



## MODELING AND PERFORMANCE IMPROVEMENT: THE REMEDY TO TREAT SOCIAL AND ENVIRONMENT ISSUES FOR ENTERPRISES IN TODAY'S DIFFICULT ECONOMIC CLIMATE

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**ABSTRACT.** **Background:** European economies have been deeply affected by different crises. The impact of the economic crisis on enterprises is now recognized by everybody. Enterprises need to reorganize in order to be better adapted to this situation and to integrate new dimensions in their development. Reduction of cost is not the only way for making enterprises more efficient. It is now clear that a mono-criterion analysis is not adapted to the actual enterprise situation. Enterprises need a multi-criteria analysis by combining quality, cost, lead time but also carbon management, social societal and environmental dimensions. If QCD criteria are already considered as necessary for obtaining the optimum enterprise system, it remains difficult to convince the enterprise management of the opportunity to integrate social, societal and environmental dimensions for improving cost. This need still needs to be clearly demonstrated.

**Method:** This paper introduces concepts for showing that enterprises would be more efficient, better-organized and adapted to the new changes in society.

**Conclusions:** The reduction of cost is necessary, the increase in enterprise turnover too, but it is also indispensable to change the structure of enterprises. Enterprise modeling (GRAI Methodology) and a tool is used for illustrating the concepts presented through a detailed case study.

**Key words:** Carbon Management, Sustainable Supply Chain Management, Quality Management, Knowledge Management, Energy Reduction.

## INTRODUCTION

No one can dispute the present plight of many European countries. However it would be a mistake to regard the entire performance in purely economic terms. In the actual global reference model (capitalism), the main enterprise performance criterion is based on economic values. It is clear that we are nowadays at the limits of this model. For instance, in Europe, debt has increased by 450 billion € despite cost reductions imposed by the IMF (International Monetary Fund) and European governments. The only prescription

offered to the PIIGS and other European countries is an increase in taxation and a reduction in government expenditure. Furthermore, the countries concerned are exposed to speculation and no alternative solution to the actual situation has been offered to them. Indeed, it is quite different in enterprises because of the introduction of quality and lead time as criteria for completing cost (Quality, Cost and lead time (QCD)). The choice of performance criteria is important for an enterprise. Indeed, this enterprise could evaluate its performance according to these criteria and prepare action plans if necessary. Since 2008 and the beginning of the crisis, the

failings of the capitalism system have become more apparent. Then in parallel to European countries, enterprises are searching for the ideal solution. Nobody knows exactly how to solve the situation not only in terms of the global economy but also in terms of performance for enterprises.

Many of these enterprises have understood that for being efficient, they need to satisfy not only customers, shareholders and but also suppliers and employees. The case of an enterprise is not just limited to production for satisfying customer demand and shareholders. Nowadays an enterprise is a multi-criteria system integrating social, societal and environmental dimensions in addition to QCD for its improvement (figure 1). The definition of a new sustainable reference model for enterprises integrating these criteria is necessary.

Enterprise modeling is regularly used to prepare enterprises for the outcome of the crisis. Enterprises need to find the best way to resist the present crisis and then to improve in order to be more efficient. GRAI Methodology is one of the three main methodologies (with PERA, CIMOSA) of enterprise modeling. To support this methodology different tools have been developed. GRAIMOD is the latest one being developed by using JAVA technology, JADE and JESS platforms, and an open architecture and structure.

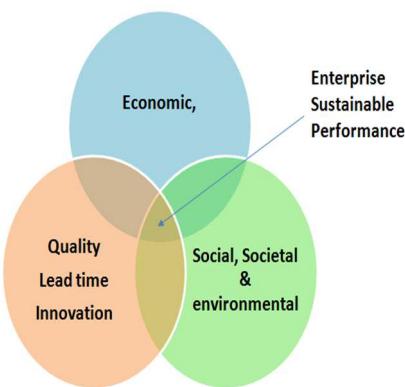


Fig. 1. Enterprise sustainable performance  
 Rys. 1. Zbalansowana działalność przedsiębiorstwa

This paper summarizes the research done at Icam Vendee in this area. Two different objectives could be defined.

