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Raising the enterprises' environmental performance by taking advantage of business process modeling

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Abstract

Tackling the environmental impact and the compliance with the environmental legislation have become critical challenges for Romanian enterprises. The paper is addressing the environmental protection and management concern by integrating different disciplinary components: environmental legislation aimed at preventing and reducing negative environmental impacts, engineering management aimed at designing the necessary systems for a coherent enterprises functioning, and IT as an efficiency tool for process modeling. The authors performed an empirical research by applying the business process modeling concept within the environmental protection domain taking advantage of the Simple BPM modeling application on the process of establishing environmental objectives. The results highlight that, regardless of industry, any enterprise acts in the green market segment has to remove the environmental management bottlenecks by designing and implementing effective management processes ease to use and correlated with the actual economic requirements.

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1. Introduction

The pace of change in IT sector is so fast that it is extremely difficult to predict how the business world will evolve. This reality creates high pressure on enterprises that invest great efforts in their capacity to innovate in order to overcome the challenges arisen from the economic competition.

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During the last decades, the scientific and research focus was directed towards the environmental protection concern due to the problems arisen from the human impact on the environment. As consequence, particularly emphasis was given to the business practices which can assure sustainable developments of the environment and the society at whole.

Regardless of industry sector, any enterprises that run its business operations related to one of the three strategic environmental resources, such as air pollution, water supply, water pollution and wastewater treatment, waste management for energy and energy recovery, has to improve the competitiveness by a continuous improvement of internal processes and by conformation to the changing requirements of the green market tendencies.

In this regard, establishing the environmental performance goals that boost the enterprise capacity with respect to minimizing pollution and improving the use of resources is recognized as important cross-cutting issue. This pressure will continue to increase over the coming years and, also, will bring benefits in terms of cost savings, improved relationships with suppliers and customers, and innovation capacity.

2. Theoretical background

Any company that establishes environmental protection goals and actively promote actions to reduce its environmental impact by using environmental management systems is interested in using certified systems such as Environmental Management and Audit Scheme (EMAS), ISO 14001 family of standard for environmental management (ISO 14004, 14010, 14011, 14012, 14040+, etc.), or other industry-specific sector/different national or regional schemes for environmental legislation. According to the public sources, the Romania enterprises which use complex environmental management system (the green core segments) are up to 4%, whilst the Small and Medium Enterprises (SMEs) that use simple measure to save energy and resources represent 19% [1].

The “Report on SMEs, resource efficiency and green markets” reveals that environmental management systems are seen as too complex and costly for micro and medium enterprises, only 25% of SMEs from EU report they have an environmental system in place comparing to 48% of large companies. Moreover, for Romania, 20% of enterprises reported a high rate of non-activity in terms of improving the resource efficiency. The main reasons for not using an environmental management system is the lack of information about the systems and their benefits (31%), high implementing and running costs (29%), and no demand for suppliers and customers (29%) [2].

As environmental legislation is a necessity and the enforcement of the legislation is considered a very important aspect so that all enterprises are effectively required to comply with it, Danish Technological Institute has studied the key issues encountered by the SMSs in dealing with the environmental challenges. According to the “Report on SMEs and the environmental in the EU”, enterprises in all sectors are affected by the legislation on emission of atmospheric pollution, waste and water management as well as REACH regulation that affects SMEs in almost all NACE C-I and K sector, whilst other particular legislative elements affect SMEs in some economic activities sector [1, 3].

According to researchers, setting the environmental targets calls for a thoughtful assessment of all enterprises activities to identify and quantify their environmental impact in their widest sense. In establishing the environmental protection objectives, the company is asked to assess the environmental impact of its activities, to identify any legislative requirements have to be satisfied, to estimate the financial cost of environmental management, and to determine the environmental performance of competitors [4].

In line with the situations described above, the research problem is dealing with the diminished capacity of Romanian enterprises in environmental performance management. The view of environmental activity as peripheral to the core business, the lack of time and money for environmental protection, and the low capacity in environmental studies demonstrate the need to develop smart IT solution for designing and implementing the necessary processes correlated with the areas of environmental legislation, relevant to enterprises such as air, water, soil, waste, and energy.

