

Development of R&D Project Management Model in Indian Construction Industry

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Abstract - One of the most difficult tasks in any organization is the management of R&D activities. These R&D activities are usually headed up by scientists, engineers, managers, employees, and even executives. All of these people, at one time or another, may act as R&D project managers. They start out with an idea and are asked to lay out a detailed schedule, cost summary, set of specifications and resource requirements such that the idea can become a reality. Unfortunately, this is easier said than done.

Project management is an attempt to obtain more efficient utilization of resources within an organization by getting work to flow horizontally as well as vertically. Furthermore, all projects must be completed within the constraints of time, cost and performance. If the project is for an outside customer, then there exists a fourth constraint, within good customer relations. Without proper training and understanding, R&D project managers might easily manage their projects within time, cost and performance, but alienate the outside customer to such a degree that follow-on (or production-type) contracts are non-existent.

R&D personnel were probably the first true project managers in the world. Unfortunately, very little training was available until the "vanguard" of modern project management occurred in the late fifties within aerospace, defense and construction companies. Even today, twenty-five years later, very little project management training is provided for R&D personnel.

Key Words: R & D Management, Project Management, Architecture Engineering and Construction (AEC), Construction Industry.

1. INTRODUCTION

R&D management as a research topic is relevant for the countries where strong industry has built its success on R&D for years and represents prominent R&D outputs suitable for further use, for instance – UK, Italy, New Zealand, China, and Sweden. One of the most difficult tasks in any organization is the management of R&D activities. They start out with an idea and are asked to lay out a detailed schedule, cost summary, set of specifications and resource requirements such that the idea can become a reality. Unfortunately, this is easier said than done.

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2. BACKGROUND OF R&D MANAGEMENT

2.1 R&D: The main concept

Research and development is an ability to conduct different type of research and use created knowledge for product and technology development. Therefore, pure research and innovative activities together with rational use of costs and optimization of products is abbreviated as R&D. List of activities that could be attributed to R&D:

- Basic/applied research;
- Ability to maintain state-of-the-art knowledge; • Technical forecasting ability;
- Well-equipped laboratories;
- Proprietary technical knowledge;
- Innovative and creative environment;
- Offensive R&D capability;
- Defensive R&D capability;
- Ability to optimize cost with performance.

2.2 EVOLUTION OF R&D MANAGEMENT

During the last century, R&D management as an innovation stimulator has passed the evolution of 5 generations, characterised by simultaneous progress of handling R&D activities [1], [2].

Every new generation adds an extra managerial task to the list of manager duties. The first generation of R&D management was expressed by corporate lab creation. The second generation emerged when R&D was incorporated into the entire business system. The third generation is represented by R&D project management and portfolio management. The fourth generation put suppliers and customers on the R&D management scene, while the next generation consists of a network of innovation actors and stakeholders. R&D management derives from knowledge management. While being responsible for the creation of new materials, processes and technologies, R&D seeks to respond to societal and market needs, when the society and the market shape the trend of R&D. Therefore, knowledge about society's expectations as to the new R&D products shapes R&D (the concept of product or process design). In the chain of knowledge management, R&D has a role of primary source of knowledge, so that R&D management and knowledge management concepts have the same origin. R&D management has survived different practices and developed management principles that evolved over time.

From the review of the scientific literature two competing explanations of R&D generations could be found. Roussel [3] have recognised three R&D management generations according to the recognition of R&D strategies, organisational forms, financial criteria, mechanisms of accountability.

The third generation	1990-	Holistic approach Partnership Market oriented Project management to R&D Target oriented evaluation and assessment
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Table 1. R&D management classification according to Roussel (1991)

Subsequently, Rothwell [4] proposed a typology of five generations of R&D management. He focused his research on technological innovation in start-up companies and proposed five generations of innovation and provided R&D management generational classification from the 1950s onwards. He found that each new generation was a response to a significant change in the market.

