Social and Techno-Economic Feasibility Study for The Implementation of An Educational Services Center in The Dominican Republic: Perspectives from A Comprehensive Methodology

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Abstract

This research work presents a comprehensive methodology based on a social, technical, and economic evaluation study of a proposal educational services center in the Dominican Republic. For this purpose, a social survey, a technical assessment and an economic were considereded and integrated with a multi-objective optimization analysis for the best decision making. The obtained results revealed that 98% of the respondents agreed with the implementation of the center, and the technical study determined that an initial investment of $ 31,200 USD is required. Moreover, the economic feasibility assessment indicated that an average bank loan percentage of 5.72 ± 0.28% was the value where the initial investment is required, and the net present value are optimized. Also, the internal rate of the return value was 41.15%, the value of the payback period was 2.92 years, and the rate of investment and profitability index values were 63.18% and 1.62, respectively, which indicated that the project is highly viable since long-term economic benefits are obtained. Therefore, the comprehensive methodology presented in this work represents a valuable procedure for the best decision-making since it considers a holistic approach. Finally, this methodology can be used for its implementation in various frameworks as a plan for different investment projects in the educational, social, and health sectors in the Dominican Republic, and the obtained results demonstrated the acceptance and feasibility of the project within a local context for its integration and proliferation in the economic development of the country.

Keywords: Education sector; social survey; financial assessment; multi-objective optimization; decision-making

1. Introduction

Education represents a fundamental human value, a social need, and is the path to constant knowledge, self-preservation, and success, and provides an understanding of social behavior, strength, character, and self-respect (Bhardwaj, 2016). During the last decades, the constant education of human beings has permitted the improvement of knowledge, skills, and competencies, increasing capacity, capability, performance, and academic and professional productivity (Ganesh & Indradevi, 2015). This training is given in professional centers that contribute to the generation of knowledge and allows it to be disseminated for the growth of society (Sangeeta & Dhamdhere, 2015). An education center is a space dedicated to the academic instruction of people that offers a variety of courses, workshops, and diplomas, that aim to teach and train them in a specific field to reinforce the knowledge acquired (Bellview, 2014). Academic training must continue to develop, expand and diversify the knowledge and skills to perform a productive activity through different actions that allow the person to be positioned in an advantageous situation for their integration into the labor market, thereby increasing their competitiveness (Weller, 2011). In the Dominican Republic, several establishments are dedicated to strengthening the skills of graduate university people who require better preparation before or after being integrated into the labor sector (Bastardo-Cedĕo, Rodríguez-Conde, &

Seoane-Pardo, 2019). However, specifically in Puerto Plata province, there is no such organization, so people who want to strengthen their academic skills have to go to other places outside this municipality, which implies a challenging position due to the time and money involved in moving out of the city. Additionally, a facility that resolves this issue significantly impacts the economic and educational sectors. On the other hand, due to the lack of employment possibilities, recent graduates from colleges and universities find it challenging to place themselves in the market since, besides the degree requirement, other selection criteria are essential in recruitment, like attitudes and aptitudes for work or indicators of employability and extensive work experience in the labor sector (Baldauf & Luchinskaya, 2019; Dávila Roca, 2019).

In recent years the education market has shown remarkable development since companies dedicated to these types of economic activities have demonstrated strengths and continuous progress, increasing by 18 %, according to the Chamber of Commerce and Production (Camara, 2022), which represents a potential market of clients from other municipalities and surrounding areas. Moreover, according to National Statistical Office (ONE, by its acronym in Spanish), about 25 % of the population is unemployed or inactive, considering both men and women. Also, only 5.2 % of the total companies in Puerto Plata province comprise the education sector (ONE, 2014). These data

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infer that there is an opportunity to integrate educational services center for the generation of employment in the region to increase the competitiveness of university graduates. During the last few years, the need to integrate educational centers has gained more importance, and the participatory action of the community focused on a new educational transition is essential since it allows identifying and designing actions to be developed in the elaboration of diagnosis actions and a strategic plan for the evaluation of the target community (López-García et al., 2021). Within this context, different works in the literature are related to this topic. An example of these was presented by (Gandarillas Ortiz & Uriarte Moisés, 2012) in which they conducted a techno-economic study to determine the viability and feasibility of a company dedicated to providing specialized services, training and technological updating services, and business management to adults, professionals, and companies. The project included a sector diagnosis that permitted for an understanding of the environment's current state, market research to analyze the client's behavior the competition, among other factors, as well as a study of the location, engineering studies, and size, organizational aspects, planning of the execution, financial evaluation, and a sensibility analysis with various economic scenes. The final results revealed that the expected incomes of the project were economically attractive, and profitability indicators were positive, with possibilities for long-term growth. (Vinueza Oñate, 2014) developed market research and a business plan for a training center, "Canadian School" in Chimborazo, Ecuador. The business plan represented the institute's technical, commercial, operational, and financial aspects. It aimed to simplify a holistic analysis that identifies the center's direct and indirect proficiencies, its marketing plans, and its strategy for selecting human talent based on competencies, avoiding administrative issues, and saving time and resources in the process. The final results demonstrated that the business plan was feasible since a positive present value was obtained and an internal rate of return that exceeds the opportunity cost of money. At present, the proposed center has already been installed and is operating in Riobamba, Ecuador with an academic gastronomic focus (Canadian School, 2023). Another proposed study and currently in progress was developed by (Cerna, Collao, Paz, & Polo, 2018), in which they presented and executed a proposal for a private educational institute of basic education in the district of "Los Olivos y San Martin de Porres", Lima, Peru. The work carries out political, economic, legal, cultural-social, technological, and ecological analysis, conforming to a holistic methodology. The results indicated that the proposal was well accepted by the study audience, and different economic indicators supported the feasibility of the project. At present, the institute is working on providing basic education in the previously mentioned location.

Moreover, (Dávila Roca, 2019) presented a business plan for the creation of a training and education center for people suitable for the Ecuadorian labor market, whose general objective was to demonstrate the importance of the installation of this project in the framework of labor competencies development for the successful integration of people in the market. Similarly, the methodological study considered different measurement instruments such as a survey questionnaire

considering a market, legal and financial analysis. The results exhibited that the project was feasible, obtaining a positive net present value, an internal rate of return higher than inflation, and a payback period of two years. Finally, another work plan executed and in operation was developed by (Erika Lizeth & Lilian Carolina, 2022) in which they conducted a proposal for the creation of an educational innovation center in the city of Bucaramanga, Santander, Colombia. The plan was developed using the "Business Model Canvas" model to offer an alternative in the teaching-learning processes in the city, and a technical, market and financial analysis were carried out. The outcomes revealed that the work presents a growing and strong importance in the market as an instrument for the improvement of the country's education. The work served to lay the foundations and reform education in the city, and currently the center has been formed as a thought center for educational innovation, with a view towards a better educational quality of the official educational institutions of Bucaramanga.

