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Balanced scorecard for performance evaluation of R&D organization: A conceptual model

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Research and Development has been recognized as most important for future competitiveness to survive in this competitive and highly turbulent environment. A huge amount of money and other resources are being deployed in R&D by government as well as private organizations. A major consideration is required on performance improvement that needs to continuously evaluate the performance of R&D in line with vision and strategy of the organization. This paper deals with evaluating the performance of R&D organizations from four perspectives (financial, customers', innovative and learning, and internal business processes) using the balanced scorecard technique.

Keywords: Balanced scorecard, Performance measurement, R&D organizations

Introduction

In spite of high costs and an increasing importance of R&D for future competitiveness, many companies and government institutions struggle to shape well their R&D function and find it difficult to assess its contribution to the organization[1]. Every R&D organization needs to focus on continuous improvement in its performance that requires evaluating the performance for tracking the exact position and getting the feedback to know the gaps to improve. In competitive market, success of R&D does not only depend upon how much resources one has employed but also depends highly on the sharp vision, mission and strategy of an organization. Performance measurement (PM) in R&D is difficult and complex as the effort levels may not be observable, high uncertainty in success, influenced by uncontrollable factors, and long gestation period. R&D has a larger extent of problems with PM (Table 1) than manufacturing and services.

Performance of an R&D organization must be in line with its vision, strategy and goals, which needs to be clearly defined and communicated at all levels of the organization and all efforts and actions be focused on achieving them followed by continuous PM. R&D PM has four main functions[1] as alignment and prioritization: i) Cascading measures from strategy; ii) Evaluation and incentives; iii) Operational control; and iv) Learning and improvement. The measures must be matched to different research profiles: basic versus applied, short verses long term, developed versus undeveloped area of research, routine support services versus breakthrough ideas and knowledge development.

Generally, organizations use financial indicators for PM. These indicators only emphasize operational results and not the processes, lack forecasting function and does not explain the cause-effect of operational results. Using only financial performance indicators may be easy, simple and cost-effective, but management may focus too much on the short-term financial effects and turn down the projects that bring long-term profits to the company[2]. A performance assessment system should integrate both financial and non-financial indicators, assess both operational results and processes, and measure organizational performance from top to bottom[3]. A strategy-oriented performance assessment can help management to evaluate business managerial system, operation process, operation system, management processes, and the complexity of the processes. Performance assessment system can provide management with on-time information about whether the business operation is on the right track or not[4]. A proper performance assessment[5] system should possess long term and short term focus, operational and strategic aspects in

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Table 1— Difference among manufacturing, service and R&D performance evaluation

Factors	Manufacturing	Services	R&D
Orientation	Fully business oriented (So performance measures are mostly objective)	Fully business oriented either given with product or without product (measures are both objective and subjective but easy to measure)	Partially business oriented and partially oriented with development objectives (Human development, Nation's priority not for business but for human development). Here, some measures are objective (needs to be measured subjectively) and others purely subjective.
Cash cycle	Short cash cycle (Fair idea about the returns)	Very short cash cycle (Fair idea about the returns)	No definite cash cycle time known. No definite idea about the returns
Risk	Calculated risk regarding sales, demand forecast, wastage and work stoppage etc	Calculated risk of not meeting the expectations of the customers	Unlimited risk of technical and market feasibility
Time Horizon	A short period (1-2) years external environment is focused upon	Current or present situation is focused, on the spot environment is considered	More than or beyond 10 years, what would be the environment is anticipated and focused
Process	All processes are standard and can be done by machines	Process is partially standard and partially customized as per the situational requirement. Partially by human beings and machines to understand the current requirements	No process is standard. All by human beings. Human resource is the key thing. Creativity and potential differ from person to person
Resources	Quantity and type requirement of resources is known	Quantity and type requirement of resources is known in advance	Quantity and type of resources to be required is not known in advance
Customer Requirement	Attributes of the product are fully known by the customer, which is to be manufactured and are the standard one	Customer knows attributes of the services to be given prior	Customer does not know up to what extent and what type of attributes will be provided to him. The outcome is not known
Results	Output in terms of market share, volume of sales, profit, increase in sales and customer's response for the product quality is important in manufacturing	Output in terms of customer's satisfaction in terms of service quality is important	In case of R&D, outcome is more important than the output i.e. the effectiveness of the output in terms of further social developments and value creation in the society

terms of the construct, and local and macro integration in terms of assessment span. Performance must be measured from the four perspectives[6] as: i) Customer's; ii) Financial; iii) Organizational learning and growth and iv) Internal business processes perspective.