- The Industrial and societal organization research team is working on the elaboration of a much-needed new reference model to replace the capitalist one. What type of society do we want in the future, what balance, which optimum to have. What organization should be adopted by local authorities taking into consideration the present parameters and how to define tomorrow's enterprise in accordance with the society we want to live in?
- The use of actual organization for defining how to progressively improve enterprises. In this context, reference models are being elaborated according to activity domains. A supporting tool is also being developed according to the concepts of GRAI Methodology.

The elaborated concept aims to consider future manufacturing, supply chain, enterprise, local authority needs etc. The choice made is to define these concepts by introducing sustainable values in the proposed changes.

The aim of this paper is to show the method to change a structure of enterprises by a multi-criteria analysis by combining quality, cost, lead time but also carbon management, social societal and environmental dimensions.

## **GRAI METHODOLOGY AND GRAIMOD**

The objective is to use reasoning (e.g. CBR or decomposition), enterprise typology, expert systems, Multi-agents systems, enterprise knowledge for defining a tool (GRAIMOD) destined to improve enterprise performance. This tool will support GRAI Methodology.

The objective of this research is to:

- Allow enterprises to evaluate their performance and to drive the change of their economic model by integrating the social, societal and environmental aspects.
- Aid enterprises towards ecologic and energy transition,

- To improve progressively and sustainably enterprise supply chains

GRAI Methodology is one of the three main methodologies used for analyzing and designing enterprises. The GRAI approach (figure 2) is composed of four phases: An initialization phase to start the study, a modeling phase where the existing system is described, an analysis phase to detect the inconsistencies of the studied system and a design phase during which the inconsistencies detected are corrected and a new system proposed. These concepts could be used to ensure the transformation of

enterprises to meet the real market needs (globalization, relocation, capacity to be proactive, cost optimization, lead time, quality, flexibility, etc....) and need to be adapted. An enterprise is completely described according to GRAI Methodology by finding five models: functional (functions of the enterprise and their links), physical (the production system), informational (the network, tools and informational flows), process (suite of sequences or tasks) and decisional (structure of orders, hierachic organization). Then these models could be improved to enhance enterprise performance.

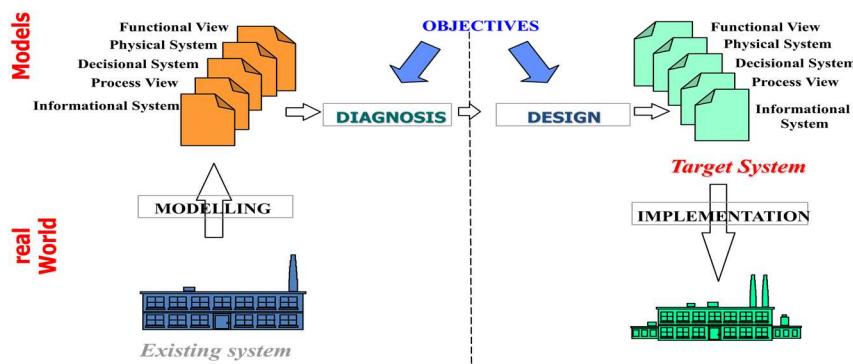


Fig. 2. GRAI approach  
 Rys. 2. Podejście GRAI

GRAIMOD is a new tool being developed by ICAM Engineer School for proposing concrete solutions to improve enterprises according to new market evolutions. At present, it contains five modules working around three sub modules (figure 3). The tool is divided into two parts: the interface containing modules for modeling enterprises and the analysis & improvement part for changing the existing system and proposing new organizations.

GRAIKERN, a graphic editor used for representing the different models associated to GRAI methodology, is an interface. GRAIWORKER is the work base elaborated for managing, modifying and capitalizing knowledge about the studied case.

GRAITRANS is a Transfer Interface used for putting the new case in GRAIXPERT in order to improve its Cases Base. The reference model elaborated for each enterprise domain will be improved by the acquisition of this new model in GRAIXPERT between the different modules

GRAIXPERT is a hybrid expert system for managing the analysis of the existing system and proposing a new system (figure 4). It is composed of two sub-modules in interaction with GRAIKERN: the Knowledge Capitalization (KCM) and the Knowledge Based System (XPERTKBM). GRAIMANAGER is a management module used for organizing the different interactions between the modules of GRAIMOD. It controls and manages the system's interactions with the users.