As noted from the literature review, the motivation for the implementation of this type of projects has been related to economic factors, the search for opportunities in competitive markets, job opportunities, and even the need for self-actualization of knowledge (Ferreira, Loiola, & Gondim, 2017). The investment in education is less expensive, can be easily implemented, does not require large organizations or coalition agreements, and typically yields visible results in short periods (Vaduva, Echevarria-Cruz, & Takacs, 2020). Furthermore, from the social point of view, most of the projects developed in this context do not present a comprehensive methodology, which strengthens the diagnosis of the community needs through parallel analysis towards a trans disciplinarity study (Mori Sánchez, 2008). Finally, the studies presented considered different economic indicators that allow the best decision-making. However, different variables are not necessarily the more optimal for each case. These variables include investment amounts, interest rates, and cash flows. Thus, economic decision analysis involves determining the action that best achieves a desired goal or objective. This means finding the case that optimizes (that is, maximizes or minimizes) the value of an objective function (Chong et al., 2022). Therefore, the reduction of costs and the increase in revenues is a topic of interest in this field. The optimization problems include pursuing the maximum or minimum value and using single or multiple objectives (Gunantara, 2018). Problems with more than one objective are referred to as Multi-Objective Optimization (MOO), a branch of mathematics used in multiple-criteria decision-making, which deals with optimization problems involving two or more objective functions to be optimized simultaneously (Nayak, 2020). The motivation for using the MOO is that it does not require complex equations, simplifying the problem (Gunantara, 2018). This type of problem can be found in many fields, including mathematics, engineering, social studies, economics, and agriculture, where optimal decisions must be made considering two or more competing goals whose solution usually requires sophisticated techniques to tackle. Therefore, metaheuristic approaches have demonstrated promise and popularity recently (Yang, 2020).

The purpose of this paper is to present a comprehensive methodology to evaluate the market, technical and economic feasibility of implementing a proposed educational services center in Puerto Plata, a province of the Dominican Republic. Also, a multi-objective optimization process for the best decision-making is performed to identify the project's feasibility, which remains as a background that can be used as a reference for future works to carry out similar studies, considering it as a global reference framework.

The objectives of this study are summarized with the actions presented below:

- Conduct a market study to determine the project's social acceptance and specify the technical study requirements.

- Identify through a technical assessment the different furniture and equipment the project needs to operate and lay the groundwork for the economic study.
- Perform a multi-objective optimization process considering various economic indicators.
- Determine the profitability of the project through an economic evaluation for the best final decision-making.

2. Comprehensive methodology

The comprehensive methodology adopted for this study can be illustrated in Figure 1, where the market, technical and economic studies are presented and related. These different assessments are described in the following sections.

Figure 1. Schematic comprehensive methodology implemented in this work.
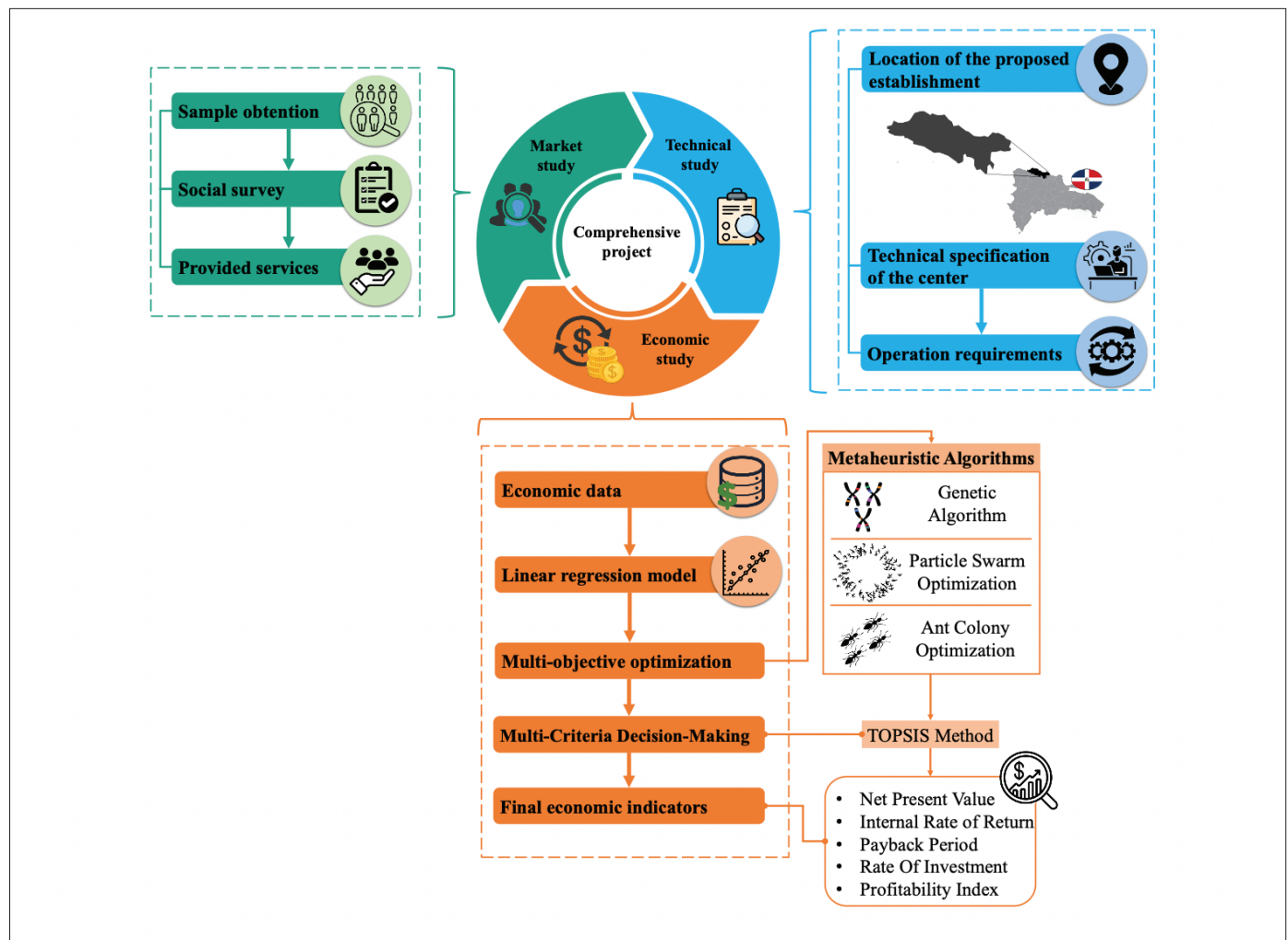
A market analysis study is essential to any project's development. Thus, this section represents a social diagnosis as part of the proposed comprehensive methodology, which involves data collection, analysis, and forecasting. The presented information allows knowing the social acceptance of the community and acts as a helpful tool that connects with the technical and economic study within a transdisciplinary context.

