Decision support system for investment projects appraisal using green accounting principle

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Abstract – *The standard investment appraisal techniques, like cash flow analysis, emphasize the economic welfare, neglecting the societal and environmental aspects of investment projects. Using these standard techniques, classical pollution-causing technologies will be always favored, compared with new environmental friendly technologies, because these techniques do not take into account environmental related costs and benefits. In this paper we will briefly describe the software that introduces the "green accounting" principles into the investment appraisal process, aiming at discouraging investments into environment damaging projects. The software facilitates distributed creation, evaluation and appraisal of investment project, using a three tier architecture based on Java Platform, Enterprise Edition (Java EE) 6.*

1. INTRODUCTION

In the investment projects evaluation and appraisal, it is often assumed that environmental costs are not significant to the operation of a new enterprise. However, now that the environmental standards are more severe, it often happens that some production costs have a significant environmental component, which is underestimated or neglected by investment analysts. For instance, the purchase price paid for the unused portion of raw materials that is emitted into air or discharged into waste water, is usually not recognized as an environmentally related cost. These costs tend to be much higher than initially estimated and should be controlled and minimized by the introduction of effective cleaner technologies whenever possible.

In the standard cash-flow analysis investment projects are appraised according to different profitability indicators, like net present value (NPV), internal rate of return (IRR) or payback period. In case of environment-related projects, recognizing and quantifying environmental costs and benefits is necessary for the profitability assessment of the project. Without these calculations, investment decision makers may come to a false and costly decision.

In the accurate investment project analysis, hidden and contingency costs should be also taken into account. The costs stated in standard methodologies are insufficient to provide an accurate estimation of the profitability and involved investment risks. Many cost items related to environmental management and protection must be included in the project appraisal. Generally, these costs may be grouped into five categories:

- **Environmental portion of raw materials, utilities, labor and capital costs.** Although these costs are conventional costs which are always taken into account during investment project analysis, the environmental portion of these costs, e.g. non-product raw material costs, are not isolated and recognized as environmental.

- **Hidden administrative costs.** Some costs like monitoring, reporting or training costs are usually underestimated and buried in other administrative costs.

- **Future contingency costs.** These costs, related to possible clean-up or recovery costs and fines, are hard to predict and very often they represent a major business risk for the company.

- **Image benefits and costs**. These are the so-called intangible or "good-will" benefits and costs, which arise from the improved or impaired perception of stakeholders (environmentalists, regulators, customers, etc.).

- **External costs**. These costs are commonly not taken directly into account when making project decisions. However, the investment managers should be aware that high levels of external costs may eventually become internalized through stricter environmental regulation, taxes or fees.

A web-based decision support system called **PEGAS** (**P**roject **E**valuation **U**sing **G**reen **A**ccounting **S**ystem), is a tool aimed at helping investment managers to take into account all these environmental related costs and benefits in investment project analysis and appraisal. It provides the standard cash flow analysis based on the UNIDO methodology, sensitivity and risk analysis as well as support for multicriteria decisionmaking for selecting the best investment alternatives based on more than 30 static, dynamic and risk criteria. In Section 2 we briefly described the functionality of PEGAS, while in Section 3 the software architecture used in PEGAS is presented.

2. BASIC FUNCTIONALITY

PEGAS Evaluation Software (Fig. 1) enables decentralized creation, analysis and appraisal of investment projects from the perspective of "green accounting" [1]. As a basis for the preparation of underlying feasibility study, the methodology of United Nations Industrial Development Organization [2] has