Within these circumstances, the scope of the practical research performed by the authors was limited to the planning processes embedded in the environmental management system with focus on the process of setting environmental objectives as the first step in designing and implementing a coherent and efficient environmental management system within any enterprise.

In this regard, worthy to be mention are the major steps needed for the process of setting up the enterprise objectives defined by the quality scholars: identifying the stakeholders’ needs, defining preliminary objectives, setting up the forum for discussion of questions of change or control, studying whether the objective can be

achieved with the available resources, defining achievable objectives for control and improvement, and communicating the objective [5].

Interestingly, the researchers in the quality management field do not claim the objectives to be achieved but they recommend that the objectives achievement be planned and resources assigned. Furthermore, for an objective to be properly established it has to be communicated, understood by the receiver, and translated into action, becoming thus the focus of all achievement [6].

The evolution of information technologies has moved the interests towards the organizational processes modeling based on Enterprise Resources Planning and workflow management system. These modelling techniques aims to assure the optimal convergence between the resources and the strategic directions needed to offer added value to the customers – enterprises [7]. Hence, the researchers are currently interested in linking the enterprise' business model and the technological advance. A well-known management system of enterprise business processes cycle named Architecture of Integrated Information Systems (ARIS) with the "Three Level Framework or Process Excellence" - is taking into account the objectives of innovation and flexibility, each phase of the process life cycle being correlated to these objectives [8].

The interest on innovation and agility is possibly because of the benefice of IT instruments. Enterprise resources planning systems, customer relationship management and other management systems are exploited by a large number of enterprises at the national and international level. Moreover, technologies such as SOA – Service Oriented Architectures – allow the interconnection between the specific components of the application and the necessary data so that the enterprise processes are designed on an ongoing base [9].

Because of the wide range of data and the complexity of the structure of these systems, there are frequently arising bottlenecks in terms of costs associated, duration of implementation, and also an ongoing training of the end users. Although, these systems are designed to optimize the processes, to improve the quality, and to reduce the costs, the enterprises are dealing with two key problems: complexity and inflexibility.

In this context, the enterprise preoccupation on using and applying the business process modeling software tools is essential for a coherent environmental management system functioning and for running the adequate working processes in flexible and cost-effective manner.

3. Research methodology

In order to address the cross-disciplinary challenges between environmental concerns, engineering management and IT technological advance, the authors have applied the Simple BPM (Business Process Management) modeling application on the process of setting up environmental objectives since, regardless of industry, any enterprise acts in the green market segment has to remove the environmental management bottlenecks and to design and implement effective management processes ease to use and correlated with the actual economic requirements.

The Simple BPM modeling application was developed by the Romanian enterprise Avantera based on ARIS methodology developed by IDS Scheer A.G. aiming at addressing the enterprises needs on achieving business excellence using IT management tools.

The process of setting up environmental objectives was modeled according to the SIPOC algorithm (Suppliers, Inputs, Process, Outputs, and Customers) and, also, taking into consideration the environmental protection legislation and ISO 14001 Environmental Management System certification aspects.

Designing the architecture for the process of setting up environmental objectives was based on Event-driven Process Chain (EPC) technique from Business Process Modeling with multiple bonds in Business Process Modeling Notation (BPMN) that creates graphical models for process operations, named flowcharts. The process flowcharts are easily understandable by all users starting with the business analyst that design the process to the technical person responsible for implementing, managing and monitoring those processes. The method allows modeling the flow diagram using: activities, events, and logical connectors as syntax elements which enable the conceptual integration of the information system design [10, 11].

The Event-driven Process Chain (EPC) technique is a modeling language for representing the logical and temporal dependencies of activities encompassed within any type of process. The process flow diagram using EPC answers to the question "what should be done?", enabling to define and design the required activities, the

corresponding events, and also the possibility to create a modular framework based on the process interfaces [12, 13].

