A RATIONAL APPROACH WITH MULTIPLE CRITERIA DECISION MAKING TO THE EXECUTION AND GOVERNANCE OF R&D PROJECTS

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ABSTRACT

Decision making on R&D projects influences the company success directly in such uncertain circumstances. Focusing on the corporate governance affects to expand the scope of work to the governance of intangible assets management. The direction of rational approach is characterized by increasing the transparency of the following items: business strategy, environmental situation by way of SWOT analysis, resource allocation, scope of work, time and budget constraints, and decision making under uncertainty with multiple criteria. The authors emphasize that the use of FTA and AHP with preparative work can contribute the increase of transparency and accumulation of knowledge. The increase of transparency in the project executions will expect to realize better status of project governance.

INTRODUCTION

It is always necessary to make efficient implement and control for R&D activities to have effective deliverables. To achieve the objectives of R&D activities it is often to organize projects so that the problems become clearly defined and it may be expected the work done within the preset deadline and budget. Unlike contracted projects, R&D projects are characterized by various uncertainties and it is not easy to accomplish the target in each phase during project execution with satisfying the time and cost constraints. In spite of the difficulty, implementing and controlling the work by project formation with MBO (Management By Objectives) may increase the efficiency of R&D activities.

A recent trend of focusing on the corporate governance affects to expand the scope of work to the governance of intangible assets and this requires higher extent of transparency in management and control. R&D activities associate with uncertainties and the deadlines as well as budgets have not been severely controlled. These are in some extents out of control in each phase of R&D activities so that the limits of these items are loosely bounded and may cause the intangible performance. The above-mentioned descriptions are limited within the scope of pipeline portfolio management and research activities are also out of scope. It is, however, not allowed for these activities to remain in the same feature of control due to the necessity of surviving in the present globally competitive environment. New products and services are required timelessly as the results of efficient R&D activities. The large part of corporate budget is required to accomplish the target of producing new products and services. This means that the portion of intangible items increases and it is not acceptable for corporations to remain the items without control. Such competitive environment will necessitate the project activities being more transparent and easy to make governance effective. Project executions with increasing the transparency of activities involved in the projects will result in better status of corporate governance. The new management item that may be called Project Governance is the governance focusing on the project execution. As described by Levin [1], “Project portfolio management (PPM) is a business practices that brings the world of projects into tight integration with other business operations. It brings projects into harmony with the strategies, resources, and executive oversight of enterprise and provides the structure and processes for project portfolio management. Project portfolio management is more than an extension of project management to deal with multiple projects. Although it addresses different needs, it is very important to have full integration with traditional project management capabilities. PPM requires governance at the executive level. The core mistake is to think that PPM is fundamentally the management of multiple projects. This definitely is not so. PPM is the management of the project portfolio so as to maximize the contribution of projects to the overall welfare and success of the

enterprise. He also describes the meaning of this statement by saying that projects must be aligned with the firm's strategy and goals, consistent with the firm's values and culture, contribute to a positive cash flow for the enterprise, and effectively use the firm's resources- both people and other resources."

One of the authors' limited experiences of the consulting work mainly on investment planning and control in R&D projects from the planning to final stage of projects, has often observed that there have been mismatch in the decisions between the executives and the persons in charge of project management, even though the standardized approach to project portfolio management have been taken. According to the analysis of such phenomena it has been revealed that there have not been well communicated between the two regarding the realizing corporate strategy and as a result they have felt that the project portfolio management were not always successful from the viewpoint of congruence with corporate or business strategies and further efforts on executing effective portfolio management are needed. She suggests this occurs due to the difficulty of identifying the preference of executives in advance and it is necessary to carry out the risk assessment by more analytical ways so that the executives' preference should be reflected in course of risk assessment in the project planning phase [2].

Among the issues remained unresolved suggested by Cooper and his colleagues [3]. based upon the results of their investigations, it is considered to be necessary to make analysis of the intangible part or implicit knowledge on implementing the portfolio management.