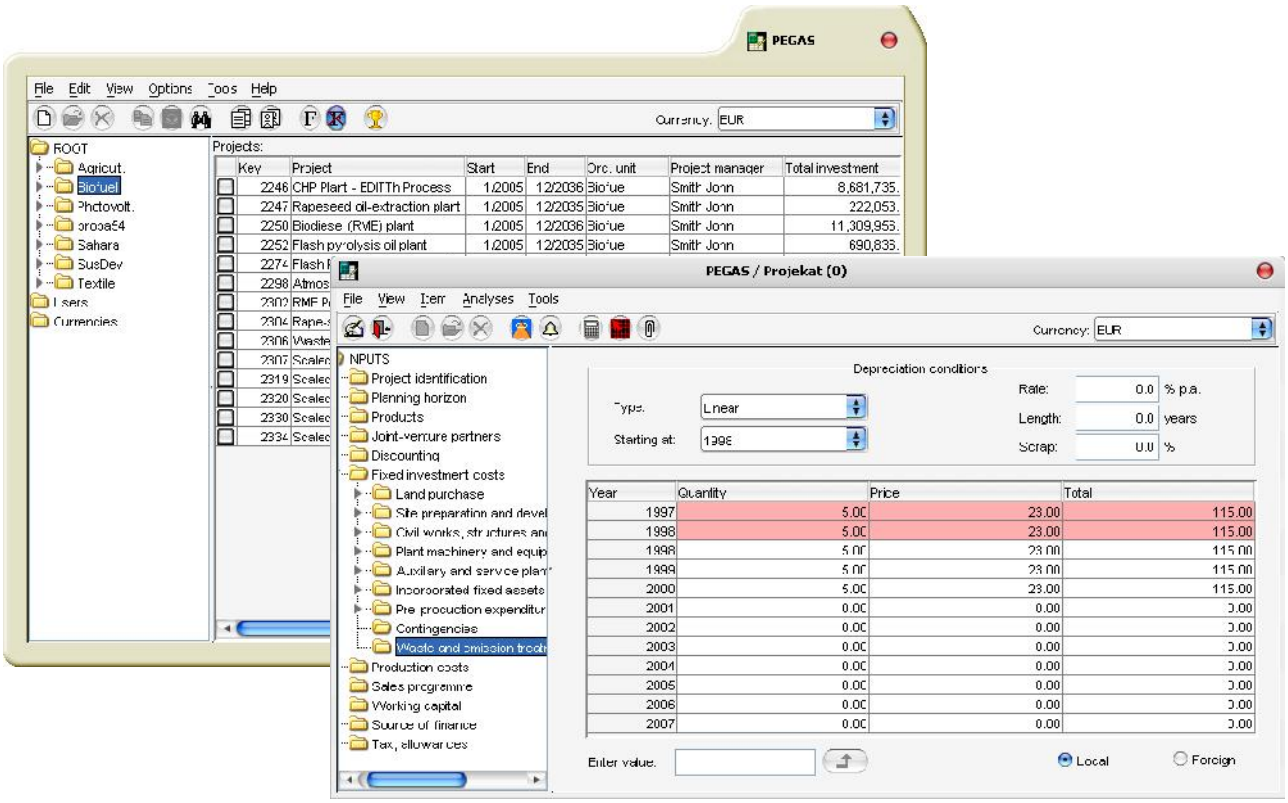

Figure1. PEGAS Evaluation Software

been chosen. The methodology is based on modifications of integrated standard analytical tables, where financial and economic analyses are based on discounted cash-flow values.

Investment project planning is an interdisciplinary task that requires a team of economists, engineers, businessmen, governmental administrators and social scientists. The UNIDO methodology can help investment decision-makers with different educational backgrounds and professional experiences in the preparation of industrial feasibility studies. The methodology is practical in approach, i.e., in an attempt to put the various feasibility studies into a similar framework with a view to make them more comparable than in the past. Industrial development centers, investment promotion centers, industrial development banks and public and private consulting firms should benefit especially from the methodology.

PEGAS use investment project data from the UNIDO methodology. As an input the following data are required:

- Basic project data (name, description, …)
- Definition of construction and production phases
- Discount rates
- Definition of product portfolio
- Investment costs (Fig. 2)
- Production costs
- Sales programme
- Sources of finance
- Working capital
- Taxes and allowances

Investment project analysis and appraisal includes the financial analysis, sensitivity and risk analysis and multicriteria decisionmaking.

