Developing a business intelligence tool for sustainability management

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Abstract

Purpose – Business intelligence (BI) is a combination of computer systems and managerial processes to support decision-making. The balanced scorecard is a kind of business intelligence tool for performance measurement and management control aimed at balancing financial and non-financial as well as short- and long-term measures. The sustainable balanced scorecard is a modification of the original balanced scorecard developed to expressly consider governance, social, environmental and ethical issues, and therefore to allow sustainability concepts to be included within the strategy and the management of the organization. However, although the sustainable balanced scorecard is one of the most suitable tools for integrating sustainability within management, there are few examples of how to develop and implement it which can be used as reference models. To help solve this problem, this paper proposes a methodology for the development of a sustainable balanced scorecard, considering different phases such as planification, analysis, design or computer tool implementation, and describes the findings of three case studies.

Design/methodology/approach – The research was conducted using the qualitative multiple-case study method. This made it possible to establish the methodological issues regarding the performance and reporting of this study. Therefore, the research method for the conceptualization and execution of the case studies was divided into seven phases: definition of research goals and questions; proposed theoretical model; identification of units of analysis; case selection; definition of research methods and resources; fieldwork; data collection, classification of information and triangulation; formulation of the enhanced theory, model or methodology; and verification of the rigour and quality of the study.

Findings – Paper shows a methodology organized in phases, activities and tasks that allow a sustainable balanced scorecard to be planned, designed, built, computerized and controlled in order to integrate sustainability within the management systems of organizations.

Originality/value – This study contributes to the currently emerging sustainable balanced scorecard literature and practice and, more generally, to research on sustainability measurement and management. The methodology for sustainable balanced scorecard development and implementation showed in this paper contributes to the management and information systems theory because it makes it possible to overcome the shortcomings identified to date: it considers all the sustainability dimensions; it describes all the project life-cycle activities; it encourages stakeholders' participation; and it has been proved to work in real situations.

Keywords Business intelligence, Computer decision support systems, Strategy management, Sustainability, Corporate social responsibility, Sustainable development

Paper type Research paper

1. Introduction

Business intelligence (BI) is a combination of computer systems, knowledge management, and managerial processes for data gathering, storage, analysis, and visualization to offer complex internal and competitive organizational information to support both operative and strategic decision-making (Nuseir, 2021). BI facilitate non-expert computer users to analyse

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and visualise linked data, thus generating actionable information by means of reporting, OLAP analysis, dashboards or data mining (Corrales-Garay *et al.*, 2022). Thanks to this information, organizations can track their performance comparing indicators with business objectives and competitors, analyse consumer behaviour, discover problems and predict success, which allows them to make better decisions to improve processes and results (Al-Okaily *et al.*, 2023).

BI implementation must be addressed from two perspectives: the technological view and the managerial view (Attar-Khorasani and Chalmeta, 2023). The technological view is focused on the tools, software and computer to find, collect, organize and access a wider range of information from disparate data sources. On the other hand, the managerial view is focused on the coordination and management of the processes to offer timely, actionable, high-value and accurate business insights from data stored in different information sources (inside and outside the company) (Chee *et al.*, 2009).

The balanced scorecard (BSC) (Kaplan and Norton, 1996) is a kind of BI tool (Nuseir, 2021; Olszak *et al.*, 2022) that allows strategy to be translated into action. It is structured in four perspectives (financial, customers, processes and training). In developing the BSC, a hierarchical structure is employed to define long-term strategic objectives and to calculate the indicators with which to measure the degree of achievement of the objectives, for each perspective. The top-down process of the BSC ensures that all the business processes and action plans are aligned with the achievement of the business strategy. This feature of the BSC, together with its relative simplicity to deal with organization intangibles, makes it suitable to manage the concepts of sustainability (Figge *et al.*, 2002).

There is a great discussion in the literature about how to integrate sustainability into management. It is being covered by the new business management style called Re-engineered 4th Generation Management (Hallioui *et al.*, 2022), a new businesses generation oriented towards sustainability and customer, to make businesses more contemporary in a landscape of Industry 4.0 (Smiari *et al.*, 2020), circular economy (Tjahjadi *et al.*, 2023), smart cities, competitiveness and diverse stakeholders (Addazi and Ciccozzi, 2021).

As pointed out by Baumgartner (2014) and Gond *et al.* (2012), to develop sustainability strategies managers need to be perfectly aware of the consequences of their decisions. This requires an accurate calculation of key performance indicators and the evaluation of their alignment with the goals. Hence, the BSC is a suitable performance measurement and management control tool for implementing the dimensions of sustainability in the strategic management of organizations (Küçükbay and Sürücü, 2019).

The sustainability balanced scorecard (SBSC) is an evolution of the BSC (Mamudu *et al.*, 2023), combining the four classical BSC perspectives with sustainability ethical, environmental, social, governance and other concerns, as well as sustainability objectives and performance measures. There are four possible ways to do this (Mio *et al.*, 2021): to integrate sustainability concepts within the four classic BSC perspectives; to incorporate sustainability concepts within the customer perspective; to define a new perspective; or to develop a new BSC with only the sustainability dimensions.

The SBSC can support companies in the implementation of a sustainable strategy, which involves promoting sustainability management and decision-making, supporting regulatory data requirements and meeting stakeholders' information demands (Schaltegger and Wagner, 2006). However, although the SBSC is a suitable business intelligence tool for integrating sustainability and strategy in businesses (Hansen and Schaltegger, 2016) and is attracting growing interest from academia and practitioners (Hansen and Schaltegger, 2018), there is a need for research on SBSC frameworks and methodologies to support their development and application (Shreyanshu *et al.*, 2023; Mio *et al.*, 2021).

