mining metallurgical production, the sum of the metallic content of refined metals and impure metals obtained from first fusion, as well as the metal content of concentrates and natural minerals whose final is the export, as well as the volume of ore of non-metallic minerals.

By general Convention in the approach to classification, refined metals are bodies simple with own shine, good conductors of heat, electricity and purified almost to 100%. The impure metals are simple bodies with their own shine, whose purity can reach up to 90%. The metal content is the amount of metal that contains the volume of

a mineral or impure metal, which is determined by the metallurgical laws obtained by sampling. National Institute of statistics geography and Informatics- INEGI [4], production volumes presented in millions of pesos and rates of variation of 30 products, which will break down into four groups:

- Precious metals (gold and silver): are used in jewellery, the minting of currency, for industrial purposes and the production of precision instruments.
- Non-ferrous industrial metals (lead, copper, zinc, antimony, arsenic, bismuth, tin, cadmium, selenium, tungsten and molybdenum): are used mainly in the manufacturing industry for the manufacture of pipes among other uses.
- Metals and steel minerals (coal, coke, iron and manganese): are used mainly in the production of steel.
- Non-metallic, mineral (sulfur, graphite, barite, dolomite, fluorite, silica, gypsum, Phosphorite, Wollastonite, Celestite, feldspar, salt and kaolin): these products are used in the production of chemicals, insecticides, fertilizers and in the industry of the Construction.

Each group is located in the databases of the major minerals of time series where the ranges of variation of the indicators shown and they represent the situation where this industrial activity is located. By agreement about National Institute of statistics geography and Informatics - INEGI [5], the minerals have been validated by sampling from databases. The mining industry - metallurgy is an activity whose metals are highly used in metallurgical processes and manufacturing as the electrical, telecommunications, automotive and aviation, among others.

The situation of mining - metallurgical is variant and influences all manufacturing activities and study their behaviour, so it is relevant mostly to the international challenges of capital flows, and constant innovations to this requirement. The impulse of economic growth by activities mining - metallurgical is based on his own regeneration processes and impact to the new technology. One study about model mining is the Benita Maldonado, at al. [6], proposed indicators of efficiency in production mining of Zacatecas. This analysis was conducted during 1998, 2003 and 2008 nationwide in Mexico identifying products of technical improvement in the State. The source of information significant on the performance of the mining industry in the city of Zacatecas State, allows identifying products of the State that are susceptible to improvement technique using the inefficient activity classes. Benita Maldonado et al. [7], the other hand, of 29 products total considering the INEG (Institute National of Geography and Statistics), ten are fundamental: gold, silver, lead, copper, zinc, coke, fierro1, sculpture, barite and fluorite Zacatecas, as we will see later, stands out as one of the leading producers of three of them: silver, lead and zinc, the reference of Secretariat of Economy, points out that was from that time when it recognized the potential of mining as a source of modernization and development, positioning itself to date as one of the main activities of provision of inputs to the great most of the industries, mainly construction, metallurgy, chemistry and electronics. Under this theme lies the importance of the analysis of the behaviour of this activity on local economies, particularly the State of Zacatecas and validity how more than important in Mexico similar a State Sinaloa for example.

Another study about the mining of Gaytan and Benita [8], is about quantified and analyze the technical efficiency levels in Mexico's non-oil mining industry. We use Data Envelopment Analysis (DEA) and a panel data econometric model in order to explore the determinants of mining efficiency, considering the Regional Economic Theory approach the results show the consistency between the patterns of localization, specialization and productive infrastructure as explanatory factors of technique efficiency. Whose methodology is a description of the approaches of agglomeration, the concentration of economic activities and penchant for the formation of clusters or networks innovation about limited geography of minerals production whit efficiently.

Gaytan and Benita [9], the mining is the importance of the linkages as a factor to trigger multiplier effects in a given productive network. The second force, centrifuge, refers to elements that drive the dispersion of economic

activities, including the diseconomies of urbanization (pollution, overcrowding, limited services, among others) and the cost of the land. The NGE also considers that agglomeration processes do not come into play only flows associated with the mobility of goods and factors, economic, but that information becomes many important. The dispersion of information involves dissemination of new and specialized technologies that, although difficult to quantify in terms of value traded, are crucial in the generation of productive synergies. Forever was mining important but is not appreciate in modelling activity.

