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Feasibility Of Materials With Analytical Hierarchy Process (AHP) And Its Impact On Users Of Parks In The Historic Center, Lima-2019

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ABSTRACT
Investments in Peru have been strategically promoted in the last decade, mainly by all levels of government, of which the Metropolitan Municipality of Lima has given greater emphasis on the historic center to promote human, urban and environmental development with sustainability, having as one of its priority axes the investment in enhancement projects. Therefore, the study proposed to describe how the feasibility of street furniture materials and electrical systems of the enhancement projects with the Analytical Hierarchy Process (AHP) will impact the users of the parks in the historic center of Lima, in the year 2019. It was based on a quantitative approach, with a hypothetical-deductive method and descriptive-correlational scope, establishing a convenience sample of 30 engineers. As result, a Spearman Coefficient of 70.7% was found between the study variables, concluding with the existence of a high positive correlation, with which it can be sustained that the Feasibility of the Valorization Projects with the Analytical Hierarchy Process (AHP) has a positive impact on the users of the parks of the Historical Center.

Keywords: Enhancement project; urban furniture; lighting system; analytical hierarchy process (AHP); user satisfaction.

RESUMEN
Las inversiones en el Perú han sido promovidas de modo estratégico en la última década, fundamentalmente por todas las escalas de gobierno, de las cuales la Municipalidad Metropolitana de Lima ha dado un mayor énfasis en el centro histórico con el objeto de promover el desarrollo humano, urbano y ambiental con sostenibilidad, teniendo como uno de sus ejes prioritarios la inversión en proyectos de puesta en valor. Por lo que en el estudio se propuso describir de qué manera la factibilidad de los materiales de mobiliario urbano y sistemas eléctricos de los Proyectos de Puesta en Valor con el proceso de jerarquía analítica (AHP) impactará en los usuarios de los parques del Centro histórico de Lima, año 2019. Se basó en enfoque cuantitativo, con método hipotético deductivo y alcance descriptivo-correlacional, estableciendo una muestra a conveniencia de 30 ingenieros. Como resultados se encontró un Coeficiente de Spearman de 70.7% entre las variables de estudio, concluyendo con la existencia de una correlación positiva alta, con lo cual se puede sostener que la Factibilidad de los Proyectos de Puesta en Valor con el proceso de jerarquía analítica (AHP) impacta positivamente en los usuarios parques del Centro Histórico.

Palabras clave: Proyecto de puesta en valor; mobiliarios urbanos; sistema de iluminación; proceso de jerarquía analítica (AHP); satisfacción de usuarios.

RESUMO
Os investimentos no Peru foram estrategicamente promovidos na última década, fundamentalmente por todos os níveis de governo, dos quais o Município Metropolitano de Lima deu maior ênfase ao centro histórico para promover o desenvolvimento humano, urbano e ambiental com sustentabilidade, tendo como um dos seus eixos prioritários está o investimento em projetos de melhoria. Portanto, no estudo foi proposto descrever como a viabilidade dos materiais de mobiliário urbano e sistemas elétricos dos Projetos de Valorização com o processo de hierarquia analítica (AHP) impactará os usuários dos parques do Centro Histórico de Lima, 2019. Baseou-se em uma abordagem quantitativa, com método hipotético-dedutivo e escopo descritivo-correlacional, estabelecendo uma amostra de

conveniência de 30 engenheiros. Como resultados, foi encontrado um Coeficiente de Spearman de 70,7% entre as variáveis do estudo, concluindo com a existência de uma alta correlação positiva, com a qual se pode argumentar que a Viabilidade dos Projetos de Valorização com o processo de hierarquia analítica (AHP) tem um efeito positivo impacto nos usuários dos parques do Centro Histórico.

Palavras-Chave: Projeto de valorização; mobiliário urbano; Sistema de luz; processo de hierarquia analítica (AHP); satisfação do usuário.

