Impact of integrated management systems on organisations and the impact of road projects on biodiversity in Colombia

Oscar A. Vásquez-Bernal† & William E. Mosquera-Laverde‡

Universidad Nacional Abierta y a Distancia, Bogotá, Colombia†
Universidad Cooperativa de Colombia, Bogotá, Colombia‡

ABSTRACT: When constructing roads in Colombia it is important to establish mechanisms for compensation for environmental deterioration and loss of biodiversity. Previous studies indicate that there is still much controversy regarding the application of the Colombian manual used to determine compensation for biodiversity loss. A bibliographic review was carried out covering biodiversity, ecosystem services and integrated management systems. The PrOACT method (problem, objectives, alternatives, consequences, trade-offs) for decision making was used as the framework for a study conducted on the impact of management systems on small- and medium-sized enterprises (SMEs) in Colombia.

INTRODUCTION

Integrated management systems (quality, environmental, occupational health and safety) are a main driver of the development of organisations. The implementation of these systems is no longer a novelty and has become a regulatory requirement. The aim in this work is to analyse the impact of integrated management systems on small- and medium-sized enterprises (SMEs) determining the difficulties and challenges they present.

Some impact on ecosystems by road infrastructure projects is covered by Colombian regulations for the estimation of compensation for biodiversity loss [1]. The current approach to the allocation of compensation for biodiversity loss caused by road infrastructure projects is different from the ecosystemic equivalence proposed in the official manual.

There are issues not yet included in the biodiversity management regime in Colombia. This study was conducted on SMEs in Colombia on the impact of integrated management systems, with the focus on construction companies. The PrOACT method (problem, objectives, alternatives, consequences, trade-offs) was used as an analysis tool in the framework of a goal-based approach.

BIODIVERSITY LOSS

There are five causes of biodiversity loss: ecosystem loss and transformation, species introduction, overexploitation, pollution and climate change [2]. Of these, transformation, the loss and change of an ecosystems through fragmentation, is considered anthropic and has a high environmental impact. This argues for its inclusion in estimates for compensation for the loss of biodiversity. If included by the environmental authorities, this would result in a more realistic approach to environmental impact.

Additionally, information for decision-making in the environmental sector in Colombia is sparse, with local effects on biodiversity not easily perceived. According to the official map (scale 1:500,000) of continental, coastal and marine ecosystems [3], Colombia has 311 types of continental and coastal ecosystems, including natural areas with little transformation and landscapes transformed by human activities of settlement, production and extraction [4]. Taking into account the minimum cartographic area of 2,500 ha given the map's scale, smaller ecosystems are not represented or taken into account.

COMPENSATION

In an attempt to *compensate* for the loss of net biodiversity in Colombia, the Ministry of the Environment has developed a compensation manual in association with the following organisations: The Nature Conservancy, World Wildlife Fund

(WWF) and Conservation International. Determining compensation for biodiversity loss needs to address how much to compensate, where to compensate and how to compensate [5]. There are three guiding principles, viz. mitigation, no net loss of biodiversity and ecosystemic equivalence [6].

The manual is applied by the Colombian National Environmental Licensing Authority as part of evaluation in the environmental licensing process [7]. This licence evaluation produces only an approximation for the compensation in terms of area and ecosystem; it has many gaps for the loss of biodiversity on a local scale.

Contained in this article is a review of the literature about the principles defined by Colombian regulations for the estimation of compensation for biodiversity loss, biodiversity conservation and the development of regulations. This article is a first attempt to cover issues not yet included in Colombian regulations regarding the management of biodiversity.

The aim is to stimulate a debate about the need for additional factors, such as fragmentation, when evaluating the impact that has to be compensated for by road infrastructure projects, and thus contribute to no loss of biodiversity on a local scale.

Based on this analysis, an additional approach is proposed for the management of biodiversity, including fragmentation as part of a compensation evaluation. This will identify conservation actions to reduce the impact caused by fragmentation [8].

INTEGRATED MANAGEMENT SYSTEMS

The importance of management systems has generated a need for compliance with requirements, and the demands of the stakeholders and interest groups (clients, associations, guilds, investors). There are numerous investigations of the implementation of management systems, and studies carried out by certifying entities on the benefits of management systems in organisations. However, there are marked differences in the studies regarding the impact on productivity of the implementation of management systems.