The mining industry´s performance ratio largely depends on the efficient operation of its mining equipment. Noncompliance with the terms of service contract results in speeding up the deterioration of the equipment and thus the need for their replacement. The replacement of the equipment in the Cuban nickel mining is not carried out based on the assessment of the equipment operating condition, economic and service aspects in addition to the experience gained from the negotiations conducted during the purchase of the equipment.

Some study about Azanero et al. [11] publicize the flowsheet, material balance, proposal of equations and development of mathematical models that allow us to predict final results such as law, recoveries and radius of concentration that a mineral will report when it is processed by floating on an industrial scale with information obtained from laboratory batch tests; this is only engineering proses on materials mining.

The importance of investment included innovation grow, the view Marzena et al. [12], technology and innovation are part of the economic growth by the automation of current processes, which have spent decades at least 60 in the knowledge and implementation of optimized it and them handling of materials by the operator, with the great diversity of tools in the manufacturing sector. Operational improvements of materials still the primary element of technological innovation whose need is related to the volume of production. Is it one study about technology and innovation but is not in the modelling method. About algorithms was aware of methods modulate, Hawthorn et al. [13] the model predictive analytics builds a statistical model that uses existing data to predict data of which because are not available minerals possibility. Jokic et al. developed relationship of Simulation Methods in Model Predictive bye open source**.**

In the design and development of the predictive model is a research of the secondary data validated by the INEGI on related variables of metallurgical production and investment. With the databases of these variables establishes the method of the algorithm in a hybrid approach of the predictive model to carry out the executable in an empirical contribution and the validation of the predictive model. For predictive model assumes basically the identification of variables and instances to represent a prospective vision of the abstraction of the current reality of the mining industry - metallurgical by applying data mining and genetic algorithm. In the development of the model and the validation of data is done the research and obtain these through the Base of economic information (BIE) of the INEGI presenting themselves already with an own validation.

Hawthorn et al. [14] approached the flow maximization problem in a natural gas transportation pipeline system. Their model incorporates the variation in pipeline flow capacities with the specific gravity of the gas and compressibility; is plicate about many maximization problems however in metallurgy investment of case in present study about that algorithm method medaling, but is not specified in the mining.

The importance of a good approach and development of models that predict future events or behaviour patterns found in historical and current data to identify risks and opportunities according to those patterns can be leveraged. With the observation of these patterns is known that predictive analysis to construct a statistic that uses existing data to create predictive model using available sample units with known attributes and behaviour known to this data set is called set of training. On the other hand, use a series of units of other shows with similar attributes, but which is not known its behaviour, this set of data is called set of test, Hawthorn et al. [15], because attributes are studied for code is necessary for identified de principals mining products is relation maximization.

Alej Parisi et al. [16] mentions that a genetic algorithm is a mathematical function or a routine which simulates the process of evolution of the species, aiming to find resolve, so the genetic algorithm receives as input a generation of possible solutions to the problem that arises and throws as the fittest specimens referred to the best solutions so that the descendants better feature than previous generations; whose use in modelling specific problems is very useful in predictions. The important genetic algorithm is discovery the level probity of investment in the industry mining on Mexico.

Based on the analysis of the references so far have not found a mathematical model proposed for metallurgy in Mexico since they are approaches to geographic about the type of existing mining production or the technological aspect and innovation or so far we have not found an indicative algorithm for the investment in the metallurgical industry in Mexico in its approach to modelling.

4. Experimentation

The explanation and design of the prediction model of investment in the mining industry - metallurgy in Mexico, is based on the prior identification of the data such as: mining production peaks and the peaks of the investment in special projects that are analyzes by which identifying data age that happened the variation follows in principle that the process of investment currently in the metallurgical industry in Mexico is mainly based on existing capacity and vision on projects by destination. The flow of investment in the metallurgical industry in Mexico is cyclical since relates to recurrent crises as the whole economy, but to sustain many sectors its recovery after the fall, it is very beneficial to investments in new projects, acquisition and replacement of equipment and exploration mainly.

