Governance Intelligence for Romanian R&D funding

Professor LIDIA NICULITA, Assistant NICOLETA LUMINITA CARUTASU,
Quality Assurance Department
RD, Innovation and Technological Transfer Management Agency
Bucharest, 313th Splaiul Independentei, 6th sector, postal code 060024
ROMANIA

www.amcsit.ro

Associate Professor GEORGE CARUTASU
Managerial IT Faculty
Romanian-American University
Bucharest, 1st B Expozitiei Bvd, 1st sector, postal code 012101
www.rau.ro
ROMANIA

Abstract: In this paper we present the principles of Romanian R&D funding activities and the architecture of an intelligent information system developed for maximize the efficiency of funding. Related with these aspects, we emphasize the concept of Governance Intelligence, as a response of today challenges in national funding activities, connected with external funding programs, after the Romania's adhesion to EU. Furthermore, we propose, as future work more fields of Governance Intelligence concept.

Key-Words: - information systems, GPM, data mining, governance intelligence

1 Introduction

As a result of large automation of governance activities, more data became available, as a support for specific decisions. The funding R&D activities, assured from public budget implies rules, strategies, policies and target domains, which together are used to define R&D funding governance policy [9]. Similarly, we define Governance Performance Management (GPM) as a set of processes used by government to sustain the funding decision from public funds in different fields.

GPM involves various activities, starting from data collecting from different sources and consolidation, querying and set an analysis method, in order to offer efficient structured information, which will be used in funding decision-making activity [5, 6]. Also, another role of GPM is to discover, in early stage, anomalies in funding process, before that can seriously affect the entire funding program. Furthermore, the same system can be used to establish the R&D budget, for specific programs or fields, in accordance with previously efficiency of funding. So, the main GPM responsibilities' is to discover, to predict and to deliver useful information in decision-making funding process [10].

By excellence, R&D is an activity having a major risk coefficient, so preliminary risk evaluation must be made, in sense to be assured that the R&D funding contractor has the financial and technical potential to develop the R&D project, Other direction of risk evaluation is to evaluate the R&D project itself, as a set of activities developed by a contractor or a consortium of contractors. Contractors' evaluation is made by analyzing a set of mandatory documents presented in original once, by recording the institution in Potential Contractors Register. Those checks are mainly oriented to R&D contractor capacity and have no debts to state budget [1].

Romanian research system covers more then 700 private and public entities, having R&D as principal domain of activity. So, are registered 74 universities (56 public universities and 18 private universities), 38 R&D national institutes, 327 public entities subordinated to Ministry of Education and Research or other ministries, Romanian Academy and over 270 enterprises with R&D main domain of activity.

As R&D personal, last record published by Romanian Ministry of Education and Research, present as being 39 985 persons, with 25 785 researchers and 6 400 PhD's. The majority of researchers (53%) are in Engineering and Technical Sciences. As age repartition, 1-2% decreasing is registered for 30-49 years old and 2-3 increasing for over 50, comparatively with last year records. The main age group is 40-49 and less than 30 years old is relatively constant, having 14% from total researchers.

The main funding instrument of Romanian R&D is Research, Development & Innovation National Plan, launched in 1999 (RDINP I), covering the period 1999-2006. In 2005, have been released another funding instrument, Research of Excellence Program, with main

objective to increase the competitiveness and strengths of Romanian Area of Research, having as imminence the adhesion of Romania to EU. In 2007, is preserved to launch another research program, as a continuity of RDINP I, named RDNIP-II, for the national funding period of 2007-2013.

In 2010 is estimated an increased for R&D funding up to 3% of National Budget, where 1% will be assured from Romanian Budget and 2% from external sources.

So in this, context more efforts must be made by funding managers, in hope to a better spending character and to assure an increased ROI for each project funded from public sources.

