DEVELOPMENT OF URBAN ENVIRONMENT IMPACT MATRICES. INCORPORATION OF ASSESSMENT INDICES.

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ABSTRACT

A methodology which can be applied to the Environment Impact Study (EIS) and which facilitates to analyse the urban variables as a whole is explained. The work can be done in different scales (urban sectors and areas) which are dependable on the analysis complexity degree. The environment impact of large local and regional interventions can be qualified and quantified. Different concepts, methods and techniques have been considered and conveniently integrated. A body of relational decision matrices has been developed, in which the concepts of **impact intensity**, **sign**, **significance** and **temporality** are included. Different levels of indices have also been developed.

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INTRODUCTION

This article deals with subject matter promoted by the World Conferences on Environment and the Conventions on Climate Change and which has begun to be unavoidable in the urban enterprises in Latin America. Consequently, and considering the Environment Impact Assessments (EIA), a methodology useful for the Environment Impact Studies (EIS) has been developed. The EIS is part of the EIA procedure and comprises a wide diversity of urban-regional variables. In this article, the EIA is considered as a legal, administrative and scientific-technologic procedure and it is an useful instrument to work on the complexity of the metropolitan areas and their region as a whole or in sectors. The urban dynamics originates constant interventions, causing environment distortions of different intensity. This deepens the imbalance in the natural-artificial environment relationship. An efficient urban management, aiming at bringing closer the sustainability concept and the development patterns, requires: (1) To know and put into practice procedures enabling to visualise the situation state; (2) To obtain truthful information; (3) To formulate accurate diagnoses; and (4) To develop and implement coherent and co-ordinated policies.

In our continent, the local and regional environment crisis is immersed in the framework of the economy globalization, the consolidation and expansion of unsustainable development patterns and life styles, and the habitat impoverishment, reaching unbearable levels in some places. [1]

In this current situation, the risk awareness of the population is increasing, being the consequences little foreseeable. In all nations and social classes, an incipient, though uneven, idea is being conceived with the purpose to build a sustainable habitat [2], thus considering that the environmental subject goes beyond the ecological dimension. As regards the term sustainable, and knowing the different entries of the concept, it is here used to refer to the space modified by the man, on regional, urban and building scales, to inhabit it with an endogenous development pattern to fulfil the fundamental needs and improve the life quality. This requires a model minimising the damage on the production and inhabitability ecological bases by means of a technological pluralism, within a democratic, just and supporting framework.

Within the international context, these processes have been known for approximately three decades and have allowed the development of technical-normative containment instruments. In general, different aspects of the problem, specific to each discipline, have been considered, producing incipient though still highly fragmented and little encouraging results at this turn of the century. Summits like the Conferencia Mundial sobre Medio Ambiente y Desarrollo (*World Conference on Environment and Development*) (Stockholm '72 and Rio '92) and the Convención de Cambio Climático (*United Nations Convention on Climate Change*) (UNCCC, Conferences of Parties: COP-1, Berlin '95; COP-2, Geneva '96; COP-3, Kyoto '97 and COP-4, Buenos Aires '98) have allowed for the environment subject to be politically recognised and for some serious procedures aiming at sustainability to be put into motion [3] [4].

On the other hand, socio-economic and environmental conditions produced by the present development style together with historical and cultural reasons have originated the movements of “Ciudades Sanas” (*Healthy Cities*) [5] in Europe since the Conference of Lisbon (1986) in order to apply the WHO “Health for All” objectives. This movement is made up of more than thirty European cities and seventeen networks with hundreds of cities and it has produced the movement “Municipios Saludables” (*Healthy Municipalities*) and later “Municipios para la Salud” (*Municipalities for the Health*) in Latin America [6].

In Argentina, actions within this subject are mainly centred in a discursive rather than in an active field. Whereas the subject is present within the society, there are incipient, greatly isolated enterprises, though their implementations present major deficiencies. Locally speaking, there are regulations which are, in most cases, fragmented. Some examples are the Certificate of Environment Aptitude within the Statue N° 11459/93 of the Province of Buenos Aires, mainly related to industrial plants and requiring the environment impact study (EIS) for **building-energetic-productive** ventures; the Statue 11347 aimed at regulating pathogenic waste; and the Statue 25018 concerning radioactive waste and co-ordinated by the Comisión Nacional de Energía Atómica. In the urban context specifically, the Statue N°123 of Ciudad Autónoma de Buenos Aires considers the Environment Impact Study from an integral point of view, though with serious judicial difficulties as the urban setting is restricted and surrounded by another state like the Province of Buenos Aires, with serious environment and legal problems.

PRECEDENTS AND METHODOLOGY

The first precedents of EIA go back to 1969 in the USA, where institutions like the National Environmental Police Activity (NEPA) established systematic guidelines for private and government activities. Since then, methodologies and working protocols [7] have been introduced in different countries as an answer to the present needs and problems. Nowadays, there are several EIS techniques, for example, Check list, Lists with temporal threshold, Data Matrices, Sign Matrices, Thematic Maps, Batelle Method and Holling Method among others. The first ones are the most widely known and they present certain restrictions for the urban area; the others are more specific and, in some cases, more complex.

Among the urban EÍS antecedents in the Republic of Argentina, the following can be mentioned: (1) The work carried by the Area of Arquitectura Ambiental of the Centro de Investigación de San Juan (CISAJ), in the Province of San Juan [8]. The methodology is based on the formulation of ten impact tables, one per each “area” of the ecosystem (economic, political, environmental, etc.); (2) The environmental plan of the city of Buenos Aires [9]; (3) The projects developed by Fundación Bariloche (FB) and the Instituto de Economía Energética (IDEE), together with the United Nations Policy for the Environment (UNPE) [10]. In general, these projects have tried to provide solutions, some of them descriptive, some comprehensive, in which the natural and landscape resources of a region or country are considered.