2.1.1. Sample obtention

According to the approach of this work, the target population is centered on the number of graduate university people residing in the province of Puerto Plata, which, according to the last census carried out by the ONE, comprised a total of 28,928 persons who completed their university studies (ONE, 2014). However, since there is no current census, a population projection is made for the actual year as part of a data pre-processing which considers the population growth rate (r) reported by the ONE of 2.8 %. Therefore, the estimated actual population is calculated using Eq. (1) (Torres-Degró, 2011).

$$P_{2022} = P_{2010} \times r + P_{2010} \qquad (1)$$

Where P_{2010} is the number of the target population in 2010 and P_{2022} the current estimated amount. Thus, the present study's sample can be obtained from a simple random sample determined with Eq. (2) (Lohr & Velasco, 2000).

$$n = \frac{z^2(p)(q)(N)}{e^2(N-1) + z^2(p)(q)} \qquad (2)$$

Where N is the population universe, z is the confidence level (considered as 1.96), p and q are the positive and negative portions, respectively, considered as 0.5 since there is no previous study, and e is the maximum error allowed, which is assumed as 5 %.

2.1.2. Social survey

The presented data was collected via a survey questionnaire using a Likert-type scale measuring importance and satisfaction based on agreement, and the collected information was accomplished virtually through the google forms tool. The survey consists of several questions divided into different sections that involve social and economic aspects. The first section considers sociodemographic and socio-economic aspects of the respondent, which aid in understanding the characteristics of the sample. This axis consists of features such as gender, age group, and monthly income, and all the variables facilitated the authors to identify correlations for an in-depth analysis presented in the results section. Subsequently, the second section records details about the acceptance to implement the project in the community. This part asks if the respondent is interested in the services provided by the center, what specific services are most in demand, and the amount of money they would be willing to pay for them. In this axis of the survey, more profound aspects of the center's services are disclosed after knowing its acceptance. Also, this section relates to the people's interest in the financial budget, which allows inferring if the respondent can be a potential client and, depending on the percentage of acceptance for the implemen-

tation of the center, consider the technical study to start up the project. Moreover, the last axis of the survey constitutes aspects such as the payment method, the advertising medium to expand the center's services, the potential location, and the project's social impact. This part allows knowing, through the different answers of the respondent, the most viable options that facilitate services to clients and contemplate a great scope at a social level. Finally, to verify the reliability of the questionnaire, Cronbach alpha's reliability coefficient was utilized (Amirrudin, Nasution, & Supahar, 2021). Therefore, the present survey allows considering the needs and points of view of the study people and can be considered a dynamic tool to analyze the community's perspective, disposition, and acceptance of the project's implementation.

2.1.3. Description of the provided services

The different services offered by the proposed center consist of educational workshops, diploma courses, oratory and writing, and other courses related to personal development, such as self-knowledge, motivational courses, personal relationships, and management of emotions and anxiety, among others. Also, as part of the services offered in the educational center, a department of orientation and psychology is considered, which supports the services related to personal development and manages the center to improve teaching and provide the client with the evaluation, monitoring, and supervision of their learning and performance within the psychological-educational framework. Moreover, part of the state's public policies does not contemplate this department's integration within this context. Therefore, its consideration in this proposal is crucial since it complements part of the needs demanded by the community.

2.2. Technical study

This section describes the technical aspects considered for this research work, which includes the location of the center, the production capacity of the establishment, as well as the installed capacity, and its operating requirements.

#### 2.2.1. Geographical characteristics of the case study

As previously mentioned, the proposed center is located in the province of Puerto Plata (20.48 ºN, 89.72 ºW), Dominican Republic, specifically in the San Felipe municipality, in a favorable geographical area where there is a constant movement of people and vehicles. The Puerto Plata province has a population of 330,601, and the current number of people with a university education level or higher is 29,738, which was obtained using Eq. (1), considering the ONE census (ONE, 2014) and the population growth rate. Figure 2 illustrates the map of Puerto Plata province and some demographic indicators of the Dominican Republic.

Figure 2. Geographic map of Puerto Plata, Dominican Republic.
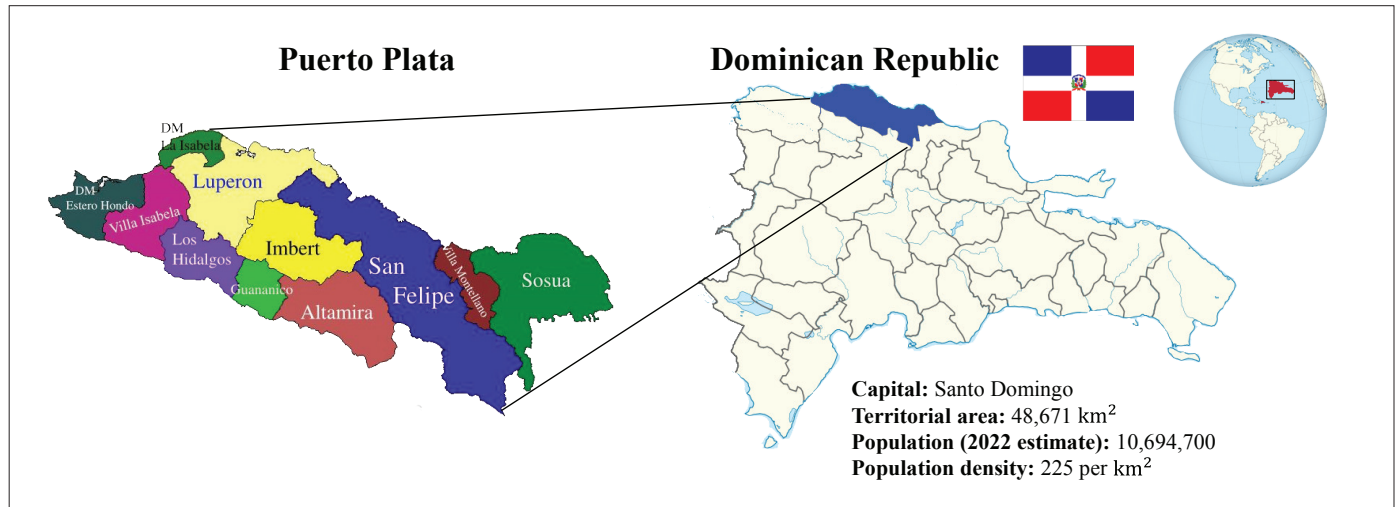
From the market study, the percentage of respondents who agreed with the implementation of the proposed center were considered potential clients; however, only 20 % of the total were considered real clients. This percentage was determined based on the 80/20 rule of the Pareto principle (Dunford, Su, & Tamang, 2014), and the different equipment and furniture were dimensioned based on this result. Also, the amount of income and expenses of the cash flow were quantified for the economic evaluation, which is presented in later sections.