From this recognition, the authors aim to clarify the reasons behind the failure of effective decision making on the basis of logical analysis and present a rational approach to executing and governing R&D projects based upon the above-mentioned recognition of status quo in the corporations. The direction of rational approach is characterized by increasing the transparency of business strategy, environmental situation described by SWOT analysis, resource allocation, scope of work, time and budget constraints, and decision making under uncertainty with multiple criteria.

The elaboration of approach along the line of the direction includes the methods of systematic risk analysis, the introduction of probability concept to key project evaluation items and multiple criteria decision making.

MANAGERIAL ISSUES ON IMPLEMENTING AND CONTROLLING R&D PROJECTS

More than three decades have been elapsed since the notion of project management began to be recognized. Project engineering and management methods had been introduced at first to plant engineering and construction business and now have been spread out into other business areas such as IT related industries and production industries of various products and services with new products development work. The methods and techniques of conventional project management are well established and standard textbooks and guidelines have been provided to common users in the applicable forms to software development and traditional engineering and construction projects. These materials have also been applied to products development projects with limited success, due to the degrees of uncertainty inherent to the developmental work are large and past experiences being not always applicable. In reality, the practical ways of decision making under uncertainty are not well established and it is common for decision makers to rely on their own past experiences and intuitive judgment. As the results, it is often occurred that the final decisions on investments by executives differ greatly from the proposals. Although the proposals presented to the executives have been made by the analytical methods such as SWOT analysis, portfolio analysis, and probabilistic analysis by preset risk levels, due to the insufficient communication, the business strategy and the intention of executives to each project are not explicitly reflected in the proposals. So that sometimes, though it is an extreme case, the final decision is made by neglecting the contents of proposal just by intuitive mismatch between the two. It is important to ensure alignment and consistent execution of strategic priorities through the diagnosis of situations in every occasion. Subject to the uncertain business environments, it is not expected to utilize traditional project management, especially in the project planning phase. The quality of project plans affects the project implementation. The revision of original project plans is required and it causes to the additional costs and time delays. During the project execution, it is useful for some methods of project

control to attain the preset sub-targets by breaking down the work attained in some short periods. This means that even if these methods are useful to efficient execution, the improper targets do not lead to effective results with no deliverables. These work environments do not give any contribution to the corporation and this may require project governance for such development- oriented projects. The important thing is to integrate the decision making on the project selection and resource allocation with multiple criteria subject to revealing the transparent details. It is expected that the approach proposed here will contribute to resolve the problem rationally.

A BRIEF DESCRIPTION OF INVESTMENT PLANNING AND CONTROL WITH DECISION SUPPORT TOOL [4.5]

Before proposing a rational approach to multiple criteria decision making to the execution and governance of R&D Projects, the way of standardized investment planning and control of R&D projects is briefly described in the following focusing on the scope of pipeline portfolio management:

Decision support tool provides an easy-to use program and project planning approach covering entire project lifecycle from initiation to project close-out The research activities in the first stage is high levels of uncertainty and the following method may not be applicable in practice as the out-of-scope of investment planning. The exploratory and basic researches are usually carried out to have more usable information from which the status toward the final products development becomes clearer and the portfolio management in this phase is premature for the decision making, though screening research results based on the visual portfolio matrix is conducted with careful consideration of risks on deleting prospective seeds of future products development. For this purpose, it is recommended to make case studies on possible change of research from which the positioning of project portfolio matrix is changed accordingly.

A unique investment and project management methodologies templates provided by a decision support tool such as Artemis7[2] which is well accepted in this area are used in this work. These tools are playing important roles in practice of investment planning and control that remain visibility and accountability for project lifecycle management based upon the concept of pipeline portfolio management. Business strategy is first translated into measurable results in the form of comprehensive views of investments, such as portfolio matrix, resource allocation, budget and other necessary information based on workflow model for the complete lifecycle of each investment. A rapidly changing business environment demands a disciplined and regular review of the portfolio. The use of a decision support tool enables to react fast to the change of business environment with the aid of functional capabilities that include achieving the right balance and mix of investments to reach business goals, prioritizing and funding the most valuable investments to generate maximum benefits, reconciling portfolio & organization budgets to align strategic and operational objectives, increasing visibility on head-count requirements and optimizing resource and skills usage to keep cost down and ensuring that actual execution, achievement of benefits and overall performance are in line with objectives. It also allows investment risk to be identified, quantified and tracked. The monitoring the status and resolution of issues and risks is an important function for this purpose. Based upon the pipeline portfolio management concept, the reviews of portfolios connected with the monitoring, in other words the diagnosis of current situations, are conducted regularly and on demand basis. Though the portfolio matrix depicts projects status in the space whose axis are executive priority and governance priority for intuitive understanding the whole status, the reasoning behind this plot is not clearly presented.