INTRODUCTION

Currently, the problem related to the conservation of historic sites is a concern not only of governmental entities but also of the community itself. In some countries, as is the case in Mexico, the category of cultural places has not been valued, this being a novel problem, but at the same time, very old (Alcántara, 2018). In Mexico this heritage is without protection norms, it is not protected by the legislation of cultural property, so the technicians who intervene in these sites consider them only of recreational or environmental value, being necessary for the participation of professionals and academics in the identification of the important elements in cultural places to study and recover them. The above, developing appropriate strategies for their enhancement would represent a boost to tourism, motivating tourist visits and generating wealth and employment for the nearby community (Zarate, n. d.).

Authors consider that Lima is a historical-artistic heritage in precarious conditions that needs adequate conservation and protection before humanity and nature, characterized by an advanced state of deterioration of its heritage, with many structural elements at risk of collapse and also characterized by its functional obsolescence (Lombardi, 2014). An example of this is the Hacienda Punchauca house, which housed in past centuries the proclaimer of freedom Don José de San Martin, subsequently passing to abandonment (Arciga, 2017), as well as problems observed in Huaca Pucllana located in the district of Miraflores, a historical element of Lima that presents inconveniences caused by the works in the area, the measurement of the perimeter, the removal of debris, people of bad living and the constant raising of dust (Mendoza, 2015).

The lack or non-existence of maintenance on the part of local authorities has made the problem of historic sites more acute, which is increased by the limited supervision and regulations that protect them. In fact, in modern times, many residential buildings and, to a lesser extent, many public and religious buildings in the historic center of Lima have suffered interventions of typological and functional alteration caused by socioeconomic and urban changes that include the phenomenon of the slumization of the buildings.

If this situation is not addressed, the disappearance of historic sites that have not been considered for investment with enhancement projects could occur in the short term, so this study seeks to solve the question: How will the feasibility of street furniture materials and electrical systems of the enhancement projects with the Analytical Hierarchy Process (AHP) impact the users of the parks in the historic center of Lima, in the year 2019? The general objective is to describe how the feasibility of the street furniture materials and electrical systems of the Projects of Valorization with the analytical hierarchy process (AHP) will impact the users of the parks of the Historic Center of Lima, in the year 2019.

Within the heritage analyzed in this study, two main components have been identified that should be analyzed from the engineering point of view: the first refers to the inadequate quality of the materials of the urban furniture in the parks, such as benches, railings, posts, among others; the second is the integral lighting system, which includes both the internal electrical installation networks of the parks, as well as the lighting fixtures. These components are basic to the functionality of the parks and should be taken into account as the main elements in projects to enhance the value of these historic sites.

At the national level, several studies have been carried out to evaluate the situation and propose solutions. Thus, reference is made to the fact that the loss of cultural heritage in the country is a consequence of the scarce capacity of the State for the enhancement of heritage by the community, so the Ministry of Culture has made various proposals, however, the projects do not reach continuity and prolonging the period of execution because the budget allocated annually is cyclical (Ministry of Culture, 2017).

On the other hand, alternatives have been presented for the public lighting of historic sites through the implementation of a lamp system based on LED technology, which has yielded positive results by adapting to the standards and lowering costs (Ticona, 2015, Dávila, 2018); likewise, in an analysis of the management of the Historic Center of Rimac, which has an invaluable cultural heritage, strengths and weaknesses have been identified in the management of the government management. All of this suggests new management guidelines, complementary to the current management and where social participation in local management is considered (Mollo, 2018). In this regard, a study identified that the level of cultural value given by the inhabitants to certain historical places is regular at 100%, specifically when evaluating the Plaza de Armas of an important district of Lima, revealing that the inhabitants show some interest in valuing this place (García, 2017).

In international studies, the historical value of various places that represent a heritage for a nation has been highlighted. Such is the case of a study carried out in La Guaira, Venezuela, to provide an enhancement of the value of the place, showing that there is a strong link with its environment due to its historical and functional centrality, which also incorporates intangible values, social uses of tangible and intangible heritage and a very important role of public spaces as a place for social and human interaction (Anato, 2016).