At a local scale, the urban council laws have started to incorporate in their articles the environmental aspects and the need to assess every major urban undertaking. For the time being, these laws require and enable professionals, in general without training, to carry out the environment impact assessment reports out of a list of basic points. None of these cases foresees a methodology or protocol making it possible to systematise, qualify, quantify or establish comparable backgrounds supporting and identifying the impacts as well as differentiating the alternatives. In this respect, our research group has started to develop methodologies to provide specific answers to the mentioned requirements [11] [12].

Within this situation state, it is necessary to formulate a flexible and instrumental methodology in accordance with our context needs and as part of the Technical-Administrative Procedure of Environment Impact Assessment (EIA). The suggested methodology shows the analysis of several urban variables as a whole or in sections and with different complexity rates. It facilitates to qualify and quantify the way small and large projects will impact in the environment both locally and regionally. The different techniques have been studied and some have been rearranged and conveniently integrated in the decision matrices. The **natural and artificial elements** of the area to be analysed and the **actions** planned in the project are incorporated in the matrices as variables.

In each intersection of the matrix, the **impact intensity** and **sign**, its **significance** and **temporality** are conceptually analysed. The concept of **intensity** would refer to the extent or relevance of the intervention, and its **sign**, to the positive or negative aspect of such intervention. In both cases, the type of landscape to be intervened and the land to be affected by the interventions (local, sectional, regional) are considered for the impact value. The **significance** would show how important the intervention is according to the context in which it would be done. And the **temporality** would estimate the degree of permanency or reversibility of the distortion produced by each intervention in relation to the affected element.

Different levels of indicators have been produced and each intersection impact is represented graphically in order to obtain comparable diagnoses in short periods of time. The indicators will: (1) Qualify and identify the relevant positive or negative intersections; (2) Select the most critical **elements** and **actions;** (3) Identify areas requiring a more detailed assessment; (4) Search "action" alternatives to minimise the impact original value. We think that the actual actions, the methods, the technologies, the materials, etc.. Must be considered among the "action" alternatives. If new alternative settings appear, the greatest number of positive values must be preserved, except in those opposed situations which would require to make a choice.

The matrices can be applied in new or recyclable urban enterprises. Variables can be analysed as a whole or, the most critical ones, individually. The aspects to be considered are, among others, the building one, the inhabitability, the technology, the transport, the energy flows, the emissions, the working aspects and the economic ones. Their choice depends on the type of the planned intervention. A good selection of variables will allow to formulate good diagnoses and to provide possible alternative settings.

FORMULATION OF THE DECISION MATRICES

Four associated matrices have been formulated. Three of them represent the concepts of **intensity**, **significance** and **temporality**. The fourth matrix summarises the results of the transversal intersections of the first three and calculates the partial and total indicators representing the impact extent of the analysed intervention. In every case, the matrices keep the original structure in which the main *natural and artificial components* as well as the planned *actions* are included. In order to enhance the comprehension of the resulting numerical matrix (matrix 4) and visualise the relevant intersections, a 3D diagram showing the maximums and their sign is provided (Fig.1 and Fig.2).

The identification of lines and columns, corresponding to *the components and the actions* of matrix 1 of **Intensity**, is typical of the qualitative and semiquantitative analyses developed by Leopold. The **extent of the impact intensity** of an action (columns) on every component (lines) is subjectively quantified. Each intersection is qualified from 0 to 10 and a positive or negative sign is incorporated depending on the type of variable intersection (actions and elements). If such intersection has an algorithm calculating the intensity, this can be included in the matrix or calculated previously and standardised in accordance to the qualification status. In this way, a map of intersections with impact intensity values is obtained.

In matrix 2, the **significance** of the impact is assessed if produced. The significance concept shows how important the impact is on a certain element. For this decision, it must be considered the affected element, its condition in relation to its existence fragility and the local and regional setting in question. It is not the same to assess elements outside an area of close risks, than settings connected to areas which are degraded or have a certain protection level. The impact significance on the element can be substantially modified according to the alternatives. The qualification ranges from 0 to 1.

Matrix 3 assesses the **temporality** of the impact and it must show the impact short, medium or long term in general. Here, it is implicitly assessed the recovery degree of an element affected by a certain action. If any algorithm evaluating the temporality or the recovery period of the element does exist, it can be incorporated with the corresponding calculus normalisation in all cases. The qualification ranges from 0 to 1.

In order to enrich the methodology, Matrix 4, of ***results***, has been developed keeping the original structure of elements and actions. This matrix comprises information about the **extent, sign, significance and temporality**. In Matrix 4, an indicator (Index 1) transversally relating each intersection field (in Matrices 1, 2 and 3) is incorporated; and a synthesis result for each intersection is calculated. **Index 1** (± $\mathbf{I_1}$) shows the participation degree that each intersection (**Action-Element-Temporality**) has in the result matrix. Formula (1) summarises Index 1 ($\mathbf{I_1}$).

$$(\pm)\ I_1 = \text{Intensity} \times \text{Significance} \times \text{Temporality} = \pm 10 \qquad (1)$$

To determine the relevance of some actions (columns) and elements (lines) within the entire project, Index 2 (± $\mathbf{I_2}$) is incorporated for each line and column. This **Index 2** aims at integrating each line (action) and each column (element) of matrix 4. $\mathbf{I_2}$ relates each $\mathbf{I_1}$ value with the number of cases of similar sign (**n cases**) giving to it a relative weight in relation to the total number of intersections (**N of actions and N of elements** at work). As an exercise, it has been suggested an intervention hypothesis consisting of 33 actions and 29 elements capable of being affected, not all the intersections needing to have a value. $\mathbf{I_2}$ is elaborated for each line and each column. Consequently, there will be one $\mathbf{I_2}$ for each element ($\mathbf{I_{2\,E}}$) and each action ($\mathbf{I_{2\,A}}$), respecting their signs.