The prediction model of investment in the metallurgical industry intends to in order to support decision-making for investment in the industry. The behaviour of investment in this industry was obtained through the analysis of historical data, in such a way that you can view the behaviour of economic indices that generate more profit in the metallurgical industry in Mexico, with this information investor may decide at what rate you can bet your investment.

The objective is to establish a predictive model with the implementation of genetic algorithm for investment in the metallurgical industry of Mexico to observe the findings of probability in contribution and income as an investment opportunity in certain minerals.

The hypothesis: the predictive modelling of investment in the metallurgical industry in Mexico with a powerful genetic algorithm can be observed in finds of certain minerals of impact in its contribution exceeding 3%, and income up to 1%.

To determine investment opportunities is establishing bye steps in experimentation:

By the way on experimentation is began were symbolic method whit Mathematical Model of the problem of investment in the metallurgical industry in Mexico:

$$Max \sum_{i=1}^{n} I_i P_i D_i \tag{1}$$

$$I = \frac{(t_s - s)p}{t_s - sp} \tag{2}$$

$$D = Exp + I \quad (3)$$

$$I \geq P \quad (4)$$

Equation (1) represents the objective function in a model of maximizing investment in the metallurgical industry in Mexico. Where: i Represents the set of products; 1 to n . $i = \{M_1, M_2, M_3, ..M_{n-1}, M_n\}$, P_i It represents the rate of production of different mining products, D_i It represents the demand for certain mining product, I_i It represents the economic price of investment account. Equation 2 represents the most suitable investment of a productive sector, Where: I It represents the economic price of investment account, s It represents the marginal rate of reinvestment of earnings or profits, p It represents annual production index, t_s It represents the social update rate, positive impact ≥ 1. Equation 3 shows the demand is directly proportional to the sum of exports and the economical price of investment account, Where: Exp It represents the rate of exports. Equation 4 is the restriction that the economic price of investment account index must be greater than or equal to the rate of production of different mining products.

It is interesting to study the perceptual change of investment effect to explain the degree of growth that presents indicators of these variables to conceptualize and implement investment behaviour and metallurgical production in Mexico empirically. About the minerals in Mexico more than greater variation impact according to their years 2009-2016 and execute model is according to the modelling the genetic algorithm whit databases the many minerals in Mexico.

Implementation of databases, related variables and selection of the information according to the indicators through the databases of metallurgical activity in Mexico, allows to analyze indicators of the gross domestic product sector, the production and the gross fixed investment since in the process of economic growth are considered related variables to establish the criterion of maximizing to the study of the investment and production and their relative importance in the behaviour of the economic analysis and set model Predictive. These data are presented for their measurement indices, in millions of pesos or dollars that are presented as follows:

The experimentation uses a powerful genetic algorithm for mathematical modelling considering the determination of authorities through the selection of databases by the criterion of maximizing tool SPSS and the program's algorithm genetically with its formulation under the elements identified as potential in their descriptive statistical variation of agreement rates.

Database selection, for the selection of data it has with information from the databases of two related variables, gross fixed investment which increases exponentially and production increasing moderately still corresponding to a level higher than the national average in gross fixed investment and production in mining industry on Mexico about equipment in steel complex because is primary processes. The information base presents the 1st table eight periods showing a growing trend.

Table 1. Gross fixed investment and production complexes and iron and steel products (percentage change)

Time period	Gross fixed investment > machinery and production equipment > iron and steel complex	Metal mining production > metals and minerals iron and steel
2009		
2010	265.6	154.7
2011	55.4	98.2
2012	47.4	105.8
2013	390.4	98.6
2014	81.4	103.6
2015	84.3	71.0
2016	67.4	125.8

Source: Own elaboration with data from the annual survey of the manufacturing industry EAIM, (2018 INEGI).