This scarcity of research on SBSC development is especially relevant in universities (Fuchs *et al.*, 2020). Universities play a fundamental role in sustainable and inclusive

development based on the transfer of knowledge and innovation through their curricula and research projects (Filho *et al.*, 2023; Hurtado *et al.*, 2019). Universities are aware that sustainability is a factor of university quality and creates a favourable reputation and enhances employees' commitment, morale and productivity in internal business processes (Saeidi *et al.*, 2015). Universities worldwide are changing their mission, vision, infrastructure (Mac-lean *et al.*, 2022; Lee and Lee, 2021) and educational practices to better cope with growing concerns about social and environmental issues and to respond to growing public demand for a sustainable society (Lin *et al.*, 2016). Indeed, the top universities in the international rankings are now increasingly institutionalizing sustainability practices within their curricula, research, business process, outreach and assessment (Salvioni *et al.*, 2017).

Therefore, it is important to know the lessons learned from universities' experiences in adopting the SBSC as a support for the integration of sustainability in their strategy and day-to-day management. This understanding will foster the adoption of sustainability by university managers around the world.

To support university managers in the management of sustainability using an SBSC, this paper describes an exploratory study conducted on the lessons learned by three universities that included sustainability within their strategic definition and implementation using the SBSC. The findings obtained make it possible to identify key aspects in the process of employing the SBSC as a tool for integrating sustainability in the management of the university. The study seeks to contribute to the recent, scarcely investigated research challenge concerning how organizations address sustainability through performance measurement tools, such as the SBSC (Wu *et al.*, 2021; Yaakub and Mohamed, 2020).

This paper is organized as follows. Section 2 discusses the research method used to carry out the research. Section 3 presents the findings obtained from the multiple-case study conducted at three universities with the aim of obtaining a methodology that can be used to develop an SBSC. Lastly, Section 4 discusses the results and shows the conclusions.

2. Research methodology and findings

The research was conducted using the qualitative multiple-case study method, which has been developed by different authors. In this research, the recommendations set out by Yin (1994) for inductive analysis of qualitative data were followed, together with the recommendations detailed by Walsham (1995) for improving an existing theory using interpretive case studies in the information systems field. This made it possible to establish the methodological issues regarding the performance and reporting of this study.

Therefore, the research method for the conceptualization and execution of the case studies was divided into seven phases:

(1) Definition of research goals and questions.

(2) Proposed theoretical model.

(3) Identification of units of analysis. Case selection.

(4) Definition of research methods and resources.

(5) Fieldwork. Data collection, classification of information and triangulation.

(6) Formulation of the enhanced theory, model or methodology.

(7) Verification of the rigour and quality of the study.

In the following sections, the results obtained in each phase of the application of the research method are outlined.

2.1 Definition of research goals and questions

The goals of this case study were: (a) to test a methodology to integrate sustainability concepts into the management systems of educational institutions using a sustainable BSC; (b) to analyse the findings in order to determine the improvement offered by the methodology; (c) to improve the initial methodology with the aid of the lessons learned and the conclusions drawn from the case study; and (d) to develop practical examples that can be used as reference models in other implementations.

A research question, which will be evaluated while the case study is being carried out, was developed:

RQ1. How can universities incorporate sustainability within their management system, thereby aligning their strategy and action plans with sustainability?

2.2 Proposed theoretical model

Firstly, to gain a better understanding and clearer vision of the topic, a literature review was carried out. Then, the theoretical model that would be applied to different universities was defined. The theoretical model is a methodology organized in phases, activities and tasks that allows a sustainable BSC (Table 1) to be planned, designed, built and controlled in order to integrate sustainability within the management systems of educational institutions. The phases are typical of the development of an information system, but the activities and tasks are specific to the development and implementation of an SBSC.

Phase	Activity	Task
BI planning	Project planning	Creation of project teams
		Project scope and objectives
		Project activities and resources
		Project communication plan
BI analysis and design	Business re-design	Internal and external analysis of the organization
		Mission, vision, values, strategy
		Identification of critical success factors
	Strategic balanced scorecard design	Definition of perspectives, objectives and indicators, at a strategic level
		Strategic cause-effect map
	Business process re-engineering	Process analysis. AS-IS model
		Process redesign. TO-BE model
		Determine the key business processes for success
		Business processes improvement plan
	Tactical and operational balanced scorecard design	Definition of indicators at the operational level
		Indicators cause-effect map
	Balanced scorecard validation	Indicators system validation
		Cause-effect relationships validation
BI implementation	BI computer system implementation	BI software implementation and integration with other enterprise systems
	Human resources	Training seminars
BI control	Project monitoring and continuous improvement	Monitoring of the achievement of the BSC goals
		Action plans

Source(s): Authors own creation

Table 1. Proposed theoretical model

2.3 Identification of units of analysis: Case selection

Following Walsham's (1995) proposal concerning the generalization of a theory from an interpretative investigation of case studies, the proposed theoretical model was applied to three universities to integrate sustainability into their management systems using a sustainable BSC.

In accordance with the purposive sampling approach for the identification and selection of information-rich cases with the most effective use of limited resources (Patton, 2002), the criterion of selecting only universities was adopted. This selection was made because it satisfied the following criteria: (1) Universities stated their availability, interest, cooperation and access to required information, which are necessary requirements to participate in this kind of research (Palinkas *et al.*, 2015); (2) In the multiple-case study method, the cases need to have a standard variable, for example a set of companies in the same industry (Diop and Liu, 2020). In this case, the three case studies belong to the same business activity: the research and education field; (3) Proposed theoretical model application to these universities had the potential capacity to generate the necessary enhancement of the basic theory, which is another necessary requirement (Crowe *et al.*, 2011); (4) Homogeneous and typical case sampling, like the one used in this study offer greater depth in the findings. Therefore, the results of the theoretical model application to the three universities can be used as reference models for academics and practitioners interested in improving the sustainability of other universities, a business activity where there is a scarcity of research on SBSC implementation; and (5) The homogeneity of the case studies makes it easier to arrange meetings, creates templates for gathering data and simplifies the process of analysing the findings.