GRAISUC is a module used for managing the choice of an ERP or SCM tool for an enterprise. It is composed of two sub-modules SpeMM and SpeCM. The Specification Management Module (SpeMM) is used for choosing the appropriate ERP or SCM Tool of an enterprise. The specifications obtained are

capitalized in the Specification Capitalization Module (SpeCM).

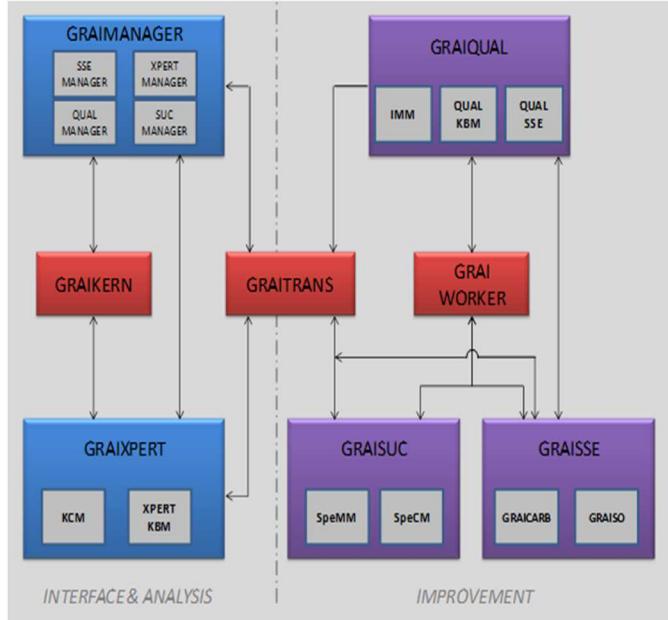


Fig. 3. Architecture of GRAIMOD  
 Rys. 3. Architektura GRAIMOD

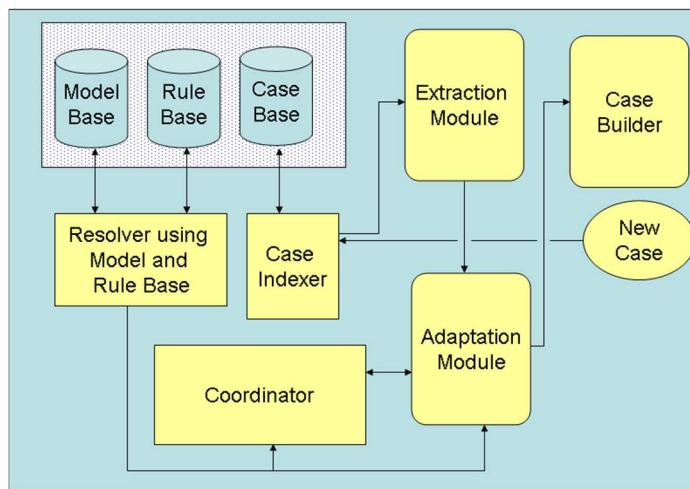


Fig. 4. GRAIXPERT structure  
 Rys. 4. Struktura GRAIXPERT

GRAIQUAL is a module used for managing quality approach implementation or quality improvement in an enterprise. It

contains two sub-modules IMM and QUALKBM. The Improvements Management Module (IMM) is used for managing the

different quality action plans of the enterprise. The Quality Knowledge Base Module (QUALKBM) is being elaborated for containing the rules related to quality certifications in order to use them for improving or elaborating quality in an enterprise.

A new module GRAICARB is being added to GRAIMOD in order to pinpoint the environmental, societal and social dimensions in enterprises. This module would integrate for example changes associated to carbon management, ISO 26000, ISO 14000 implementations, social and societal evolution impact not only on enterprises but also territorial collectivities (states, associations, local authorities, etc.).