In this regard, designing the architecture of the process of setting up environmental objectives, modeled by Simple BPM tool, was consisted of defining the activities resources as follows: participants, process roles, required documents, and working instruments. The research methodology followed two steps: 1) designing the process diagram; 2) assigning resources required and drawing meta-information about the process from the operational table of the process.

3.1. Designing the process diagram for setting up environmental objectives

Designing the architecture of the process of setting up environmental objectives modeled by Simple BPM tool was consisted of defining:

- The activity (A) that describes clearly and concisely the action that has to be performed.
- The event (E) that defines pre-conditions and post-conditions of functions. They do not use any kind of resources.
- The process interface (P) that designates the necessity of executing the process in question between the predecessor element and the successor element of the flowchart.
- The connector that describes the precedence relationship between the activities or the process interfaces. Connectors have either multiple incoming with one outgoing arcs JOINT-connectors (J) or one incoming and multiple outgoing arcs (split connectors): AND-split (A) - triggers the execution of all subsequent branches in concurrency, OR-split (O) - triggers the execution of any combination of the multiple subsequent branches, based on the condition of at least one branch execution, and XOR-split (X) - represents a choice between one of several alternative branches and requires the execution of the selected branch.

The process diagram for establishing environmental objectives modeled by Simple BPM is represented in figure 1.

3.2. Assigning resources required for setting up environmental objectives

The resources, as objects flow, are characterized by attributes that could be chosen from a dropdown list or could be defined by the user. The assignment of the resources on the activity or the process interface also implies associating resources with appropriate values. The SIMPLE BPM modeling tool uses five resources' types as follows:

- Financial resources associated as activity "Costs", being defined three levels: small, medium, and high costs.
- Material resources associated as distinctive objects in relation to an activity, being represented as "Resources".
- Facilities resources associated as working instruments, being represented as "Instrument".
- Informational resources are approached as: informatics resources being considerate as "Instruments" and documented information represented as "Document" or "Knowledge".
- Human resources are related to the agents' type: individual jobs or organizational unit, and to the role of the agent chosen.

These steps clearly answer to the question: "who does what?", and also define the working instruments and documents required for completing the activities from the process flowchart. In this regard, Table 1 reveals the operational table of the process needed for setting up environmental objectives and table 2 pinpoints all detailed information, enabling process owner to extract meta-information about the process, properly.

4. Results

By simulating the process of setting up environmental objectives it will be generated useful information about the process as follows: process diagram, synthetic table of the process, general and detailed information about the process.