2.2.2. Technical proposal and specifications of the educational center

The proposed center has a reception room, an administrative department, an orientation, and psychology department, two teaching rooms, a toilet, and a maintenance room. Also, it can attend to approximately 40 people simultaneously, divided into two classrooms, and the services are provided in two periods, morning and evening. Therefore, it is essential to clarify that the number of people relates to the center's maximum capacity and corresponds with the number of real survey clients whose value is presented in the results and discussions section. The proposed sketch of the center is illustrated in Figure 3.

Figure 3. Proposed sketch of the educational center divided into different areas.

A: Administrator
B: Bathroom
M: Maintenance room
P: Orientation and psichology department
R: Reception
T: Teaching room
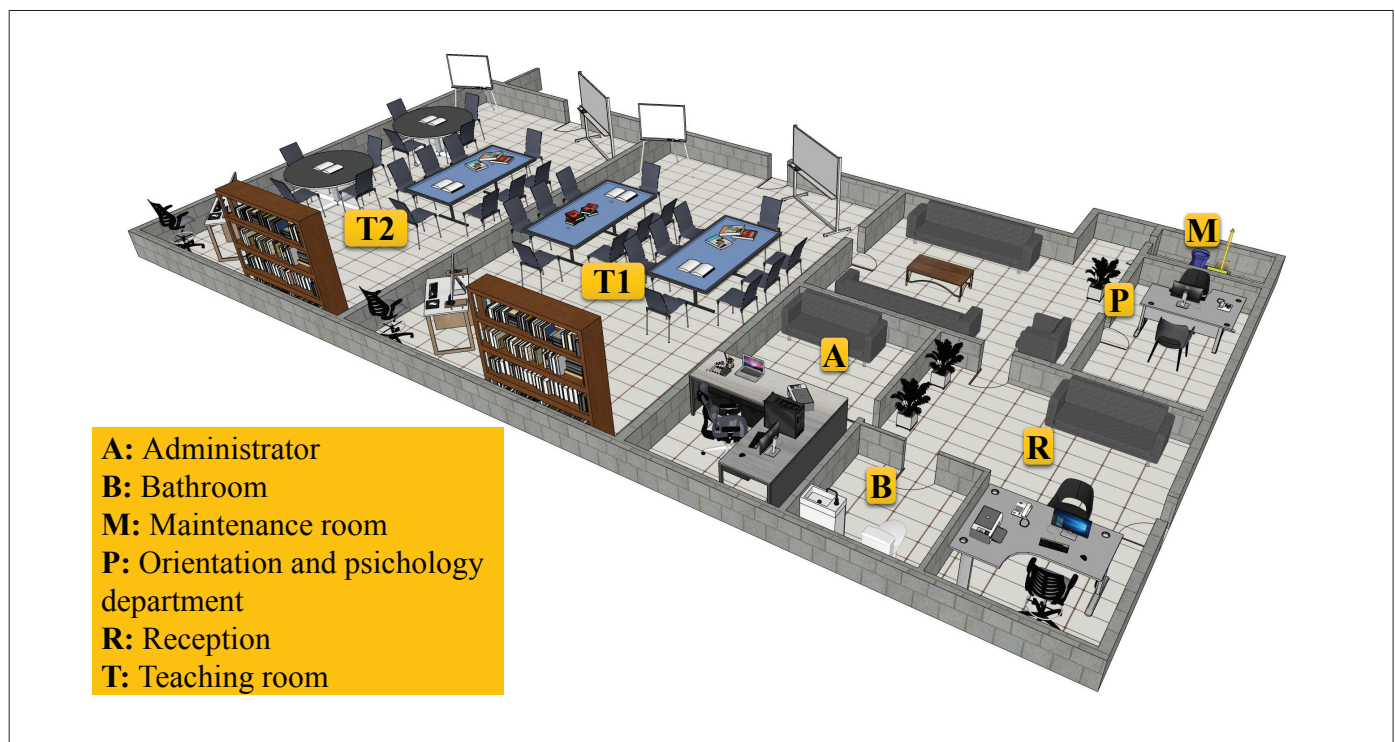
2.2.3. Operation requirements

For the operation of the proposed center, different equipment that includes furniture and fixtures, electronic equipment such as computers and printers, as well as the expenses for remodeling the establishment, are required. These expenses are referred to as fixed or tangible investments. Furniture and equipment expenses were based on the prices reported by (IKEA, 2022) in the Dominican Republic, while remodeling expenses were considered based on local average prices. Specifically, for used electronic equipment, an annual maintenance expense is considered with costs established by local businesses. Moreover, it is considered an intangible investment that includes operating contract expenses such as electricity services (Edenorte, 2022), potable water (INAPA, 2022), telephony and internet (CLARO, 2022), the initial deposit of the premises, as well as feasibility, marketing, and advertising expenses for the initial promotion of the center's services. Finally, working capital is considered, corresponding to the initial amount required for the purchase of cleaning and office material which is replaced monthly, as well as the payment of rent and salary payments to employees according to average values reported by (WageIndicator, 2022) and the first monthly payment of the essential services of telephone, internet, electricity, water, and waste collection.

2.3. Economic study

2.3.1. Initial investments

The monetary value of each investment described in the previous section correspond to values of $ 25,245 USD for tangible investment, $ 1,948 USD for intangible investment, $ 4,007 USD for working capital, giving a total of $ 31,200 USD, and finally the annual equipment maintenances of $ 1,317 USD. The breakdown corresponding to each concept and its respective cost considered for the initial investment is described in detail in Table 1.

Table 1. Breakdown of concepts and costs related to the initial investments of this study.

Tangible investment		Intangible investment		Working capital	
Concept	*Cost*	*Concept*	*Cost*	*Concept*	Cost
Furniture	$ 7,621.2 USD	Electric service	$ 38 USD	Process material (sheets, pen, folders, notebooks, etc.)	$ 413 USD
Computational equipment	$ 2,817.7 USD	Telephone and internet service	$ 10 USD	Payment of basic services (rent payment, light, water, telephone, internet, and waste collection)	$ 687 USD
Surveillance system	$ 528.1 USD	Initial deposit	$ 760 USD	Payroll payments (administrator, psychologist, teacher, receptionist, janitor)	$ 2,907 USD
Lighting and work equipment	$ 2,403 USD	Feasibility study costs	$ 475 USD	**Sub total**	**$ 4,007 USD**
Establishment remodeling	$ 11,875 USD	Publicity and marketing	$ 665 USD		
Sub total	**$ 25,245 USD**	**Sub total**	$ 1,948 USD		
				TOTAL	**$ 31,200 USD**

As can be observed from Table 1, the tangible investment is used for the purchase of all equipment related to furniture, computing, surveillance, lighting, as well as the renovation costs of the establishment. Furthermore, the intangible investment costs correspond to the initial contracts for basic services such as electricity, telephone and internet that the center requires. Likewise, an initial deposit cost is contemplated as part of the contract, as well as feasibility, publicity and marketing costs. Finally, the working capital involves the costs of process materials, mainly basic stationery products, as well as the monthly payments of the contracted basic services, and the payroll payments of the different employees of the center.