There is still a lot of debate regarding the impact of regulations on the performance, operations and competitiveness of companies [9-14]. An important point is that performance can be improved through the certification of a management system. The implementation of quality management systems in Europe has been important in providing a *passport* for doing business with companies from other countries. However, it is the norm for management to be tempted to implement a management system superficially causing least difficulty within the organisation. [9].

Commercial market pressures affect organisations and their internal objectives may not be aligned with the demands of the marketplace. The rapid development of management systems based on the ISO (International Standards Organisation) 9000 series of standards has addressed the internal and external factors. There are commercial tools for the external factors and internal management systems for the internal factors [9].

An organisation must focus on these two aspects and many studies indicate that the commercial aspect has an important impact on the decision to implement management systems. However, the internal effects on the organisation are often not considered.

There is a positive correlation between the implementation of quality management systems (ISO 9000 based) and the performance of an organisation [15]. However, the presence or absence of ISO 9000 certification is a poor predictor of the performance of an organisation [15][16], i.e. there is no positive statistical relationship between whether a company is certified and its performance and quality [17].

Research analysing the relationship between ISO 9000 certification and an organisation's performance is scarce and contradictory. It emphasises the importance of developing empirical studies for further academic research [15].

PROBLEM STATEMENT

Mosquera-Laverde and Vásquez-Bernal show in their exploratory study of SMEs in Bogotá, a negative impact of the certification of quality and environmental management systems [18]. Small- and medium-sized enterprises do not know how to measure productivity nor do they see the alignment of a management system with financial results and sales revenue.

The implementation of the management system may be obligated by a client, a group of companies or unions to be competitive in the marketplace. Hence, these stakeholders have a high degree of influence in the management decisions of the SMEs.

On the other hand, it was observed that in the certified SMEs of the study, their certified management system is used to fill out forms as evidence of compliance with quality standards. This responsibility often falls on a single official in

charge of monitoring. Due to the above, it is not adequate to compensate for the loss of the biodiversity with only a payment as proposed by Mosquera-Laverde [19], which increases global environmental risks.

METHODOLOGY

Analysis and Criteria

For the problem presented, it is important to highlight the aspects for analysis and the criteria involved in decision-making, as well as their impact on the solution to the problem. Various authors have developed methods that facilitate and simplify the process of decision analysis. One of the most used for the analysis of decision making is the PrOACT method (problem, objectives, alternatives, consequences, trade-offs) developed by Bond et al [20] and Carlson at al [21].

Profiles of the Experts

Two experts were consulted. They researched and analysed the secondary information, and applied the PrOACT method. Below are the characteristics and specifications of the experts.

Expert 1

The first expert was a PhD candidate in the engineering industry; a specialist in engineering project management with a Master of Business Administration degree and extensive experience in the productive sector.

Expert 2

The second expert was a professor and researcher; a chemical engineer with a Master in Environmental Management, and extensive experience in the productive sector.

ANALYSIS OF DECISIONS USING PrOACT

Review of Information

The experts reviewed information, such as bibliographic material, documents from the certifying bodies and regulations for the certification of management systems. The PrOACT method was then used to perform the analysis, guided by the experience, professional and academic skills of the experts. The following components make up PrOACT:

Problem Recognition (Pr)

Assessing the impact of the implementation of quality and environmental management systems on the productivity of small businesses is essential for the continuous improvement of administrative and managerial processes in decision making.

Objectives (O)

- O1 - Analyse the impact of the implementation of quality and environmental management systems on SMEs in Bogotá.
- O2 - Identify the criteria with the greatest influence on productivity from quality and environmental management systems.
- O3 - Prioritise the elements that influence the impact of quality and environmental management systems on SMEs in Bogotá.

Alternatives (A)

Based on the bibliographic, regulatory and information resources from the certification bodies and research on the impact of the certification of management systems on the performance of companies, a list of alternatives was prepared:

- A1 - ISO 9001: 2000 standard and its reference documents.
- A2 - ISO 14001: 2004 standard and its reference documents.
- A3 - Research articles on the impact of certification on the performance of organisations.
- A4 - Results of the exploratory study conducted on a sample of SMEs in Bogotá.