For the financial analysis of investment projects it is necessary to gather and feed into the system all the required data to be able to create a net-income statement, cash-flow, discounted cash-flow (Fig. 3) and balance sheet.

According to the classical cash flow analysis, two types of indicators are used in the investment project appraisal: dynamic and static. The static approach uses the financial and efficiency indicators for the representative year. This approach resembles the standard economic and rentability appraisal of the investment projects, which can be used to approximately assess the efficiency of the investment project.

In the dynamic appraisal of investment projects, the following indicators are used: net present value (NPV) of investment, internal rate of return (IRR), payback period, and the break-even point in the exploitation of the investment. Each of these indicators has its advantages and disadvantages, therefore for the investment appraisal, to be as objective as possible, it is necessary to use all of them in combination with the static indicators, providing the complete efficiency appraisal of the investment projects.

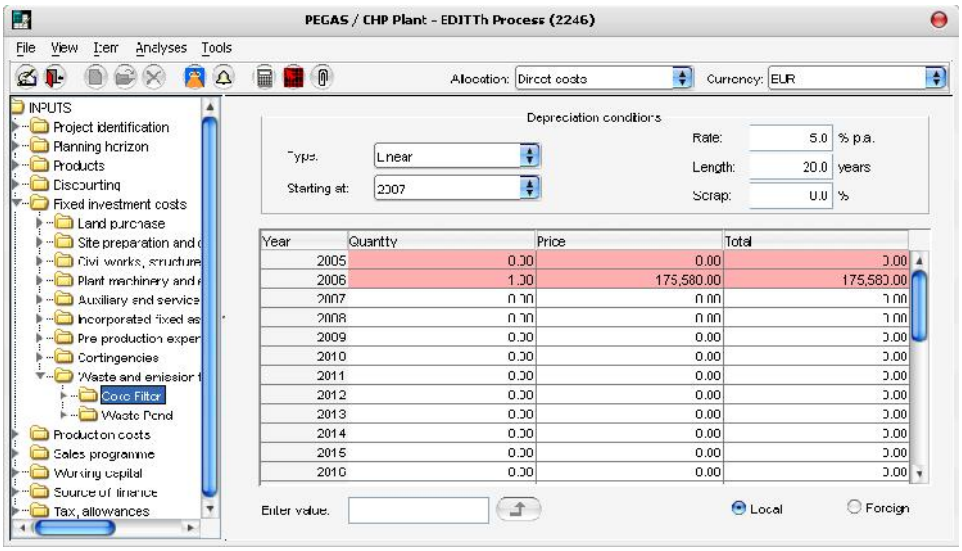

Figure 2. Fixed investment costs

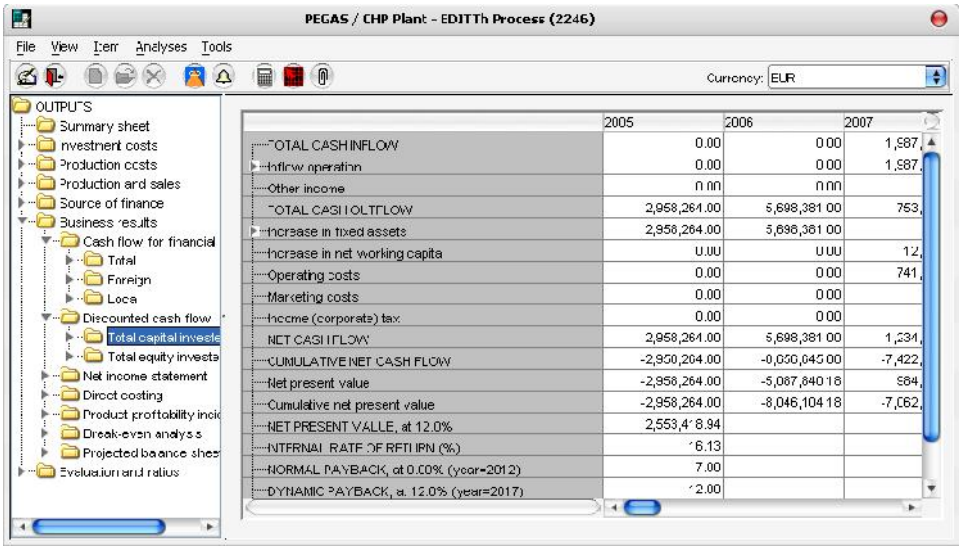

Figure 3. Discounted cash flow

Inability to correctly assess the input parameters used in the efficiency appraisal of the investment projects represents the main source of risk in the investment decisionmaking. Besides the sensitivity analysis of NPV and IRR which takes into account the changes of the critical input parameters (e.g. sales programme, investment costs, prices of the inputs, macro-economic measures etc.), some additional methods are used in the classical risk analysis. In a classical risk-bearing model, given a combination of uncertain variables that affect profits, a probability distribution