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Risk Reduction Performance Measuring System (RRPMS)

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This paper discusses a program outline for the development of a risk reduction performance measuring system (RRPMS). The risk factors, the RRPM system's objectives, organization, general features, project schedule, and cost benefits are described. The project approach, such as user requirements, system design, and implementation, are examined. The RRPMS's most important elements—risk, cost, schedule, and performance measurements—are also discussed. The paper imparts a broad knowledge of project management and control and its application to an RRPMS. The environment in today's construction industry is in a constant state of flux due to unprecedented competition, frequent corporate mergers, and changing US and international economic conditions involving considerable risk to the sponsor/owner. Only with a well-conditioned RRPMS for managing and controlling the projects can risks be substantially reduced.

Today's construction industry is in a state of constant flux. This is due to the cumulative impact of various factors such as rapid, often radical, advances in technology, unprecedented changes in US and international economic conditions, and frequent corporate mergers. It is in the context of this dynamic environment that the project manager conceives the project objectives and molds the planning and scheduling to grapple with relevant tasks in terms of available resources and expected risks. **Jelen's Cost and Optimization Engineering** text defines risk as "a measure of reaction to uncertainty" [1].

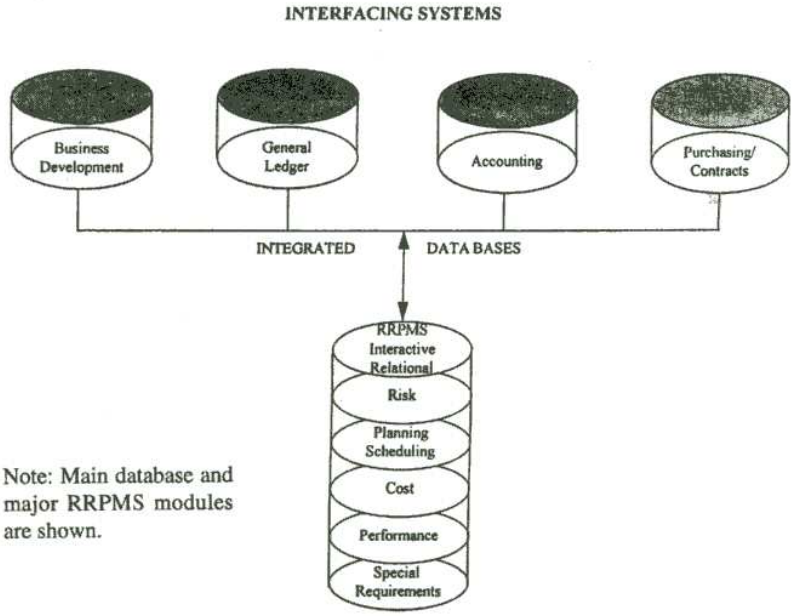
Even during ideal conditions, large construction projects are complex, involving considerable risk(s) to the sponsor/owner. One can well imagine the challenges the project manager encounters today in achieving his/her goals. Hence, the significance of the risk performance measuring system (RRPMS) proposed here: it ensures comprehensive success in managing large projects; however, smaller versions can be used in managing medium or small projects.

The system as identified here (see figure 1) provides timely, accurate, and rationally structured information/data concerning the aspects of cost, schedule, and performance of a project. This enables the formulation of timely decisions necessary for the effective use of resources. It resolves problems and reduces the risks.

The RRPM system emerged out of the author's experience working with Fortune 100 companies. In the late 1980s, the author was involved in development of a new system and US nationwide survey evaluating several project management application software packages. He found that the existing systems, both manual and computer-based, conceived by the project managers to manage and control projects, are inadequate (figure 2) to meet the challenging business requirements that are evident today and are likely to be more challenging in future.

To cite an instance, users reported that whenever management requests data on a specific project, a mad struggle is initiated to obtain the data. The functional groups of the organization do not have access to data on specified time limits; similarly, the report formats and data integrity are poor; also, cash flow projections, trend analyses, and alert reports are not available. Above all, schedule details, critical path analysis, and performance measurements, both actual and envisaged, are lacking.

Those factors put the project managers in a situation where they do not know whether their projects are on time, within budget, and cost effective. Consequently, timely and effective management decisions are disallowed. The basic question of getting a reasonably adequate return for investment is thus insistently raised.