The experiences on business planning and consultation using a decision support tool show that it has been welcome to the wide range of users, though there are some rooms to improve the ways of using it for appropriate decision making leading to the desire results congruent with business strategy. As pointed out in the previous section, the mismatch of the decisions between the executives and the persons in charge shows the incongruence and this occurs mainly due to the difficulty of identifying the preference of executives in advance and it is necessary to carry out the risk assessment by more analytical ways so that the executives' preference should be reflected in course of risk assessment in the project planning phase.

A RATIONAL APPROACH WITH MULTIPLE CRITERIA DECISION MAKING TO THE EXECUTION AND GOVERNANCE OF R&D PROJECTS

From the above-mentioned experience, it is desired to improve the ways of utilizing a decision support tool with developing a rational approach which is based upon the analysis of experiential facts observed from a different angle [6] that is based on engineering analysis. As results, it is found that the traditional approach to project portfolio management does not reflect explicitly the uncertainties accompanying risk and executives' intuitive judgment to decrease the gap between their intensively conceived plans and presented plans for final decisions. A widely known method of fault tree analysis (FTA) in engineering is applicable to the risk analysis being associated with portfolio management.

To resolve the problem described in the preceding sections, it is necessary to develop a rational way of decision making congruent with business strategy. It may be successful in developing a rational approach if executives satisfy the plans proposed by persons in charge of making preliminary but objective results that are produced by the rational approach using the framework for investment planning and control provided by a decision support tool. In such cases, the executive's decisions will be made without revisions. Due to the fact that each project is unique in characteristic and the lessen learned from each project plan does not give us consistent findings leading to the useful guide to other project planning even if standardized ways of utilizing A decision support tool. One of the promising approaches to resolve these problems is instrumental and analytical elaboration supporting the transparent decision making. It aims to eliminate as much as possible the gap between the executives' intention to the plans and the preliminary plans provided. Therefore it is at first necessary to identify the executives' intention to each project before the project planning being finalized. Especially their attitudes toward risks are important and those attitudes to be made clear are risk aversion or risk taking to specific projects because there exist various uncertainties in project planning and it is needed to clarify reasoning on decision making. This has a strong relation to corporate strategy from which business units are to be selected. As shown in Fig.1 strategic positioning in the selection of R&D projects is deployed by taking the levels of uncertainties [6] into consideration.

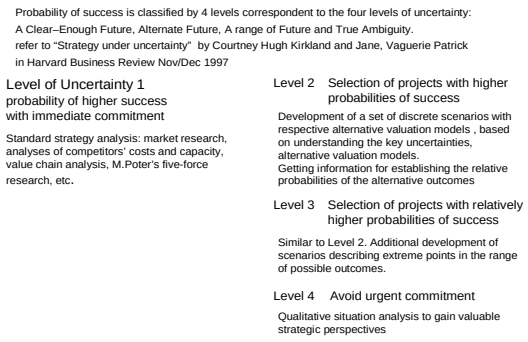

Fig. 1 Strategic positioning in the selection of R&D projects

The way of project segmentation with reasoning is to pick up items in each evaluation criterion regarding strategy, business and technology. The levels of uncertainties relate to the R&D activities and resources allocation. The estimate of probability for the degrees of uncertainties in level 4 is difficult, so that the detailed analysis described in the following may be eliminated in practice.

The result may be depicted in the framework shown in Fig. 2, the visible understanding of present internal and external situation for projects will be useful to making decision. The degrees of uncertainty in the vertical axis is classified by the four level mode.[7] The internal and external situation in the horizontal axis is classified by S,W,O,T. The balanced situation from the viewpoint of SWOT analysis is shown by the figure in which the projects are assembled in the center.