for the investment effectiveness is defined. In order to evaluate, for instance, the net present value probability distribution, subjective probability distributions are first evaluated for the series of broad categories of revenue variables, cost variables, project life cycle, the cost of capital, etc. According to the literature on this subject, random variables are usually generated [3], assuming a normal or uniform distribution.

Using a well-known Monte-Carlo method [4], some statistical parameters can be determined for NPV and IRR (Fig. 4): mean values, standard deviations, coefficients of variance, probabilities that some values will be less than the given thresholds, and some indicators that represent the extent to which the project evaluator is averse to taking risk (by using a utility function) such as "zero risk equivalent" or δ-value. These values can be used as measures of "risk" or "uncertainty" in the project appraisal

Using various classical efficiency investment indicators, risk indicators and real options indicators, it is possible to determine the partial or total order of different investment projects (Fig. 5), and then to make a choice of investment projects having in mind the available financial resources. The PROMETHEE II method [5] is applied as a multicriteria decisionmaking algorithm.

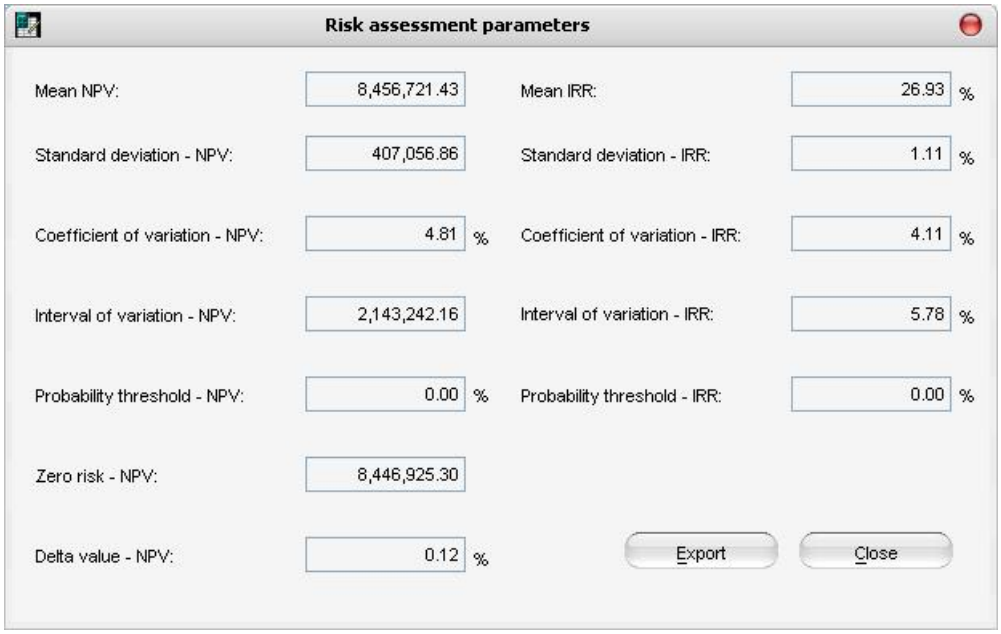

Fig. 4. Risk measures

Apart from the analysis and appraisal of investment projects, which is the main functionality of the framework, PEGAS facilitates an easy overview and work with investment projects, searching and filtering of investment projects, as well as export of data and results to MS Excel. PEGAS also supports the creation of organizational tree, defining of currencies and exchange lists, personnel records for project managers responsible for some investment projects and users of the system.