Unlike GRAIQUAL whose goal is to improve enterprise performance by using the criteria defined, GRAISSE focuses only on the social, societal and environmental aspects. This module is composed of two sub modules:

- GRAICARB to calculate enterprise carbon footprint and to propose environmental improvements according to ISO 26000 norm
- GRAISO focusing on the improvement of social and societal aspects in enterprises.

Carbon management is an approach based on the setting up of a project for the evaluation and reduction of gas emissions consisting of six main stages:

1. Awareness of Greenhouse gas emissions
2. Definition of the area to be studied
3. Data acquisition
4. Exploitation of findings
5. Establishment of reduction action plan
6. Execution of reduction action plan

In GRAICARB the ADEME (French environmental agency) method is promoted according to ISO 14000 norms. This method proposes the use of a step by step approach of calculation rules, of calculation software and of associated documentation. The database used is "Carbon base" and external data could also be used by the users.

This method is used in three stages:

- The preparation for defining the perimeter of the study.
- The accounting analysis for collection of precision data
- And strategic analysis classifying the critical areas and those at risk. The action plans are elaborated after that for correcting the situation.

The concepts contained in the ADEME Method are combined to the Greenhouse Gas (GHG) Protocol, the regular guide for Gas management and data from the "coach carbone" tool. The GHG protocol describes principles and requirements for quantifying enterprise activities, gas emissions and defining accounting and reporting principles.

The methodological guide describes the way to follow to obtain an official Gas emission management.

The "coach carbone" tool is developed by FHN (Nature and Human Foundation) and ADEME. It allows to visualize the energy consumption in Kwh and liters of fuel and to compare it with other enterprises. The tool also allows to generate savings in Euros and in CO<sub>2</sub>.

GRAISO is dedicated to social and societal aspects according to concepts of ISO 26000 and Lucie Label, which will be presented later. With ISO 26000 there is no certificate contrary to Lucie which issues a certificate to validate the work done.

## ENTERPRISE TYPOLOGY AND REFERENCE MODELS

In regards to the actual situation of enterprises and new constraints of the market, the use of a structured approach for improving enterprises is pertinent. GRAIMOD is being elaborated by using different types of reasoning and applying them to enterprises: decomposition reasoning, CBR (Case Based Reasoning), Rules Based reasoning, transformation reasoning. The objective is to define formalized processes of enterprise improvement and to be able to manage each

step of these processes and defining action plans for short, middle and long terms.

Then, three modes of knowledge representation are used in GRAIMOD:

- The reference models show the standard for a given sector of activity. They allow to define an ideal for each sector of activity, which can be used as a reference in the elaboration of the future model (TO BE model).
- The cases studied are capitalized in order to enrich the knowledge capitalization module of GRAIXPERT with the objective being to improve the use of CBR (Case Based Reasoning).
- The rules are used throughout the different phases of the operation of GRAI methodology. Not only do they serve to elaborate the modules concerning the existing situation of the enterprise (AS IS) but also to detect the malfunctions of the enterprise and establish its strengths and weaknesses and finally during the design phase of the future system (TO BE).

The use of a generic model corresponding to a precise activity sector appears as pertinent. A new enterprise typology (figure 5) based on four criteria is established and a reference model according to each defined domain is being elaborated.

The first criterion chosen is the economic sector:

- The Primary sector is composed of activities linked to the natural resources exploitation such as agriculture, forestry; fishing and mining are included in the primary sector. It also includes all activities producing unprocessed raw materials.
- The Secondary sector corresponds to activities linked to the processing of raw materials from the primary sector in production and consumption goods are included together with the construction or manufacturing industry.
- The Tertiary sector contains service activities linked to that sector. We can find very wide types of activities such as commerce, administration, transport, financial and real estate activities, services to businesses and individuals, education, health and social action.

This sector decomposition is used by both economists and geographers. The sectors correspond to the three main economic sectors and are widely used.

The second criterion used is defined as size:

- Small companies correspond to enterprises with employees from 0 to 49
- Medium companies are composed of employees from 50 to 499
- Large companies correspond to enterprises with more than 500 employees

For reducing the number of reference models to elaborate, only three sizes are defined.