Table 1 shows percentage changes metal mineral and metallurgical in investment and production and that on the average growth of gross fixed investment is many change and production complexes and iron and steel products is less than 2009 to 2016. Gets graph of the relationship between investment and production that shows the data in the table.

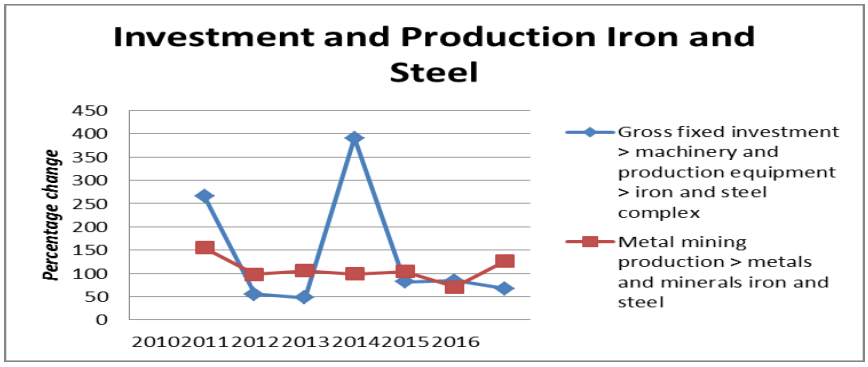

Figure1. Gross fixed investment and production complexes and iron and steel products in Mexico. *Source: Own elaboration with data from the annual survey of the manufacturing industry EAIM, (2018 INEGI).*

Figure 1 shows a predictable trend which is also by selection of ores produced in the iron and steel complex to be identified by the predictive model as the best chance of investment for what is observed that it affects the production, i.e. the percentage change metal mineral and metallurgical means an effect widespread for the production of iron and steel ores and the endless chain that is generated, for example investment in the mine and its respective effect of the investment in the company steel.

Genetic algorithm, before selective date base of maximization model is necessary the model predictive. Method of data mining is used for the treatment of the investment in the metallurgical industry databases in Mexico since it is used with when there are large amounts of data has gone with the evolution of the technology of the for (BD) database since the 1980s and now allow the development of models with relational and deductive criteria. Predictive Analytics is a sub-discipline of data analysis you use techniques from statistics, such as computational learning and data mining, in use date base is part-time.

Hawthorn et al. [17], Jiawei have & Micheline Kamber, et al. developed (2001) in the process of discovering the knowledge of large amounts of data stored in databases, data warehouses, or another repository of information. Also selected for being the stage of data mining techniques properly such includes predictive modelling and ad hoc classification techniques. Based on the analysis of references to envelope models in general now have not found an indicative model only with respect to the mathematical and we have not found an indicative algorithm as such.

The process establishes for categories of minerals classification for genetic algorithm use execute method of the present study. In this paper, the sequence is programming genetic algorithm about maximized, and optimization problem of investment is complete with database programing about considerations the selective data about maximized and more provability several minimalists in the genetic algorithm execute all.

Table 2. Codes of individuals of minerals in the study the genetic algorithm model predictive

CODES OF INDIVIDUALS OF MINERALS	
CODE	***INDIVIDUAL***
A	HIERRO Y ACERO
B	METAL AND MINERAL STEEL
C	METALS NO FERROSOS
D	METALS PRECIOSOS ORO Y PLATA
E	VIDRIO
F	MINERALS NOT METALLICS ARENA SILICA
G	MINERALS NOT METALLICS
H	METALS INDUSTRY NOT FERROSOS*/

** / includes the category of industrial source: own elaboration according to the algorithm of the indicative model (2019). Source: Own elaboration with data from the annual survey of the manufacturing industry EAIM, [18] (INEGI 2018).*

Table 2 shows the codes that were established for the algorithm according to the diagram indicated in the example of implementation of a genetic algorithm for the modelling guidelines.

- **The behaviour experimentation of data executes of a genetic algorithm;** the genetic algorithm is overview one example with empirical execute is contain forty because is study mutation generational time establish is many important say that is necessary bye observe empirical sequence for results.