The (±) $\mathbf{I_{2E}}$works with each **element** capable of being affected (line) and, in this case, with a total of 16 intervening actions with value (N=16). Formulae (2) and (3) show the calculus of (±) $\mathbf{I_{2E}}$.

$$(-)I_{2E} = \left[\sum (I_1)_i \div n\right] \times \frac{\mathrm{n}}{\mathrm{N}} = \;\; ; \;\; I_{2E} \in [\text{-}10, 0]; \; \forall (I_1)_i \in (I_1) \text{ y } (I_1)_i \langle 0 \qquad (2)$$
$$n = \text{number of } (I_1)_i \langle 0 \;\; ; \mathrm{N} = \text{Total of columns with value } (\mathrm{N} = 16)$$

$$(+)I_{2E} = \left[\sum (I_1)_i \div n\right] \times \frac{\mathrm{n}}{\mathrm{N}} = \;\; ; \;\; I_{2E} \in [0, 10] \;\; ; \forall (I_1)_i \in (I_1) \text{ y } (I_1)_i \rangle 0 \qquad (3)$$
$$n = \text{number of } (I_1)_i \rangle 0 \;\; ; \;\; \mathrm{N} = \text{Total of columns with value } (\mathrm{N} = 16)$$

The (±) $\mathbf{I_{2\,A}}$ is elaborated considering the **actions** (columns) that would affect the elements; in this case, a total of 24 elements affected with value (N=24). The formulae (4) and (5) show the (±) $\mathbf{I_{2\,A}}$.

$$(-)I_{2A} = \left[\sum (I_1)_i \div n\right] \times \frac{\mathrm{n}}{\mathrm{N}} = \;\; ; \;\; I_{2A} \in [\text{-}10, 0] \;\; ; \forall (I_1)_i \in (I_1) \text{ y } (I_1)_i \langle 0 \qquad (4)$$
$$n = \text{number of } (I_1)_i \langle 0 \quad ; \quad \mathrm{N} = \text{Total of lines with value } (\mathrm{N} = 24)$$

$$(+)I_{2A} = \left[\sum (I_1)_i \div n\right] \times \frac{\mathrm{n}}{\mathrm{N}} = \;\; ; \;\; I_{2A} \in [0, 10] \;\; ; \forall (I_1)_i \in (I_1) \text{ y } (I_1)_i \rangle 0 \qquad (5)$$
$$n = \text{number of } (I_1)_i \rangle 0 \quad ; \quad \mathrm{N} = \text{ Total of lines with value } (24)$$

The number of intersections can vary depending on the undertaking analysed by the EIS.

In order to make a global synthesis of the undertaking, it is needed an index summarising all the detailed results and showing the impact extent of the suggested project. Consequently, **Index 3** (±$\mathbf{I_3}$) was elaborated to synthesise the $\mathbf{I_2}$ results. The difference between the addition of (+)$\mathbf{I_{2E}}$ and (-)$\mathbf{I_{2E}}$ (elements) and that of (+)$\mathbf{I_{2A}}$ and (-)$\mathbf{I_{2A}}$ (actions) would allow to assess the global impact of the undertaking. The formulae of (±)$\mathbf{I_3}$ are shown in (6) and (7):

$$(\pm)I_{3E} = [\ \sum(+I_{2E}) - \sum(-I_{2E})\ ]/\mathrm{N} \quad ; \quad \mathrm{N} = 24 \qquad (6)$$

$$(\pm)I_{3A} = [\ \sum(+I_{2A}) - \sum(-I_{2A})\ ]/\mathrm{N} \quad ; \quad \mathrm{N} = 16 \qquad (7)$$

The result of (±) $\mathbf{I_{3E}}$ and (±) $\mathbf{I_{3A}}$ will globally determine if the undertaking produces strong positive, negative or balanced impacts. It is clear that the term balanced does not mean that there are not high value impacts; in this case, it is necessary to resort to the detailed information ($\mathbf{I_2}$ and $\mathbf{I_1}$) to identify the relevant actions or elements as well as the intersections of higher impact.

To help visualization, the intersections of Matrix 4 for hypotheses 1 and 2 are shown in a bar chart (see figures 1 and 2). This graph allows the identification of the impact extent of the different aspects by means of surfaces in which valleys, peaks and discontinuities can be identified.

If alternative settings are elaborated for a same undertaking, the indicators will allow to assess and compare its differences. The options with lower impact will be based and selected according to the setting comparative analysis.

In order to apply the EIS with the proposed alternatives, an example with two working hypotheses is shown. The first hypothesis presents the height extension of an energyintensive health institution by means of traditional technology, in a partially urbanised area and within a partially intervened piece of land. In the second hypothesis, energy conservation measures are incorporated, being applied to the building envelope and quantified by thermal balances. Cleaning measures in the effluents by a treatment plant are also incorporated. In the example, the construction stage and its subsequent use are both considered. It is necessary to remember that the matrices can work with objective and subjective values, that is to say, some variable values are based on calculus procedures such as thermal balances, gas emission calculus, treatment capacity, etc.