2.3.2. Economic evaluation indicators

The economic evaluation study for the current project is presented in this section. This study is critical because it allows decision-making and identifies the minimal return on investment that a potential investor should expect, considering the opportunity costs and risks. In this case, the project's profitability can be determined using several indicators proposed for this study. The first of these is the required investment (I_r),), which corresponds to the difference between the total initial investment (I_0)) and the amount of investment covered by the bank loan (I_b),),) which can be calculated by Eq. (3).

$$I_r = I_0 - I_b \qquad (3)$$

The investment covered by the bank loan is estimated by multiplying the bank loan percentage by the initial investment. When this percentage increases, the required investment decreases.

Another relevant indicator is the Net Present Value (NPV), which compares the present cost of a specific quantity of future cash flows resulting from an investment. This considers the monetary amounts of their equivalent value from the future to the present (Aranday, 2018). When NPV is more significant than zero, economic benefits are obtained so the project can be accepted. Otherwise, if NPV is less than zero, the project should be rejected because there are no economic benefits. The NPV can be estimated as the difference between the cost of the initial investment (I_o) and the aggregate of all related cash flows (CF_t),), considering the income and expenses of money during the evaluation time (*n*) of the project (Haixia, 2015).

$$NPV = -I_o + \sum_{t=1}^{n} \frac{CF_t}{(1 + MARR)^t} \qquad (4)$$

Where the MARR is the Minimum Acceptable Rate of Return which determines the acceptability of the project's investment, which is considered equal to the interest rate of the bank (Ministerio de Hacienda, 2014) and CF_t is estimated by Eq. (5).

$$CF_t = I - E - FE - O\&M - tax + SV(last\ year) \qquad (5)$$

Where I is the income, the expenses, the financial expenses, which is the payment of the bank loan, is the annual equipment operation and maintenance expenses, and is the salvage value only considered for the last year of the evaluation. Therefore, for the assessment of the project, a time of 5 years is considered (Urbina & Castellanos, 2016), and it is the period that the bank authorizes to repay the loan.

The breakdown of each expense is described below.

- The estimated annual revenue comprises $ 68,400 USD, which was projected considering an average monthly payment for services. These services correspond to the delivery of workshops and diploma courses with an estimated monthly income of $1,881 USD and $513 USD, respectively, ss well as different courses (oratory and writing, personal development, motivational courses, personal relationships, and management of emotions and anxiety, among others) provided by the center, with an estimated revenue monthly total of $ 3,306 USD. The amount for each service was estimated from previous studies and average values of similar services offered in the city according to the social fees of the state. Hence, it is considered that the center would be able to support itself with the income produced by all the different services until the original investment is pay back.

- Expenses include annual rental, employee payroll payments, replacement expenses for cleaning and office supplies, and disbursement for essential services (telephony and internet, water, electricity, and garbage collection). This total includes an amount of $ 48,080 USD per year.

- On the other hand, the financial expenses contemplate the bank loan repayment considering the interest established by it. This amount depends on the percentage of the initial investment that the bank loan covers. In this work, an interval between 1 and 100 % is established, and an interest rate of 18.35 % is considered (BANRESERVAS, 2022). Furthermore, the total amount returned to the bank can be estimated using Eq. (6) (Campolieti & Makarov, 2018).

$$P = C(1 + i_r)^n \qquad (6)$$

- Moreover, the annual payment is calculated by Eq. (7).

- Where C is the amount of the bank loan and i_r the interest rate.

- The annual equipment maintenance includes a total in the first year of $ 1,317 USD, and an annual increase is considered with an inflation rate of 9.43 % according to the "Banco Central" of the Dominican Republic (Central, 2022).

- Regarding the amount of taxes, a value of 27 % is considered, according to the "Ministerio de Hacienda" of the Dominican Republic (Ministerio de Hacienda, 2014). This percentage is applied to the accumulated sum of the incomes, expenses, financial expenses, and annual equipment maintenance.

- Finally, the salvage value is estimated, considering that products depreciate over time, where office and data processing equipment have an annual depreciation rate of 25 %. All other depreciable assets of a company lose value at a rate of 15 % per year (Ministerio de Hacienda, 2014; Urbina & Castellanos, 2016).

When the NPV is obtained, the Internal Rate of Return (IRR) which is the MARR that equates the NPV to zero, can be achieved (Campolieti & Makarov, 2018). The concept of IRR presupposes that all profits are wholly reinvested each year. That is the rate of return produced only by investing within the company, which is calculated by Eq. (8).

$$A = C \left[\frac{i_r (1 + i_r)^n}{(1 + i_r)^n - 1} \right] \qquad (8)$$

This rate is obtained by iteration or graphically. When the NPV is zero, the project has an income equivalent to the initial investment. Therefore, if IRR is greater than the discount rate, the project is feasible; otherwise, the project is not feasible.

Finally, other economic indicators were considered, such as the Payback Period (PP), which refers to the time required to earn back the amount invested in an asset from its net cash flows. The Return of Investment (ROI) assesses an investment's efficiency or profitability, and finally, the profitability index or profit investment ratio (PI) that represents the relationship between the costs and benefits of a proposed project. A higher PI indicates that a project is more feasible (Investopedia, 2022). Eqs (9 – 11) estimate all these indicators.

$$PP = \frac{initial\ investment}{average\ annual\ cash\ flow} \qquad (9)$$

$$ROI = \frac{current\ value\ of\ investment - cost\ of\ investment}{cost\ of\ investment} \qquad (10)$$

$$PI = \frac{present\ value\ of\ future\ cash\ flows}{initial\ investment} \qquad (11)$$

2.3.3. Multi-Objective Optimization

This section describes the process used to optimize the percentage of the investment covered by the bank (i_b) (input variable), and the required for the project (I_R), as well as the NPV, considered as output variables. By increasing the value of i_b, I_R decreases, and NPV also decrease since the financial expense that is returned to the bank is greater.

