International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com ǁ Volume 1 - Issue 8 ǁ September 2016 ǁ PP. 49-53

Managing Risk in New Product Development Using Design Structure Matrix

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Abstract: The risk management process refers to uncovering weaknesses in methods used in product development through a structured approach so that timely mitigation actions are initiated to avoid risk, transfer risk, reduce risk likelihood or reduce risk impact. About 80% of manufacturer new product development projects fail before completion. There are few systematic methods on the establishment of risk management systems for New Product Development like Analytic Hierarchy Process(AHP), Analytic Network Process(ANP) and Bayesian method. But these methods have some implementation disadvantages for analyzing risks. So, a better approach is needed to overcome the shortcomings would be sought. Design Structure Matrix(DSM) can meaningfully represent a fairly large complex system relatively small space. Design structure matrix provide a system level view that can support more globally optimal decision making and help orient those focus on a particular element. It help us to improve process understanding reduce process cost, duration and risk.
Keywords: Risk management, NPD, DSM

I. INTRODUCTION

Risk management is important element of product design. It helps to minimize the project-and product-related risks such as project budget and schedule overrun, or missing product cost and quality targets. Risk management is especially important for complex, international product design projects that involve a high degree of novel technology. Risk management provides a guideline for decision making in managing new product development project, reduce its uncertainty and increase success rate. In contrast the acceptance of formal risk management process in industry, especially for new product Development projects still in question.
Intensified international competition, diverse and rapidly changing technologies and demanding customer expectations have made the innovation process more complex and the possible outcome considerably less certain. Empirical research indicates that the success rate of major new product development (NPD) projects is still low [1]. It is therefore no surprise that identifying and managing risks have become increasingly important issues in the product innovation literature [2].Worldwide, approximately 80% of manufacturer new product development projects fail before completion. More than half of the 20% of successful cases fail to return investment costs and become profitable. Higher costs and more time have been used than expected to achieve the project goals [3-5].

Many studies on risk analysis and management have been performed, but systematic research on how a risk management system is built has been rare. In particular, there are few systematic studies on the establishment of risk management systems for NPD. As in similar studies about other fields, Carr and Tah developed a Hierarchical Risk Breakdown Structure (HRBS) as a model of risk evaluation and analysis for risk management in construction projects. As a risk evaluation method, the fuzzy model was used [6].Wu at al. used Graphical Evaluation and Review Technique (GERT) as a model for managing risk factors during product development based on concurrent engineering[7].Savci and Kayis established a risk classification system in order to identify risk factors in NPD projects [8]. Ahmed et al. and Dey proposed the AHP method for risk analysis, and evaluated the impact of each risk factor in a project by performing pair-wise comparison [9]. The manufacturers are under pressure to keep and increase their places in the market[10]. To improve their ability to innovate, bring products to the market faster, and reduce manufacturing bottlenecks, the manufacturers have been improving their product development and management abilities. Companies have to invest more money to product lifecycle management and enterprise resource planning systems [11 - 12]. Risk management protects a project by maximizing opportunities and value whilst minimizing the threat. It is a prerequisite of all effective project management solutions [13].

Method based on Design Structure Matrix (DSM) is introduced to build the network of risk interactions [14].The design structure matrix (DSM) methodology has made many contributions toward improving complex A decisions involving choice of product, process, and organizational architectures[15]. It is a powerful tool for representing and analyzing task dependencies of a product development project. This method provides a major need in engineering design management through documenting information that is exchanged. Analyzing the structure of a design processes can identify many opportunities to improve it. Building a DSM model of a

project/system, improves the visibility and understanding of project/system complexity through information flows. With the help of a DSM model it can easily convey the processes to others in a single snapshot. Through DSM model we can easily optimize product development processes and reduce the time and cost of product development cycle [16].

DSM method used to identify risk interactions, for determining the cause–effect relationships among project risks. It provides a simple and concise way to represent the interrelationships in a complex system [17]. Although some additional analyses have been developed, most product DSM analyses to date have focused on clustering components to determine modular architecture [18].