RESULTS

If $\mathbf{I_1}$ values are considered in the first hypothesis, the areas with a density of intersections and levels between ±10 indicate the relevant variables for the study. The complexity of the intervention will determine the number of intersections to analyse. As regards the actions, those registering the greatest negative interventions are the areas of "Ground alterations", "Traffic changes" and "Emissions-Particle Settling". The positive actions are registered in the area "Land transformation and construction", specially the "urbanization" aspect in the intersection with employment; and "traffic changes" in the intersection with the commercial sector. As for the second hypothesis results, the negative values related mainly to the sector "Emissions-Particle settling" are minimised and the intersection "Urbanization-Employment" is slightly improved. The decrease in the areas of energetic "emissions" is proportionally related to the values obtained in the energetic balances made with the improvements performed on the building envelope. As for those areas of "sewage", the incorporation of a treatment plant reduces the waste according to the treatment plant capacity and its dimensions. On the other hand, the treatment plant generates permanent jobs, positively modifying the corresponding intersections.

With regard to the $\mathbf{I_2}$ (±10) for the first hypothesis, the relevant actions are mainly related to “Emissions-Particle settling”, and, to a lesser extent, to “Waste disposal” and “Motor vehicles”. The affected elements are “Open spaces quality”, “Health and security”, “landscape”, “recreation” and “residence”. In the second hypothesis, actions are mainly minimised in the areas of “effluents” and, to a lesser extent, in “chemical waste”, “particles” and “contaminant emission”. The affected elements improve in relation to the mitigation actions.

With regard to $\mathbf{I_3}$ (±10), though it is an important social-welfare intervention, it shows, in general, low negative impact results in the first hypothesis. In the second hypothesis, the mitigation measures register significant reductions but maintain the mentioned sign.

According to the intervention hypothesis, the suggested exercise qualifies and quantifies the results with an acceptable approximation as it highlights the most critical and relevant situations. On the whole, the development of the EIA methodology, added to the diagnosis one, makes it possible to understand and to approach the real situation. The suggested methodology provides necessary elements and information to assess the planned actions in every urban intervention. It also allows to quickly define and fundament new mitigation settings. The comparison of the different suggestions and situations facilitates the assessment of their consequences and the minimisation of the impacts.

Hypothesis 1. Extension with traditional technology. Matrix 1

Matrix 1 (Impact Extent)	Actions to be considered in the new or recyclable undertaking																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGeneració		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	-1																-1	-1		-1						-3				-2			
Soils																				-1												-1	-1
Water quality																															-5		-1
Atmospheric quality(Emis.)																									-1	-1		-1		-1		-1	
Microfauna																				-6										-1	-5		-1
Fauna						-5																								-2			
Flora																				-5										-4	-6		-3
Open spaces																				-1										-8	-8	-8	-3
Undertaking building																				-3										-8	-8	-8	-3
Residence	-4					-8					-4									-5	-3				-6	-9				-8	-8	-8	-3
Commercial	-4					-8					-4									-4	5				5	5				-8	-8	-8	-3
Recreation	-5					-10					-4									-7					-6	-6				-10	-8	-10	-4
Lamdscape	7					-10		4												-7	-9				-9	-9				-8	-8	-10	-2
Open spaces quality	-5					-10		4												-7	-9				-9	-9				-10	-8	-10	-4
Health and security	-4					-8		-4			-4									-5					-2	-3				-10	-10	-10	-10
Employment								8			4									1					3	2			4				
Transport network																					-6				-6	-7		1		-4		-4	
Service provision								3			4																		7				
Micro industries											2														4	2							
Industries																	1	1															
Utilities netwoks infr.											2																		6				
Garbaje collections								-2																							-8	-8	-8
Architectural barriers																																	
Accesses and corridors								-2																	-6	-7		-2		-8		-9	