Description of Alternatives

- A1 - ISO 9001: 2000 standard and its reference documents - standard for quality management systems, which includes quality requirements for design, production, marketing and after-sales service.

- A2 - ISO 14001: 2004 standard and its reference documents - standard for environmental management systems covering the use of materials, production processes and the impact of a product life cycle on the ecosystem.

- A3 - Research articles on the impact of certification on the performance of organisations - analysis of secondary information from studies and research conducted on the impact of certified management systems on the performance of organisations using articles by Boiral and Roy [9] and Celadyn [14] and their references.

- A4 - Results of the exploratory study conducted on a sample of SMEs in Bogotá - analysis of the results of the exploratory study carried out by Bond et al [20] for a sample of SMEs in Bogotá.

Consequences (C)

To understand the consequences of a decision analysis, it is pertinent to evaluate each alternative with respect to the objectives set. It should be noted that the *scale used (strong, medium, etc)* is by way of example. It is essential to use current methods of assessment and evaluation. The strength of support for each alternative in meeting each objective is shown in Table 1.

Table 1: How alternatives satisfy the objectives.

Objectives/Alternatives	A1 ISO 9001:2000	A2 ISO 14001:2004	A3 Research articles	A4 Results of exploratory study
O1 - Analyse the impact of the implementation of quality and environmental management systems on SMEs in Bogotá	Medium	Medium	Strong	Strong
O2 - Identify the criteria with the greatest influence on productivity from quality and environmental management systems	Strong	Strong	Strong	Strong
O3 - Prioritise the elements that influence the impact of quality and environmental management systems on SMEs in Bogotá	Medium	Medium	Strong	Strong

A strong relationship is shown between objectives O1, O2, O3 and alternatives A3, A4, as well as a medium (average) relationship between the objectives O1, O3 and alternatives A1, A2. The analysis of the alternatives by objective was the result of an analysis of the secondary information, as well as an exploratory empirical study carried out for each of the alternatives with respect to the objectives set.

Trade-offs (T)

In order to evaluate the alternatives with respect to the objectives, it is necessary to contrast the alternatives and establish whether they maximise or minimise the achievement of the objectives as shown in Table 2.

Table 2: Comparison between the alternatives in meeting the objectives.

Objectives/Alternatives	A1 ISO 9001:2000	A2 ISO 14001:2004	A3 Research articles	A4 Results of exploratory study
O1 - Analyse the impact of the implementation of quality and environmental management systems on SMEs in Bogotá	Minimum	Minimum	Maximum	Maximum

O2 - Identify the criteria with the greatest influence on productivity from quality and environmental management systems	Maximum	Maximum	Maximum	Maximum
O3 - Prioritise the elements that influence the impact of quality and environmental management systems on SMEs in Bogotá	Minimum	Minimum	Maximum	Maximum

Similarly, an influence analysis between the proposed objectives of the problem was carried out, to determine how objectives are related in relation to the problem posed, as shown in Table 3.

Table 3: Analysis of influence among the objectives.

Influence matrix Question: How much does the impact of factor A (row) affect factor B (column)? Scale: 0: No influence 1: Low influence 2. Medium influence 3. High influence	O1	O2	O3
O1 - Analyse the impact of the implementation of quality and environmental management systems on SMEs in Bogotá		3	3
O2 - Identify the criteria with the greatest influence on productivity from quality and environmental management systems	3		2
O3 - Prioritise the elements that influence the impact of quality and environmental management systems on SMEs in Bogotá	2	3	

Selection of Criteria

Information extracted from the alternatives was taken into account when selecting criteria. The analysis of the sources of information resulted in the following criteria, as shown in Table 4.

Table 4: Criteria and sub-criteria.