2   Romanian basic R&D funding process

Romanian R&D funding process is structured, accordingly with figure 1, on three major levels. First level is represented by Government Authority, named National Authority for Scientific Research (NASR), organized as Governmental Agency subordinated to the Romanian Ministry of Education and Research.

2.1 R&D funding institutions

The NASR's responsibility is to provide a strategic and tactical planning, to define strategic and tactical objectives and to define, apply, monitor and assess all the necessary policies in order to reach the national objectives regarding scientific research and technological development.

The second level is represented by R&D Program Management Units, who implement the NASR's policies for specific R&D programs, having in mind the entire management set of activities, which will be detailed below. Those Managements Units are structured as independent organizations, having as main activity field R&D funding, but also can develop their own R&D activities, completed with consultancy, technological transfer support for other R&D institutions, sustaining the scientific research by organizing conferences, editing books and reviews etc.
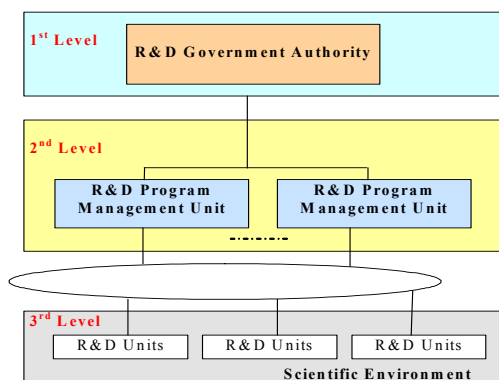

Figure 1 Structure of Romanian R&D funding process

The base level is the R&D units, the end-user of public R&D funds, and accordingly with Romanian Law Frame, they can be organized as Public Institution (e.g. universities, research institutes, agencies, public enterprises) or Private Organizations (e.g. private enterprises, SMES's, private universities). For being eligible to funding activities, the R&D units must be registered to Potential Contractors Register, who provides public interest records about any R&D units, certifying the R&D capacity and providing history of R&D activity, acting as national R&D competences certification.

2.2 R&D Program Lifecycle

The funding activity is program based. The institutions corresponding to 1st an 2nd level, group the funding process, resulting R&D funding programs. The R&D Program Lifecycle is presented in figure 2. The first step is to make the funding announcement (Call), where the institution mentioned before publish their funding intention to potential contractors (3rd level). This activity is completed by supplying with full information packages (forms, documents, call fiche, work program, fact sheets, Guides for Applicants etc.) necessary for Proposal redaction and evaluation.

After call announcement, R&D units present to R&D Program Management Unit their research funding proposals, in a proper manner (accordingly with information package). All research proposal submitted by R&D units, in consortium or as unique partner, is evaluated by experts from R&D Program Management Unit. In this R&D auction, more criteria are followed, from institutional (capacity to develop R&D activities), scientific (state of the art, scientific background of partners) and financial (ROI of the project etc.). As result of this auction a set of proposal is declared eligible for funding.

The next step is negotiation between R&D units and the funding institution (R&D Program Management Unit) regarding timetables, intermediary results and financial issues. In this phase of R&D Program Lifecycle, all issues signaled by experts are debated with project leaders.

The debates have as objective to assure the full understanding of project objectives and results, having in mind activities and phases budget' for each project.

After that, the contracting phase is initiated, subscribing all details into R&D frame funding contract, established into negotiation step, together with annexes:

- Accomplishment Plan (for entire project)
- Collaboration Agreement (between partners into consortium)
- Financial Specifications
- Personnel List (for each partner)
- Equipment Acquisition List (for each partner)

- Phase Estimates
- Expenditure List
- Payment Schedule
- Subcontracts (between project leader and partners)
- Timetable

In Implementing/Monitoring phase of R&D Program Lifecycle, project evaluation are made with intermediary reports (annually or six months) and final report, the funding process being stopped whenever R&D Program Management Unit consider that the objectives covered into Accomplishment Plan could not be reached. To prove the accomplishment of R&D, the consortium must present a Technical Report and a Financial Report for each phase. The Financial Report includes:

- Activity Report
- Approving Acknowledgment
- Frame Expenditure List
- Wages
- Materials Acquisition List
- Equipments Acquisition List

After the enclosure for all projects, a New Call decision is making. This decision depends of financial, technical and political factors, the last step consisting into funding program evaluation. We concentrate over the information system realized in order to sustain the funding process presented before, having in mind all the details related with funding process, covering also an analyses set for program evaluation, using neural network, applied on large inconsistent data amount.
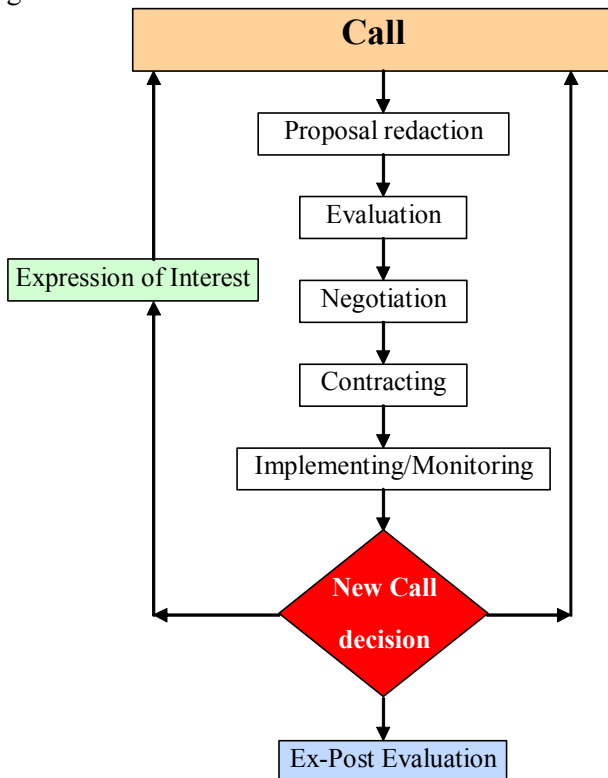

Figure 2 R&D Program Lifecycle

3 RDMIS project

RDMIS (Research & Development Management Information System) project was financed by Romanian Ministry of Education and Research in the period 2004-2006, having as partners two R&D Program Management Units (National University Research Council and RD, Innovation and Technological Transfer Management Agency) and two software companies (SIAT and CORNERSOFT). The budget project was over 400 000 Euro, involving wages, computers acquiring, disseminating materials, etc. It main objective was to unify the information systems of all R&D funding programs [12].

RDMIS can be used for:

- Scientific environment interaction with specific elements from Potential Contractors Register (PCR) ant Potential Evaluators Register (PER), so any enterprise who want to obtain funding for R&D activity must register on PCR (www.mct.ro/rpc/home.jsp) before applying for funds. Any R&D program may use any evaluator from PER, to evaluate a project (now, all data about evaluators on national level are registered in single register www.cncsis.ro/CV_straini/cv.html);
- Electronic redacting of proposal for a specific funding program;
- Electronic redacting of specific documents needed for contracting;
- Phases report for intermediary and final stage of the project in on-line format;
- Interactivity of the evaluation process for project proposals;
- Contracting and project management;
- Interaction between contractor regarding the project and contract monitoring, having in sight the preliminary reports, scheduled costs, payments;
- Specific element of contracts planning;
- Storing the electronic version of contract documents;
- Diverse information, analyses, prediction and templates used by decision level of NASR.

3.1 RDMIS modules

For all R&D funding programs end selection procedures of contractors, next instruments are needed:

- Potential Contractors Register (PCR);
- Potential Evaluators Register (PER);
- Human Resources Register (HRR);
- Project Management (PM);
- Proposal Electronic Submission (PES);
- Electronic contracting (e-C);

- Electronic Report (e-R);
- Notes&Memos (N&M).