Value enhancement projects

The enhancement of cultural heritage is the recovery and rehabilitation of cultural assets to provide them with new uses (tourism, cultural, sports, residential, etc.) and reinsert them back into the social fabric to ensure their protection (Palacios & Hidalgo, 2009). It is in line with what today is understood as integrated conservation, i.e., the result of the joint action of conservation techniques, research and adaptation of this heritage to the needs of the society of the moment. They are also defined as the recovery of local identity with some of its assets, the effective rehabilitation through the implementation of small works and implementation of signaling projects of some of the abandoned, degraded or simply undervalued spaces that today can be visited and enjoyed (Escribano, 2010).

Among the main principles of this type of project is the promotion of national and international tourism under a dynamic relationship with conflicting valuations between heritage and tourism that must be managed sustainably for current and future generations, where the cultural value of the place is highlighted and the conservation of the places is planned even when receiving tourist visits, for which the community must be involved, both for this conservation and to be benefited (Cabeza et al., 2015). Legally, in Peru this type of project is governed by the provisions of Law 28296, General Law of Cultural Heritage of the Nation and Supreme Decree No. 011-2006-ED, which is the regulation of the law (Cabeza et al., 2015).

Fuzzy analytic extended hierarchy process (AHP) method.

It is a method of decision theory that combines both quantitative and qualitative criteria and compares the different alternatives that the decision maker has for each criterion, similarly, the criteria are compared to each alternative; to make a comparison it makes use of a table of preferences, which has values from 1 (equally preferable) to 9 (extremely preferable). This is a pairwise comparison matrix, where the decision-maker determines his relative preference for one concept over another, and also indicates the intensity of this preference according to the following scale (Durand, 2021).

Firstly, it is a multi-criteria decision method that helps to select among different alternatives based on a series of selection criteria or variables, usually hierarchical, and that usually conflict with each other, maintaining a hierarchical structure from top to bottom which would be: the final objective, criteria and sub-criteria (if applicable) and finally the alternatives to be compared. One of the fundamental aspects of the method is to choose well the selection criteria and sub-criteria, to define them adequately and make them mutually exclusive. Secondly, the operation to perform the paired comparison uses the Saaty Fundamental Scale, which is one of the keys to the success of this method, since it allows transforming qualitative aspects into quantitative ones, facilitating notably the comparison between the different alternatives and giving rise to more objective and reliable results (Durand, 2021).

The analytical hierarchy of process-based building materials selection to improve construction performance consists of selecting the best materials that guarantee maximum performance being

essential in the construction engineering design of any construction project; the proper selection of construction materials is very effective as a method as it helps to increase construction performance, managing to address problems involving decreased productivity, safety accidents and environmental damage; identifying problems of this type that need to be improved with the complement of materials that have been made empirically and intuitively that satisfies the demand load condition (Doming et al, 2020).

METHOD

The study was developed under a quantitative methodological approach, with a descriptive-correlational level and a non-experimental-cross-sectional design, applying a survey technique and a questionnaire of 88 items with a Likert scale validated by experts and with high reliability. The population was made up of registered engineers specialized in the development of enhancement projects, who carry out their activities in the city of Lima, and 30 were considered as a study sample determined by convenience through non-probabilistic sampling. The data were statistically processed using SPSS software.

RESULTS

The following are the results obtained from the situational analysis for the diagnosis of the situation at the time of the study, which made it possible to identify failures and needs for urban materials in the Historic Center of Lima, specifically in 14 parks and squares, showing the failures shown in Table 1 and 2 below.

Table 1. Failures in urban material in squares and parks in the Historic Center of Lima, 2019.

Location	Urban material failures
Plaza de Armas de Lima	Metal garbage cans in poor condition, iron bollards with poor paint finishes.
Plazuela Santo Domingo	Ornamental posts and traffic lights poorly insulated from the ground and rusted at the bases, colliding with light cables. Fiberglass poles poorly insulated from the ground, rusted at the bases, poor paint finishes. Poorly protected flowerbeds and busts.
Parque Santa Rosa de Lima	Polyethylene tubs poorly insulated from the ground and rusted. Non-ornamental benches that do not fit in with the surroundings.
Plaza Italia	Ornamental and pipe benches poorly insulated from the ground. Rusty pipe benches. Extensive deterioration of the wood on the pipe benches. Absence of garbage cans.
Plaza Castañeda	Cast iron benches and trash cans poorly insulated from the ground and rusted. Ornamental posts that do not match the surroundings.
Parque Universitario	Polyethylene garbage cans poorly insulated from the ground, rusted and inadequately painted. Mesh garbage cans poorly insulated from the ground, not aesthetically pleasing. Cast iron ornamental benches poorly insulated from the ground. Ornamental posts that need to be replaced. Signs poorly insulated from the ground.