This is present behaviour of the database of investment more feasible result because it contains forty executes of genetic algorithm, where demonstrate mutations finalist and present possibilities optimization.

Table 3. The behaviour of data indicative of investment and more feasible results

		The behavior of data indicative of investment and more feasible results table										
Actor/Actor	A	B	C	D	E	F	G	H	FITNESS %	RENT %	Executen number
F	0.451	0.789	1	0.446	0.609	1	1	0.196	5.491	1.294	1
B	0.005	1	0.553	0.214	0.407	1	0.789	0.165	4.133	1.284	2
G	1	0.086	0.421	0.152	0.179	0.067	1	0.123	3.028	1.269	3
A	1	0.407	0.403	0.332	0.58	0.451	0.359	0.156	3.688	1.108	4
A	1	0.047	0.403	0.332	1	0.451	0.359	0.156	3.748	1.126	5
H	0.156	0.165	0.223	0.819	1	0.196	0.123	1	3.682	1.158	6
B	0.005	0.152	0.553	1	0.407	0.789	1	0.165	4.071	1.265	7
D	0.332	0.819	0.085	1	0.189	0.446	0.152	1	4.023	1.243	8
G	0.359	1	0.421	0.086	0.179	0.067	1	0.123	3.235	1.355	9
H	0.156	0.165	0.223	0.819	0.498	0.196	0.609	1	3.666	1.153	10
G	0.359	0.086	0.421	0.152	0.179	0.067	1	0.123	2.387	1	11
B	0.165	1	0.553	0.214	0.407	0.789	0.086	1	4.214	1.309	12
C	0.403	0.553	0.421	0.085	0.628	0.686	1	0.223	3.999	1	13
D	1	0.214	0.085	1	1	0.446	0.152	0.819	4.716	1.457	14
B	1	1	0.553	0.214	0.407	0.086	0.086	0.165	4.214	1.309	15
A	1	1	0.403	0.332	0.047	0.451	0.359	0.156	3.748	1.126	16
G	0.359	0.086	0.421	0.179	0.152	0.067	1	0.123	2.387	1	17
G	0.359	0.086	0.421	0.152	0.179	1	1	0.123	3.32	1.391	18
C	0.686	0.553	1	0.085	0.628	0.403	0.421	0.223	3.999	1	19
D	0.446	0.214	0.085	1	0.189	0.58	0.152	0.819	3.485	1.077	20
C	0.403	0.421	1	0.085	0.628	0.686	0.553	0.223	3.999	1	21
C	0.403	0.686	1	0.085	0.628	0.553	0.421	0.223	3.999	1	22
A	0.446	0.047	0.403	1	0.58	1	0.359	0.156	3.991	1.199	23
B	0.005	1	0.553	0.214	0.407	0.789	1	0.165	4.133	1.284	24
D	0.332	0.214	1	0.223	0.189	0.446	1	0.819	4.223	1.305	25
G	0.359	0.086	1	0.152	0.179	0.067	1	0.123	2.966	1.243	26
B	0.005	1	0.553	0.214	0.407	1	1	0.165	4.334	1.35	27
C	0.403	0.553	0.553	0.553	0.628	0.686	0.421	0.223	4.02	1.005	28
H	0.156	0.165	0.223	1	0.498	0.196	0.819	1	4.057	1.276	29
G	0.359	0.086	0.421	0.152	1	0.179	1	0.123	3.32	1.391	30
A	1	0.58	0.403	0.332	1	0.451	0.359	0.156	4.281	1.286	31
E	1	0.58	0.628	0.189	1	0.609	0.179	0.498	4.683	1.145	32
D	0.332	1	0.085	1	0.189	0.446	0.152	0.819	4.023	1.243	33
B	0.005	0.609	0.553	0.214	1	0.789	0.086	1	4.256	1.322	34
B	0.005	1	0.553	0.214	0.407	0.789	1	0.165	4.133	1.284	35

Source: Own elaboration with genetic algorithm about classification by authors (2019).