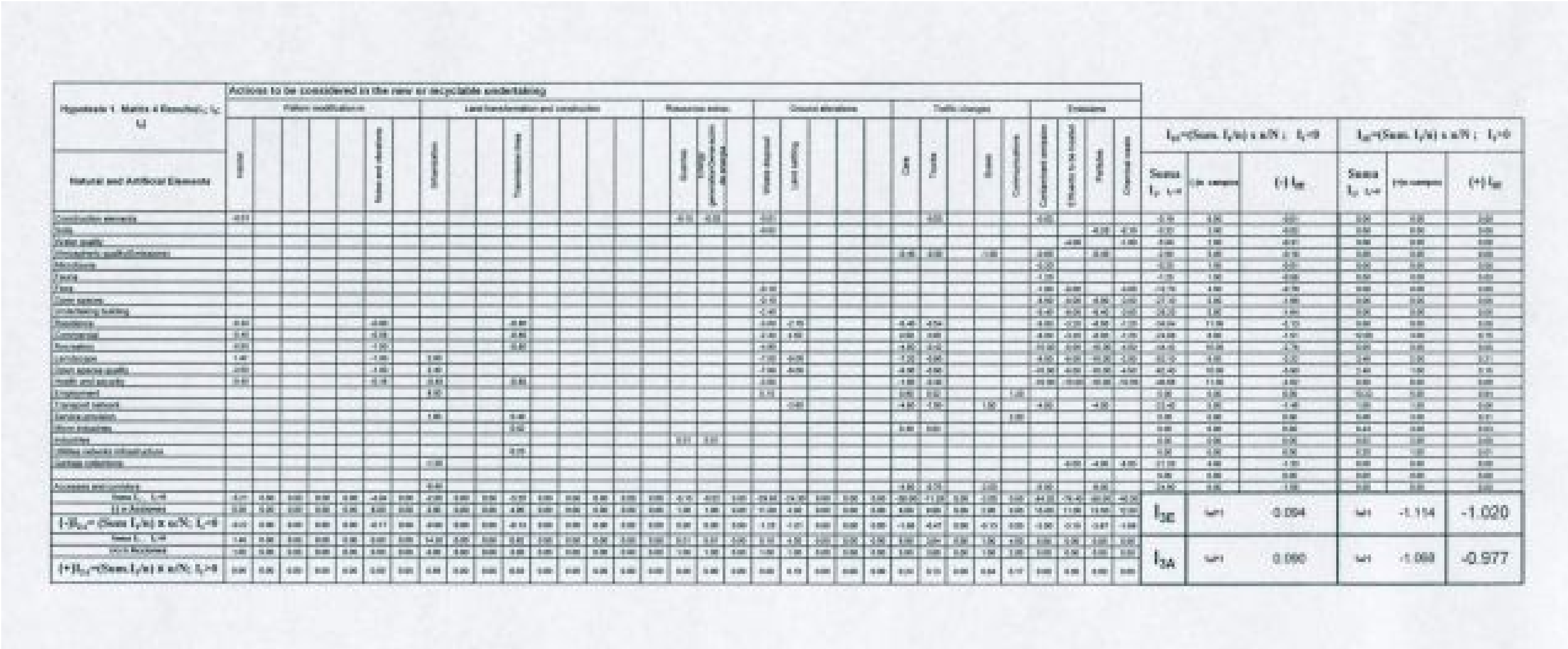
Hypothesis 1. Extension with traditional technology. Matrix 2

Matrix 2 (Impact significance)	**Actions to be considered in the new or recyclable undertaking**																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGeneración		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	0.1																0.1	0.1		0.1						0.1				0.1			
Soils																				0.2												0.2	0.1
Water quality																															0.8		1.0
Atmospheric quality(Emis.)																									0.4	0.5		1.0		0.6		0.4	
Microfauna																				0.1										0.1	1.0		1.0
Fauna						0.7																								0.3			
Flora																				0.1										0.2	1.0		1.0
Open spaces																				0.1										1.0	1.0	1.0	1.0
Undertaking building																				0.8										0.8	1.0	0.8	1.0
Residence	0.1					1.0					0.2									0.6	0.9				0.9	0.6				1.0	0.4	1.0	0.4
Commercial	0.1					0.1					0.2									0.6	0.9				0.9	0.6				1.0	0.4	1.0	0.4
Recreation	0.1					1.0					0.2									0.7					0.8	0.7				1.0	1.0	1.0	1.0
Lamdscape	0.2					1.0		0.5												1.0	1.0				0.8	1.0				1.0	1.0	1.0	1.0
Open spaces quality	0.7					1.0		0.6												1.0	1.0				1.0	1.0				1.0	1.0	1.0	1.0
Health and security	0.1					0.2		0.1			0.2									0.6					0.8	1.0				1.0	1.0	1.0	1.0
Employment								1.0			0.1									0.1					0.3	0.1			0.3				
Transport network																					0.6				0.8	1.0		1.0		1.0		1.0	
Service provision								0.6			0.1																		0.4				
Micro industries											0.1														0.1	0.1							
Industries																	0.1	0.1															
Utilities netwoks infr.											0.1																						
Garbaje collections								0.6																							1.0	0.5	1.0
Architectural barriers																																	
Accesses and corridors								0.2																	0.8	1.0		1.0		1.0		1.0	

Hypothesis 1. Extension with traditional technology. Matrix 3

Matrix 3 (Impact temporality)	**Actions to be considered in the new or recyclable undertaking**																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGenera		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	0.1																1.0	0.2		0.1						0.1				0.1			
Soils																				0.1												1.0	1.0
Water quality																															1.0		1.0
Atmospheric quality(Emis.)																									1.0	1.0		1.0		1.0		1.0	
Microfauna																				1.0										1.0	1.0	1.0	1.0
Fauna						0.1																								1.0			
Flora																				1.0										1.0	1.0	1.0	1.0
Open spaces																				1.0										1.0	1.0	1.0	1.0
Undertaking building																				1.0										1.0	1.0	1.0	1.0
Residence	1.0					0.1					1.0									1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Commercial	1.0					0.1					1.0									1.0	1.0				1.0	1.0				1.0	1.0	1.0	1.0
Recreation	1.0					0.1					1.0									1.0					1.0	0.1				1.0	1.0	1.0	1.0
Lamdscape	1.0					0.1		1.0												1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Open spaces quality	1.0					0.1		1.0												1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Health and security	1.0					0.1		1.0			1.0									1.0					1.0	0.1				1.0	1.0	1.0	1.0
Employment								1.0												1.0					1.0	0.1			1.0				
Transport network																					1.0				1.0	1.0		1.0		1.0		1.0	
Service provision								1.0			1.0																		1.0				
Micro industries											0.1														1.0	0.1							
Industries																	0.1	0.1															
Utilities netwoks infr.											1.0																		1.0				
Garbaje collections								1.0																							1.0	1.0	1.0
Architectural barriers																																	
Accesses and corridors								1.0																	1.0	0.1		1.0		1.0		1.0	