Table 2. Continued failure of urban material in squares and parks in the Historic Center of Lima, 2019

Location	Urban material failures
Plaza Luis Alberto Sánchez.	Trash cans poorly insulated from the ground and with mismatched paint. Benches poorly insulated from the ground.
Plaza Democracia	Fiberglass poles poorly insulated from the ground, lack of poles caps, poor welding, poor splicing and total deterioration. Ornamental posts poorly insulated from the ground, rusted and with inadequate manhole covers.

	Absence of tree wells. Ornamental benches with twisted wood and poorly finished iron
Plaza San Martín	Cast iron ornamental posts poorly insulated from the ground, rust on the post flange. Lighting that does not match the surroundings. Trash cans poorly insulated from the ground and with poor paint finishes. Absence of tree wells.
Plaza Helguera	Cast iron ornamental benches poorly insulated from the ground and poorly supported. Trash cans poorly insulated from the ground, without pedestals, causing them to fall over and need to be completely replaced. Ornamental cast-iron postcards without concrete bases and rusted.
Plaza Francia	Ornamental cast iron benches poorly insulated from the ground, rusted or with curved wood due to lack of support. Trash cans poorly insulated from the ground, rusted, on the verge of collapse. Ornamental posts without adequate base, rust on the post flange and not matching the surroundings.
Parque Juana de Alarco Dammert.	Benches that do not match the surroundings, with deformed, very thin and misaligned wood. Concrete supports of the benches cracked by rust. Poorly designed trash cans and some different ones that do not match the surroundings. Poles with broken arms.
Plaza Alameda de los Bobos.	Cast iron ornamental benches poorly insulated from the ground, rusted. Trash cans poorly insulated from the ground, rusted. Trash cans removed due to rust and need to be replaced. Rusty posts. Bollards poorly insulated from the ground with rusted bases.
Plaza Alameda de los Descalzos	Pits poorly insulated from the ground. Poorly constructed posts. Cast iron ornamental benches poorly insulated from the ground and rusted. Trash cans poorly insulated from the ground, with corrosion and missing cans that need to be replaced. Bollards poorly insulated from the ground with rusted bases.

Figure 1. Main failures in urban material in squares and parks in the Historic Center of Lima, 2019.

Also, the lighting systems were evaluated for fault diagnosis as part of the objectives of this study, showing the results in Table 3 and 4 below.

Table 3. Main failures in lighting systems in squares and parks in the Historic Center of Lima, 2019.

Location	Lighting failures
Plaza Francia	Dirty glass, painted glass, rain-type glass, asymmetric light bulbs, insufficient lighting, burned-out luminaires.
Plaza Elguera	Dirty and broken glass, painted glass, rain glass, asymmetrical light bulbs, burned-out light fixtures.
Plaza San Martín	Dirty windows, ball-type streetlights that generate energy waste, insufficient lighting.
Plaza Democracia	Broken, dirty and painted glass. Rain type glass. Asymmetrical light bulbs.
Plaza Luis Alberto Sánchez	Broken, dirty and painted glass. Cathedral glass. Asymmetrical spotlights
Parque Universitario	Dirty windows. Burned street lamps
Parque Juana Alarco de Dammert	Broken, dirty and painted glass. Cathedral glass. Asymmetrical light bulbs. Poor quality intermittent and burned out LEDs.
Plaza Italia	Dirty glass. Rain type acrylics.
Plaza Castañeda	Streetlights never turn on. Asymmetrical lamps. Unsuitable spherical streetlights.