University 1 (UNI 1) is a young Spanish university founded at the beginning of the 1990s. It has around 15,000 students, 1500 teachers and 480 employees. University 2 (UNI 2) is a Spanish university also founded at the beginning of the 1990s, with around 161,231 students, 1500 teachers and 1400 employees. Finally, University 3 (UNI 3) is a South American university founded at the beginning of the 1990s with around 22,000 students, 1300 teachers and 500 employees.

2.4 Definition of research methods and resources

After selecting the three universities, the fieldwork was prepared and begun. To carry out the application of the proposed theoretical model, mixed work teams were set up, whose members were the authors and staff of the participating universities. Throughout seminars and meetings, department managers and middle management staff of the different universities related to the project were informed of the goal of the project, the phases of the proposed theoretical model and the aspects related to sustainability that had to be worked on in each of those phases.

After executing each phase of the methodology, data were collected through interviews using a combination of templates and questionnaires, as well as copies of the reports and documents used in the universities. Interviews were carried out after executing each phase to solve any problems and/or apply the improvements suggested before starting execution of the next phase. The objectives of the interviews at each phase were to analyse the findings, to obtain feedback from the experience of the interviewees, to detect problems and errors encountered, and to collect proposals for improving the methodology. The questions asked in the interviews were adapted to the specific characteristics of each phase and were the same for each interviewee.

2.5 Fieldwork: Data collection, classification of information and triangulation

Data collection consisted in gathering the results of applying the proposed theoretical model in each of the universities. The next step was to classify the different suggestions for

improving the proposed theoretical model put forward by each of the mixed work groups as a result of their experience.

In accordance with Yin (1998), multiple data sources (primary data from semi-structured interviews and questionnaires) and secondary data (from universities' documents and information disclosure on the web and social networks) were chosen to ensure the research could be replicated theoretically. Other sources used in qualitative studies, such as images and videos, were not used because they were considered of lesser value.

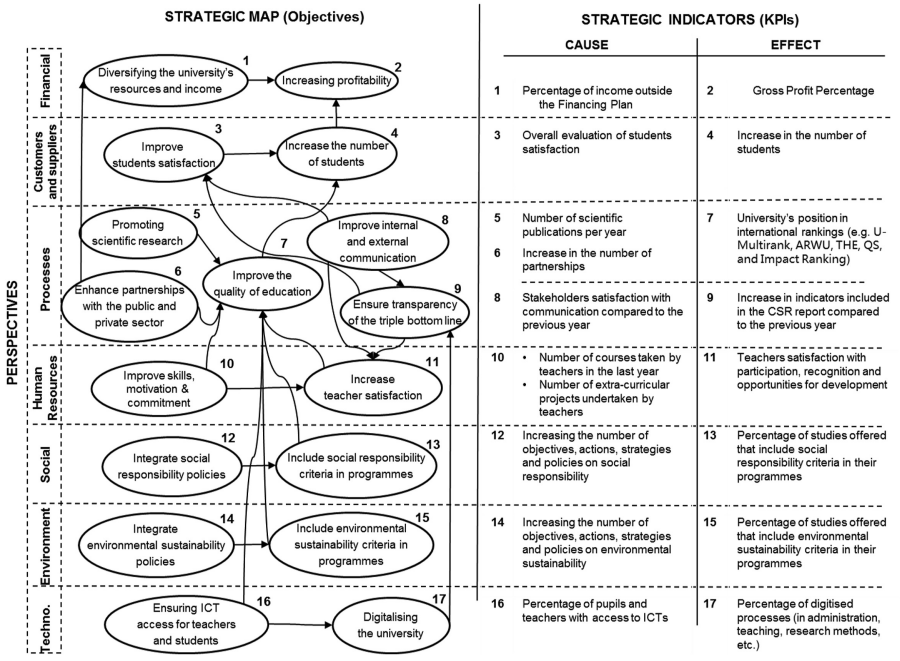
Following the principle of triangulation, the criterion adopted in this research was that of incorporating into the initial SBSC methodology any proposal for improvement reviewed and agreed on by the members of the mixed work teams.

2.6 Formulation of the enhanced theory, model or methodology

Next, the most important improvements suggested by the three universities are shown, organized according to the activities displayed in Figure 1, together with examples of the application of the methodology.

2.6.1 Project planning activity. The first activity consists of project planning and aims to create project teams, determine the scope, carry out a project plan and create a communication plan.

2.6.1.1 Team building. In the three cases, the first proposal is to create a coordinating team and several organizational units made up of personnel from the university itself. Each team and individual member must know their roles, responsibilities and objectives. To this end, an analysis of the organizational structure of the university is carried out and the key units of the



Source(s): Authors own creation

Figure 1.
Example of the strategic map of a university, and the cause-effect relationships

university that must participate in the project are identified. In addition, the profiles required to undertake the project are identified, namely, specialists in finance, human resources, computer engineering and quality management. In the case of UNI 3, profiles specialized in CSR and sustainability, and workers' representatives are also included.

In the three cases, the teams will have access to training and information actions to promote the skills and commitment of the participants that make up the team. Voluntary participation and transparent selection of team members are also promoted. There should be a balanced representation of men and women in the teams. UNI 2 highlights the importance of the involvement of senior management as of this initial phase for the success of the project.