Note: Main database and major RRPMS modules are shown.

Figure 1—Risk Reduction Performance Measuring System

With this situation in view, this paper describes a system—RRPMS—that when correctly developed and implemented has potential benefits. The benefits to be derived from the proper use of RRPMS can be translated to approximately 5% of the project costs through actively managing and controlling the projects.

RISKS IN CONSTRUCTION PROCESS

Different authors have given different meanings to the concept of risk. Risk has been regarded as uncertainty or chance of loss. It can be classified by different types and degrees. Also there are many methods of estimation and measurement of risk.

Generally, risks are inherent in most construction projects. Due to technological advances, most construction projects involve numerous participants and agencies in various roles. Overlapping responsibilities increase the risk exposure. However, some risk factors are unforeseen and unavoidable. On the other hand, there are many risk factors involved in the construction process that are oftentimes avoidable, such as poor communication, management controls, lack of preplanning, reduced productivity, inadequate performance measurements, inefficient material management, inaccurate information leading to costly managerial decisions, and schedule delays. Those factors will lead to change orders/claims, disputes, and suspensions/terminations of the contracts. Furthermore, the high cost involved in resolution of disputes and litigations may affect the performance of an organization.

The sponsor/owner can reduce these risk factors by using trained personnel to perform risk analysis, cost/schedule analysis, and performance measurements with RRPMS.

OBJECTIVES

The primary objective of RRPMS is to reduce the risk to the sponsor/owner. Some other objectives include

- integrating cost/schedule and performance measurements and other support functions such as accounting and purchasing;
- integrating functional organization structure with project work breakdown structure;
- providing effective communication channels among various functional groups and uniting all levels of management to efficiently accomplish the work;
- providing visibility on key decisions and timely feedback for all levels of management;
- providing a basis for measuring progress—planned verses actual;
- prioritizing and making efficient use of resources; and
- providing a basis for the pricing of services.

However, more specific objectives can be developed based on the business needs of an organization.

ORGANIZATION

The system development projects are complex, often crossing organizational boundaries and drastically affecting and changing the operations of an organization. Since development and implementation of RRPMS is not an easy task and requires tremendous effort and resources, it is recommended that a separate task force be formed to plan and execute the program. For the reasons discussed above, the appropriate placement of an RRPMS task force within the corporate structure is crucial for the development and implementation of the system. To get cooperation from various levels of organization and for timely and successful execution of the project, it is important to show users

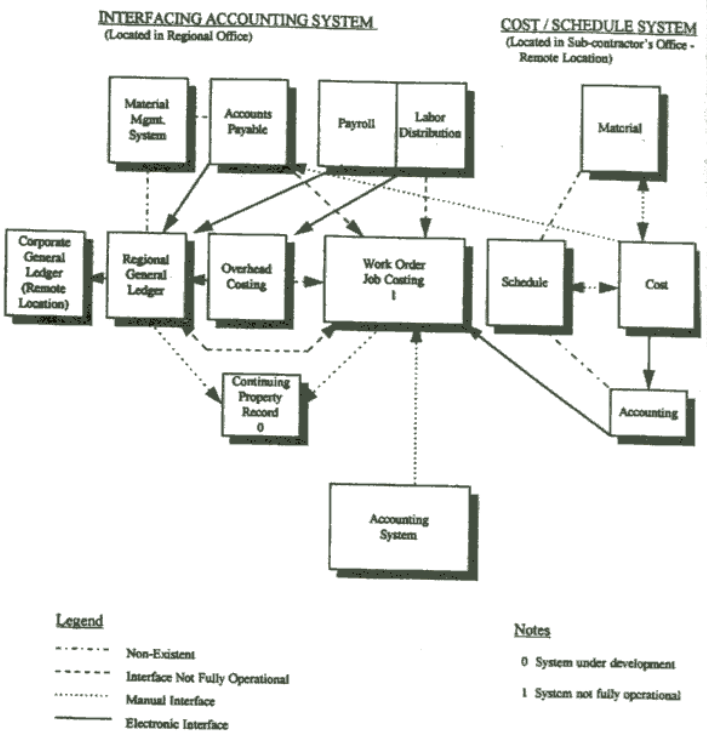


Figure 2—Interfacing Systems for RRPMS Based on Author's Survey
(inadequate to meet business requirements)

that the program has top management support. Five organizational alternatives are shown in the figure 3.