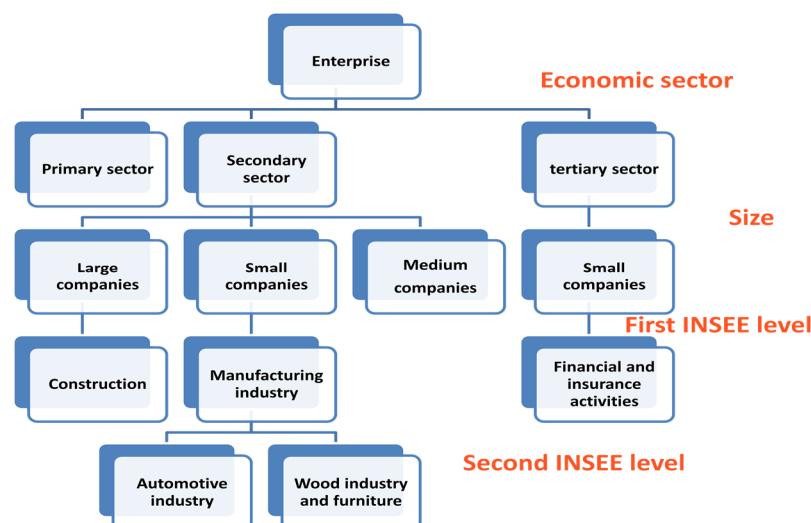


Fig. 5. Enterprise typology  
Rys. 5. Typologia przedsiębiorstw

The third criterion chosen (first INSEE level) is activity domain according to NAF code. A SIREN number is assigned to any French companies during their registration and this number is used for the lifetime of the company. As soon as the SIREN number is assigned, the company needs to select an APE code (Main Activity Practiced) which characterizes the activity. This code is used for the nomenclature of French activities (NAF).

The APE code is fundamental information for statistical data companies because all the rankings of firms by industry are based on it. The quality of the studies about the economic and the structural situation also depends on it.

We decided to only use the first level of the NAF for the primary and tertiary sectors (sections A, B, G ... in the table in the previous page). The explanation of this decision is because we are convinced that the performance models of these companies would be close to each other. But the second INSEE level, the fourth criterion is used for dividing manufacturing industry into activity domain.

## TEST OF THE DEFINED TYPOLOGY: RANGE OF ENTERPRISES

The elaboration of reference models for each domain has been undertaken. The process of elaboration is the same: acquisition of context, existing system modeling, analysis, design and finally proposition of reference model.

All the enterprises of Vendee are chosen as a study area. Indeed, there are more than seven thousand enterprises in Vendee, corresponding well to a quota of all enterprises in France for making a scientific study. The result of the study could easily be extended to enterprises nationwide in France, then throughout Europe. The quota chosen is really representative. So, Vendee enterprises represent for the study the global mathematical population. A meeting with the Chamber of Commerce allows to

define how many enterprises would give an answer to a questionnaire sent to them for acquiring context and to make an enterprise classification. Because of the crisis and the difficult economic situation of enterprises, enterprises find it difficult to allocate the time to answer to this kind of questionnaire; only 10% would surely give an answer. For the population, it means that 700 enterprises would be ready for giving us data for our analysis.

The proposition of an extension of GRAIMOD is in order to treat the data obtained and exploit it for elaborating reference models. GRAICARB, this extension, contains a data base with the questionnaire in which the responses will be studied. It allows to find good habits of enterprises by taking into account social, societal and environmental dimensions. The use of GRAIMOD for improving enterprise performance is now already efficient. Indeed, for an enterprise, the modeling, the analysis and the design phase are really well managed by the tool. The tool is also efficient for reducing lead time, choosing and implementing new tools in the enterprise, and implementing quality approach. But it is clear that the tool is less efficient in the management of improvement integrating carbon footprint reduction, social and societal dimensions, and respect of environmental norms. Then, GRAICARB will bring this efficiency, by focusing only on this criterion. The linear combination with the other performance criteria would be managed by GRAIMANAGER.

The ISO 26000 norm presents the main lines for all organizations wanting to assume the impacts of their decisions and activities. The societal responsibility is defined as the responsibility of an organization according to its decisions and activities towards society and the environment through an ethical and transparent approach which

- Contributes to the sustainable well-being including health and development of society.
- Takes into account all interested parties.