There are certain other difficulties in defining the output of R&D as: 1) R&D organization output[7,8] measures can be subjective or objective, discrete or scalar, and quantitative and non-quantitative and there can also be qualitative aspects associated with them; 2) Relationship[8] of output measures to organizational goals must be included; 3) Different organizations (governmental, commercial, and educational) will weigh the different criteria differently[7,8]; 4) Getting the clarification and deciding the specific criteria to determine the attainment by the individual or the organization takes time and is too complex[8,9]; 5) Different criteria should be measured and weighted fairly and objectively[7] 6) R&D PM tends to vary with the character of work[10]; 7) Different R&D projects have different objectives to accomplish and take varying time, skills and other resources; 8) Different R&D projects have different risk associated with them and different technological complexities and uncertainties[1]; 9) Some R&D organizations might include local (national) operations but some might include international operations also; 10) Some R&D organizations might be working on radical innovations but some might be doing incremental innovations; 11) Sometimes number of patents or number of new products formed cannot be the sole criteria for judging the performance but also skills formation or technical capability formation can be the criteria; 12) Sometimes the market conditions, government regulations and political factors might not be favorable towards a particular technology at a particular time but might be in demand later on in

Table 2 — Issues to be considered when designing a performance measurement system.

Issues	Explanation	References
Individual measures	Measures should be clearly defined/easy to understand.	12, 13
	Measure should be purposeful	14
	Measures should be practical. They should have the appropriate scale	15
	Measures should form part of the control loop	16
	Measure should be failsafe/self checking	12, 17
	Measure should be cost effective	12, 17
Performance measurement system	Performance measures should be integrated over both the function and hierarchy	18
	System should provide data for monitoring past and planning future performance	19
	Measurement system should provide a balanced picture of the business	6
	Measurement system should show how results are a function of determinates	20
	Measurement system should not contain any measures, which conflict with one another	21
	Performance measurement system should reinforce the firm's strategies	14, 22
Performance measurement system and environment	Performance measurement system should match the firm's culture	23
	Performance measurement system should match the existing reward systems	23
	Performance measurement system should provide data for external comparison	17

Table 3 — The balanced scorecard as a strategic control framework[6]

Sr No	Characteristics	Comments
1	Clarifying and translating the vision and strategy	Clarifying the vision Gaining consensus
2	Communicating and linking	Communicating and educating Setting goals and decomposing Linking rewards to performance measures
3	Planning and target setting	Setting targets Aligning strategic initiatives Allocating resources Establishing milestones
4	Strategic feedback and learning	Articulating the shared vision Supplying strategic feedback Facilitating strategy review and learning

future; and 13) It is difficult to describe the quality of scientific manpower.

A good performance assessment system should provide forecasting function. Neely *et al*[11] have given the issues to be considered while designing PM system (Table 2). In this paper, balanced scorecard has been used to design the performance evaluation of R&D organizations.

Balanced Scorecard (BS)

Balanced scorecard[6] is a strategic measurement system including both non-financial and financial measures adopted by academic scholars and practitioners to measure the performance of a business organization (Table 3). It is distinct from other strategic measurement systems in that it is more than collection of financial and non-financial measures. It contains outcome measures and the performance drivers of outcomes, linked together in cause-and-effect relationships and thus aims to be a feed-forward control system. Furthermore, BS is intended not only as a strategic measurement system but also as a strategic control system, which can align departmental and personal goals to overall strategy[6]. BS translates the vision and strategy of a business unit into objectives and measures in the financial, customer, internal-business-process and learning and growth perspectives. The crux of BS[24] is the linking together