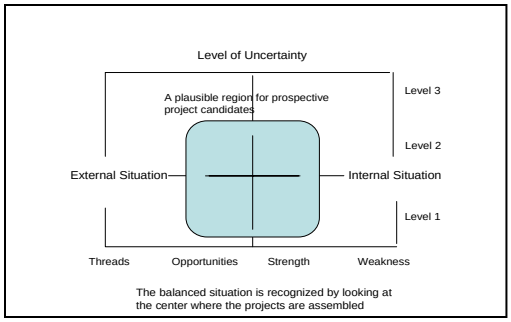

Fig.2 Framework of SWOT analysis with the degrees of uncertainty

The degrees of uncertainty may be presented by the probability of success in each evaluation criterion. The results of risk analysis with FTA will be utilized to specify the probabilities, so that as shown in Fig.3 [8] , the mapping of a portfolio matrix into what is called probabilistic portfolio matrix that reflects the degrees of uncertainties using estimated values for the probability of success in R&D projects. The approach to portfolio management includes three independent axis: strategy, business and technological axis. It is assumed that SWOT analysis is already finished before the mapping of portfolio matrix. The business and technological criteria may be classified by economic and non-economic criteria combined with the degrees of uncertainty.

The application of fault tree analysis is helpful to make it clear what base component may cause an unsuccessful result. A fault tree is a logic diagram that displays the interrelationships between a potential critical event in a system or organization and he reason for this event. The reasons may be environmental conditions, human errors, normal events and specific component failures. A fault tree analysis may be qualitative, quantitative, or both, depending on the objectives of analysis [8]. This technique has been widely utilized mainly in the engineering areas since 1960s

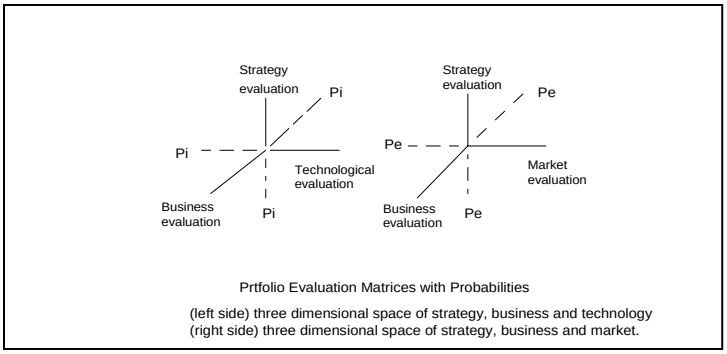

Fig.3 Probabilistic portfolio matrix on four dimensional space shown by the three dimensional spaces

For an illustrative purpose, a fault tree developed for the case of strategic failure is shown in the later section. The probabilities of failure occurrence in base components are to be determined if the past experiential data are available, otherwise to be specified subjectively by taking the degrees of uncertainties into consideration. The framework for portfolio management is characterized by the consistency among the activities. As well known the goals of portfolio management are to maximize the portfolio value, to achieve a balanced portfolio of short- and long-term programs and to allocate the resources on those programs and the portfolio management is a dynamic decision process with rolling-based forecasting and alignment of portfolios. It is reported for the AHP methodologies to be applied in conjunction with the portfolio management processes [9,10]. Involving these analytical tools for risk management, a rational approach to planning, execution and governance of the R&D projects is developed. The Procedural framework depicted in Fig.4 is developed using a general framework for planning corporate or business strategies [11].