Hypothesis 1. Extension with traditional technology. Matrix 4



Actions to be considered in the new or recyclable undertaking

Natural and Artificial Elements

I_{3E}		-0.094	-1.114	-1.020
I_{3A}		0.090	-1.088	-0.977

Hypothesis 2. Extension with traditional technology. Matrix 1

Matrix 1 (Impact Extent)	**Actions to be considered in the new or recyclable undertaking**																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGeneració		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	-1																-1	-1		-1						-3				-2			
Soils																				-1												-1	-1
Water quality																															-1		-1
Atmospheric quality(Emis.)																									-1	-1		-1		-1		-1	
Microfauna																				-6										-1	-1		-1
Fauna						-5																								-1			
Flora																				-5										-2	-1		-2
Open spaces																				-1										-5	-1	-5	-2
Undertaking building																				-3										-5	-1	-5	-2
Residence	-4					-8					-4									-5	-3				-6	-9				-5	-1	-5	-2
Commercial	4					-8					-4									-4					5	5				-5	-1	-5	-2
Recreation	-5					-10					-4									-7					-6	-6				-7	-1	-7	-3
Lamdscape	5					-10		4												-7	-9				-9	-9				-5	-1	-7	-2
Open spaces quality	-5					-10		4												-7	-9				-9	-9				-7	-1	-7	-3
Health and security	-4					-8		-4			-4									-5					-2	-3				-7	-1	-7	-8
Employment								9			4									1					3	2			4				
Transport network																					-6				-6	-7		1		-4		-4	
Service provision								3			4																		7				
Micro industries											2														4	2							
Industries																	1	1															
Utilities netwoks infr.											2																		6				
Garbaje collections								-2																							-1	-7	-6
Architectural barriers																																	
Accesses and corridors								-2																	-6	-7		-2		-8		-9	

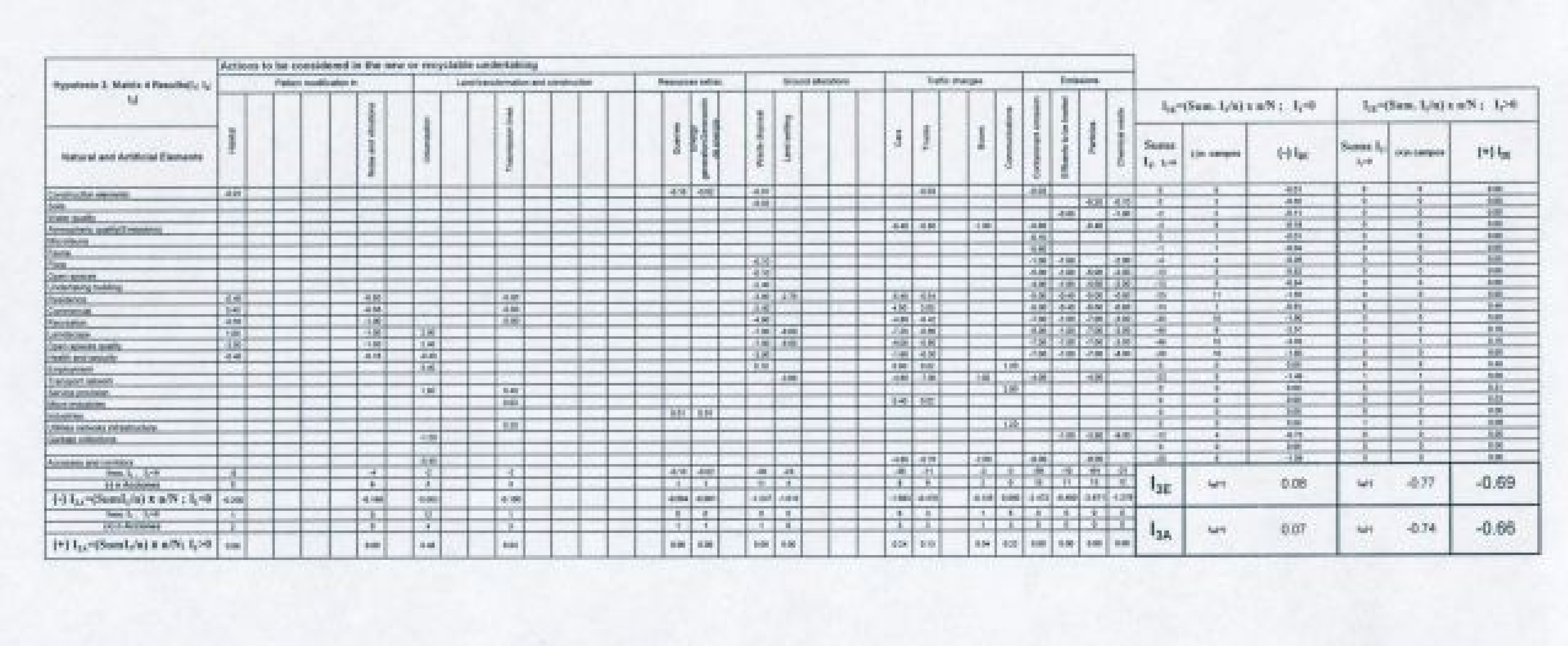
Hypothesis 2. Extension with traditional technology. Matrix 2