4. SOFWARE ARCHITECTURE

In PEGAS implementation, we have applied the three-tier host-to-Web solution that has gained so much publicity in recent years, because it forces clear separation of functionality between the tiers, thus easing the development and testing of applications as well as future extension and/or reuse.

In the three-tier architecture the first tier is a presentation tier, the second tier is a business tier, while the third tier is a data tier. In the Enterprise JavaBeans (EJB) technology [6] the first tier corresponds to the Java EE client (runs on client computers), the middle tier represents the Java EE server (runs on a server computer) with the EJB container, while the third (EIS-Enterprise Information System) tier includes database or file system (on the database server computer).

The EJB technology represents a part of a larger framework – Java Platform, Enterprise Edition (Java EE) 6 [7]. This platform provides architecture for the development, distribution and execution of the applications in a distributed environment. The applications that run in a distributed environment require some system services such as transaction management, communication with clients, security, database access, etc. The Java EE platform provides these services, allowing a programmer to focus on the business logic of the application instead on the system services. The business logic is implemented within the EJBs, which can be reused and called from the client application. The EJBs are running on the Java EE server, which is operating as a middle-tier server in the generic three-tier architecture.

PEGAS Evaluation Software (Figure 3) contains the following components: PEGAS Client Application, Dispatcher Session Bean, Working Session Bean, Project Session Bean, Evaluation Session Bean and PEGAS database.

PEGAS Client Application is implemented as a thick client running on client computers and representing a part of the client (presentation) tier. Apart from the main functionality of investment projects analysis and appraisal, PEGAS Client Application provides the functionality of a typical Web portal enabling easy overview and work with investment projects.