- Respects laws and is adapted to international norms.
- Is integrated to all the organization and is used in its relations.

For guiding the discussions between all the parties, the designers identified seven main questions:

- Environment
- Loyal practices
- Community and local development
- Organization governance
- Relations and working conditions
- Questions related to consumers
- Human Rights

Each of these questions is divided into action domains, explaining the main lines to be followed. An ISO 26000 approach respects three major steps:

- The realization of a diagnosis for defining action priority
- The deployment of identified actions
- The phase of account making
- The diagnosis management is based on:
- The definition of the perimeter of societal responsibility
- The identification of the parties concerned and their interest
- The review of the seven main questions

The diagnosis serves to identify pertinent action domains on which the organization could be based for fixing its priorities. Then an auto-evaluation could be done according to requirements referential or an evaluation by an outside party could be done according to universal requirements referential.

The deployment implies the study of the organization values for defining strategy, objectives, resources and skill development. The results are followed by the regular review as part of a dynamic continuous improvement process.

The last step is destined to summarize what has been done and how to address what remains to be done.

The result of the questionnaire would allow to adjust the enterprise typology elaborated. It would show us the enterprises which changed their economic model by integrating other dimensions than cost, quality and lead time. For instance, some of them are green, ecological, virtuous, showing solidarity, ethical, or responsible enterprises. The study allows to focus on this kind of enterprises and to valorize them (figure 6). The objective is to show those not having chosen to follow this way the real advantages of such an approach and for those who have already started to help them become even more efficient.