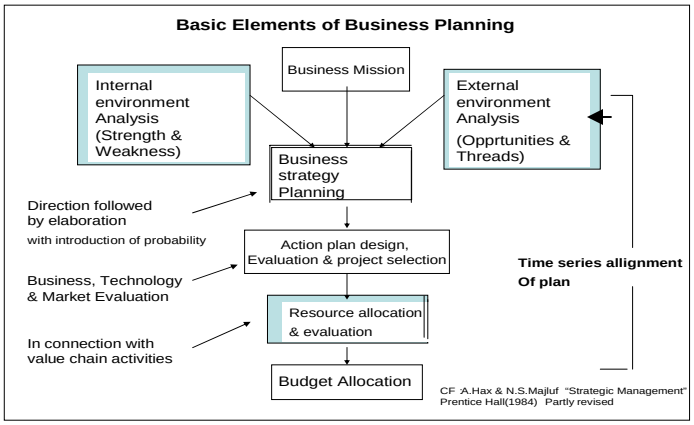

Fig.4 A systematic procedure of business planning

The probabilistic portfolio matrix depicts candidate alignment of projects with proper sequence of priority by using the AHP method. This method is applicable to select optimal rank order on the preset weighting for evaluating multiple criteria. The case studies by changing the weights with reference to Table1 give us a set of useful information on decision making. An illustrative presentation of hierarchical structure is shown in Fig.5 [5].

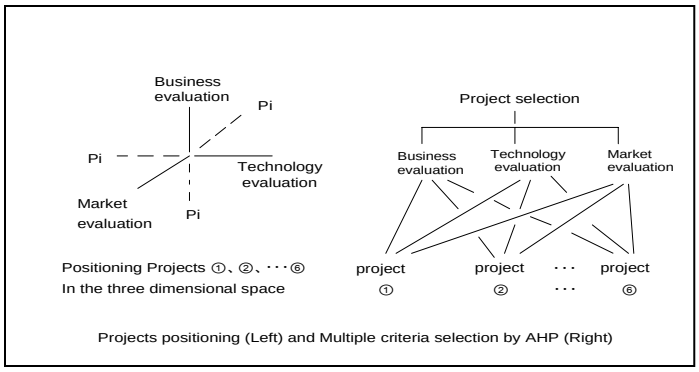

Fig.5 Projects selection by the AHP method

AN ILLUSTRATIVE EXAMPLE OF THE APPLICATION

The main objectives of solutions for the clients including pharmaceutical companies using a decision support tool are maximizing pipeline portfolio, managing the total life cycle of project candidates and optimizing cross functional performance. Those software products related to pipeline portfolio management aim to provide the clients the desired characteristics of pipeline portfolio and portfolio life cycle visibilities, strategic alignment with executives and governance priorities, and executions with simulations, and program management with project planning, resource planning and cross functional coordination.

Based upon the experiences related to portfolio management in the R&D activities of pharmaceuticals, a trial of the proposed approach as a benchmarking is described as follows:

At first the ordinal product portfolio was developed by the data of market share, number of patents, NPV with more subjective criteria as the strategic decision criteria But those criteria did not reflect risks based on the logical way. So that, as the next step, the FTA method was applied to evaluate risks in each criterion with understanding the reasoning of probabilities of project success(H.M.L as shown in Fig.8). For an illustrative purpose, a fault tree developed for the case of strategic failure is shown in Fig 6.

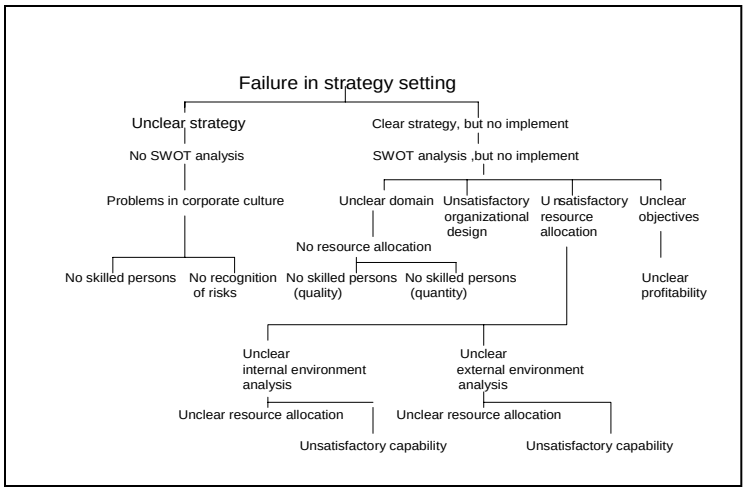

Fig.6 An example of fault tree in the case of strategic failure

Though the fault tree is useful to analyze qualitatively the relationship of the causes and consequences among the items shown in this figure, it is desired to know the quantitative value and the level of probable occurrence, L, M, H have been subjectively specified by reflecting the past experiences on R&D management. In order to estimate the probability, the following table (Table1) had been used. This table shows what kinds of criteria are used to judge the value of project and how they are waited on decision making.