Matrix 2 (Impact significance)	**Actions to be considered in the new or recyclable undertaking**																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGeneración		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	0.1																0.1	0.1		0.1						0.1				0.1			
Soils																				0.2												0.2	0.1
Water quality																															0.8		1.0
Atmospheric quality(Emis.)																									0.4	0.5		1.0		0.6		0.4	
Microfauna																				0.1										0.1	1.0		1.0
Fauna						0.7																								0.3			
Flora																				0.1										0.2	1.0		1.0
Open spaces																				0.1										1.0	1.0	1.0	1.0
Undertaking building																				0.8										0.8	1.0	0.8	1.0
Residence	0.1					1.0					0.2									0.6	0.9				0.9	0.6				1.0	0.4	1.0	0.4
Commercial	0.1					0.1					0.2									0.6	0.9				0.9	0.6				1.0	0.4	1.0	0.4
Recreation	0.1					1.0					0.2									0.7					0.8	0.7				1.0	1.0	1.0	1.0
Lamdscape	0.2					1.0		0.5												1.0	1.0				0.8	1.0				1.0	1.0	1.0	1.0
Open spaces quality	0.7					1.0		0.6												1.0	1.0				1.0	1.0				1.0	1.0	1.0	1.0
Health and security	0.1					0.2		0.1			0.2									0.6					0.8	1.0				1.0	1.0	1.0	1.0
Employment								1.0			0.1									0.1					0.3	0.1			0.3				
Transport network																					0.6				0.8	1.0		1.0		1.0		1.0	
Service provision								0.6			0.1																		0.4				
Micro industries											0.1														0.1	0.1							
Industries																	0.1	0.1															
Utilities netwoks infr.											0.1																		0.2				
Garbaje collections								0.6																							1.0	0.5	1.0
Architectural barriers																																	
Accesses and corridors								0.2																	0.8	1.0		1.0		1.0	0.1	1.0	

Hypothesis 2. Extension with traditional technology. Matrix 3

Matrix 3 (Impact temporality)	**Actions to be considered in the new or recyclable undertaking**																																
	Pattern modification in							Land transformation and construction								Resources extrac.				Ground alterations					Traffic changes					Emissions			
Natural and Artificial Elements	Habitat					Noise and vibrations		Urbanization			Trasmission lines						Quarries	Energy generationGenera		Waste disposal	Land settling				Cars	Trucks		Buses	Communications	Contaminant emission	Effluents to be treated	Particles	Chemical waste
Construction elements	0.1																1.0	0.2		0.1						0.1				0.1			
Soils																				0.1												1.0	1.0
Water quality																															1.0		1.0
Atmospheric quality(Emis.)																									1.0	1.0		1.0		1.0		1.0	
Microfauna																				1.0										1.0	1.0	1.0	1.0
Fauna						0.1																								1.0			
Flora																				1.0										1.0	1.0	1.0	1.0
Open spaces																				1.0										1.0	1.0	1.0	1.0
Undertaking building																				1.0										1.0	1.0	1.0	1.0
Residence	1.0					0.1					1.0									1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Commercial	1.0					0.1					1.0									1.0	1.0				1.0	1.0				1.0	1.0	1.0	1.0
Recreation	1.0					0.1					1.0									1.0					1.0	0.1				1.0	1.0	1.0	1.0
Lamdscape	1.0					0.1		1.0												1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Open spaces quality	1.0					0.1		1.0												1.0	1.0				1.0	0.1				1.0	1.0	1.0	1.0
Health and security	1.0					0.1		1.0			1.0									1.0					1.0	0.1				1.0	1.0	1.0	1.0
Employment								0.6												1.0					1.0	0.1			1.0				
Transport network																					1.0				1.0	1.0		1.0		1.0		1.0	
Service provision								1.0			1.0																		1.0				
Micro industries											0.1														1.0	0.1							
Industries																	0.1	0.1															
Utilities netwoks infr.											1.0																		1.0				
Garbaje collections								1.0																							1.0	1.0	1.0
Architectural barriers																																	
Accesses and corridors								1.0																	1.0	0.1		1.0		1.0	1.0	1.0	1.0

Hypothesis 2. Extension with traditional technology. Matrix 4



Actions to be considered in the new or recyclable undertaking

Natural and Artificial Elements

I_{3E}		0.08		-0.77	-0.69
I_{3A}		0.07		-0.74	-0.66

Figure 1. 3D bar chart. Hypothesis 1, Matrix 4.

Figure 1. EIS. I_1 Results matrix. Hypothesis 1.