PROJECT APPROACH

The system developmental process is very extensive, and each activity consists of several steps. However, this paper covers some of the important aspects for the development of an RRPMS. The process discussed here may not apply to every situation, as it varies with size and complexity of the project. The project approach consists of the following major components: feasibility study, user requirements, design and implementation, testing, documentation, and training. All these components are interrelated and are important for the success of an RRPMS. The process must begin after completion of a feasibility study and management approval and commitment to the program.

Feasibility Study

The feasibility study is conducted to determine the technical and economical aspects of the project and provide management with a basis for whether or not to proceed with the project. The feasibility study must include activities such as a detailed work plan, and an analysis of current system(s), operations and associated costs, organizational functions and relationships, users, procedures, documentation flow, inputs, outputs, and difficulties. The study should also discuss proposed system(s) and their benefits.

User Requirements

The user requirements constitute a vital and difficult phase of the system developmental process. This phase includes activities such as functional and information requirements, new system work flow diagrams, interfaces, and organizational responsibilities. To accomplish

these activities, a team is formed composed of business analysts, system analysts, programmers, and a project manager as a full-time task force. The team also includes part-time members from various functional departments such as data processing, engineering, construction, finance, and administration.

Apart from technical knowledge, it is essential that the team should have knowledge of current processes and excellent interpersonal skills. The difficulties that may arise are mainly political and communication related, since the new system will be serving several conflicting interest groups. The communication problems are typical of any situation where people of different backgrounds and views are working together.

The team's priority objective during this phase is to conduct interviews with various departments within the organization to elicit specific information regarding project management systems, methods, and procedures.

The following actions are to be taken before the interview process is initiated:

- A letter describing briefly the project and introducing the project team should be written by the senior management of the organization to all the participants.
- A questionnaire in the form of a checklist should to be developed. The checklist should include questions pertaining to the department and its functions such as tasks, interfaces, problems, and suggestions for improvement. The questionnaire should be sent as an enclosure/appendix to the introductory letter.
- A project kick-off meeting should be scheduled.

During the interview the team should further investigate the following:

- current project management systems (hardware, software, input, output, and problems thereof);
- requirements for the new system;
- current information flow, including bottlenecks;
- requirements for new information flow;