Therefore, a multi-criteria problem is presented, for which to carry out the best decision-making, a multi-objective optimization methodology is required. Practically all real-world optimization problems are best represented using competing objectives, making multi-objective optimization an essential component of optimization operations. However, the evolutionary strategy has been to solve a multi-objective optimization problem instead of the conventional strategy of scalarizing many objectives into a single objective (Deb, 2014). MOO techniques are designed for simultaneously optimizing two or more objective functions, which independently do not guarantee a satisfactory solution for one another.

To implement the multi-objective optimization method, an objective function is required to optimize it, which can be obtained from a linear regression of the form of the input variable with each output variable. This regression is implemented in the data analysis and graphing software Origin®. Moreover, to execute the optimization process, three metaheuristic algorithms were implemented in the programming environment MATLAB, in which the feasibility of the solution was evaluated and compared with each other. These algorithms were the Genetic Algorithm (GA) (Whitley, 1994), Particle Swarm Optimization (PSO) (Kennedy & Eberhart, 1995), and the Ant Colony Optimization (ACO) (Dorigo & Blum, 2005), whose pseudocodes are better described in Appendix A.

The optimization problem of this study is expressed by Eq. (12).

$$\text{Min}(y) = \begin{cases} y_1 = I_R(i_b) \\ y_2 = -NPV(i_b) \end{cases} \tag{12}$$

It should be noted that the optimization process by the algorithms mentioned is intended to minimize the targets; however, maximizing a variable has to be considered negative.

A set of design variable restrictions constrains the search space or solution zone of the multi-objective optimization problem. Since only one input variable is presented, this limit is defined as $1 \leq i_b \leq$, which is described as a percentage interval.

2.3.4. Multi-Criteria Decision-Making

Multi-Criteria Decision-Making (MCDM) is a required procedure for selecting the final solution in a MOO problem where a collection of non-dominating candidate solutions are represented by a Pareto front and are the outcome of multi-objective optimization. Before decision-making, the Pareto front can be used to highlight situations where the objective functions are non-dimensionalized. In this work, The Order of Preference by Similarity to Ideal Solution (TOPSIS) method was considered, where the relative distance (Di^+, Di^-) of each possible solution (f_i)) are calculated considering the ideal and non-ideal solutions (Tariq et al., 2021). TOPSIS is based on two relative distances calculated for each alternative criterion in terms of the ideal and non-ideal solutions. Eqs. (13 – 14) estimate these distances. (Çelikbilek & Tüysüz, 2020).

$$D_i^+ = \sqrt{\sum_{j=1}^{n}\left(f_{ij} - f_j^+\right)^2} \tag{13}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}\left(f_{ij} - f_j^-\right)^2} \tag{14}$$

where f_{ij} is the decision matrix value for the jth criterion of the ith alternative.

Finally, the calculation for the final ranking, which corresponds to each alternative's closeness coefficient (C_i) to the ideal solution is obtained by Eq. (15).

$$C_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{15}$$

After sorting the relative closeness matrix in ascending order, the solution with the highest value is obtained.

3. Results and discussions

3.1. Market research analysis

This section presents the results of the survey used during the market study. For this purpose, the proposed questions are graphically presented, as well as the answers obtained by the sample of the target community with a value of 380 inhabitants, which was estimated from Eq. (2). The Cronbach's alpha obtained was 0.9621, which is in excellent consistency, and indicates the reliability of the scale used during the survey. Figure 4 presents the survey results considering a percentage for each response option.
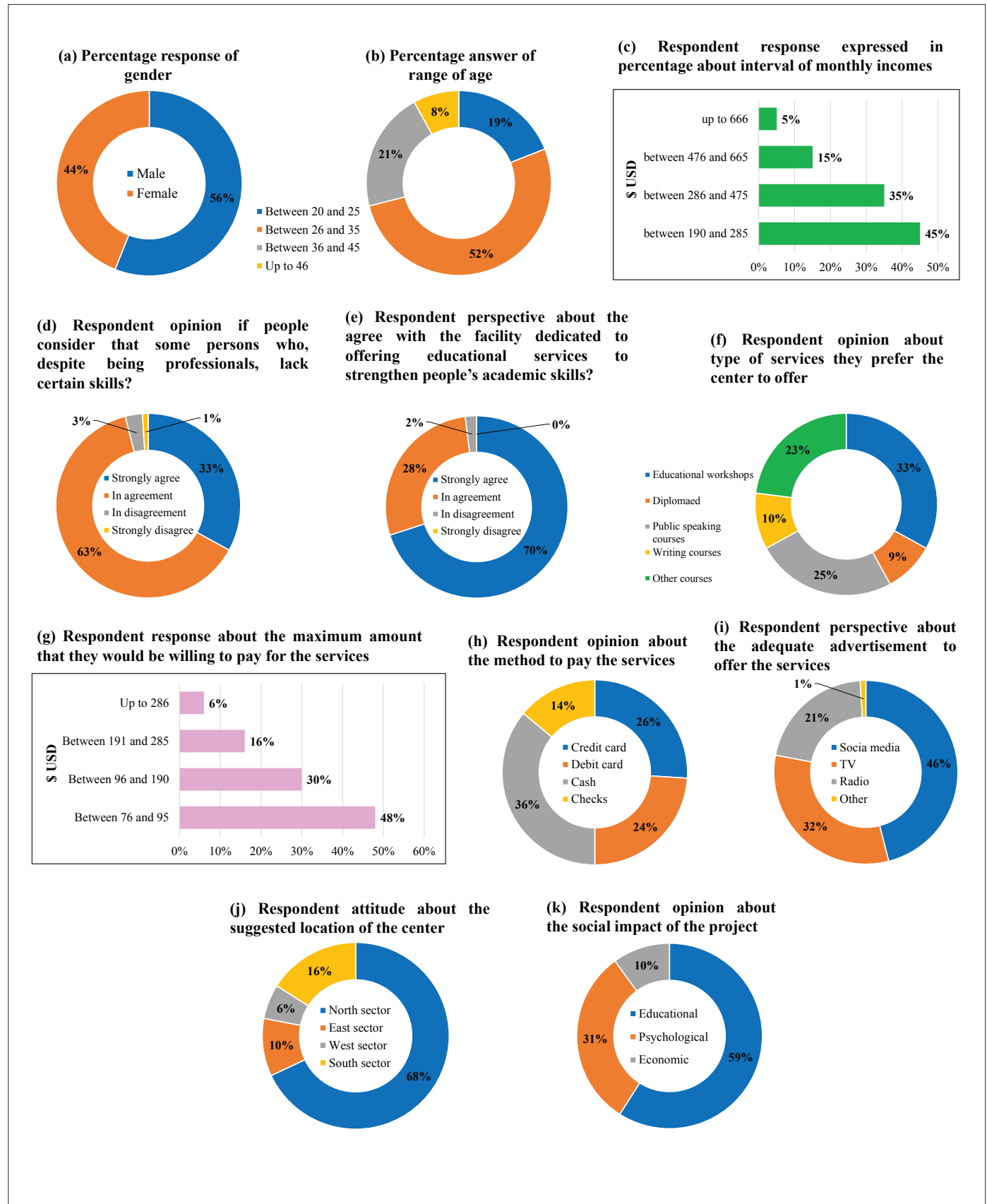
Figure 4. Results of the social survey related to the market study. Note: the alphabets (a-k) correspond to each question.