II. NEW PRODUCT DEVELOPMENT AND RISK INVOLVED

Product development projects should include also risk assessment, that allows managers to identify and measure the risks associated with resource constraints and then develop appropriate responses. It is a cycle by means of which an innovative firm routinely converts ideas into commercially viable goods or services. In business and engineering, new product development is the term used to describe the complete process of bringing a new product to market. A product is a set of benefits offered for exchange and can be tangible (that is, something physical you can touch) or intangible (like a service, experience, or belief).

Mostly new product development projects fails before completion. The risk in NPD process is a barrier to the successful development of new products. Most of the companies are unsuccessful in the development of new products because of an increase in time and costs at all stages. NPD projects fails because of the deficiency of a complete decision-making system. Risks in NPD are interlinked with design within a complex process where risks are temporary, and are difficult to be described.

III. RISK MANAGEMENT PROCESS AND CONTEXT ESTABLISHMENT TECHNIQUES

In general, unexpected events occur in projects and may result in either positive or negative outcomes that are a deviation from the project plan. Positive outcomes are opportunities while negative outcomes generate a loss. Risk focuses on the avoidance of loss from unexpected events. Several definitions of risk are available in the literature and risk is usually referred to as an exposure to losses in a projector as a probability of losses in a project the later definition of risk has been used because this definition implies that risk is quantifiable and lends itself to assessment and analysis through computational methods. Situation where it is not possible to attach a probability of occurrence to an event is defined as uncertainty while uncertainty is not measurable, it can be estimated through subjective assessment techniques.

The risk management process refers to uncovering weaknesses in methods used in product development through a structured approach so that timely mitigation actions are initiated to avoid risk, transfer risk, reduce risk likelihood or reduce risk impact. The risk management process proposed by the Australian Standard for Risk Management is shown in Figure 1. It is composed of seven iterative sub-processes of establishing the context of risk, identifying risks, analyzing risks, evaluating risks, communication and consultation across stakeholders and monitoring and controlling risk events. The risk management process blends itself to CE product design and development, as changes and iterations in the design stage cost less than changes initiated in the implementation phase. Hence, early discovery of risk events leading to downstream losses is much more preferable than treating losses when they cannot be prevented.

Context establishment in the risk management process involves representation of project units (functional, process, data, etc.) and their inter-relationships. This enables in representing project status in several forms such as resource usage, equipment requirements, budget availability, stakeholder involvement, contract deliverables, strategic goals and schedule, depending on the desirable aspect of the project that is important for any particular purpose.

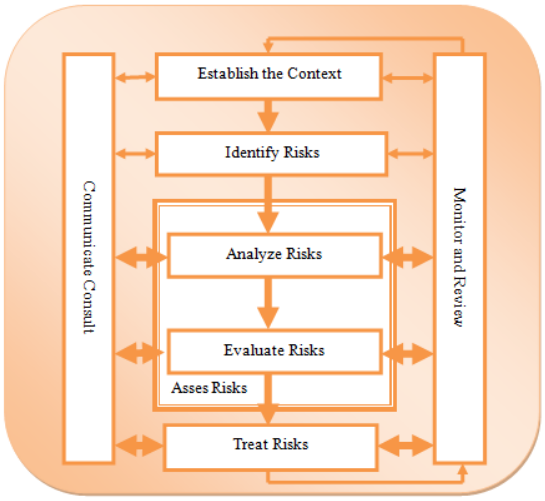

Figure 1. Techniques for context establishment

IV. DESIGN STRUCTURE MATRICES

Project modeling tools and methods are in common, are as well the technique for context founding for risk management. In the direction of model and structure NPD processes, decisions are frequently completed on the difficult strategies for project observing and manage the amount of overlap, plus the intended timing and order of design actions. The design structure matrix (DSM) is becoming a popular representation and analysis tool for system modeling, especially for purposes of decomposition and integration. A DSM displays the relationships between components of a system in a compact, visual, and analytically advantageous format. A DSM is a square matrix with identical row and column labels. The Design Structure Matrix (DSM) (also referred to as dependency structure matrix, is an easy, dense and symbolic representation of a system or project. The DSM takes compensation of simplicity as well as conciseness in representation holding through suitable analysis, be capable to besides emphasize the significant patterns inside system architectures for example design structures like modules and cycles.