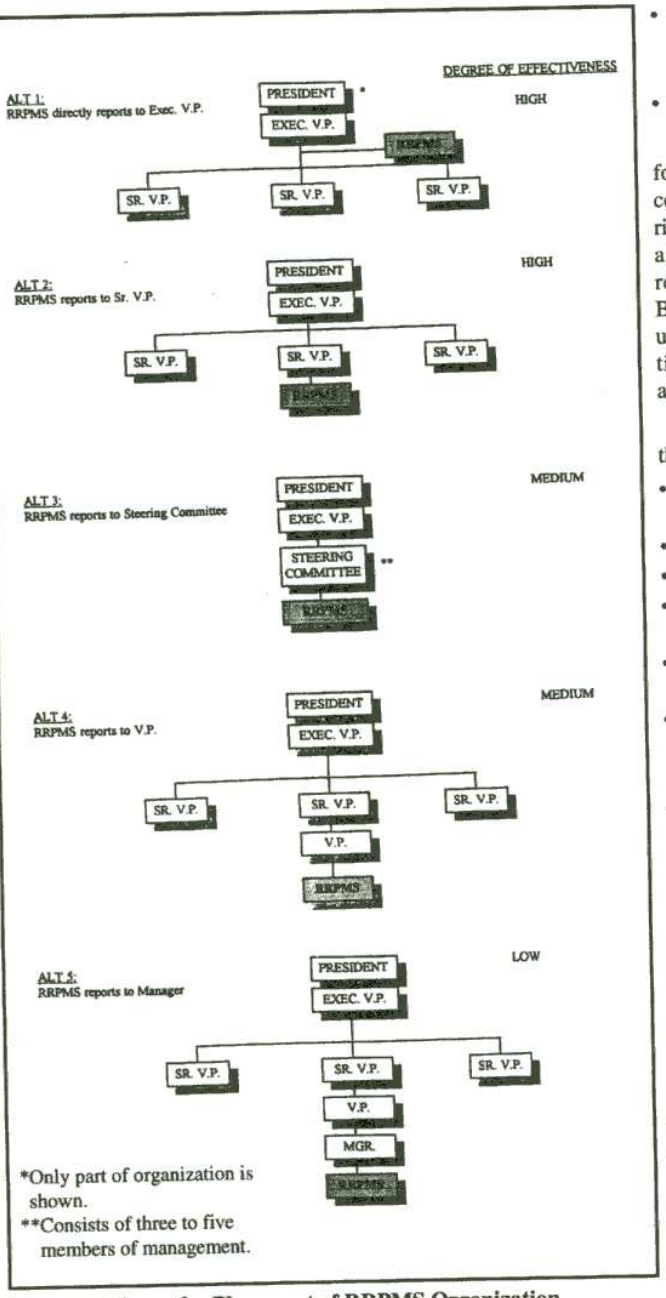


Figure 3—Placement of RRPMS Organization

- current operational methods, policies, procedures, and problems; and
- new operating requirements.

After collection of the above information, requirement analyses are conducted. The analyses are categorized in terms of technical and management areas. The common requirements are then prioritized. Based on a thorough analysis of user requirements, recommendations are made for system design and implementation.

The final analysis must include the following:

- critical path method (CPM) schedule;
- cost estimates;
- RRPMS organization;
- identification of major processes for the new system;
- a checklist of new system features;
- identification of new hardware, software systems, and network requirements; and
- identification of methods to utilize the current system (if possible) i.e., either by modifying or replacing.

The above-mentioned approach will facilitate in system design and implementation.

Design and Implementation

Once the user requirements are established, identifying system features and capabilities including methods and procedures for specific corporate environment, the project manager can initiate the system design and implementation phase by developing a conceptual design and specifications of the new system.

The design of the RRPMS includes information management—data storage and retrieval giving timely visibility and project controls—identifying deviations from plan for timely corrective action. Based on the software design approach, i.e., modification of the available off-the-shelf software or development of a new software, a plan of action must be developed. The potential system software and hardware packages should be obtained from the vendors to perform technical and user reviews. The software system includes a database management system (DBMS) for managing data on a logical bases, and project management application software packages. Some major application modules are described under a separate section of this paper, entitled RRPMS Elements.

Table 1 summarizes some of the features for evaluating a planning and scheduling system. Additional features, including comparisons of various systems, can be developed based on specific user needs.

Table 1—Sample Evaluation of Application Software

OBJECTIVE FEATURES	
DESCRIPTION	*COMMENTS*
Integrated cost and schedule	Not integrated
Integrated cost and material control	Not integrated
Target Scheduling	Yes
Resource Scheduling Time Constraint	Yes
Resource Scheduling Resource Constrained	Yes
Prioritize Activities	No
Interactive Graphics	No
Report Writer	Yes
SUBJECTIVE FEATURES	
DESCRIPTION	*COMMENTS*
Implementation Costs	Poor
System Useability	Good
Sorts and Selects	Good
Report Flexibility	Fair
Documentation	Poor

SUMMARY OF SYSTEM STRENGTHS AND LIMITATIONS

SYSTEM	*STRENGTHS*	*LIMITATIONS*
XYZ	Easy to use.	Allows no other applications

Recommendation: Does not meet organizational needs.

The implementation planning includes activities such as preparation of hardware and software installation plans, user training, and procedures. The installation and testing of hardware and software systems should be done according to the vendor specification. Integration of software packages will be accomplished by the use of a database management system.

Implementation can be achieved by various methods. Depending on the operating environment, one method is to continue with the current system until the new system is installed and accepted. Sometimes the effort involved in keeping the current system running until the new system is implemented interferes with the developmental process of the new system.

After termination of the current system and installation of the new system, the system performance and efficiency must be reviewed to comply with the acceptance criteria. The team should conduct post-implementation user interviews to measure operating efficiency and make necessary adjustments.

System Test

The system validation test must be conducted based on a previously developed test plan. The test should include all the aspects of system operation designed to meet the established requirements.

Documentation and Training

Proper procedures, documentation, and training, including cost analysis, are vital for the successful operation and maintenance of any system. Documentation and training should start early in the developmental phase. Documentation should include all the aspects of the hardware and software so that all concerned can use the system.

For effective utilization of the system, it is important to have a clear understanding of the system, as well as good training programs. Various training programs such as seminars, workshops, and vendor / manufacturer training programs must be implemented. The training must include all the levels of the organization, making sure that the system capabilities are fully utilized.