Generation	Period	Characteristics
First Generation	1950-1960	Technology development Linear model of innovation
Second Generation	End of sixties	Primacy of needs Market-oriented innovations
Third Generation	1970-1980	Synergetic model Chain Linked Model
Fourth Generation	1980-1990	Integrated model Horizontal and competed innovation
Fifth Generation	1990-	System and networking models innovation process

Table 2. R&D management classification according to Rothwell (1994)

Generation	Period	Characteristics
The first generation	1950-1960	Independent strategy of R&D Independent scientific laboratories R&D activities Real organisations
The second generation	1970-1980	Partly strategic competitive environment Needs-oriented R&D and risk-sharing R&D budgeting. Differentiation of R&D activities Binary system of R&D management.

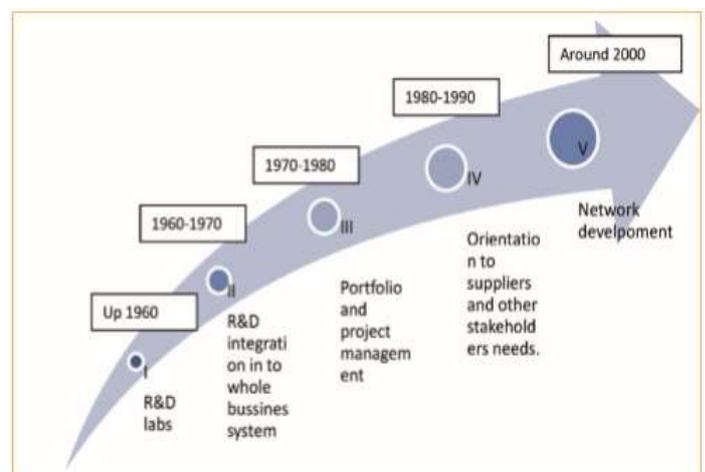


Figure 1: Evolution of R&D Management Generation

3. R&D PROJECT MANAGEMENT

When talking about a R&D project R&D specificities such as complexity, high uncertainty and high risk should be respected, some adoption of project management application could be applied or some approaches could be softened, however the main project characteristics need to be respected in full meaning. Time scheduling and strict compliance, keeping proper budget distribution or team mobilization are the key points that should be carefully planned and followed during project implementation.

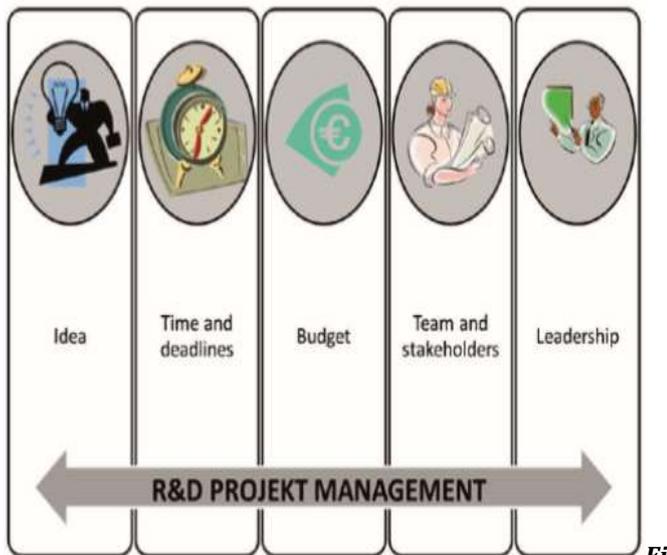


Figure 2: The Concept of R&D Project Management

Project management helps mobilize human efforts to accomplish activities at a certain point in time. Deviation between the scheduled project completion time and the actual finish date of activities occurs naturally and varies largely (see Figure 3). Such a situation could be damaging for interconnected processes, as the delay could break contracts, ruin confidence, postpone product elaboration for an unpredictable period of time and reduce productivity. Therefore, project management seeks for supportive measures, carry out activities at moderate speed and to avoid a situation whereby efforts needed to complete the project increase dramatically to an enormous level.