The table 3 shows up to 40 mutations is shown in the data series and selected tow for the more fitness and rent that are presented in the form common to different results of contribution - income of executions, in this case, the first algorithm. This is represented all empirical practice method of optimized problem about investment in minerals in Mexico. The graphic in combination of higher-income - fitness, all executions represent all selective is obtain the graphics are observing.

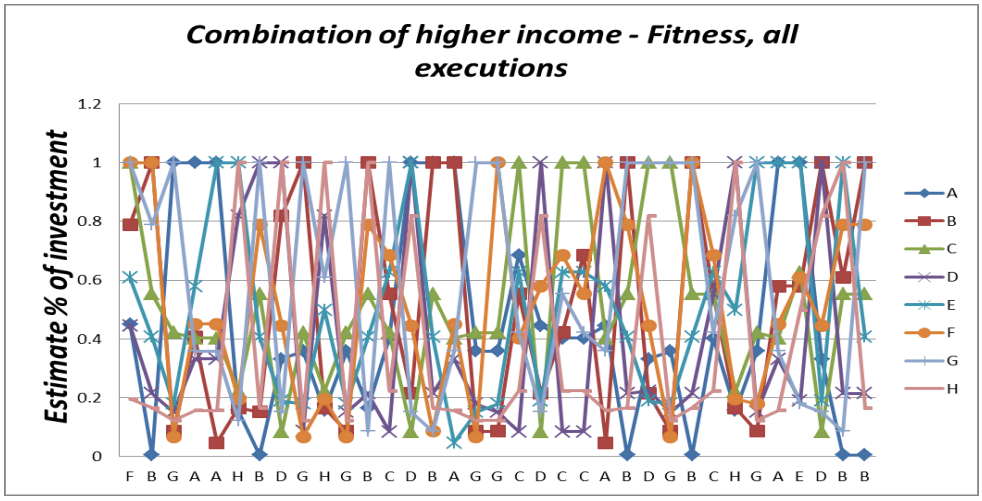

Figure2. Gross fixed investment in all execute. *Source: By authors (2019).*

The figure2 is resulted according to on table 3, estimate percent of investment on forty executes is all whit tow more than combination of higher income and fitness. Is it observing in all executes one fitness whit one percent in idealist optimization.

Next time is including the more than average mining according to success current about forty executes.

Table 4. The greater of data indicative of investment and more feasible results the actor

B = Metal and steel ore, number one	RESULTS of the ACTOR with greater data indicative of investment behavior and more feasible average										1er
Veces	A	B	C	D	E	F	G	H	FITNESS %	RENTA %	Ejecución #
B-1	0.005	1	0.553	0.214	0.407	1	0.789	0.165	4.133	1.284	2
B-2	0.005	0.152	0.553	1	0.407	0.789	1	0.165	4.071	1.265	7
B-3	0.165	1	0.553	0.214	0.407	0.789	0.086	1	4.214	1.309	12
B-4	1	1	0.553	0.214	0.407	0.086	0.086	0.165	4.214	1.309	15
B-5	0.005	1	0.553	0.214	0.407	0.789	1	0.165	4.133	1.284	24
B-6	0.005	1	0.553	0.214	0.407	1	1	0.165	4.334	1.35	27
B-7	0.005	0.609	0.553	0.214	1	0.789	0.086	1	4.256	1.322	34
B-8	0.005	1	0.553	0.214	0.407	0.789	1	0.165	4.133	1.284	35
Average									4.186	1.301	

Source: Own elaboration with genetic algorithm about classification by authors (2019).

Table 4 is RESULTS of the ACTOR with greater data indicative of investment behaviour and more feasible average, when the reason is whit more than executes successes.