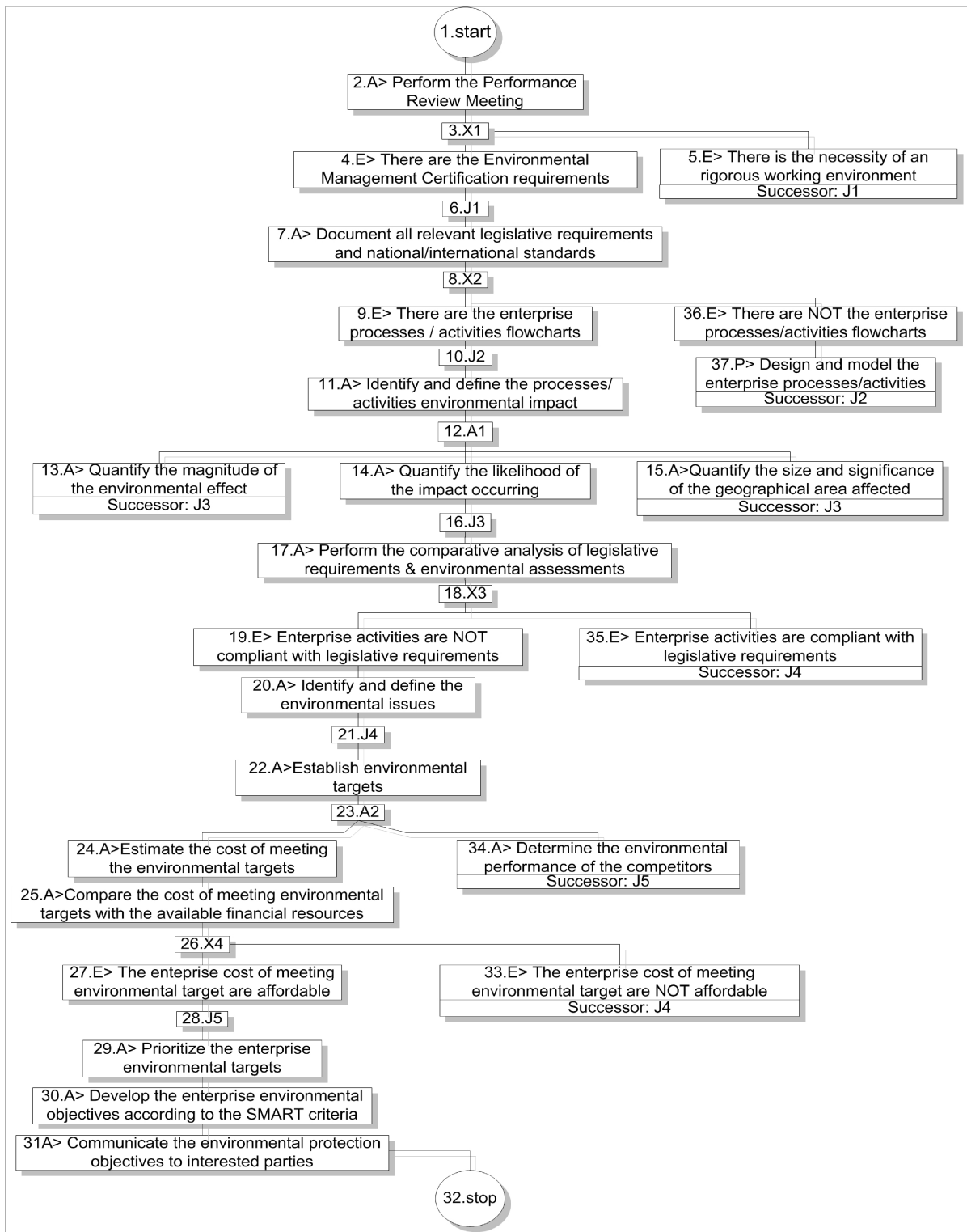


Fig1.JPG Setting up environmental objectives – process diagram.

Table 1 represents the operational table of the process with the following notation for the flow: A >Activity; E > Event; P> Process Interface; Ai, Xi, Oi, Ji – operators/connectors, and for the assigned resources: [I] - records, [IS] - instruments, [K] - knowledge, and [Lv] - deliverables as documents. Table 2 shows detailed information about the process with focus on the agents' types that performed the activity and on the roles of the agents. In this way, it will be acquired useful data which allow decisional factors to analyze opportune, accurate, and structured information in order to make managerial decisions.

Table 1. Setting up the environmental objectives – operational table of the process.