Finally, the stakeholders that must be taken into account are defined. UNI 3 defines stakeholders classified on three levels, according to the model proposed by Jancic (1999): (1) stakeholders with whom an unavoidable relationship is maintained: students, employees and suppliers; (2) stakeholders with whom a necessary relationship is maintained: media, environment, other universities, local population, companies, public administration, alumni; and (3) stakeholders with whom a desirable relationship is maintained: neighbours' associations, sports associations, NGOs, social action groups, cultural action groups. UNI 1 also includes the creation of a Stakeholders Committee that will actively collaborate in the development of various project activities and in the validation of project results.

2.6.1.2 Project scope. The scope of the project is broken down in financial, social and environmental terms. UNI 3 also emphasizes the need to consider the academic, research and management fields of the university.

2.6.1.3 Project Plan. In the three cases, the project plan includes objectives, responsibilities, phases, activities and timing.

2.6.1.4 Communication plan. In the case of UNI 1 and UNI 2, the communication plan is internal to disseminate the project to all internal university stakeholders. However, in the case of UNI 3, an internal and an external communication plan are defined. In addition to the communication plan, it is defined who will be responsible for preparing and disseminating the communication material, and the communication mechanisms and channels to be used (meetings, emails, web content, etc.).

Table 2 shows a summary of the proposed improvements to the project planning activity.

2.6.2 Business re-design activity. 2.6.2.1 Mission, vision, values and organizational strategy. In all three cases, the mission, vision, values and organizational strategy were re-defined from a triple bottom line perspective, including economic, environmental and social aspects, and considering the relevant stakeholders.

(1) In the case of UNI 1, it was considered essential that the Stakeholders Committee created in the first phase actively participated in the re-definition of the university mission, vision, values and strategy.

(2) UNI 2 included within its mission facilitating access to university education as much as possible – always in favour of sustainability.

(3) UNI 3 included within its vision being socially recognized for its university social responsibility.

2.6.2.2 Internal and external analysis of the university and the identification of the key success factors.

(1) The three universities used a SWOT analysis (Table 3). In the comparison, although all the universities consider different sustainability aspects, little emphasis is placed on the environmental dimension.

Task	Improvements	Who	How
Creation of project teams	Definition of a coordinating multidisciplinary team (CT)	Management Staff	–
	Definition of multidisciplinary teams at the operational level (OT)	CT	
	Definition of objectives per team	CT and OT	Meeting
	Definition of roles and responsibilities per team and member	OT	
	Definition of dialogue mechanisms between the different teams	CT	–
	Training actions in the team prior to the start of the project		
	Stakeholder mapping		
	Creation of a Stakeholders Committee (SC)	Management Staff	
Definition of the scope of the project	Definition of the economic scope	Management Staff, CT and SC	Round table
	Definition of the social scope		
	Definition of the environmental scope		
	Definition of the organizational scope (academic, research and management)	Management Staff and CT	Meeting
Realization of the project plan	Definition project goals	Management Staff, CT and SC	Round table
	Timing of the phases and activities of the project including those responsible in each case	CT	–
Create a project communication plan	Internal communication plan		–
	External communication plan		
	Definition of communication managers and channels		

Source(s): Authors own creation

Table 2. Improvements to the project planning activity

(2) In addition to the SWOT analysis, UNI 1 used other techniques such as the PESTEL (political, economic, social, technological, environmental and legal) analysis, and the Porter (1985) value chain analysis.

(3) In UNI 3 the SWOT analysis was complemented with another technique, the CAME (correct, confront, maintain, export) analysis.

Examples of critical success factors identified are: (1) The quality and the social and environmental commitment of the teaching provided; (2) Efficiency in economic, social and environmental management; and (3) Having a socially responsible research and development (R&D) programme.

Table 4 shows a summary of the proposed improvements to the Business Re-Design activity.

2.6.3 Strategic balanced scorecard design activity. In this activity, the strategic map of the university is built, which includes the strategic objectives organized by perspectives and their relationships; the indicators proposed to measure the degree of achievement of the strategic objectives; and the cause-effect relationships between the indicators.

Each university has considered different perspectives to classify the indicators:

(1) UNI 1 establishes four perspectives: knowledge transfer, transparency and accountability, governance, and relations with the environment and society.

SWOT	DIM	UNI 1	UNI 2	UNI 3
S	ECO	• High-quality technological infrastructure	• Increase in technological resources	
	SOC	• High commitment to promoting equal opportunities between women and men	• Continuous improvement of services • Commitment to social responsibility • Increase in the number of qualified personnel	• New policy for the integration of students in vulnerable situations • Implementation of the transparency and information law
	ENV			
	E&R	• High quality of teaching • Permanent increase in international cooperation agreements • Attractive offer of undergraduate and postgraduate studies	• Integrated and well-structured system • Large size and deployment of the university with centres in all provinces and abroad • Implementation of the balanced scorecard	• Graduate students tracking system
W	ECO	• Difficulty in obtaining funds for R&D&I • Need to improve infrastructures	• Limited financial resources	
	SOC		• Distant relationship between students and university • Lack of social presence and attention to students	• Limited accessibility of data to stakeholders
	ENV			
	E&R	• Need to improve students' skills (communication, leadership, public speaking, etc.) • Improvement of the transfer process in research • Need to improve language teaching	• The students have a limited perception of the university's work (administration, teaching, etc.) • Results in satisfaction surveys could be improved • Stagnation in the promotion of research	• System for collecting student satisfaction ratings could be improved

Table 3.
Comparison of the SWOT of each university

(*continued*)