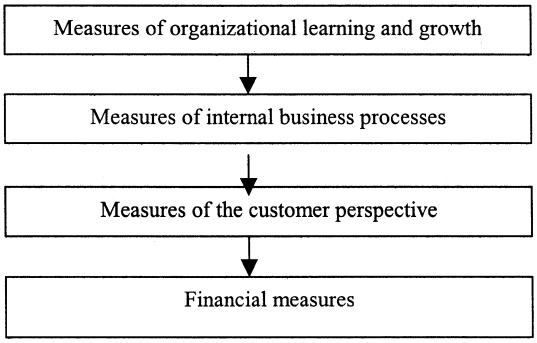

Fig. 1 — Causal relationship of the four perspectives

of the measures of four areas in a causal chain, which passes through all four perspectives (Fig. 1).

Measures of organizational learning and growth are drivers of the measures of internal business processes. Measures of these processes are in turn the drivers of measures of customer perspective, while these measures are the drivers of measures of the customer perspective, while these measures are the drivers of the financial measures. A good BS should have a mix of outcome measures (lag indicators) and performance drivers (lead indicators). BS has following strengths: i) It Integrates both financial and non-financial indicators, assess both operational results and processes, and measures organizational performance from top to bottom; ii) It not only records operational results but also explains the cause-effect of operational results, and forecasts possible future; iii) Scorecard translates vision and strategy of a business unit into objectives and measures of four areas (Fig. 2); and iv) It is simple to use.

Balanced Scorecard applied to R&D

(i) Customer Perspective

The output of an R&D organization is generally in the form of new knowledge, product, process or technology or in the form of a solution to a particular problem. For these outputs, organizations may have either internal or external customers or both. Internal customers are their parent business units and the external customers can be end users, industrial customers or the society. It depends upon the scope and target of the R&D organization, which they are targeting. But there is no meaning of investing in R&D unless it is useful for the society whether in terms of new knowledge, product or technology. It must give some value to the society who acts as the customers of the output of R&D. Performance must be measured from the customer's perspectives (Table 4) with following objectives: i) Match the needs of the customers; ii) Create the demand for a new product/process/technology; iii) Provide value to the customer; iv) Improve customer satisfaction; and v) Improve product quality and features.

(ii) Internal Business Perspective

Internal-business-process perspective describes the business processes at which the company has to be particularly adept in order to satisfy its shareholders and customers[6]. The objectives from internal business perspective may be (Table 5): i) Persist in project's schedule and shorten lead times; ii) Improve cost effectiveness in a product supply chain; iii) Identify different requirements of the supply chain, e.g. produceability of a product; iv) Efficient in resource utilization; and v) Extend and intensify co-work done in R&D.

(iii) Innovation and Learning Perspective

Organizational learning and growth perspective involves changes and improvements, which the company needs to realize if it is to make its vision come true[24]. Continuous innovation and learning is the key to success of R&D. Objectives from innovation and learning perspective (Table 6) are: i) Innovate; ii) Improve company's or product's competitiveness; iii) Extend and intensify co-work done in R&D; iv) Increase knowledge and learning; and v) Improve manufacturing process.

(iv) Financial Perspective

Financial perspective identifies how company wishes to be viewed by its shareholders[24]. R&D organizations cannot continue to survive without generating profits and funds for R&D. Objectives of an R&D organization from financial perspective (Table 7) are: i) Improve cost effectiveness of R&D; ii) Influence company's or product's sales; iii) Maximize shareholders wealth; iv) Source funds for R&D; v) Avail funds in time; vi) Minimize cost of capital; vii) Generate internal funds for R&D; viii) Run supporting business for R&D; ix) Arrange funds from external sources from government or customers; x) Improve returns; and xi) Continuous flow of funds. Different R&D organizations have different objectives and strategies. Appropriate PM parameters depend upon objectives of the specific organization. Therefore, BS can be designed for an individual R&D organization depending upon its vision and strategy.