PCR module is realized in idea to reduce the time necessary for checking the eligibility of contractors once for all proposals that they make, being used for all funding programs. So, in proposal is included an RPC number, which express the eligibility of contractors for funded R&D activities. All changes in this register (VAT number, stock holders, address, organization form etc.) are in responsibility of each contractor. This module is connected with a similar database of National Trade Register Office (Ministry of Justice), and is resident on NASR server [11].

All internal and foreign experts, used in evaluation and monitoring process, together with their competencies are registered in PER. At the beginning, each evaluator is attested by a scientific commission, for a specific domain. Furthermore, if, for a specific project, an evaluator is needed, the database offer possible matching, depending of the evaluators competencies and availability. This database is stored on National University Research Council and is address is mentioned above.

The third module (HRR) is on construction and will response to who's who in Romanian R&D question, in sense that all experts used in R&D funded programs will be registered with their capabilities and background. After this portal will be finished, the evaluator for a proposal, employed by a R&D Program Management Unit, may evaluate the experience in R&D for each expert and for entire team, using the data registered in this portal, more scoring algorithms being prepared, to quantify the risk of failure.

The PM module offers the specific tools to design and organize a project, such as Gantt Diagrams, PERT associations, leveling of resources, Critical Path defining etc.

The lasts module involves e-signature use, to electronically signing for all documents, in order to eliminate the birocratic nature of funding. This supposing a large effort made by the government, for extensively using the IT&C meanings in Public Administration.

3.2 RDMIS data structure

Primary data used and RDMIS and also the aggregate one have specific characteristics:

- Diverse structure;
- Are numbers and letters;
- Are informative fields and selection fields;
- Having a table structure;
- Are used for reports;
- Some have an aggregate data structure;
- Must be used in a imposed layout;
- Are used by searching engines (indexes);

- Searching process will used for relational database and text searching type;
- Are used in relationship process between different levels (e.g. similarity identification between proposal submitted on different calls)
- Some have public access and some have restricted access (multiple access levels);
- May have different format (e.g. multimedia for Training Manuals or presentations);
- Are stored as e-signed document or scanned holograph signed document;
- For several documents the printing layout must be preserved;
- Some have a one-to-many relationship structure (e.g. PCR or HRR where a specific resource (an expert) must not exceed the possible overtime specified by Romanian laws);
- Have mutiversion character;
- Must be indexed;
- Uses fields with specialized data (e.g. CAEN, UNESCO, NABS, SIRUES, ORTELIUS, bank accounts, etc.).

3.3 RDMIS technologies and infrastructure

RDMIS present a three-tier structure, using large implemented Operating Systems and Database Servers: MS W2003 Servers and MS SQL 2005. The concept of data' is referred to three different layers: Data layer, Information layer and Knowledge layer.

Data layer, where primary data are inserted in the system, information. All data are stored in a data warehouse as main repository of the R&D historical data.

Information is data obtain after aggregation process, using aggregate functions depending on subject, interconnected by communication nods existent between organizations involved (NASR, a R&D Program Management Unit) named data mart. This concept supposes a repository of data gathered from operational data and other sources that is designed to obtain knowledge [2, 8].

So, the information is obtained from data warehouse after suffering an data mining process. Also, an OLAP (On-Line Analytical Processing) system is provided, to assure a framework for the analysis of multidimensional data. Metadata are expressed in a condensed data mine-able format, or one that facilitates the practice of data mining [3, 7].