SWOT	DIM	UNI 1	UNI 2	UNI 3
O	ECO	• European funds for R&D&I	• GDP growth • Increased demand for study due to high unemployment rate • Low bargaining power of suppliers	
	SOC		• Increased social mobility • Increased cultural interest • Better reputation through CSR	• Becoming one of the most advanced universities in CSR
	ENV		• Increased environmental awareness	
	E&R	• Selection system for the best students • Companies demand lifelong learning • Improved collaboration with the private sector to expand job opportunities	• Technological improvements facilitating distance study • High barriers to entry	• Talent attraction through graduate tracking system • Increased demand for access
T	ECO	• High competitiveness with surrounding universities	• Cuts due to non-compliance with the deficit • Lower public investment in R&D&I • Increase in potential competitors • High rivalry between competitors • Increased customer bargaining power	• Reduction of public subsidies for the financing and maintenance of the university due to the economic crisis
	SOC	• Declining industrial environment • Legislative uncertainty	• Demographic aging • Political uncertainty	• Increased dropout and repetition rates among its students • Loss of qualified staff on a voluntary basis • Drop in staff performance
	ENV	Weather conditions in winter		
	E&R			• Termination of work placement agreements with companies and institutions

Note(s): S: Strengths; W: Weaknesses; O: Opportunities; T: Threats; DIM: Dimension; ECO: Economic; SOC: Social; ENV: Environmental; E&R: Education and research
Source(s): Authors own creation

Table 3.

Task	Improvements	Who	How
Vision, mission, values and strategy	Redefinition of the vision, mission, values and organizational strategy from the triple bottom line	Management, CT and SC	Round table
Internal and external analysis of the company	Analysis economic perspective Analysis social perspective Analysis environmental perspective		Round table, SWOT, PESTEL, CAME and value chain analysis
Identification of critical factors for success	Critical factors for economic success Critical factors for social success Critical factors for environmental success	Management and CT	–

Source(s): Authors own creation

Table 4. Improvements to the business re-design activity

(2) UNI 2 establishes five perspectives: funders, customers and suppliers, internal processes, employees and training, and society and environment.

(3) UNI 3 defines seven perspectives: financial, customers and suppliers, processes, technology, training and labour relations, social, and environmental. Once the perspectives have been defined, in all three cases the strategic objectives and the indicators for their measurement are identified.

Regarding the definition of indicators, UNI 2 uses a template to detail the characteristics of each indicator, the maximum and minimum acceptable values for the indicator, the frequency of measurement, the degree of importance, as well as the corrective actions in the event that the indicator is out of range.

Regarding the representation of the strategic map:

(1) UNI 2 uses a table that includes perspectives, objectives and indicators, without showing the relationships between the different objectives.

(2) However, UNI 1 and UNI 3 have made a graphic model that organizes the perspectives hierarchically, and establishes the relationships between the different strategic objectives of each perspective.

Figure 1 shows an example of part of the strategic map of a university, showing the definition of objectives and indicators by perspective, and the cause-effect relationships between the indicators.

Table 5 shows a summary of the proposed improvements to the strategic BSC design activity.

Task	Improvements	Who	How
Define objectives and indicators by perspective at the strategic level	Inclusion of social and environmental perspectives Definition of strategic objectives based on the triple bottom line	Management, CT and SC	Round table
	Definition of indicators for each strategic objective	Management and CT	Template
Cause-effect strategy mapping	Detect, define and represent cause-effect relationships using a graphic model	CT	–

Source(s): Authors own creation

Table 5. Improvements to the strategic balanced scorecard design activity

2.6.4 Business process Re-engineering activity. In this phase, the university's business processes are analysed and a redesign is carried out, incorporating the necessary improvements to achieve the previously defined strategic sustainability objectives.

(1) In all three cases, templates are used to collect different aspects of the process, such as the name of the process, description, type of process, objectives, indicators, critical factors for success, inputs, outputs, relationship with other processes, deficiencies and improvement plans.

(2) In UNI 1, a graphic modelling of the processes is also carried out to facilitate their understanding and analysis.

(3) In UNI 3, templates are also proposed to document the improvement actions.

(4) In the case of UNI 1 and UNI 3, a proposal was put forward to define a periodic evaluation system based on internal and external audits, and internal stakeholders' satisfaction surveys.

Examples of the business processes identified and improved at the three universities are: Teaching, Research, Research transfer, Student placement assistance, Human resources management, Technological development, Purchases, Design of the training offer, and Infrastructure and equipment.

Table 6 shows a summary of the proposals put forward to improve the Business Process Re-Engineering activity.

2.6.5 Tactical and operational balanced scorecard design activity. In this phase, the objectives and indicators at the operational level and their cause-effect relationships are defined. To this end, the three universities define a set of responsibility centres (for example, office of the rector, administration and services staff, teaching staff, etc.) and establish tactical and operational objectives. All these objectives are aligned with the previously defined strategic objectives, establishing a hierarchy of objectives. In addition, the indicators that will make it possible to measure its degree of compliance are defined. Table 7 shows an example of this hierarchy of indicators.

Task	Improvements	Who	How
Analysis and re-design of processes: AS-IS →To-BE	Business process modelling	CT	Templates, modelling
Process improvement plan	Establishment of a periodic evaluation system		Internal and external audits, satisfaction surveys

Source(s): Authors own creation

Table 6. Improvements to the business process re-engineering activity

	Strategic	Tactical	Operational
Goal	Promote the environmental responsibility of the university	Improve waste management on university campuses	Reduce waste generated Reduce consumption of paper in administrative posts
Indicator	Percentage of waste generated according to type (paper, plastic, glass, organic)	Number of waste disposal points established per campus	Number of orders for paper placed per year by the university centre

Source(s): Authors own creation

Table 7. Example of the hierarchy of indicators

In all three cases, it stands out that each unit and person in the university must know the importance of their work in achieving the strategic objectives of the university. Therefore, they can also participate in defining the indicators at the tactical and operational level.