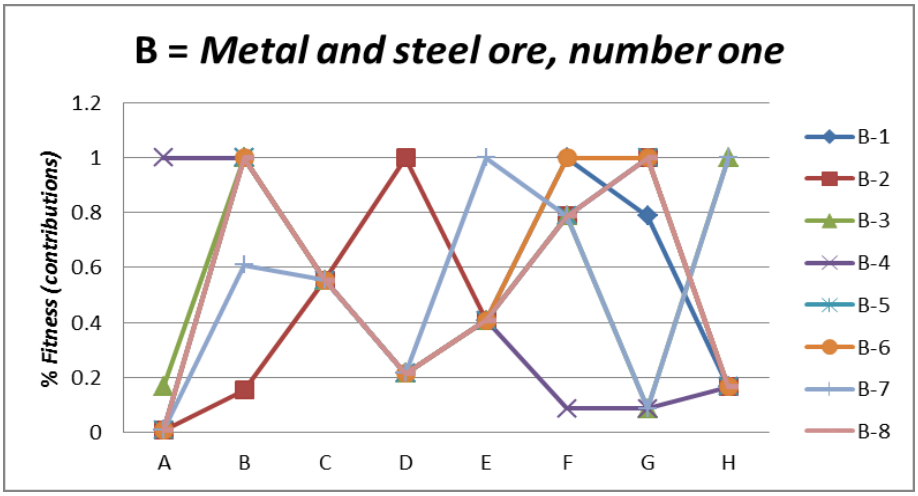

Figure 3. Gross fixed investment of iron and steel products number one. *Source: By authors (2019)*

Figure 3 results according to table 4 for fitness probability more than and is referee about mineral and steel ore number one, because this is eight combination whit optimization all fitness 1%.

5. Discussion and future research

Finally, it is found where are iron and steel ores have presented great potential by the estimated values of contribution and income according to the execution of the algorithm for modelling, observing the following behaviour. This is relevant because metal and steel ore is number one because selected to execute the genetic algorithm more than according Fitness (contributions) and the income. According to table 4 is result other four-figure indicate only fitness and rent.

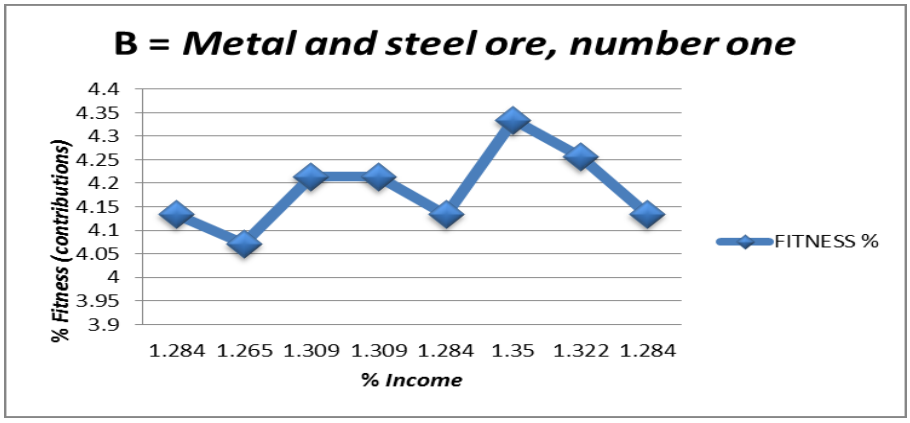

Figure 4. Income - Fitness, relation in solved with simulation methods. Source: By authors (2019).

Figure 2 shows according to table 4, a range of income of 1.3% and contribution of a range of 4.2% higher than the national average of 1.5%, due to which there is a production chain in most of the manufacturing sectors of technological innovation. The results point to a promising future for the metallurgical industry.

In the selection of the main minerals according to the criterion of the maximum value obtained with the statistical method and tool SPSS, determined the structure of the individual - gene.

Also note that ore and steel metal presents a better opportunity, demonstrating empirically that was obtained by having a greater occurrence of executions of the genetic algorithm and therefore is considered ore with greater investment opportunity. Which is true since this mineral is located in the innovative economy productive chain demonstrates that it shows how it optimizes a range of 1%, which means that it can be used in combination with other minerals that contain it n even with less opportunity obtained, with respect about 4.9%. of fitness is observed that it is higher than the expected national average contribution which fluctuates between an average of 1.2% to 3% within the metallurgical industry of Mexico.