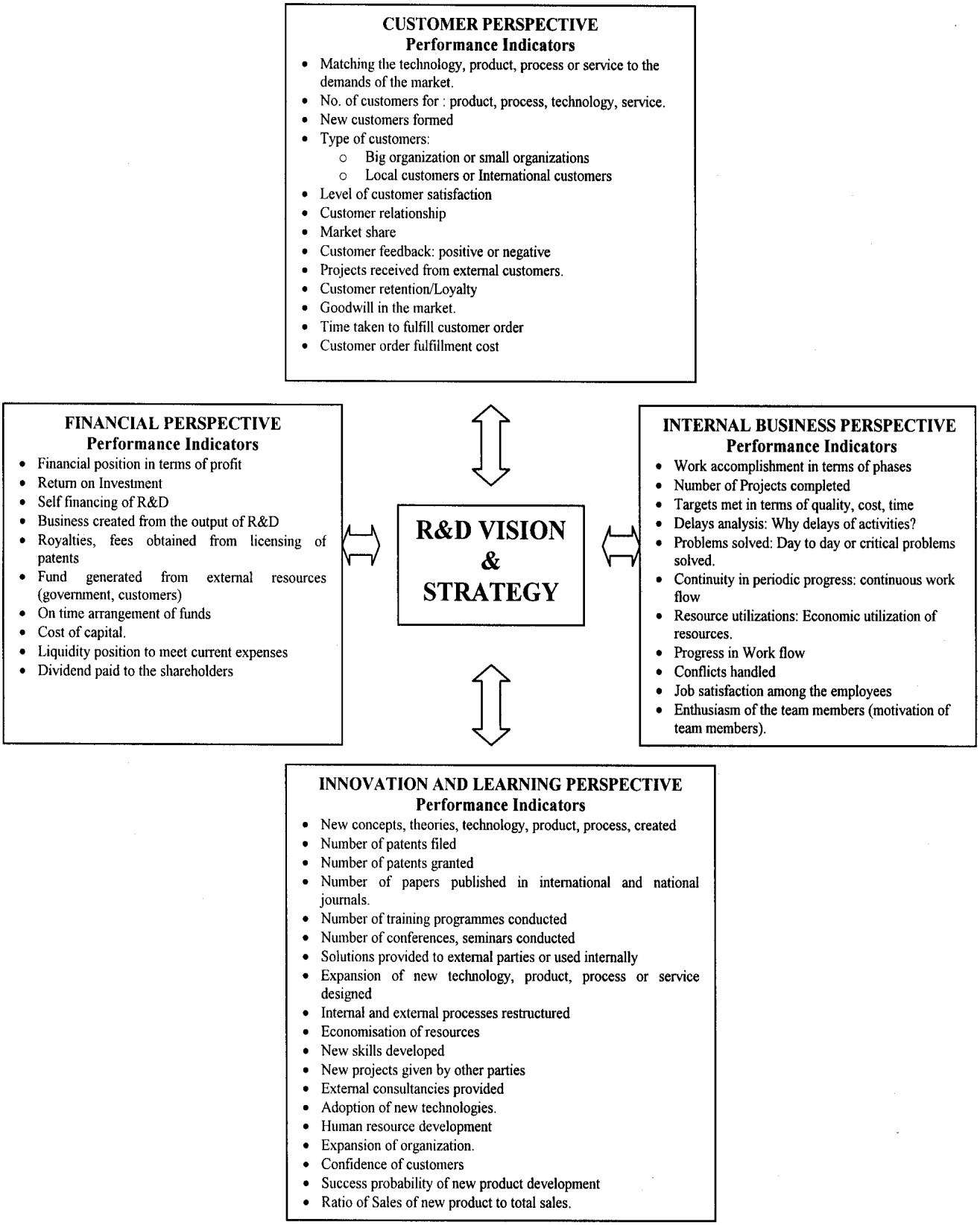

Fig. 2 — Balanced Scorecard framework for R&D Organizations

Table 4 — Scorecard from customers' perspective

Scope of activities of R&D organization pertaining to customers	How the customer perceives?	Key areas to be focused	Performance evaluation indicators
• Knowing who are it's customers. • Understanding the customers needs • Creating the needs for it's outputs in the market: technology, product, service. • Educating the customers. • Providing the required features, attributes in minimum cost and maximum quality. • Creating advanced technologies. • Finding solutions to certain problems.	• Trust the capabilities, skills • Loyalty • Goodwill in the market • Reliability • Flexibility • Commitment • Strong fundamentals • Reasoning of scientific concepts • Environmental concern • Safety concern	• Excellent R&D-market interface. • Skills and expertise development. • Identification of market. • Knowledge of external environment: Market, Competitors, and government regulations. • Building relationship with the customers. • Making the presence in the market. • Participation in trade fairs, conferences etc.	• Matching the technology, product, process or service to the demands of the market • No. of customers for : product, process, technology, service • New customers formed • Type of customers • Big organization or small organizations • Local customers or International customers • Level of customer satisfaction • Customer relationship • Market share • Customer feedback: positive or negative • Projects received from external customers • Customer retention/Loyalty • Goodwill in the market

Table 5 — Scorecard from internal business processes perspective.

Scope of activities of R&D organization pertaining to internal business	How should internal business be perceived?	Key areas to be focused	Performance Indicators
• Project Selection • Planning • Organizing • Staffing • Delegation • Directing • Controlling • Communication • Decision making • Problem solving	• Smooth flow of information • No delays in work accomplishment • No disputes	• Synergy formulation • Perfect coordination • Timely communication • Team building • Leadership • Optimum resource utilization • Right Skills available • Continuous development through training • Open discussions, seminars • Culture aligned with R&D • Commitment of team members • Dedication to the work • Motivation of whole organization • Availing required resources in time.	• Work accomplishment in terms of phases • Number of projects completed • Targets met in terms of quality, cost, time • Delays analysis: Why delays of activities? • Problems solved: Day to day or critical problems solved. • Continuity in periodic progress: continuous work flow • Resource utilizations: Economic utilization of resources. • Progress in Work flow • Conflicts handled • Job satisfaction among the employees • Enthusiasm of the team members (motivation of team members).

Conclusions