Table 8 shows a summary of the proposed improvements to the tactical and operational BSC design activity.

2.6.6 Balanced scorecard validation activity. In this phase, the entire system of indicators, the goals established, and the cause-effect relationships are validated, making any adjustments that might be required. To validate the relationship between indicators and to define the goals:

(1) UNI 1 uses data from previous periods, and the participation of the Stakeholders Committee.

(2) UNI 2 proposes the participation of stakeholders through dialogue tables for validation through a triangulation analysis of the indicators and their relationships.

(3) UNI 3 uses data from previous periods and proposes the periodic validation of the BSC and its indicators, so that the cause-effect relationship can be verified and, where appropriate, modified.

Table 9 shows a summary of the proposed improvements to the BSC validation activity.

2.6.7 Implementation of business intelligence system activity. Digital tools are needed to facilitate the implementation of SBSCs (Olawumi and Chan, 2022). They automatically allow the collection and processing of data to calculate the indicators, and their subsequent visualization.

(1) In all three cases, the implementation of the BI computer system requires a project led by a person in charge of the information systems department.

(2) Also, in all three cases, the purchase of an existing BSC BI software package is chosen. To select it, at UNI 2 the functional requirements that must be fulfilled were

Table 8. Improvements to the tactical and operational balanced scorecard design activity

Task	Improvements	Who	How
Definition of objectives and indicators at the tactical and operational level	Definition of responsibility centres	Management and CT	–
	Definition of the levels to be included in the scoreboard according to the project objectives and the structure of the university	CT and OT	
Cause-effect strategy mapping	Detect, define and represent cause-effect relationships using a graphic model	CT	–

Source(s): Authors own creation

Table 9. Improvements to the balanced scorecard validation activity

Task	Improvements	Who	How
Validation of the indicator system	Identification of relevant indicators	CT and SC	–
	Periodic validation of relevant indicators		
Validation of cause-effect relationships	Historical data/subjective estimations	CT, OT and SC	Computer program
	Stakeholder opinions		Triangulation

Source(s): Authors own creation

previously defined and classified in seven areas: administration, monitoring, decisional, alert, general, human resources and technological (Table 10).

(3) In all cases, it is necessary to develop the ETL processes (extraction, transformation and loading) to obtain data from the source systems (for example, the ERP of the university) and to load them in a data warehouse.

Table 11 shows a summary of the proposed improvements to the computer system implementation activity.

2.6.8 Human resources implementation activity. In all three cases, emphasis is placed on the importance of human resources (HR) training for correct change management, the use of the BSC BI software, the execution and management of the university business project, and obtaining information from the stakeholders to support decision-making.

(1) At UNI 1, two communication and training plans are established, one for the SBSC development and the other for change management. Therefore, all university units and employees are aware of the SBSC implementation and adapt their work to the new strategic, tactical and operational objectives.

(2) UNI 2 points out the need to extend training to all relevant stakeholders.

(3) In the case of UNI 3, they implement a communication and change management plan, establish a group of specialists to support university staff in the use of the BSC BI software, promote staff training and introduce a continuous improvement system based on users' suggestions (for example, a suggestions box).

Table 12 shows a summary of the proposed improvements to the human resources implementation activity.

Aspects	Functional requirements
Administration	• Capacity to easily set up perspectives, objectives, action plans, indicators and cause-effect relationships
Monitoring	• Monitor strategy implementation in real time, with detailed analysis reports on objectives and indicators
Decisional	• Include mechanisms to verify the behaviour of indicators based on the decisions and the action plans drawn up
Alert	• Provide warning signals if indicators are behaving outside the established limits
General	• Users can easily design reports and graphic representations
Human resources	• Analyse the performance of each employee by verifying the achievement of their objectives and goals for the fulfilment of the strategy
Technological	• Facilitate mechanisms to distribute and exchange information among all members of the university • Integration with other existing IT systems

Source(s): Authors own creation

Table 10. Software functionalities of the balanced scorecard BI software

Task	Improvements	Who	How
Design, implement/parameterize BI software	Definition of requirements	CT	Template
Integrate the application with ERP and other systems	Creation of a data warehouse Develop ETL processes		–

Source(s): Authors own creation

Table 11. Improvements to the computer system implementation activity

2.6.9 Project monitoring and continuous improvement activity.

(1) At UNI 1, the monitoring phase begins with the establishment of a plan for communicating the project results to the stakeholders. A strategy monitoring committee is then established to periodically analyse the indicators, identify risks and define improvement action plans.

(2) In the case of UNI 2, in the different associated centres such as schools and faculties, there is a person in charge of monitoring the SBSC. They are responsible for analysing the result of the indicators, assessing deviations and making proposals for improvement when appropriate. The results will be made public on the university website. Suggestions for improvement from the various internal and external stakeholders will be taken into account to draw up action plans.

(3) In UNI 3, different monitoring periods are defined at the strategic and operational levels. In the first case, the indicators will be evaluated every six months and in the second case, monthly. The strategic objectives and the indicators to measure them will be valid for a maximum of 4 years, coinciding with the strategic plans of the university. After this period, their validity will be reviewed. In the case of the operational objectives and the indicators to measure them, a validity period of one year is established. After this period, its continuity will be reviewed.

Table 13 shows a summary of the proposed improvements to the project monitoring and continuous improvement activity.