Table 4. Continuation of main failures in lighting systems in squares and parks in the Historic Center of Lima, 2019

Location	Lighting failures
Plaza Alameda de los Bobos	Dirty glass. Rain type glass.
Plaza Alameda de los Descalzos	Dirty glass. Rain type glass. Asymmetrical streetlights. Lighting on only one side of the square.
Paseo de Aguas	Dirty glass. Rain type glass. Asymmetric lanterns. Street lamps without cover.
Plaza de Armas de Lima	Dirty glass. Rain type glass.

Figure 2. Main failures in lighting systems in squares and parks in the Historic Center of Lima, 2019.

Concerning the selection of materials for urban furniture to correct the flaws found in the Historic Center of Lima, the opinion of the experts is shown in Table 5, where it is observed that 3.3% disagree and another 3.3% agree, 6.7% strongly disagree and another 6.7% were indifferent to this, indicating that the majority of experts (80%) strongly agree with the selected materials.

Table 5. The choice of materials for urban furniture - D1xV1.

D1xV1: Selection of Urban Furniture Materials with the Analytical Hierarchy Process (AHP)					
		Frequency (Score)	Percentage %	Valid percentage	Cumulative percentage
Valid	Strongly Disagree	62	6.7	6.7	6.7
	Disagree	31	3.3	3.3	10.0
	Indifferent	62	6.7	6.7	16.7
	Agree	31	3.3	3.3	20.0
	Strongly Agree	744	80.0	80.0	100.0
	Total	930	100.0	100.0	

Regarding the selection of lighting materials for the correction of failures in the parks and squares of the Historic Center of Lima, the experts' opinions are shown in Table 6, where 6.7% strongly disagree, another 6.7% disagree, 10% are indifferent, 3.3% agree and 73.3% strongly agree.

Table 6. The selection of lighting system materials - D2xV1.

D2xV1: Selection of Lighting System Materials					
		Frequency (Score)	Percentage	Valid percentage	Cumulative percentage
Valid	Strongly Disagree	74	6.7	6.7	6.7
	Disagree	74	6.7	6.7	13.3
	Indifferent	111	10.0	10.0	23.3
	Agree	37	3.3	3.3	26.7
	Strongly Agree	814	73.3	73.3	100.0

	Total	1110	100.0	100.0

The satisfaction of specialist users was also evaluated and the results are shown in Table 7, showing that 20% disagreed strongly, 3.3% disagreed, 10% were indifferent, 6.7% agreed, and 60% strongly agreed with the alternative.

Table 7. Specialist user satisfaction - D1xV2.

D1xV2: Specialist User Satisfaction					
		Frequency (Score)	Percentage	Valid percentage	Cumulative percentage
Valid	Strongly Disagree	120	20.0	20.0	20.0
	Disagree	20	3.3	3.3	23.3
	Indifferent	60	10.0	10.0	33.3
	Agree	40	6.7	6.7	40.0
	Strongly Agree	360	60.0	60.0	100.0
	Total	600	100.0	100.0	

The above results made it possible to obtain the levels of user satisfaction with the project and to determine whether the selection of materials is appropriate, to have data to test the hypotheses of the study, for which Spearman's Rho Coefficient was used. Table 8 shows the test to the general hypothesis, which states that the feasibility of urban furniture materials and electrical systems of the Valorization Projects with the analytical hierarchy process (AHP) will have a positive impact on the park users of the Historic Center of Lima, in the year 2019, which was accepted because p=0.000 being p<0.050 and r=0.707 that reflects a positive and high relationship between the variables.

Table 8. Correlation of the general hypothesis

Correlations				
			Variable 1 - The Feasibility of Street Furniture Materials and Electrical Systems for Upgrading Projects	Variable 2 - Impact on users of the Parks of the Historic Center of Lima.
Spearman's Rho	Variable 1 - The Feasibility of Street Furniture Materials and Electrical Systems for Upgrading Projects	Correlation coefficient	1,000	0,707**
		Sig. (bilateral)	.	0,000
		N	30	30
	Variable 2 - Impact on the users of the Parks of the Historic Center of Lima.	Coeficiente de correlación	0,707**	1,000
		Sig. (bilateral)	0,000	.
		N	30	30

Table 9 shows the test to the specific hypothesis 1, which states that the selection of materials of urban furniture with the analytical hierarchy process (AHP) will impact the users of the parks of the Historic Center of Lima year 2019, which was accepted because p=0.000 being p<0.050 and r=0.748 reflecting a positive and high relationship between the variables.