The main settlements of the DSM method for modeling projects is, emphasize the iterations in the project, aggregate coupled tasks keen on blocks, improved understanding of information flows and generate an extra precise schedule. Identify Potential project risk by classical methods. The result is a project risk list that allows creating Design Structure Matrix (DSM). Define risk interactions using the DSM developed by Steward (1981), to handle dependences and relations between items. DSM can meaningfully represent fairly large, complex system in a relatively small space. The DSM highlight relationship patterns of a particular interest to a system designer.DSM provide a system level view that can support more globally optimal decision making and help orient those focus on a particular element.DSM analysis can also illuminate indirect links, change propagation, process iteration and converegence.DSM is highly flexible method.

	A	B	C	D	E	F	G
Element A		1				1	
Element B				1			
Element C	1						1
Element D					1		
Element E		1				1	
Element F			1				
Element G	1				1		

Figure 2. DSM Basic Architecture

V. DSM STRUCTURE

A design structure matrix (DSM) represents precedence relationships of project tasks on a square matrix containing equal number of rows and columns representing the number. A DSM is a square matrix, representing linkages between the system elements. These elements can represent for example product components, organization teams, or project activities. The off-diagonal cells are used to indicate relationships between the elements. A marking of the cell indicates a directed link between two elements and can represent design relations or constraints between product components, communication between teams, information flow or precedence relations between activities. The cells along the diagonal are typically used to represent the system elements. However, the diagonal cells can be used for representing self-iterations.

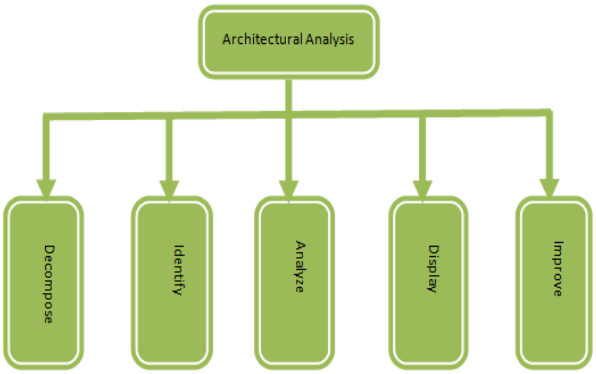

Figure 3. DSM Architecture analysis

VI. ADVANTAGES OF DSM

1) DSM can meaningfully represent a fairly large complex system relatively small space.
2) DSM provide a system level view that can support more globally optimal
3) Decision making and help orient those focus on a particular element.
4) DSM analysis can illuminate indirect links, change propagation, process iteration and convergence.
5) The DSM in a process is very useful because it generates and represents alternative prospective on process architecture.
6) It help us to improve process understanding reduce process cost, duration, and risk. DSM is highly flexible method.

VII. CONCLUSION

NPD process is a system of activities and their interaction comprising a project or business function, such as engineering design and development project. NPD is a process with high risk as well as elevated ambiguity that's why a correct prediction and risk identification is compulsory in NPD process. After prediction and identification we need to control the risk from the project, however, it can cause large delays or unexpected spending in projects. Quality, delay or cost, problem in one component may have an influence on another and then budgets limits will cross. Traditional methods or frameworks available for risk analysis in NPD are too unsystematic or abstract to be applied in real industry.. DSM can meaningfully represent fairly large, complex system in a relatively small space. The DSM highlight relationship patterns of a particular interest to a system designer.DSM provide a system level view that can support more globally optimal decision making and help orient those focus on a particular element.DSM analysis can also illuminate indirect links, change propagation, process iteration and convergence.

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