Predecessor	Flow	Successor	Assigned resources
	1.START		
START	2.A> Perform the Performance Review Meeting		[I] Financial and Technical Performance Reports, [IS] International Legislation, [Lv] Performance Review Report
X1	4.E> There are the Environmental Management Certification requirements	J1	
X1	5.E> There is the necessity of an rigorous working environment	J1	
J1	7.A> Document all relevant legislative requirements and national/international standards		[IS] ISO 14000 Environmental Management Standard, [Lv] Company processes flowcharts
X2	9.E> There are the enterprise processes/activities flowcharts	J2	
J2	11.A> Identify and define the processes/activities environmental impact		[Lv] Environmental Impact-Qualitative Analysis Report
A1	13.A> Quantify the magnitude of the environmental effect	J3	[IS] Environmental Impact Simulation Software, [Lv] Magnitude of Environmental Impact-Quantitative Analysis Report
A1	14.A> Quantify the likelihood of the impact occurring	J3	[IS] Environmental Impact Simulation Software,[Lv] Magnitude of Environmental Impact-Quantitative Analysis Report
A1	15.A> Quantify the size and significance of the geographical area affected	J3	[IS] Environmental Impact Simulation Software, [Lv] Magnitude of Environmental Impact- Analysis Reports
J3	17.A> Perform the comparative analysis of legislative requirements and environmental assessments		[I] Environmental Management Requirements Report, [I] Environmental Impact-Qualitative Analysis Report, [Lv] Comparative Analysis Report
X3	19.E> Enterprise activities are NOT compliant with legislative requirements		
X3	20.A> Identify and define the environmental issues	J4	[I] Comparative Analysis Report, [Lv] Company Environmental Issues Report
J4	22.A> Establish environmental targets		[I] Company Environmental Issues Report, [Lv] Company Environmental Targets list
A2	24.A> Estimate the cost of meeting the environmental targets		[Lv] Estimated cost of meeting the environmental targets
A2	25.A> Compare the cost of meeting environmental targets with the available financial resources		[I] Departmental budget, [Lv] Financial Analysis of Meeting Environmental Targets
X4	27.E> The enterprise cost of meeting environmental targets is affordable	J5	
J5	29.A> Prioritize the enterprise environmental targets		[Lv] Prioritized environmental targets list
J5	30.A> Develop the enterprise environmental objectives according to the SMART criteria		[I] Management Science literature, SMART criteria for developing objectives, [Lv] Company Environmental Objectives Documentation
J5	31.A> Communicate the environmental protection objectives to interested parties	STOP	[IS] Formal communication tools
X4	33.E> The enterprise cost of meeting environmental targets is NOT affordable	J4	
A2	34.A> Determine the environmental performance	J5	[IS] Market Research Database, [Lv] Report on Competitors

Predecessor	Flow	Successor	Assigned resources
	of the competitors		Environmental Performance
X3	35.E> Enterprise activities are compliant with legislative requirements	J4	
X2	36.E> There are NOT the enterprise processes/activities flowcharts		
	37.P> Design and model the enterprise processes/activities	J2	

Table 2. Setting up the environmental objectives – detailed information.