Table 9. Correlation of specific hypotheses 1.

Correlations

			D1xV1 - The selection of Urban Furniture materials using the Analytical Hierarchy Process (AHP)	Variable 2 - Impact on users of the Parks of the Historic Center of Lima
Spearman's Rho	D1xV1 - The selection of Urban Furniture materials with the analytical hierarchy process (AHP)	Correlation coefficient	1,000	0,748**
		Sig. (bilateral)	.	0,000
		N	30	30
	Variable 2 - Impact on the users of the Parks of the Historic Center of Lima.	Correlation coefficient	0,748**	1,000
		Sig. (bilateral)	0,000	.
		N	30	30

Table 10 shows the test to the specific hypothesis 2, which states the selection of the lighting system with the Analytic Hierarchy Process (AHP) will positively impact the users of the parks of the Historic Center of Lima, in the year 2019, which was accepted because p=0.000 being p<0.050 and r=0.696 reflecting a positive and high relationship between the variables.

Table 10. Correlation of specific hypothesis 2.

Correlations

			D2Xv2 - Lighting system selection with the Analytic Hierarchy Process (AHP)	Variable 2 - Impact on users of the Parks of the Historic Center of Lima
Spearman's Rho	D2xV2 - Lighting system selection with the Analytic Hierarchy Process (AHP)	Correlation coefficient	1,000	0,696**
		Sig. (bilateral)	.	0,000
		N	30	30
	Variable 2 - Impact on the users of the Parks of the Historic Center of Lima.	Correlation coefficient	0,696**	1,000
		Sig. (bilateral)	0,000	.
		N	30	30

Discussion

Discussion of result test No. 1, the feasibility of the enhancement projects with the analytical hierarchy process (AHP), a very good positive correlation was found between the study variables, 70.7%, which leads to optimal results in line with the objectives of the study, i.e. it was found that the enhancement projects have an impact on the specialized users who were part of the sample because they are knowledgeable about the technical factors of projects in historic centers, composed of urban furniture and electrical systems of the historic center of Lima. The results obtained are consistent with what was exposed by Anato (2016) in Venezuela, which evaluated the influence of the projects of enhancement of the cultural heritage of La Guaira on the satisfaction of the inhabitants, over twenty years, covering elements such as the value of the cultural-historical centers, which was recognized by national and international organizations, where it was concluded that the projects achieve value through the participation of the state and the satisfaction of the users, i.e., the population.

Discussion of test result N° 2 - Selection of materials for urban furniture with the Analytical Hierarchy Process (AHP); in this regard, a very good positive correlation was verified between the research variables, in 74. 8%, which suggests results that support the proposed objectives. In this sense, it was verified that the ideal selection of materials for urban furniture has an impact on users specialized in the infrastructure of historic centers since these professionals know in detail the properties and specifications of the inputs that

make up the urban furniture, and also identify the appropriate maintenance process. Similarly, the results are in line with those obtained by García (2017) who analyzed the impact of the infrastructure project on the parade ground and the elements that compose it, such as urban furniture and others, with the satisfaction of its users, this due to a good association of variables (project and user satisfaction), where it was found that 100% of the population values the infrastructure composed by the parade ground, in addition, it was found that 90% of the inhabitants consider this infrastructure as a historical, educational and cultural source. Likewise, Abad (2016) who made a study on the design of a recreational park for the urban landscape renovation of the La Florida neighborhood in the city of Loja, proposes the construction of a Recreational Park for the La Florida neighborhood in the city of Loja which contemplates the design of equipment and urban furniture aimed at the typology of users and the functionality of the park prioritizing the needs of the neighborhood and the city, and thus providing a place according to the lifestyle of people with pedestrian and cycling accessibility facilities, shelter, security. Additionally, the result is aligned with the article published by Doming et al. (2020) who indicates that the analytical hierarchy in the selection of building materials is based on processes to improve the performance of building construction, where he talks about how to select the best materials to ensure maximum project performance and the importance of applying systematic and scientific evaluation methods based on the method of analytical hierarchy processes, to validate the suggested model conducted a case study for a form of a concrete system whose result showed that the proposed material selection model provides a better combination of materials, and the solution was technically more advanced and ensured better performance.