Fig. 6. Collection of best practices

Rys. 6. Zbiór najlepszych praktyk

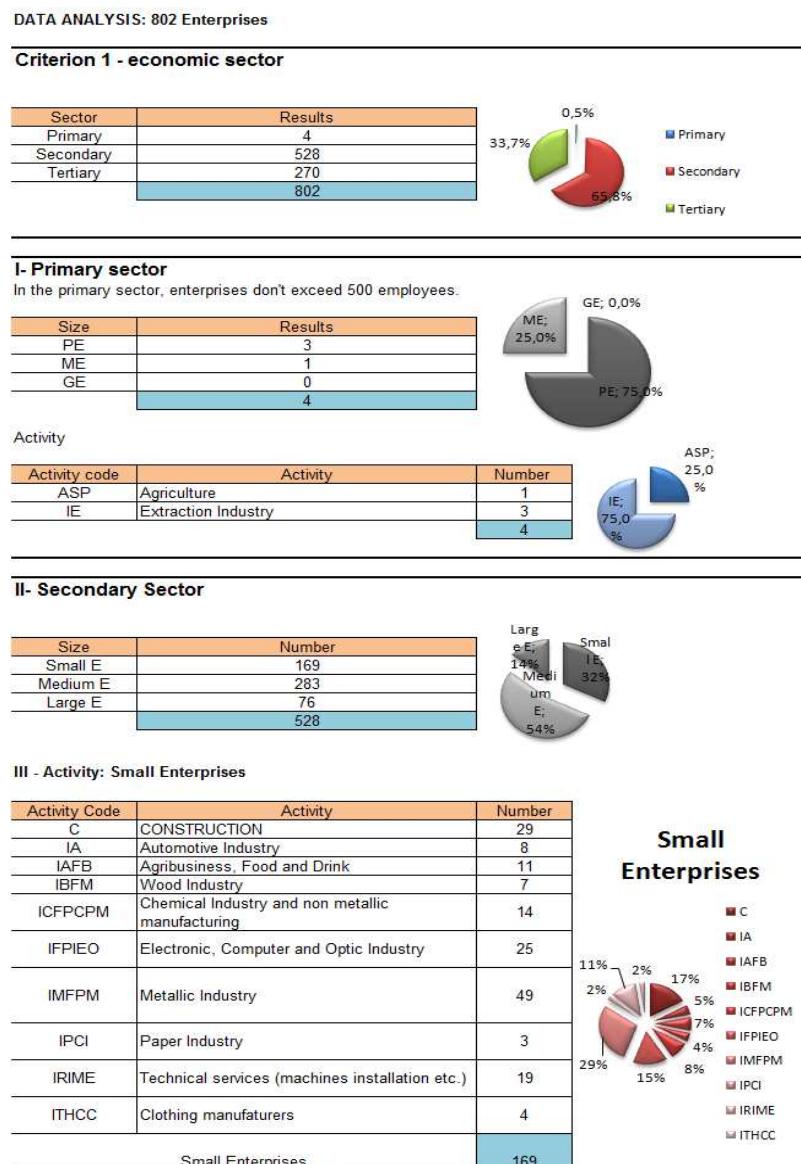


Fig. 7. Example of typology structure  
 Rys. 7. Przykładowa struktura typologii

GRAICARB would be used for doing carbon management, implementing ISO 26000, managing ergonomic practices, managing how to make employees happy with their job and more efficient for the enterprise. The societal aspect could also be managed. The tool would also serve for improving local authorities.

To conclude, the study extended to the department of Vendée has been undertaken (figure 7). The first step was finished in

February 2013. Then the typology elaborated will be adjusted and reference models developed for each new class. The next step will be modeling of the enterprises which will start using specific models in order to improve the reference models defined. Simultaneously, the elaboration of another economic model more adapted to the actual context and able to protect enterprises in the future will be developed.

## NEW ECONOMIC AND SUSTAINABLE MODEL

Existing economic models, including the capitalist one which many consider to be behind the actual world crisis, have shown their limitations. It is necessary to think about a new model that will be adapted to the actual world context and more efficient.

The objective is to develop a model with a complete break from a purely liberal one. This model has to take into account the reason of the actual crisis and parameters such as the environment, society, social view, and to offer an optimization in terms of a balanced model.

The particularity of the new proposed model would be to think globally about local organization, an enterprise, a department or a country. It means that all parameters would have to be integrated in the definition of the model without giving priority for one criterion as it was in the old capitalist model.

For instance, for energy independence, it would be to think about how to implement a global energy vision according to a department or town. For the department of Vendee an audit would be done for analyzing in detail the existing system and then detect inconsistencies, and deduce points to improve. The next step would be to define a new specific Vendee model in accordance with other best models used in the world according to energy optimization but with the specificity and the identity of Vendee. The result would be a combination of best energy transition habits, integrating biomass and waste energy, or solar energy, wind energy, thermal resource energy, and so on. The model would be according to the parameters the most balanced possible. For validating this model, a demonstrator would be designed, elaborated and exploited on a new ICAM school for example. The model obtained and validated only by focusing on one aspect would be improved by introducing the other aspects in order to define an optimum.

This approach proposed for the energy self-sufficiency problem, would be generalized to all the previous questions in order to build

reference models adapted to specific problems of enterprises and local government.

To conclude we could say that the department of Vendee department will serve as an example which will be studied completely and statistically with a scientific approach for defining a new economic and sustainable model.

## CONCLUSIONS

Enterprise modeling is used for preparing enterprises for the post-crisis period by reorganizing them according to the evolution of society and globalization rules. It is important to show them how to integrate different new parameters in order to adapt to future conditions. The objective to make enterprises sustainable needs to redefine an optimum including environmental, social and societal dimensions in addition to the main performance criteria (QCD). GRAI Methodology supported by GRAIMOD a new software tool, allows to improve the global performance of Enterprises and particularly SMEs. A focus is made on GRAISSE and GRAICARB dedicated for managing carbon footprint and social, societal and environmental aspects in enterprise improvement.

In this paper, the process of reference models elaboration is presented. An enterprise typology is also proposed with the objective to give the most appropriate model to each enterprise which desires to improve its performance. The new economic model is being elaborated and will be presented in detail in future papers. The proximity of Icam Vendee to enterprises will allow not only to enrich the case base of GRAIMOD by doing modeling of them but also to improve the reference models and the typology elaborated.