Figure 4 (a, b, and c) registers the sociodemographic and socio-economic details of the respondent, indicating that a large part of the sample was male; 52% were between 26 and 35 years old, which reveals that this age range can be a great market potential and coincides with the range where most people are concluding their university studies and want to strengthen different skills. Finally, the highest average percentage prevailed between $ 190 and 285 USD income per month. Moreover, Figure 4 (d, e, f, and g) highlighted that most respondents are conscious that the majority of university graduates lack skills that can be communicative or written that the labor field demands, also, 70 % of respondents strongly agree and 28 % agree with offering different educational courses. This question permits knowing the potential client and the acceptance of the project. As for the type of services that people demand, there are other courses (23 %) that cover personal development, such as self-knowledge, motivational courses, personal relationships courses, management of emotions and anxiety, among others. These courses are intended to be imparted with the aid of the department of orientation and psychology, while for the educational section, 25 % corresponded to public speaking courses and 33 % to educational workshops. Regarding the opinion on the maximum amount of money that the respondent would be willing to pay, 48 %, corresponding to the range between $ 76 and 95 USD, was obtained, which corresponds to the minimum amount of the options presented, which is related to the question (c) since the maximum amount to pay for the services depends on the monthly income of each person. Finally, the questions of the last section (Figure 4 (h, i, j, and k)) allow for knowing the most practical alternatives that support client services and considering the project's impact on a social level. Thus, it was found that 36 % of respondents prefer a cash payment method, 46 % prefer that advertising and the scope of services be through social networks, 68 % agree that the establishment is located in the north, and finally, 59 % consider that the impact of the project corresponds to the educational field. The outcomes obtained from this study revealed a clear general trend toward the acceptance of the target community, so the technical study proposed in section 2.2 justifies this approach considering the initial amounts of the investment for its evaluation of economic feasibility.

3.2. Economic analysis results

Based on the results obtained from the market study and those proposed in the technical study, this section presents the economic study's results, subdivided into different sections from the previous proposed comprehensive methodology.

Linear regression model

The results of the regression analysis are presented in this section. For this purpose, 100 values corresponding to i_b were set as an independent variable and I_R and NPV considered dependent variables were processed for obtaining a linear regression equation. These results are presented in Figure 5.

Figure 5. Linear regression model corresponding to (a) initial investment required and (b) net present value.
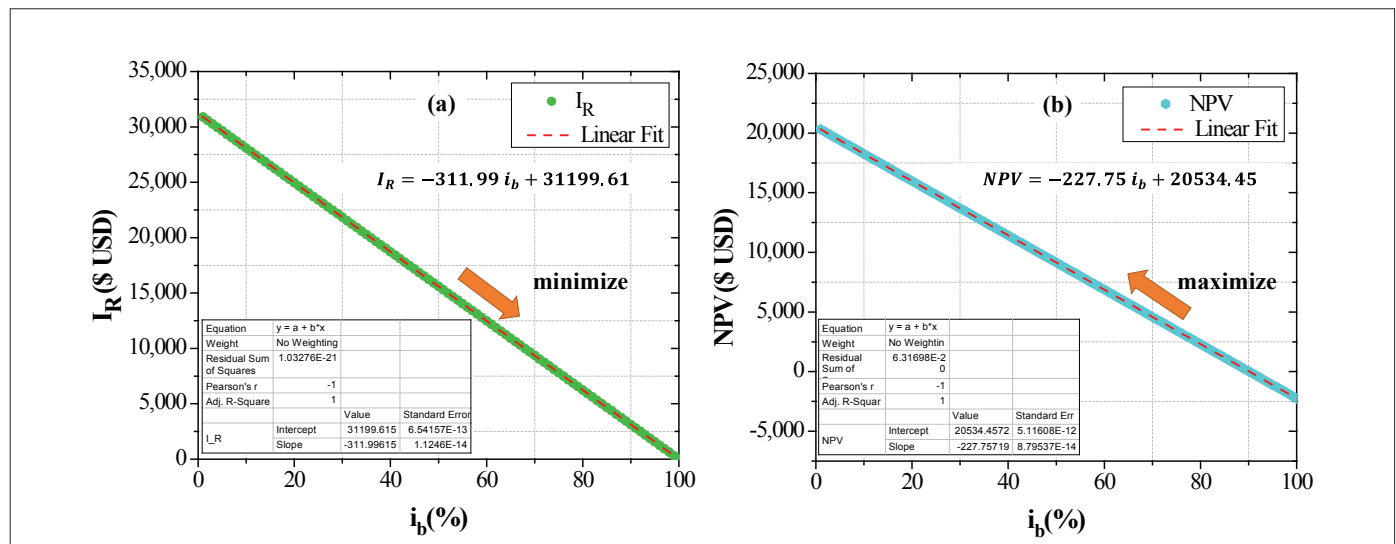

As can be observed in Figure 5(a) and (b), the linear fits presented a high correlation with the reported data, with a coefficient of determination of 1 for both cases where the corresponding equation of the linear regression fit is reported. For I_R it is intended to minimize the initial investment amount; however, when making the economic evaluation during the proposed period, it is desired to increase the NPV so that the project's investment Both regression equations can be rewritten using a single function to perform the multi-objective optimization.

Multi-Objective Optimization

The outcomes of the application of multi-objective optimization and the TOPSIS solution are presented in this section. It can be noted that the results of the multi-objective optimization are a set of solutions contained within the domain of economic performance indicators. Therefore, the results of the Pareto front are presented (see Figure 6), and the three optimization algorithms mentioned above were used.