No matter how difficult the development and implementation of an RRPMS may be, if it serves the users and meets the business requirements of an organization, then the benefits will outweigh the costs and difficulties.

RRPMS ELEMENTS

Some of the most important modules of RRPMS such as risk, planning/scheduling, cost, and performance are described below:

1. *Risk*—Risk can be reduced by thorough planning and analysis with computer simulations. The risk module interfaces with other functions, namely planning/scheduling and utilizes powerful tools such as Monte Carlo simulation to quantify the level of risk. This provides management with greater visibility on critical items and proactive control.
2. *Planning and scheduling*—The planning and scheduling module provides a mechanism to achieve and maintain schedule control. It interfaces with functions such as engineering, procurement, and construction. Generally, the module uses network analysis programs for critical path method (CPM) scheduling, using the precedence diagram method. The CPM schedule acts as an excellent communication tool, giving graphical representation of integrated engineering, procurement, and construction activities. The information generated by the CPM schedule provides management with workhour and production rate levels, float, logic interrelationships, interdisciplinary restraints, critical activities, and other useful data.
3. *Cost*—The cost module interfaces with functions such as accounting, planning/scheduling, and risk and provides a mechanism to achieve financial control of a project. This is accomplished by analyzing and monitoring actual costs verses budget costs; forecasting—by assessing probabilities, uncertainties, and inflation; and by trending—using historical data and techniques such as regression analysis to predict cost/schedule trends.
4. *Performance*—The performance module interfaces with all essential functions and provides the status of each project activity in a meaningful fashion. Project performance can be quantitatively measured at any given point by performance measurement techniques. The method is based on work breakdown structure and accumulation of accurate cost/schedule data. The cost/schedule variances will alert management to implement corrective actions.

Following are some outputs for the above discussed modules:

- risk analysis models;
- progress and performance curves/graphs;
- schedule networks/barcharts: master, management, project control and look ahead schedules;
- schedule analysis report: critical activities, activities ahead of schedule, activities behind schedule;
- critical action item report;
- schedule variance report;
- cost estimates;
- project cost report;

- commitment report;
- cost variance report;
- exception report;
- trend report;
- integrated cost/schedule report;
- productivity report;
- progress analysis report (performance indices);
- materials and equipment report; and
- subcontract report.

The above outputs will highlight risks and performance before the fact, giving management a "big picture" of the project for timely corrective action.

The most important elements of the RRPMS, which are key determinant for risk reduction and performance measurements, are shown in figure 4. Specialized elements can be developed based on specific needs of an organization.

- includes retrieval, manipulation, and analysis of data associated with the project in an easy and simple fashion;
- includes coding in an efficient, widely used industry language;
- has immediate multiple-user access as well as response processing; and
- is a good documentation, training, and maintenance facility.

PROJECT SCHEDULE

The project schedule will depend largely on the size and complexity of the project as well as the programming approach and hardware configuration. The scope of work may involve modification of available off-the-shelf software packages oriented to the specific needs of an organization. Or, alternatively, it could be development of a new software package and, finally, selection of a hardware system, i.e., mainframe, mini, micro, or an effective combination of one or more hardware systems. The various phases for a medium-size project could be identified as :