Table 1 Project Evaluation Item-Idea of Standard Valuation Item/Standard definition (Example)

Valuation Items				Valuation Standard					Evaluator
				VL (Point0)	L (25)	M (50)	H (75)	VH (100)	
PJ Value Evaluation	Objective Value Evaluation	Technical Evaluation [100]	Technological domination [30]	• Inferior to other companies	• One line in side	• Within top 3 technology concerned	• Top in the situation with the competition	• Non Competitor (Only one)	R&D PJ Leader (Initial Assessment)
			Presence of patent[50]	• No. No expectation of acquisition all in the future	• No. Although the situation is severe, but room for acquisition in the future	• Yes. But the right is limited • No. But room for acquisition in the future	• Yes. Has a strong right	• Yes. Has a strong right that the other companies cannot enter	R&D PJ Leader (Initial Assessment)
			Period to Market in[20]	• 5 Years or more	• Within 4 Years	• Within 3 Years	• Within 2 Years	• Within 1 Year	R&D PJ Leader (Initial Assessment)
		Business Evaluation [10]	NPV (5Years) [100]	• Δ NPV is less than 1 billion yen	• Δ NPV is between 110 billion yen	• Δ NPV is between 1050 billion yen	• Δ NPV is between 50 100 billion yen	• Δ NPV is more than 100 billion yen	R&D PJ Leader (Initial Assessment)
	Strategic Place Putting	Strategy Adjustment Section [10]	Location seen from the entire company [100]	• Examination necessary PJ (Importance is very low)	• Middle of VL M	• Usual PJ	• Middle of M VH	• Most important PJ (Importance is very high)	R&D Planning Section
		Judgment in R&D Section [10]	Judgment of R&D Leader [70]	• Possibility of cancel or cut the investment	• Middle of VL M	• Desire to continue like the currentstte	• Middle of M VH	• Desire to proliferate the investment	R&D Leader
			Researcher's (leader) Desire [30]	• Other PJ or start another PJ	• Middle of VL M	• Continuation of this theme	• Middle of M VH	• Continuation of this PJ Leader	R&D PJ Leader

(L:VL-L, M:M, H:VH-H)

As the last step, the project status was added to the criteria. The result is shown in Fig.7.

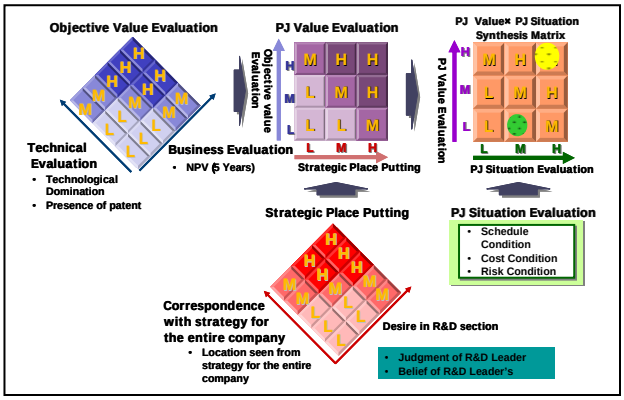

Fig.7 Decision Criteria Including Project Status

In order to judge the project GO/NOGO properly and effectively, it is necessary to know the current status of all projects. Fig.8 is an example of the Project Portfolio used in a pharmaceutical company.