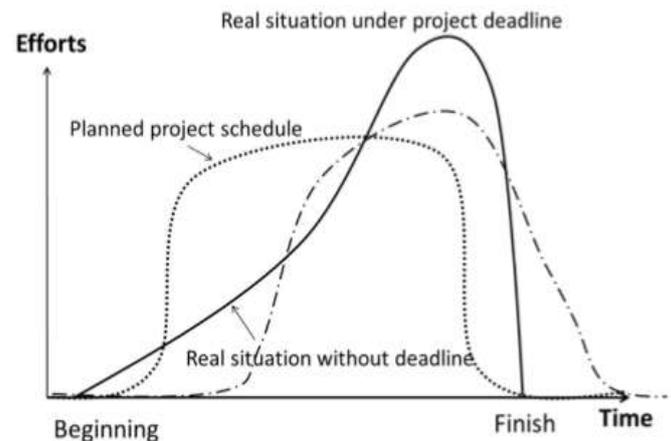


Figure 3: Efforts and time interdependency with & without Project

3.1 R&D PROJECT MODELS

Huchzermeier, A. and Loch, C. (2001) have proposed a model with five types of operational uncertainty that allow R&D managers to decide whether to continue, abandon, expand, contract, or switch the project from the planned stage. This model recognizes five possible variances of the project that has crucial impact on project performance. Those variances represent five sources of risk that R&D project could meet.

1. Market payoff variability. It is prices and sales forecasted. They depend on the external factors that are outside the project control: for instance, demographic changes, behavior of competitors etc.
2. Budget variability. The running project cost is hard to keep at planned level for R&D projects. Both the direction overspending and underspending could occur, however the direction of overspending is more common.
3. Performance variability. It corresponds to uncertainty of product development. Some technical aspects of technologies could be developed in multiple ways and which one will gain better performance is hard to predict.
4. Market requirement variability. Market requirements are almost unknown, especially at the beginning phase of the project and in the idea conceptualization phase.
5. Schedule Variability. Project performance impacts scheduling and the project could be completed earlier or later than planned in advance.

The flexibility of R&D management via controlling variances for the risky project management characteristics realize the instrument for a manager to obtain additional information to make decisions in a timely manner.

4. BENEFITS OF R&D PROJECT MANAGEMENT

In order to reach the best possible effect of applying project management technique to R&D activities, one needs to realize the benefits that can be obtained out of these efforts. First of all, project management approach manages to cope with R&D uncertainties via helping in objective setting. Planning techniques help manage time and resources and assist the team with:

- seeing the big picture
- Better understanding difficult tasks ahead and when they will happen
- putting first things first by prioritizing important tasks above less important tasks
- minimizing efforts on unfruitful side tracks
- staying focused on the objectives
- making better estimates of time and resource needs
- improving communication among key personnel
- seeing the need to look at alternative approaches or technologies
- making better decisions when dealing with trade-offs between time, performance and resource constraints [5].

5. R&D PROJECT SUCCESS CRITERIA

Summarizing the most commonly used criteria for project success evaluation, the following set of criteria can be listed:

- Organizational value:

How perfectly will results help company in R&D cooperation in the future? Whether any new idea has been created for the next R&D stage? If many partners took part in the project, added value for all organizations needs to be evaluated.

- Social value: Sooner or later, R&D output usually becomes a public good, social value for the city, region or country could thus be evaluated.

- Professional value: Renewing and regaining professional competence is as relevant as primary goal achievement of the project. The individual professional competencies of a researcher are equally valuable as research competence of the whole organization.

- Economic value: Economic value is the most widespread practice to evaluate project success, however it is rather complicated to measure it directly for a R&D project. Nevertheless, the supplementary economic value, such as

new jobs, economic growth or increase innovation capacity needs to be evaluated jointly.

In summary, project success could be evaluated from both project organization and societal perspectives. The main criteria applied for R&D project success is the added value to knowledge creation and systematization.

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