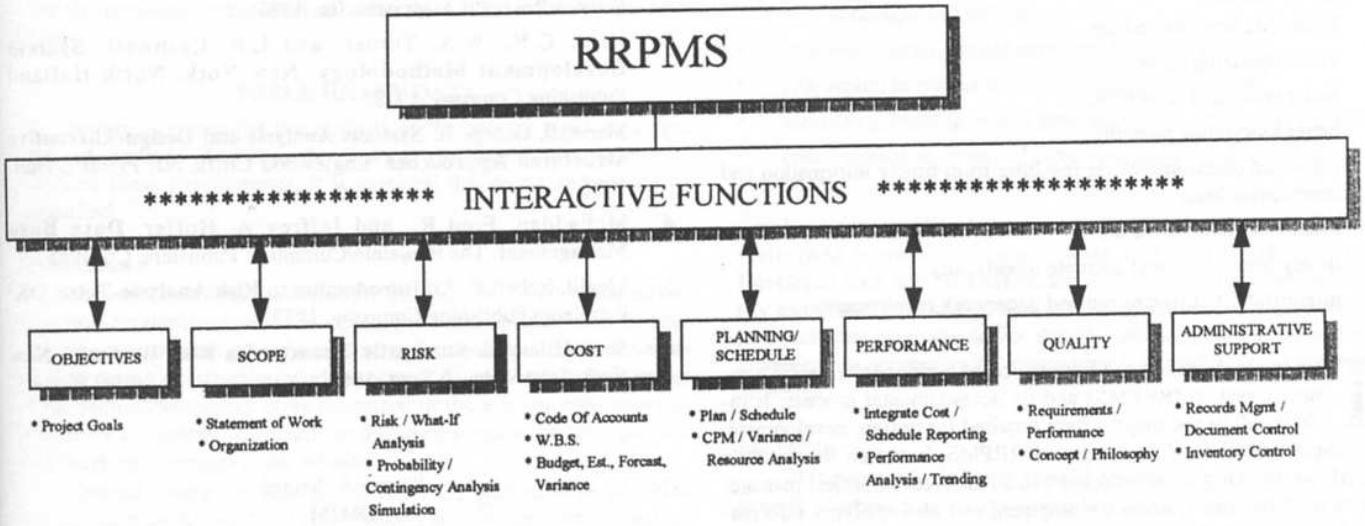


Figure 4—Risk Reduction Performance Measuring System Elements

GENERAL FEATURES OF RRPMS

Following are some general features of the RRPMS. More specific features of the system can be developed based on such items as scope/data boundaries, operating environment, and user requirements. The RRPMS

- is suitable for the unique requirements of an organization;
- is an online, state-of-the-art relational database system with an ability to integrate information, thereby linking all functional groups;
- includes project management application modules such as risk, planning/scheduling, cost, and performance must be powerful enough so that the project manager can make effective and timely decisions;
- is reliable and cost effective;
- is a flexible operating system requirements;
- is an efficient security system to rigorously control and maintain the data integrity and confidential information of an organization;

Phase 1: Feasibility Study—Provides a basis to undertake development (4 months).

Phase 2: Requirement Analysis—Determines user requirements (5 months).

Phase 3: Design and Implementation—Includes design and implementation of the system modules in phases, based on user requirements (12 months).

Phase 4: System Test—Provides validation tests including all the aspects of operations (3 months).

Documentation and training are ongoing activities starting early in phase 3. The total duration of the project is 24 months (including overlapping activities).

This project schedule with its phased approach is based on the author's hands-on experience with actual projects and has two basic assumptions:

1. modification of available off-the-shelf software, and
2. hardware configuration of microcomputer networking.

COST BENEFITS

Various project management surveys conducted by the author indicate some of the following tangible and intangible benefits achieved by the proper use of a state-of-the-art RRPMS.

Tangible Benefits

Tangible benefits include

- about 3% reduction in project execution time due to schedule control;
- about 1% improvement in labor productivity due to resource levelling;
- about 0.5% improvement in purchase prices (assuming 50% of the project costs are material related); and
- about 0.5% improvement in budget accuracy.

Potential cost benefits are about 5% of the project costs (in some cases, they may exceed 5%).

Intangible Benefits

Intangible benefits include

- lower operating costs;
- better control of resources;
- better long-range planning;
- improved decision-making resulting from timely information and communications;
- improved quality control;
- timely, consistent, and accurate reports; and
- minimization of procedural and paperwork requirements.

This paper discusses the importance of a risk performance measuring system (RRPMS) and its developmental process. It includes all of the major topics required for design, development, and implementation of an integrated RRPMS, based on the author's experience working for several years in all the areas of project management, controls, and systems development and also applying information from various sources.

It is difficult to highlight all the problems, solutions, and alternatives encountered by project managers during development and implementation of RRPMS, since problems vary by the size and complexity of the project. However, this paper provides some guidelines for developing an effective RRPMS. An RRPMS should be designed to meet the specific project management needs within a specific organizational environment.

To survive in the present economic conditions, it is vital to have a disciplined approach for planning, organizing, coordinating, budgeting, managing, and controlling projects consistent with the long-term market strategy of corporate management of an organization. To achieve this objective an integrated RRPMS must be developed. Due to continued global recession, the need for a risk performance measuring system (RRPMS) increases all the more.

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