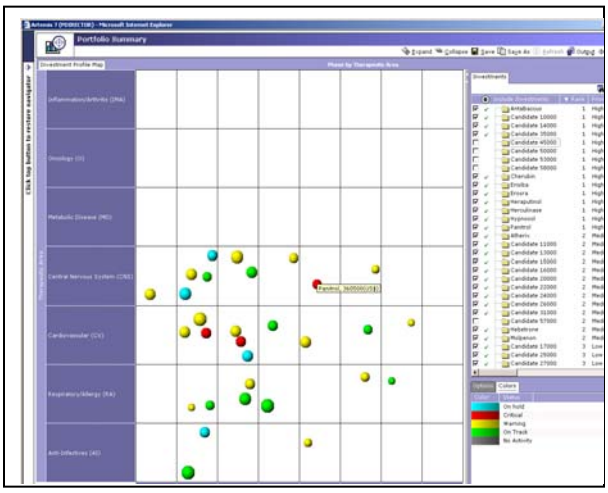

Fig.8 Project Portfolio snapshot example (Given by Artemis7)

Even if the product value which will come from a project is very high, there is no commitment as a result so that company can proceed the project in proper way. In addition, the AHP method was applied to project selection and the result is depicted in Fig.9. The result was referred to project selection with supplemental role in final decision.

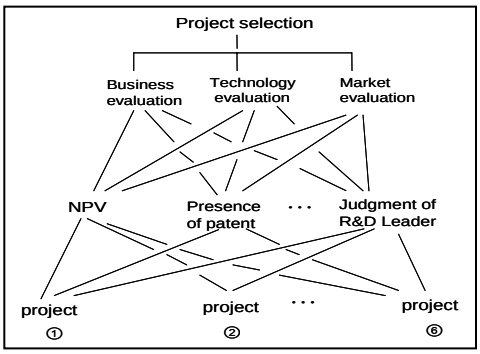

Fig.9 Project selection by the AHP method

With the set of information, they can recognize the real value of projects timely and decision making is much speedy and properly than before.

DISCUSSIONS AND CONCLUDING REMARKS

A rational approach to decision making in the R&D projects is presented. Unlike the daily used methods, the mismatch among the stakeholders especially between the executives and the planners in charge of the projects is decreased. This is mainly due to the increase of transparency of the basis regarding the decision making. The use of FTA and AHP with preparative work can contribute the accumulation of knowledge by the explicit presentations. A benchmarking for a R&D project in a pharmaceutical company has shown the rationale of the present approach. Regarding the business characteristics, the resource allocation is implicitly involved and due to the space limit, detailed discussions on this item is given elsewhere [12].The increase of transparency in the project executions will expect to realize the better status of project governance.

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REFERENCES

[1] Harver A.Levin. *Project Portfolio Management*, Introduction and Section 2.4, Jossey-Bass, 2005.
[2] Artemis 7 Catalog: Investment Planning and Control Software
[3] Cooper, R.G., Edgett, S.J. and Kleinschmidt, E.J. *Portfolio Management for New Products*, 2nd ed. Basic Books, 2001.
[4] Nakamura, K., Project Governance in Japanese Companies. *Journal of SPM*, 2005, 7 (4), 21-25.
[5] Nakamura, K., Artemis 7-Integarted Portfolio & Project Management Tool of achieving Investment Planning & Control. *Journal of SPM*, 2004, 6 (6), 29-30.
[6] Umeda, T., Discussion materials on Risk management of project portfolio. *Private Communication*, 2006.
[7] Courtney, H., Kirkland, J., Vigueria, P. *Harvard Business Review*, 1997, Nov/Dec No.6.
[8] Hoyland, A. and Rausand, M. *System Reliability Theory*. John Wily & Sons, 1994.
[9] Yelin K.C. “Linking Strategy and Project Portfolio Management” in Harvey A. Levine ed. *Project Portfolio Management*, John Wily & Sons Inc., 2005.
[10] Seibert, R. “Managing Your Technology Pipeline Portfolio Management Process and its Evaluation Over Time” in Harvey A. Levine ed.” *Project Portfolio Management*. John Wily & Sons Inc., 2005).
[11] Hax, A.C. and Majluf, N.S. *Strategic Management-An Integrative Perspective.* Prentice–Hall, 1984.
[12] Nakamura, K. and Umeda, T. A Heuristics Evolutionary Approach to the Resource Allocation to Multiple projects, presented at *WDSI 36th Annual Meeting*, 2007.