6. Conclusions and recommendations

To highlight the empirical contribution of the results shown that using the databases data mining is formulated properly a powerful algorithm for the prediction model on the metallurgical industry in Mexico Stressing that iron and steel ores have an estimated value higher than the national average, confirming their relative importance that permeates with effect multiplied the majority of sectors of manufacturing with technological innovation.

Investment and production as two variables that relate because to increases the investment also production result of exploitation and production cycle during periods in time-series, it is important to apply the study to different tests for other minerals and complementary verifications, as well as to other sectors in the search for values empirically estimated positive and higher than the national average.

The application to different databases to other sectors is recommended to discover the degree of investment and future optimization opportunity user in many situations of investment. The more then is about metal and steel ore because it is according optimization investment. The recommendations are plicate in another database, and other sectors in economy bye observe the probability opportunity in optimization investment.

References

[1] Organization for co-operation and economic development OECD (2016). The new indicators in the OECD. Mexico. *www.oecd.org/eco*
[2] National Chamber of the industry of steel CANACERO (2016). The Infographic Mexico.
[3] National Institute of statistics geography and Informatics INEGI (2016) the industrial sector of Mexico: Mexico Industry Economic growth-ready. Mexico.
[4] National Institute of statistics geography and Informatics INEGI (2016) the industrial sector of Mexico: Mexico Industry Economic growth-ready. Mexico.
[5] National Institute of statistics geography and Informatics INEGI (2016) the industrial sector of Mexico: Mexico Industry Economic growth-ready. Mexico.
[6] Maldonado, F. J. B., Alfaro, E. D. G., & Portillo, M. C. R. (2012). Un estudio no paramétrico de eficiencia para la minería de Zacatecas, México. Revista de Métodos Cuantitativos para la Economía y la Empresa, 14, 54-75.

[7] Maldonado, F. J. B., Alfaro, E. D. G., & Portillo, M. C. R. (2012). Un estudio no paramétrico de eficiencia para la minería de Zacatecas, México. Revista de Métodos Cuantitativos para la Economía y la Empresa, 14, 54-75.
[8] Gaytan, E. & Benita, f. (2014). The mining industry in Mexico: performance patterns and determinants of efficiency. The Economy readings 80 (January-June), pp. 103-131 © Antioquia University. Medellin. Colombia.
[9] García M. & Ulloa M. & Belete O. (2013) Minería y Geología / v.29 n.2 / abril-junio / p. 46-70 El reemplazo de equipos mineros: un enfoque desde el rendimiento y los servicios técnicos de la contratación. Cuba. page 2
[10] Gaytan, E. & Benita, f. (2014). The mining industry in Mexico: performance patterns and determinants of efficiency. The Economy readings 80 January-June, pages 103-131 © Antioquia University. Medellin. Colombia.
[11] Azanero O. A. (1999). Modelos matemáticos para simular flotación industrial a partir de pruebas de laboratorio. Instituto de Investigación (RIIGEO), FIGMMG-UNMSM Vol. 2, N.º 03 Enero – Junio. Perú.
[12] Marzena, L.. Innovation in Economic Theory and the Development of Economic Thought. Warsaw University of Life Sciences – SGGW. Poland. ACTA Scientlarum Polonorum, 12, (2015).
[13] Hawthorn, M. F. (2017). Predictive Analytics: techniques and models used and applications of it - tools ope source. Catalonia: Universidad oberta de Catalunya, Spain.
[14] Hawthorn, M. F. (2017). Predictive Analytics: techniques and models used and applications of it - tools ope source. Catalonia: Universidad oberta de Catalunya, Spain.
[15] Hawthorn, M. F. (2017). Predictive Analytics: techniques and models used and applications of it - tools open source. Catalonia: Universidad oberta de Catalunya Spain, page 14.
[16] Alej Parisi, A. (2004). Models of genetic algorithms and neural networks in the prediction of variation of the IPSA sign. Research Gate. University of Chile.
[17] Hawthorn, M. F. (2017). Predictive Analytics: techniques and models used and applications of it - tools ope source. Catalonia: Universidad oberta de Catalunya, Spain.
[18] INEGI (2018). The annual survey of the manufacturing industry EAIM, Indicators Mexico.