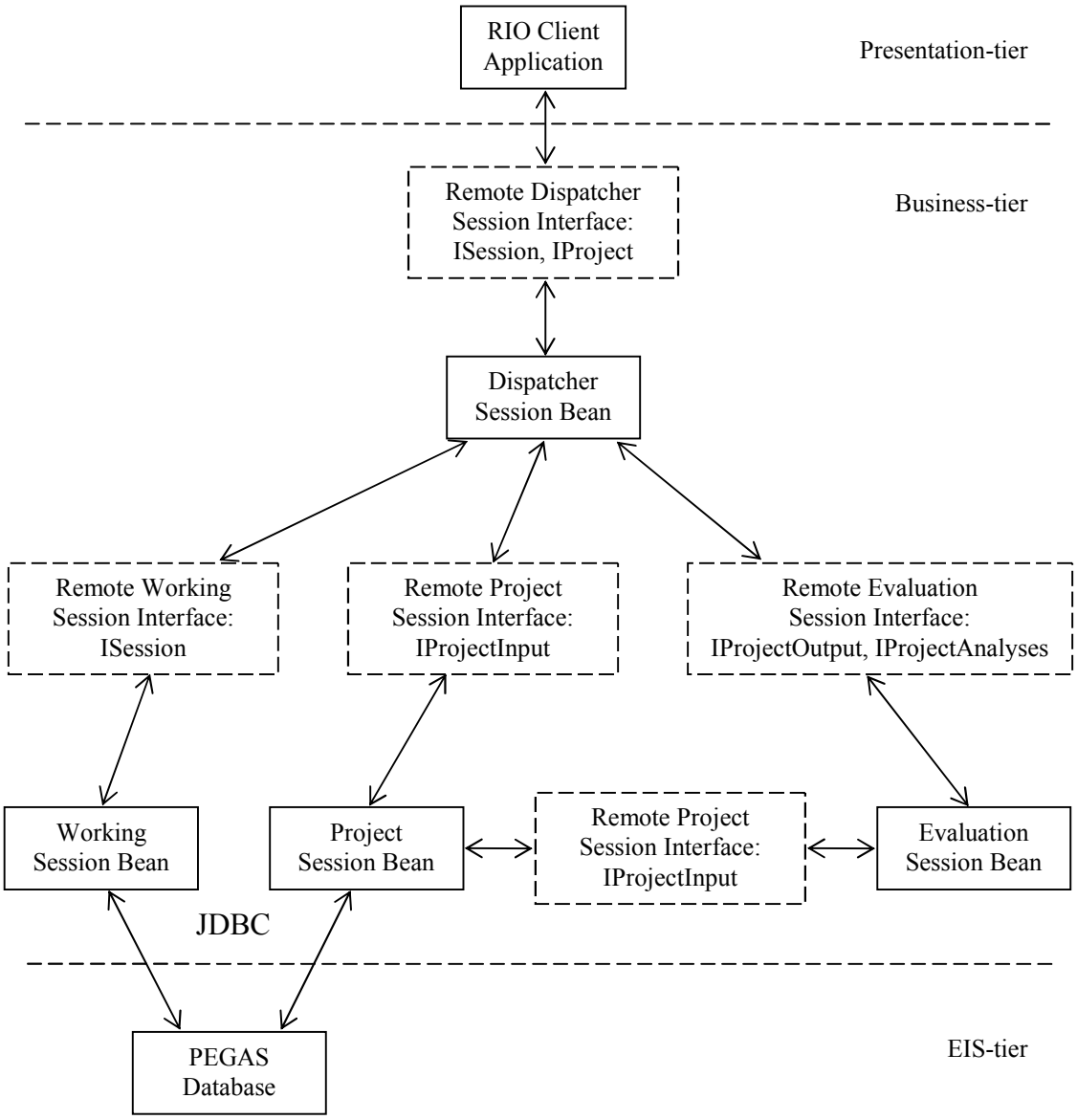

Figure 3. PEGAS Architecture

Dispatcher, Working, Project and Evaluation Session Beans represent parts of the business-tier that is running on a server computer. Dispatcher Session Bean represents a client within the server and corresponds to one interactive session. This component enables the conversation between the client and other beans. Dispatcher Session Bean does not access the database, but dispatches only the requests to other beans. Working Session Bean provides business logic required for Web portal. It serves many clients, performing some common tasks. It accesses the database to fetch the data frequently asked by clients. Project Session Bean implements logic needed for fetching and saving input data for one investment project, while Evaluation Session Bean performs classical cash-flow analysis of projects and supports sensitivity and risk analysis by taking into account all environmental related costs and benefits.

PEGAS database represents a part of the enterprise information system (EIS-tier) that is running on the database server computer. It contains information about company organization, employee records, users and all data related to investment projects

4. CONCLUDING REMARKS

Too long the investment analysts have been turning the blind eye to the environmental impact of their new enterprises. The investment appraisal based on green accounting is the best option to facilitate businesses to play their roles in reducing the greenhouse gases and other pollutants pouring into the environment. This approach includes the value of diminishing natural resources, and the cost of increasing atmospheric pollution, into the price of what we buy and consume! At the moment, these costs often do not appear in anyone's

balance sheets, or even if they do, they appear on the wrong side. Almost all of these costs, for which future generations will pay expensively, are given no value in corporate accounts. They should be given value in both corporate and national balance sheets and this value should be visible not only in financial reports that appear on business radars, but also to the overall community. Green accounting assumes that, in addition to having capital and labor accounts, there should be accounts for the natural capital, like forests, clean water and air, etc. Therefore, this software combines conventional UNIDO methodology for investment project appraisal with modern sustainability principles, facilitating its users in making socially and environmentally respectful investment decisions. The software is web based, meaning it can be exploited in accordance with SaaS (software as a service) principle as well.

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