Task	Improvements	Who	How
Training seminars for HR	Establishment of a training team (TT)	Management	–
	Definition of a training plan for SBSC development and another for change management, including stakeholders		
	Development of a BI software management guide for the implementation of the SBSC	TT	
	Establishment of dialogue mechanisms to obtain feedback and implement improvements in the user experience of the BI software		

Source(s): Authors own creation

Table 12. Improvements to the human resources implementation activity

Task	Improvements	Who	How
Monitoring of the achievement of the SBSC goals	Establishment of an evaluation team (ET)	Management	□
	Establishment of review periods for the validity of strategic objectives and indicators	CT and ET	
	Establishment of review periods for operational objectives and indicators		
Action plans	Establishment of internal and external dialogue mechanisms to obtain feedback and implement improvements	ET	–
	Internal and external communication plan for accountability/sample of results and improvements made		

Source(s): Authors own creation

Table 13. Improvements to the project monitoring and continuous improvement activity

2.7 Verification of the rigour and quality of the study

Lastly, findings were evaluated to check their degree of confidence and validity using the model developed by Yin (1998). This model proposes four tests to ensure the consistency and reliability of research based on case studies: construct validity, internal validity, external validity and the reliability tests. Therefore, to ensure the validity of the results, each of the four tests was checked according to Yin's (1998) recommendations. Construct validity has been proved because data collection was carried out using multiple data sources, and the final methodology was decided by agreement from the members of the different team works. Internal validity has been proved because triangulation was applied to the analysis of the information gathering from semi-structured interviews, direct observations and review of documentation. External validity has been proved applying the methodology to more than one case. This has proved its theoretical replication, a fundamental issue in external validity achievement. Finally, reliability has been proved because a strict protocol has been followed for data collection, the Walsham (1995) protocol. Therefore, the study can be repeated with the same results. So, the validity and quality of the study that was carried out can thus be confirmed.

3. Discussion

Existing SBSC research lacks a systematic methodology that can be used by universities to integrate sustainability concepts into their management systems, along with practical examples that can be used as reference models. Therefore, this study contributes to the development of SBSC since the proposed methodology covers the following gaps in current SBSC applications in universities:

(1) Existing SBSC methodologies focus only on specific sustainability issues such as supporting university green marketing strategies (Fuchs *et al.*, 2020), to implement and monitor environmental education programmes in universities (Guerra *et al.*, 2018), to foster industrial academic cooperation (Lin *et al.*, 2016) or to achieve university economic sustainability (Yaakub and Mohamed, 2020) instead of adopting a holistic approach that would enable them to improve all the environmental, social and economic university performance. Therefore, they offer limited sustainability information to effectively address the stakeholders' needs (Nejati and Nejati, 2013). This is the *first contribution* of the methodology proposed in this study. The methodology addresses a comprehensive vision of the concept of sustainability, considering all sustainability dimensions in the project planning, business re-design, BSC design, business process reengineering, human resources and technology development.

(2) It is necessary to develop methodologies to guide the implementation of SBSC throughout the whole project life cycle. Existing methodologies consider only part of the SBSC project life cycle, such as in the work by Hurtado *et al.* (2019), who focus only on the university key performance indicators design. This is the *second contribution* of the proposed methodology. The methodology covers this gap in the literature since it guides practitioners in SBSC implementation, considering, aligning and integrating different aspects that must be taking into account in the SCRM project such as project planning, business re-design, BSC design, business process reengineering, human resources and technology.

(3) Finally, there is a lack of empirical verification (Hubbard, 2009). This is the *third contribution* of this study. The methodology has been tested and debugged by means of a study of three real-life cases.

Therefore, the methodology for SBSC development and implementation showed in this study contributes to the management and information systems theory because it makes it possible to overcome the three above mentioned shortcomings identified to date in sustainability management implementation in universities. Thus, it considers all the sustainability dimensions; it describes all the project life-cycle activities; it encourages stakeholders' participation; and it has been proved to work in real situations.

On the other hand, findings demonstrate that the classical BSC, which has been widely proved and tested in real business situations, can be used to integrate sustainability aspects into the strategy and the management system of universities, thereby aligning their strategy objectives and action plans with sustainability (answer to the research question in Section 3.1), which is in line with claims made by other authors (Al-Bahi *et al.*, 2021; Leal Filho *et al.*, 2018; Mohd *et al.*, 2018), but it needs to be modified to address stakeholder and sustainability aspects simultaneously.

3.1 Impact of the research in the universities

The application of the methodology has led to changes in the values and organization of the different universities where the methodology was applied. These changes are summarized in a greater commitment from the governing bodies to social and environmental sustainability; the improvement of transparency and accountability; the analysis and reduction of the environmental impact posed by the establishment and development of an infrastructure like that of the university on the territory and its biodiversity; the enhancement of well-being, quality of life and coexistence within the university community; the utilization of the institution's physical, human and scientific resources in a collaborative manner to serve the nearest society and those communities most in need; and in the necessity of establishing mechanisms to identify and respond to the interests and expectations of stakeholders.

As a consequence, new objectives, action plans to achieve them, and indicators, which were not previously present in the performance measurement systems of the three universities, have been proposed. They are mainly related to the governance, social and environmental sustainability dimensions. However, they also will have positive financial impact in the universities in the medium term because some of them lead to increased incomes and to the reduction of costs such as energy costs.

Table 14 shows a compilation of the new objectives, action plans and indicators related to sustainability due to the application of the methodology. They are measurable results of the benefits of applying the methodology.

3.2 Limitations

This research is based on three cases within a specific sector. The small sample size and case method approach limits the ability to generalize the findings. Therefore, the results may not be necessary generalizable to other business and industry settings. Some case specific features such as the sector or company size might influence the generalizability. Nonetheless, the preliminary results, the use of primary data (interviews and questionnaires) and secondary data (documents), and the rich understanding of the phenomenon provided by the three in-depth real case studies suggest that it could be considered as a representative case of companies of the time and its findings sufficiently generalizable. On the other hand, another limitation is that any quantitative positive or negative financial impact was observed during the research.