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## POPRAWA MODELOWANIA I REALIZACJI: PODEJŚCIE DO ZAGADNIEŃ SOCJALNYCH ORAZ OCHRONY ŚRODOWISKA W PRZEDSIĘBIORSTWACH W OBECNYM TRUDNYM KLIMACIE EKONOMICZNYM

**STRESZCZENIE.** **Wstęp:** Gospodarki europejskie zostały dotkliwie dotknięte przez różne kryzysy. Wpływ kryzysu ekonomicznego na przedsiębiorstwa dostrzegany jest obecnie wszędzie. Przedsiębiorstwa te muszą poddać się gruntownej reorganizacji oraz dodać nowe elementy i wymiary do własnego rozwoju. Redukcja kosztów nie jest jedyną metodą poprawy sytuacji przedsiębiorstwa. Wymagana jest wielokryteriowa analiza, obejmująca jakość, koszt, czas reakcji jak również zużycie dwutlenku węgla, oddziaływanie na środowisko czy aspekty socjalne. Kryteria QCD są obecnie uznawane jako niezbędne do osiągnięcia optymalnego systemu zarządzania, tak jest trudnym zadaniem przekonanie zarządzających firmą o konieczności i wynikających z nich też korzyściach dla optymalizacji kosztów, wprowadzenia również wymiarów socjalnych i środowiskowych.

**Metody:** Praca przedstawia koncepcję, która umożliwia stworzenia przedsiębiorstwa jako bardzo efektywnego, lepiej zorganizowanego i dostosowanego do zmieniającego się społeczeństwa.

**Wnioski:** Redukcja kosztów jest niezbędna, tak samo jak wzrost obrotów, ale jednocześnie konieczne jest zmienienie struktury przedsiębiorstwa. Modelowanie przedsiębiorstwa (metodologia GRAI) została użyta jako do zaprezentowania koncepcji w szczegółowym studium przypadku.

**Słowa kluczowe:** zarządzanie emisją dwutlenku węgla, zrównoważone zarządzanie łańcuchem dostaw, zarządzanie jakością, wiedza menadżerska, redukcja zużycia energii

## VERBESSERUNG DER UNTERNEHMENSMODELLIERUNG UND IHRE DURCHFÜHRUNG: EIN HERANGEHEN AN SOZIALE FRAGEN UND DEN UMWELTSCHUTZ IN UNTERNEHMEN IM GEGENWÄRTIGEN SCHWIERIGEN WIRTSCHAFTSKLIMA

**ZUSAMMENFASSUNG.** **Einleitung:** Die europäischen Landeswirtschaften wurden von verschiedenen Krisen schwer betroffen. Überall wird heutzutage der Einfluss der Wirtschaftskrise auf Unternehmen wahrgenommen. Die davon betroffenen Unternehmen müssen sich einer grundlegenden Reorganisation ergeben und neue Elemente, Ausmaße und Impulse für ihre Entwicklung in Angriff nehmen. Die weitgehende Kostenreduzierung vermag nicht die einzige Methode

einer Verbesserung der Situation im Unternehmen zu sein. Es wird dabei eine Mehrkriterien-Analyse benötigt, die die Qualität, Kosten, Reaktionszeiten, sowie die Kohlenstoffdioxid-Emission, die Umweltbeanspruchung und soziale Aspekte umfasst. Die QCD-Kriterien gelten heutzutage als unentbehrlich für die Erzielung eines optimalen Management-Systems, es fällt allerdings schwer, die Geschäftsführer davon zu überzeugen, dass die nötige Einfügung von sozialen und umweltschutzmäßigen Aspekten in die Managementsmodelle viele Optimierungsvorteile mit sich bringen kann.

**Methoden:** Die vorliegende Arbeit stellt ein Konzept für die Etablierung eines sehr effizienten, besser organisierten und an die sich verändernde Gesellschaft angepassten Unternehmens dar.

**Fazit:** Die Kostenreduzierung ist unentbehrlich, ähnlich wie die Umsatzerhöhung. Gleichzeitig bedarf das Unternehmen einer Veränderung seiner Struktur. Die Modellierung des Unternehmens (gemäß der GRAI-Methodologie) wurde als Methode für die Darstellung des Konzeptes im detaillierten Fallstudium angewendet..

**Codewörter:** Management der Kohlenstoffdioxid-Emission, ausgewogenes Management der Lieferkette, Qualitätsmanagement, Management-Wissen, Energiereduzierung

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