Detailed description
Activity: 2.A> Perform the Performance Review Meeting
<ul style="list-style-type: none"> • writes: Financial and Technical Performance Reports (Document type - record; Deliverable - Main; Global - Yes) • uses: International Legislation Abstract; produces: Performance Review Report (Deliverable - Main; Type - Product)
Activity: 7.A> Document all relevant legislative requirements and national/international standards
<ul style="list-style-type: none"> • uses: ISO 14000 Environmental Management System Standard • produces: Company processes flowcharts (Deliverable - Main; Type - Product); executes: FD~LgC (Organizational unit (OU) - Financial Department; Position type - Legal Consultant; Role - Approval)
Activity: 11.A> Identify and define the processes/activities environmental impact
<ul style="list-style-type: none"> • produces: Environmental Impact-Qualitative Analysis Report (Deliverable - Main; Type - Product) • executes: DE&TP~ThC (Organizational unit (OU) - Department of Environmental and Technological Processes)
Activity: 13.A> Quantify the magnitude of the environmental effect
<ul style="list-style-type: none"> • processes: Environmental Science Literature, Environmental Science Studies, Research Reports (Document type - draft) • uses: Environmental Impact Simulation Software; produces: Magnitude of Environmental Impact-Quantitative Analysis Reports (Type - Product)
Activity: 14.A> Quantify the likelihood of the impact occurring
<ul style="list-style-type: none"> • reads: Environmental Science Literature, Environmental Science Studies, Research Reports (Document type - draft) • uses: Environmental Impact Simulation Software; produces: Magnitude of Environmental Impact-Quantitative Analysis Report (Deliverable - Secondary; Type - Product)
Activity: 15.A> Quantify the size and significant of the geographical area affected
<ul style="list-style-type: none"> • reads: Environmental Science Literature, Environmental Science Studies, Research Reports (Document type - draft) • uses: Environmental Impact Simulation Software; produces: Magnitude of Environmental Impact-Quantitative Analysis Reports (Deliverable - Secondary; Type - Product)
Activity: 17.A> Perform the comparative analysis of legislative requirements and environmental assessments
<ul style="list-style-type: none"> • writes: Environmental Management Requirements Report (Document type - record; Deliverable - Secondary; Global - Yes) • reads: Environmental Impact-Qualitative Analysis Report; produces: Comparative Analysis Report (Type - Product)
Activity: 20.A> Identify and define the environmental issues
<ul style="list-style-type: none"> • writes: Comparative Analysis Report (Document type - record; Deliverable - Secondary; Global - Yes) • produces: Company Environmental Issues Report (Deliverable - Secondary; Type - Product)
Activity: 22.A> Establish environmental targets
<ul style="list-style-type: none"> • reads: Company Environmental Issues Report (Document type - record; Deliverable - Secondary; Global - Yes) • produces: Company Environmental Targets list (Deliverable - Secondary; Type - Product)
Activity: 24.A> Estimate the cost of meeting the environmental targets
<ul style="list-style-type: none"> • produces: Estimated cost of meeting the environmental targets (Deliverable - Secondary; Type - Product) • contributes to: DE&TP~ISO14000 Sp (Organizational unit (OU) - Department of Environmental and Technological Processes)
Activity: 25.A> Compare the cost of meeting environmental targets with the available financial resources
<ul style="list-style-type: none"> • reads: Departmental budget (Document type - record; Deliverable - Secondary; Global - Yes) • produces: Financial Analysis of Meeting Environmental Targets (Deliverable - Secondary; Type - Product)
Activity: 29.A> Prioritize the enterprise environmental targets
<ul style="list-style-type: none"> • produces: Prioritized environmental targets list (Deliverable - Secondary; Type - Product); coordinates: DE&TP~ISO14000 Sp (Organizational unit (OU) - Department of Environmental and Technological Processes)
Activity: 30.A> Develop the enterprise environmental objectives according to the SMART criteria
<ul style="list-style-type: none"> • reads: Management Science literature, SMART criteria for developing objectives (Document type - record) • produces: Company Environmental Objectives Documentation (Deliverable - Secondary; Type - Product)

Detailed description
Activity: 31.A> Communicate the environmental protection objectives to interested parties <ul style="list-style-type: none"> • uses: Formal communication tools • coordinates: DE&TP~DM (Organizational unit (OU) - Department of Environmental and Technological Processes)
Activity: 34.A> Determine the environmental performance of the competitors <ul style="list-style-type: none"> • produces: Report on Competitors Environmental Performance (Deliverable - Secondary; Type - Product) • contributes to: DE&TP~ISO14000 Sp (Organizational unit (OU) - Department of Environmental and Technological Processes)

In enterprise practice, the general and detailed information about the process of setting up environmental objective can emerge from the mutual exchange of information between the process architecture and the process owner. More exactly, the process architecture is in charge with designing, modelling, and simulating the process whilst the process owner is in charge with implementing and monitoring the process execution, in order to achieve the environmental performance targets. As tables 1 and 2 designate, the responsibilities of all persons or employees involved in the process are clearly defined and assigned, with a significant impact on improving the enterprise activities and, also, the overall environmental performance.

The results of the empirical research show the integration between the enterprise' environmental management system and the technological advance make a significant difference. Therefore, the interest on innovation and agility of the management system has become a key driver for raising the enterprises environmental performance.

5. Conclusions

Nowadays, the environmental performance of enterprises has become a critical part of measuring the overall business performance. These required Romanian enterprises to overcome the burdens envisaged by complying with environmental requisites based on a continuous improvement of the products, services, and internal processes, by flexibility and fast reaction and conformation to the changing customers' needs and requirements (green market segment).

In overall terms, the paper aims to augment the environmental knowledge base through a better exchange of good practices and improved coordination towards shared environmental performance goals, and by integrating the environmental management, engineering management based on process thinking, and the modern tendencies in IT with emphasis on process modeling.

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