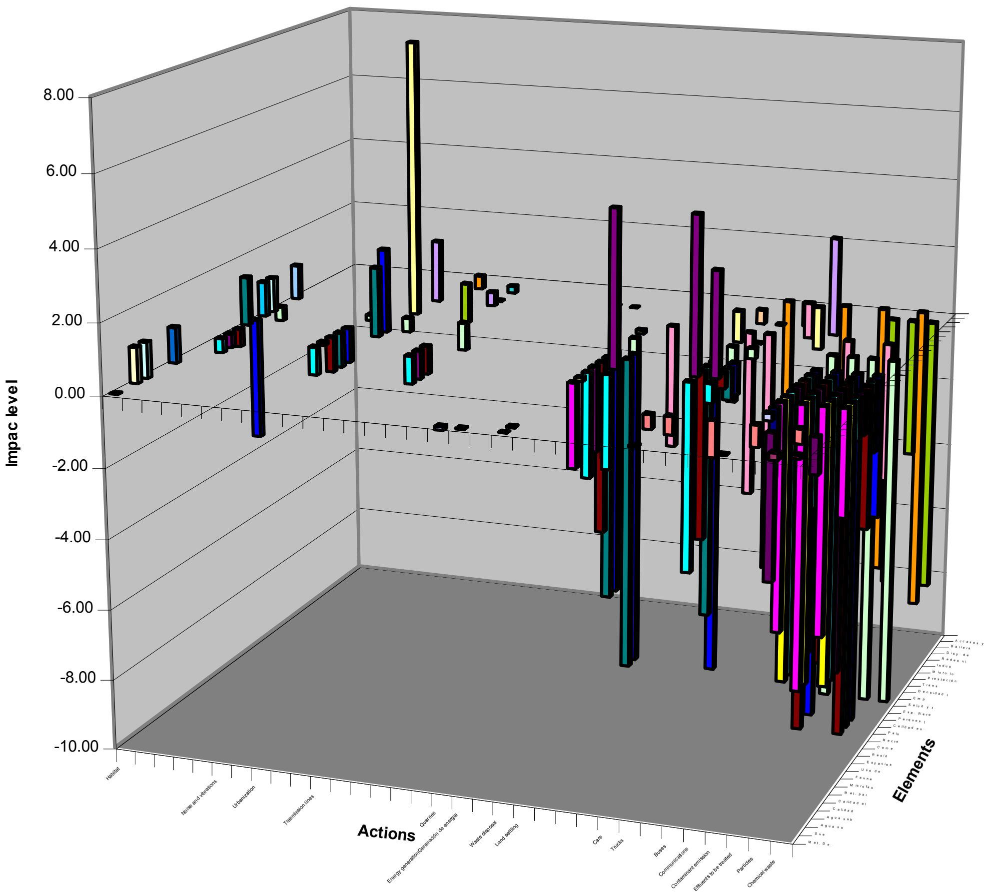
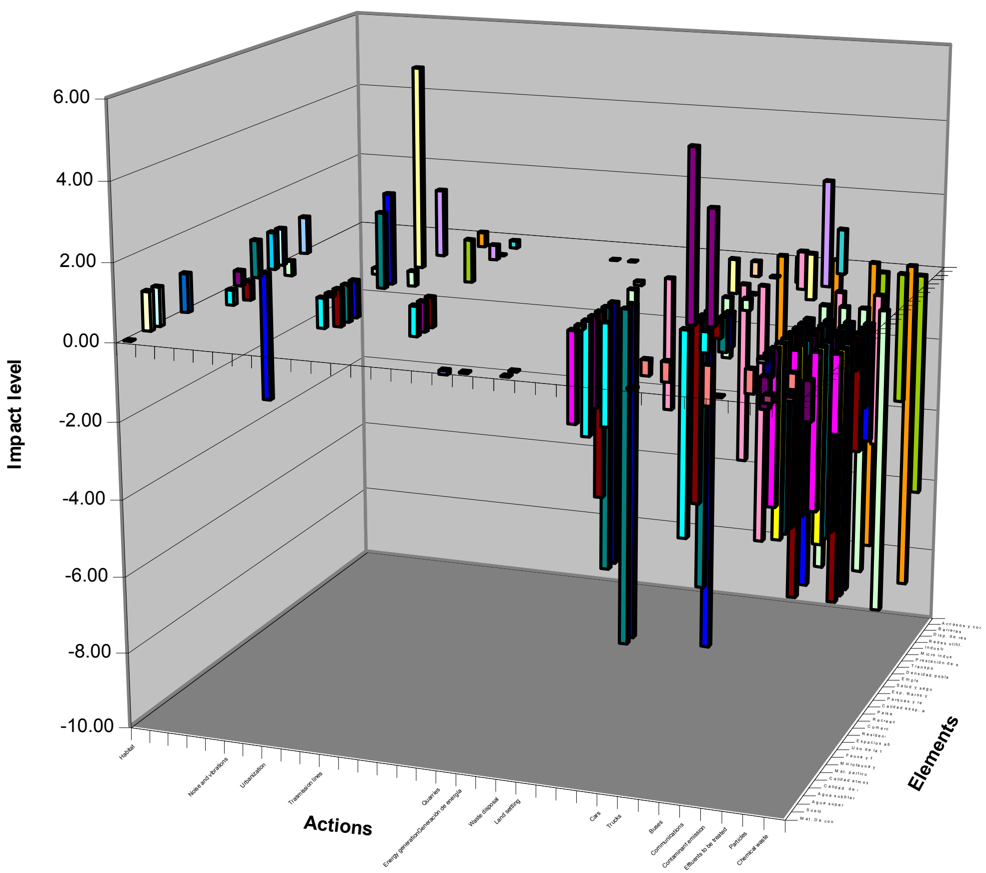


Figure 2. 3D bar chart. Hypothesis 2, Matrix 4.

Figure 2. EIS. I_1 Result matrix. Hypothesis 2.



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FIGURES AND TABLES

Hypothesis 1. Extension with traditional technology. Matrix 1 (EXCEL 2000)

Hypothesis 1. Extension with traditional technology. Matrix 2 (EXCEL 2000)

Hypothesis 1. Extension with traditional technology. Matrix 3 (EXCEL 2000)

Hypothesis 1. Extension with traditional technology. Matrix 4 (EXCEL 2000)

Hypothesis 2. Extension with traditional technology. Matrix 1 (EXCEL 2000)

Hypothesis 2. Extension with traditional technology. Matrix 2 (EXCEL 2000)

Hypothesis2. Extension with traditional technology. Matrix 3 (EXCEL 2000)

Hypothesis 2. Extension with traditional technology. Matrix 4 (EXCEL 2000)

Figure 1. EIS. I_1 Results matrix. Hypotesis 1 (EXCEL 2000)

Figure 2. EIS. I_1 Results matrix. Hypotesis 2 (EXCEL 2000)