Abbreviations	Criteria	Abbreviations	Sub-criteria
C1	Impact of quality and environmental management systems	SC11	Impact on productivity
		SC12	Impact on management
C2	Difficulties in the implementation of quality and environmental management systems	SC21	Level of difficulty of implementation
		SC22	Restrictions on implementation
		SC23	Pressure of interest groups
C3	Strategic, social, financial and productive reasons that influence the implementation of quality and	SC31	Competitive strategy
		SC32	Social impact

- C1 - Impact of quality and environmental management systems on the performance of an organisation.
- SC11 - Impact on productivity: the impact on productivity of the company due to reduction of costs and/or increase of profits.
- SC12 - Impact on the fulfilment of the corporate objectives.
- C2 - Difficulties in the implementation of quality and environmental management systems.
- SC21 - Level of difficulty of implementing quality and environmental management systems in the organisation.

- SC22 - Restrictions on the implementation: the restrictions in implementation at a regulatory and normative level.

- SC23 - Pressure from the stakeholders: the level of urgency (power and interest) of the different interest groups related to the organisation.

- C3 - Strategic, social, financial and productive reasons that influence the implementation of quality and environmental management systems.

- SC31 - Competitive strategy: the management and productive processes needed to stay in the market and be competitive.

- SC32 - Social impact: corporate responsibility regarding ecological environmental impact.

CONCLUSIONS

Clear Alternatives and Decision Criteria

The analysis of decisions by the PrOACT method leads to a number of observations. For a start, it is essential to have clear alternatives and decision criteria, with a thorough and reliable analysis for the allocation of weights. The allocation of weights depends directly on the decision maker. Therefore, there is great importance in the decision-maker's impartiality and objectivity.

Grouping Factor

The grouping factor was determined based on the analysis of the results in the exploratory study, the experience of the decision-making team and the interviews conducted with the businessmen who validated the results. The results presented in the exploratory study were used as input to establish the criteria.

The sub-criteria define in greater detail the characteristics to be analysed and the impact on the decision-making process taking into account priorities and relative importance. The analyses presented in this document represent decision-making with the use of multi-criteria analysis methodologies, such as the analytic hierarchy process.

Manual is Starting Point in Estimation

The manual for the allocation of compensation for loss of biodiversity is a good starting point for estimating the conservation of biodiversity. However, the net loss of biodiversity is not really known, when the impacts are caused by projects that require an environmental licence in terms of biodiversity loss. Furthermore, the ecosystemic equivalent evaluations ignore the real state of ecosystems.

Particularly for linear projects, the manual for the allocation of compensation for the loss of biodiversity has weaknesses. The impact of this type of project occurs in different ecosystems, each with a small impact, and does not include the impact caused by fragmentation. In addition, the short duration of these projects does not allow sufficient monitoring and follow-up in determining compensation.

Mitigating Reduction of Species Reproduction

The fragmentation of ecosystems by road infrastructure is not taken into account when granting environmental licences to road concessions. This impact can be compensated to mitigate the effect of the reduction of reproductive capacity of a species. This could require management tools that could be integrated into the project, so that there would be constant supervision and monitoring of the concession. Off-site compensation, in the case of road projects, would be a better alternative, taking into account the fragmentation of natural ecosystems, and would be ideal if the responsibility for the maintenance of such infrastructure was transferred to the concession. This is similar to what was proposed by CEPAL [22].

Conservation Habitat Banks

Habitat banks would be a good alternative approach to restoring, creating or conserving habitats with credits awarded for a species, habitat or ecosystems. This would require compliance with a legal obligation of compensation. These credits could be used as compensation to comply with legal obligations [23].

For the habitat bank system to operate transparently, efficiently and effectively, it is necessary to establish a minimum agreement for its operation. The foregoing is key, as this will define a solid basis to give sufficient clarity and, in turn, allow the system to mature over time. The minimum agreement should include:

- Definition of the roles and responsibilities.

- Definition of technical, legal and financial rules.

- Political will.