PM system of R&D organization should be aligned with its vision, strategy and goals to know exactly it wants to be, where it is and what it should be and the performance should be measured from different perspectives. BS helps to measure performance of an organization in line with its vision, strategy and goals. BS technique can be used to measure the performance of R&D organizations from the four perspectives as customer, innovative and

Table 6 — Scorecard from innovation and learning perspective.

Scope of activities of R&D organization pertaining innovation and learning	How innovation and learning be Perceived?	Key areas to be focused	Performance Indicators
• Finding internal weaknesses • Finding areas for improvements • Finding new opportunities	• Leadership position in creating innovating new products, processes and technology • Highly competent in skills • Solution provider • Every time updated in knowledge, skills and expertise	• Broader vision • Attitude towards innovation • Ideas generation • How seriously an idea is looked • Optimistic approach • Promptness to change • Maximum exposure to outer world • Enhancing creativity through training and mentoring • Supporting ideas of people • Freedom to express • Informal hierarchy • Interlinking different disciplinary knowledge • Information and knowledge networking	• New concepts, theories, technology, product, process, created • Number of patents filed • Number of patents granted • Number of papers published in international and national journals. • Number of training programmes conducted • Number of conferences, seminars conducted • Solutions provided to external parties or used internally • Expansion of new technology, product, process or service designed • Internal and external processes restructured • Economization of resources • New skills developed • New projects given by other parties • External consultancies provided • Adoption of new technologies. • Human resource development • Expansion of organization. • Confidence of customers

Table 7 — Scorecard from financial perspective

Scope of activities of R&D organization pertaining innovation and learning	How financial position be perceived?	Key areas to be focused	Performance Indicators
• Business creation • Funds requirement • Sources of funds	• Adequate profits • Self sustaining • Adequate liquid position • Good will in market	• Focus on key areas of business • Availability of supporting business • Good Liaisons with the customers • Good liaisons with the government funding agencies • Accountability of fund utilization	• Financial position in terms of profit • Return on Investment • Self financing of R&D • Business created from the output of R&D • Royalties, fees obtained from licensing of patents

learning, internal business processes and financial perspective, which focus on achieving the R&D vision and strategy. This technique also provides feedback and initiatives to be taken to achieve the desired performance level. A BS can be designed for an individual R&D organization, private or government, to capture its performance from four perspectives in line with one's vision, strategy and goals.

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