4. Conclusion

In this paper, the authors have presented a methodology that enables university managers to implement the three sustainability dimensions in their day-to-day university management, using a sustainable BSC. The proposed methodology describes all the phases, activities and tasks of the whole university SBSC project life cycle, integrating the improvement of the

Objectives (O) and action plans (AP)	Indicators
O: Contribute to social progress and sustainable development AP: Develop a university model that contributes to the dissemination of ethical values and promotes respect for the environment UNI 1	• Number of academic programmes that incorporate ethical and values education into their curriculum (UNI 2) • Number of R&D projects per year related to sustainable development and contribution of the business world to generate a positive impact on the environment (UNI 2)
O: Establish mechanisms for external communication to receive and process the needs and expectations of external stakeholders AP: Implement an online communication system to receive suggestions and complaints from various stakeholder groups. Establish a department to filter requests and redirect them to the appropriate body	• Number of queries-responses processed through the online platform, differentiated for each stakeholder group (UNI 1; UNI 3) • Satisfaction survey with feedback from stakeholders, differentiated for each stakeholder group (UNI 1)
O: Achieve a sustainable and stable funding model AP: Increase alternative sources of funding beyond government funding	• Volume of income from self-financing sources (academic courses, research & development & innovation projects funded by public and private organizations) (UNI 2; UNI 3) • Volume of income from donations (UNI 3)
O: Publish economic, social and environmental results AP: Enhance transparency and facilitate access to information through a material and relevant accountability process for various stakeholder groups	• Increase in sustainability indicators included in the sustainability report compared to the previous year (UNI 1; UNI 2) • Increase in fulfilled expectations of stakeholder groups compared to the previous year (UNI 1; UNI 3) • Number of improvements introduced in communication channels and tools for processing information from dialogues with stakeholder groups (UNI 1; UNI 2)
O: Drive new governance models in the university AP: Disseminate the purpose and focal point of the organization as well as principles and conduct through the existence of a code of conduct	• Number of periodic reviews/evaluations of mission, vision, and strategic objectives (UNI 1) • Number of issues incorporated into the ethical, conduct and good governance codes (UNI 1) • Number of periodic evaluations of the effectiveness of ethical policies (UNI 1) • Number of gender equality training courses (UNI 1; UNI 2)
O: Integrate environmental sustainability policies into institutional policy and university management AP: Increase institutional involvement in sustainability policies. Translate institutional commitment into daily actions led by the university. Establish environmental sustainability policies in supplier contracting. Create an environmental office	• Number of governance agreements including sustainable policies compared to the previous period (UNI 1) • Increase in the percentage of contracts with suppliers meeting environmental requirements compared to the previous period (UNI 1; UNI 2; UNI 3) • Environmental certification of processes (UNI 1; UNI 2)
O: Strengthen the quality and social content of teaching AP: Enhance support for groups with specific needs	• Number of teachers and students with disabilities (UNI 2; UNI 3)

(*continued*)

Table 14.
New objectives, action plans and indicators related to sustainability

Objectives (O) and action plans (AP)	Indicators
O: Minimize the most common environmental impacts of university activity resulting from consumption (energy, water and materials) and their subsequent pollution (mainly in commuting to university facilities in private vehicles) AP: Quantify and analyse consumption in all facilities to subsequently carry out efficient improvement actions. Increase the use of renewable energies generated by the university itself. Promote initiatives to encourage the use of public transportation and carpooling	• Increase in the number of university facilities powered by renewable energy sources and the percentage of such facilities compared to the previous year (UNI 1; UNI 2) • Decrease in energy consumption compared to the previous year (UNI 1) • Increase in the percentage of university community members using public and shared transportation (data obtained from internal staff surveys and student enrolment forms) (UNI 1; UNI 3) • Percentage of direct and indirect greenhouse gas emissions (UNI 3)
O: Environmental education and awareness for the entire university community AP: Environmental volunteering programmes that provide training and awareness through practical activities in contact with the environment where the universities are located	• Increase in the number of environmental awareness activities, volunteer programmes, biodiversity characterization programmes of the environment, cross-cutting environmental education content in curricula, training actions for staff and faculty, etc., compared to the previous period (UNI 1; UNI 2; UNI 3)
O: Engage the "university community" in supporting charitable causes AP: Development of actions that facilitate volunteering and collaboration with NGOs, and promotion of applying knowledge to charitable causes	• Increase in the number of volunteer promotion plans among the "university community" (UNI 1) • Increase in the number of international cooperation projects involving the university, agreements and active projects in collaboration with NGOs (UNI 1; UNI 2)
O: Strengthen the presence of the university in its surroundings AP: Bring the local community closer to the University	• Increase in the number of sports and cultural activities held for the population and projects carried out between the university and local authorities, compared to the previous year (UNI 1) • Increase in the number of contracting with geographically close supplier companies (UNI 3)

Table 14. **Source(s):** Authors own creation

university sustainability strategy; fulfilling the stakeholders' requirements and needs, and at the same time encouraging and involving them in the establishment of the university's objectives and action plans; the re-engineering of the university business processes; the development of the computer system for the calculation and visualization of indicators; and human resources training.

Findings can be useful for academics, who can complement the methodology by new theoretical contributions, and can adapt the methodology for the application to other business sectors. It can also be helpful for practitioners (university managers, computer engineers, sustainability managers) who can use the methodology and the examples of the application of the methodology to the three case studies as a guide for SBSC development in other universities.

Finally, future research should be led to avoid the main paper limitation, the necessity to prove the generalization of the findings. To do so, more cases with similar and different contexts would provide more insights about the cross-sectional application of the proposed methodology. Only analytical generalization is claimed rather than any statistical generalization. On the other hand, quantitative analysis of the financial impact of a sustainable BSC implementation could be addressed.

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