REFERENCES

1. Andrade, G., Sandino, J.C. and Aldana, J., *Biodiversidad y Territorio: Innovación para la Gestión Adaptativa Frente al Cambio Global, Insumos Técnicos para el Plan Nacional para la Gestión Integral de la Biodiversidad y los Servicios Ecosistémicos.* Bogotá: MAVDT Publishers, 64 (2011) (in Spanish).
2. Millennium Ecosystem Assessment (MEA). *Ecosystems and Human Well-being.* New York: Island Press, 35 (2005).
3. Ministerio de Ambiente y Desarrollo Sostenible. Subportal Biodiversidad y Servicios Ecosistémicos (2014), 20 April 2015, www.minambiente.gov.co (in Spanish).
4. IGAC - Instituto Geográfico Agustín Codazzi. *Ecosistemas Continentales, Costeros y Marinos de Colombia.* Bogotá: IGAC Publishers, 250- 276 (2007) (in Spanish).
5. Mosquera-Laverde, W.E. and Vásquez-Bernal, O.A., Herramientas de gestión ambiental para las carreteras de cuarta generación (4G) en Colombia. *Publicaciones e Investigación*, 9, **1**, 87-98 (2015) (in Spanish).
6. Ministerio de Ambiente y Desarrollo Sostenible. *Manual para la Asignación de Compensaciones por Pérdida de Biodiversidad.* Bogotá: MADS Publishers, 5-87 (2012) (in Spanish).
7. Ministerio de Ambiente, Vivienda y Desarrollo Territorial. Decreto 2820 (2010), 17 June 2015, www.anla.gov.co
8. Congreso de la República de Colombia. Ley 165 de 1994 de Convenio de las Naciones Unidas sobre Diversidad Biologica (1994), 20 April 2015, www.minambiente.gov.co (in Spanish).
9. Boiral, O. and Roy, M., ISO 9000: integration rationales and organizational impacts. *Inter. J. of Operations & Production Manage.*, 27, **2**, 226-247 (2007).
10. Walgenbach, P., The production of distrust by means of producing trust. *Organization Studies*, 22, **4**, 693-714 (2001).
11. Wilson, J.P., Walsh, M.A. and Needy, K.L., An examination of the economic benefits of ISO 9000 and the Baldrige award, *Engng. Manage. J.*, 15, **4**, 3-10 (2003).
12. Acharya, U.H. and Ray, S., ISO 9000 certification in Indian industries: a survey. *Total Quality Manage.*, 11, **3**, 261- 266 (2000).
13. Aarts, F., The impact of ISO registration on New Zealand firms performance: a financial perspective. *The TQM Magazine*, 13, **3**, 180-192 (2001).
14. Celadyn, M., Inner space elements in environmentally responsible interior design education. *World Trans. on Engng. and Technol. Educ.*, 14, **4**, 495-499 (2016).
15. Sampaio, P., Saraiva, P. and Monteiro, A., ISO 9001 certification pay-off: myth versus reality. *Inter. J. of Quality & Reliability Manage.*, 29, **8,** 891-914 (2012).
16. Terziovski, M., Samson, D. and Dow, D., The business value of quality management systems certification: evidence from Australia and New Zealand. *J. of Operations Manage.*, 15, **1**, 1-18 (1997).
17. Quazi, H., Hong, C. and Meng, C., Impact of ISO 9000 certification on quality management practices: a comparative study. *Total Quality Manage.*, 13, **1**, 53-67 (2002).
18. Mosquera-Laverde, W.E. and Vásquez-Bernal, O.A., Análisis de calidad en las pequeñas y medianas empresas de Bogotá. *Revista Ontare*, 2, **1**, 57-83 (2015) (in Spanish).
19. Mosquera-Laverde, W.E., La industria y el desarrollo sostenible. *Estrategias*, 11, **2**, 7-14 (2013) (in Spanish).
20. Bond, S.D., Carlson, K.A. and Keeney, R.L., *Generating Objectives: can Decision Makers Articulate What they Want?* Atlanta, Georgia, EEUU: (Informs®, Ed.) Management Science, 56-70 (2008).
21. Carlson, K.A., Janiszewski, C., Keeney, R.L., Krantz, D.H., Kunreuther, H.C., Luce, M.F., Russo, J.E., van Osselaer, S.M.J. and von Winterfeldt, D., *A Theoretical Framework for Goal-Based Choice and for Prescriptive Analysis*. The Wharton School, University of Pennsylvania, Pennsylvania (2007).
22. CEPAL, *Evaluaciones del desempeño ambiental. Colombia.* New York: ONU Publishers, 35-45 (2014) (in Spanish).
23. Sarmiento, M., *Los Bancos de Hábitat Como Herramienta de Compensacion en Colombia.* Bogota: Fundepúblico Publishers, 25-75 (2014).