Figure. 6. Pareto front and best decision-making result obtained with TOPSIS method with different algorithms: (a) genetic algorithm, (b) particle swarm optimization, (c) ant colony optimization.
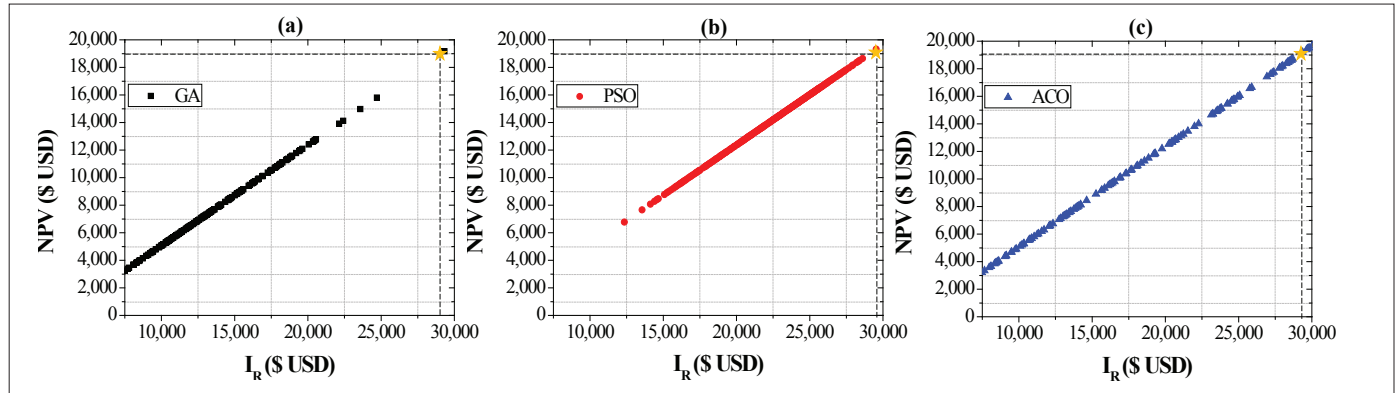

As observed in Fig. 6, the Pareto frontier of the three different optimization algorithms reported very similar values with an increasing linear trend. From Figure 6(a), the optimal value of i_b obtained with the TOPSIS method was 5.98 %, which produces an I_R value of $ 29,333.58 USD and an NPV value of $ 19,172.25 USD. Figure 6(b) reported an optimal i_b value with the PSO algorithm of 5.33 % corresponding to an and NPV value of $ 29,536.03 USD and $ 19,320.04 USD, respectively. Finally, Figure 6(c) presents a i_b value of 5.84 % obtained with the ACO algorithm, which produces a value of $ 29,375.12 USD and % 19,202.58 USD, for I_R and NPV, correspondingly. These values were averaged, and a final approximation value of 5.72 ± 0.28 % was considered with a corresponding I_R value of $ 29,414.9 USD and an NPV of $ 19,231.6 USD. These results indicated that it is not advisable to consider a high loan percentage that guarantees all the initial investment, since if it assurances part of the money required in the present, but in the long-term future, the net present value decreases, and it is more feasible to consider a low i_b value where the required investment and the NPV are balanced, and the project's profitability is ensured.

Final economic indicators

The optimal value of obtained from the previous section is used to estimate the different economic indicators presented in section 2.3.2. First, to obtain the IRR, different values of MARR were considered. These results are illustrated in Figure 7.

Figure 7. Graph of MARR vs NPV of optimized results to obtain the IRR.
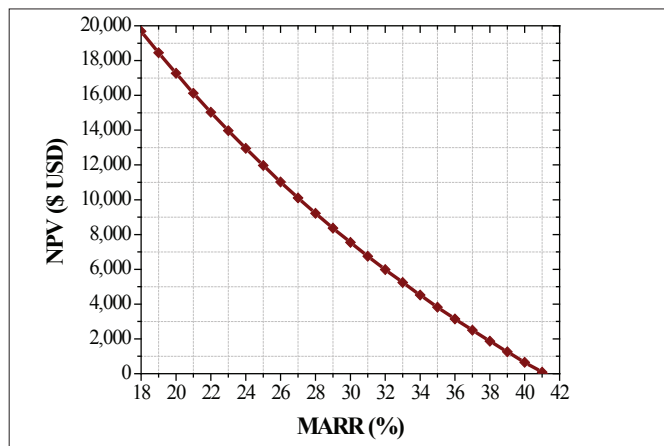
As can be observed, by increasing the value of the minimum acceptable rate of return, the net present value decreases until it finds the intersection with the axis where the value of the internal rate of return is obtained. This value corresponded to 41.15 %, indicating the project's feasibility since benefits are obtained more than four times the value of inflation in the long term. Finally, the value obtained from the payback period was 2.92 years, the rate of investment reached a value of 63.18 %, equivalent to 12.64 % per year, and finally, the profitability index was 1.62. All these results indicated that the investment for the development of the proposed project is economically attractive since revenues are obtained during the time to repay the bank loan, so higher profits are expected after five years of operation.

Conclusions

This research study presented the proposal of a center that provides educational services in Puerto Plata province of the Dominican Republic, considering a comprehensive methodology that involves social, technical, and economic assessments as well as a multi-objective optimization process to determine the best decision-making and viability of the project. Key conclusions are summarized as follows:

I. The results obtained from the social survey corresponding to the market study revealed that 98 % of respondents agreed with the proposal of the educational center, and most of the people agreed that this project allows satisfying and solves the educational demand considering the different offered services, as well as the cost, the means of advertising, payment, location, and the social impact of the project. These findings demonstrated a tendency toward the target community's acceptability and the importance of educational development within the local context of this research, which supports the importance of this study within the comprehensive methodology with the technical and economic analysis.

II. Regarding the technical study, different furniture and fixtures were considered, as well as the essential services of the building, such as water, electricity, telephone and internet, and waste collection. The total amount of the initial investment was $ 31,200 USD, whose value was used for the economic evaluation.

III. The results of multi-objective optimization indicated that the best average percentage of the bank loan was 5.72 ± 0.28 %, which corresponded to a required investment of $ 29,414.9 USD and an NPV of $ 19,231.6 USD, which elucidated that the project is more feasible with low values that guarantee a higher long-term NPV.

IV. Concerning the economic study, the internal rate of return value was 41.15 %, while the payback period, rate of investment, and profitability index reported values of 2.92 years, 63.18 %, and 1.62, respectively, which indicated that the project investment is highly feasible considering an optimized percentage of bank loan.

The proposed project presented a high social acceptance and profitability from the obtained results since desirable economic indicators values are obtained. It is expected that the center can sustain itself with the revenues from the different services until the initial investment is recovered, since good acceptance of the project was obtained according to the market study and considering the technical and economic analysis of the project. Therefore, these obtained findings indicated the importance of the economic study because this complements the best decision-making, and the multi-objective optimization method help to ensure the optimal value that allows an investor to obtain long-term economic benefits and recover the investment.

The comprehensive methodology presented in this work transcends the multidimensional study since the obtained results reflected the need and interest of the proposed educational center because it comes to solving a problem within this framework. Also, this methodology constitutes a research strategy for social development, considering a holistic viewpoint for its implementation in various contexts. Finally, this research approach can be applied to various investment projects in different educational, social, and health sectors in the Dominican Republic, and the proposed project contributes to the generation of jobs, educational development and demonstrates its acceptance within a local framework considering a national perspective for its prolific progress and contribution to the economic development of the country.

Acknowledgments

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