Discussion of test result N° 3 - Selection of the lighting system with the analytical hierarchy process (AHP). In this regard, a good positive correlation was verified between the research variables, 69.6%, which suggests results that support the stated objectives. 6%, which suggests results that support the stated objectives. In this sense, it was contrasted that the ideal selection of materials of the lighting system has an impact on users specialized in the infrastructure of historic centers because these professionals know in detail the properties and specifications of materials, equipment, and technologies, This can be contrasted with the research developed by Dávila (2018), in which a proposal was developed to optimize and control the efficient use of electrical energy through a lighting system based on LED lighting, achieving a 53% monthly savings.

Discussion of the results of the urban furniture selection criteria using the analytical hierarchy process (AHP). It was determined that both cost and technical criteria were used to select urban furniture. In the case of cast iron urban furniture, in terms of cost criteria, it was determined that gray cast iron has a cost of S/ 6.00 per kilogram, which is cheaper compared to nodular iron (ductile), which has a cost of S/ 12. Concerning the technical criteria for cast iron, it was determined that gray cast iron is the one that meets the minimum and requirements for the use that will be given to it since the main characteristic of cast iron street furniture is that it works in compression and not in traction, which contrasts with what Guzmán (1996) obtained in his thesis Metallographic and mechanical analysis of gray iron, where he concludes that quality castings have high resistance to traction, compression, bending, wear, etc. Therefore, a quality iron is not necessary since, as mentioned above, it would have a high cost.

In the case of wood, screw wood was chosen after a cost study, which in the market is S/ 19. 4 soles the lath to be used, another important aspect was that it is the most commercial wood that there is in Peru, besides having a mechanical resistance which obtained a maximum bending load 360 kg, which guarantees its use since it needs that force to break the lath and taking into account that an average person weighs 80 kg this would resist it completely, which can be contrasted with what is indicated by Barrueta (2018) who manages to know the admissible effort to bend in beams of screw wood, being this value equal to 14. 98 MegaPascals, proving its good mechanical behavior against bending stresses according to experimental tests, a characteristic that allows its use as a construction material for structural elements working under bending stress.

In a discussion of the criteria for the selection of materials for the lighting system using the analytical hierarchy process (AHP), it was determined that both technical and cost criteria were used to select the materials for the lighting system. In the case of the luminaires, LED technology was chosen because of its low long-term cost, since it has a high initial cost, which

guarantees its high durability since its useful life is 10 years. Another important requirement is that it has a self-regulating lighting system, which guarantees lower energy consumption at times when the LED is not needed at full power, which leads to significant cost savings of 50%.

On the other hand, in the case of the cables, N2X0H was chosen, which unlike the others has the quality of not emitting toxic gases. As for the control systems, the ideal is the Arduino 1 module since it is a user-friendly system, which contrasts with what Castro (2018) indicated when expressing that the cost of Arduino 1 is S/35.00, in addition to achieving the design of a prototype led phototherapy lamp with brightness control for the treatment of jaundice in neonates using the ATMEGA328 Arduino microcontroller.

CONCLUSIONS

It is concluded that the feasibility of the enhancement projects has a positive impact on the specialized users of parks in the historic center of Lima, at a significance level of 5%, adding that the relationship between the variables is good and positive at 70.7%. Likewise, the selection of adequate urban furniture leads to greater satisfaction of the specialist users, since a positive and good relationship was obtained between the variables (74.8%), as well as the adequate selection of materials for the illumination has a positive impact on the satisfaction of the specialist user, since a positive and good relationship between the variables was obtained (69.6%).

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