The third layer, knowledge is resulted after two separate processes of knowledge discovery and prediction. Knowledge discovery provides information for AS IS stage of the system, having a readable form and being understood by a user. Otherwise, the second process, forecasting, or predictive modeling provides predictions

of supposable future events, having in mind preset scenarios and can be transparent and readable for some algorithms or opaque in others, such as neural networks. [4]. Each phenomenon must be modeled with specific or combined methods in order to assure more accurate result of prediction, methods tested in time, based on history records. The system infrastructure is presented in figure 3, where are underlined the layers mentioned above together with its components (e.g. Predication, Notification, OLAP etc.).
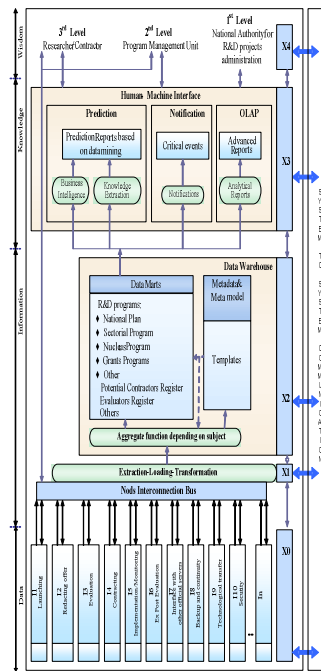

Figure 3 RDMIS Infrastructure

4   Governance Intelligence

We define Governance Intelligence as a large set of methods, analyses of AS IS, prediction and forecasting of TO BE stage, where knowledge is obtain by mining large volume of data. This concept is necessity of today's government funding activity, having in mind to increase ROI or other parameters which define the efficiency of funding. Also, the same system of may be used for forecasting funding budgets, discover miss functionality before it actually appear, better accordance between

funding programs and contractors needs. Furthermore, it sustains political decision system, to correct some interventions of public administration to encourage specific activity field.

Data aggregation functions, especially for analytical and forecasting reports have special features such as:

- Calculus over large data volume;
- Using historical records;
- May use data outside of the system;
- More often 'off line' analyses are made and 'drill down/up' searching features, from a higher aggregate layer to a lower one, with special data preparation;

The presented architecture present a high scalability function, assured by logical servers or database servers. Those are functioning as independent modules interconnected on software bus, implemented using communications protocols and adaptors.

As consequence, all data from third level, ore obtained from extraction, transformation and loading process in data warehouse, where data are aggregated, depending on subject of matter, for typical, analytical or predictive reports and analyses necessary to higher levels.

RDMIS assure a integrate solution for R&D management project-based, including Potential Contractors Register (PCR), Potential Evaluators Register (PER), Human Resources Register (HRR), Project Management (PM), Proposal Electronic Submission (PES), Electronic contracting (e-C), Electronic Report (e-R) and Notes&Memos (N&M) modules.

So, the requirements for such system are underlined by multiple data flows, large volume of data to reach the objectives:

- To be o complete solution, developed to actual standards, to assure the management (including presentation, printing and reporting to all R&D results from Romania) of public funds;
- Client/server and three tier architecture, for unified storing procedure, so any changes are transmitted in entire system, having a real time system, with minimum of delays;
- Scalable security system, with gradual access rights, with different security defined roles for specific department or organization.

5   Conlcusions

Main contribution presented in this paper is the RDMIS project, where the authors were Project Leader or member in the research team, with Governance Intelligence (GI) definition. Most of scientific approaches, for typical, analytical or predictive reports and analyses, are called Business Intelligence (BI).

The funding activity from public budget must be respected in every country, is governed by a local law frame which, after Romanian adhesion on EU, is accordingly with EU funding policy fir R&D activity. R&D funding management requires special tools in comparison with generally BI concept. These tools are more oriented to frauds detection, preventive control, reallocating and forecasting budgets. More then this, large data volume is involved, obtained from different organizations, with many inconsistencies, providing huge problems for data automation.

In this context, preset scenarios and templates, must be set for each type of activity, resulting complex algorithms. The knowledge obtained can be transparent and readable for some algorithms or opaque in others, such as neural networks. The modeling of economic and technical phenomena, implied by an R&D project, must be based on Romanian experience (previous R&D funding programs) but also on EU experience (results of FP7 and before) in order to assure more accurate result of prediction, methods tested in time, based on history records.

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