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Analysis of the effect of risk management practices on the performance of new product development programs

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ABSTRACT

Risk management is receiving much attention, as it is seen as a method to improve cost, schedule, and technical performance of new product development programs. However, there is a lack of empirical research that investigates the effective integration of specific risk management practices proposed by various standards with new product development programs and their association with various dimensions of risk management success. Based on a survey of 291 product development programs, this paper investigates the association of risk management practices with five categories of product development program performance: (A) Quality Decision Making; (B) High Program Stability; (C) Open, problem solving organization; (D) Overall new product development project success; and (E) overall product success. The results show that six categories of risk management practices are most effective: (1) Develop risk management skills and resources; (2) Tailor risk management to and integrate it with new product development; (3) Quantify impacts of risks on your main objectives; (4) Support all critical decisions with risk management results; (5) Monitor and review your risks, risk mitigation actions, and risk management process; and (6) Create transparency regarding new product development risks. The data shows that the risk management practices are directly associated with outcome measures in the first three categories (improved decision making, program stability and problem solving). There is also evidence that the risk management practices indirectly associate with the remaining two categories of outcome measures (project and product success). Additional research is needed to describe the exact mechanisms through which risk management practices influence NPD program success.

1. Introduction to risk management in new product development

1.1. The importance of risk management in new product development programs

There are several definitions of risk depending on the application. In decision theory, risk is related to making decisions under known probabilities of the states of nature (Luce and Raiffa, 1957). In economic theory, risk arises when the decision maker can assign probabilities to possible outcomes (Knight, 1921). A well accepted definition of risk given in project management body of knowledge considers risk as "an uncertain event or condition that, if it occurs, has a positive (opportunity) or negative (threat) impact on project objectives" (PMI, 2008). However, for most practitioners project risk management seems to be about identifying and managing threats. For NPD, we follow the ISO 31000 definition (ISO, 2009) which defines risk as the effect of uncertainty on achieving the NPD objectives.

New product development is inherently linked to taking and managing risks (e.g. Baba et al., 1995; Kwak and LaPlace, 2005), as most activities can be interpreted as a structured reduction of uncertainty. Studies of customer needs and market trends reduce the uncertainty surrounding requirements; technology development, testing and evaluation create certainty regarding the capabilities and cost of new technologies, and the improvement and standardization of NPD processes within the organization increases the reliability of executing the development process (Mu et al., 2009). Reducing risks in new product development can also increase customer value (Browning et al., 2002), and can be used as a lens to analyze and optimize product development processes (Oehmen and Seering, 2011). More generally, improving the "risk-return balance" is a central tenant of business decision

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making, from project portfolio choices (Floricel and Ibanescu, 2008) to business strategy and investment allocation (Fama and Macbeth, 1973).

There is also evidence that new product development suffers from risks, and is prone to serious cost and schedule overruns, as well as problems in achieving the targeted technical performance of the product (GAO, 2010). In the related field of software development, average cost overruns of projects are reported on the order of 30–40% (see Jørgensen and Moløkken-Østvold, 2006 for a detailed discussion). Similarly, in complex infrastructure construction projects, average cost overruns are quoted in the range of 28–50%, with up to 77% of projects experiencing cost overruns (see Cantarelli et al., 2010 and references therein). Of particular relevance are findings of the US Government Accountability Office that analyses the success of engineering programs, among them new product development programs, of the US Department of Defense (GAO, 2010, 2006). While all engineering programs (including those that focus on production or life-cycle management) suffer from an average cost overrun of 25%, those programs that focus on new product development show an average cost overrun of 42% and schedule delay of 22 months (GAO, 2006).

1.2. NPD risk management literature

There is a vast literature dealing with various aspects of risk management in NPD that cannot be covered in detail in this paper. The reader may find more details in a recent review (Oehmen et al., 2010). In this section, we simply highlight the literature dealing with types of NPD risks and their classification. The relationship of risk management with success on NPD projects is discussed in Section 1.3 and relevant risk management processes and frameworks for NPD are discussed in Section 2.

One of the most comprehensive collections of NPD risks is presented by Keizer et al. (2005) based on a literature survey and case studies in the fast-moving consumer goods industry. A list of 142 R&D program risks is grouped in 12 categories (commercial viability, competitor, consumer acceptance and marketing, public acceptance, intellectual property, manufacturing technology, organization and project management, product family and brand positioning, product technology, screening and appraisal, supply chain and sourcing, and trade customer risks). Persson et al. (2009) also develops an extensive list of development project risks based on a literature review, presented in 7 risk areas (task distribution, knowledge management, geographical distribution, cultural distribution, stake holders relations, communication infrastructure, and technology setup) divided into 24 risk factors. Jiang and Klein (2000) develop a risk collection for software development projects, falling into 9 project risk categories (technological acquisition, project size, five categories dealing with team expertise and communication, lack of user support and experience, and application complexity) containing 49 risks. Sicotte and Bourgault (2008) identify four types of risks (technical and project uncertainty, market uncertainty, fuzziness and complexity) that impact R&D project effectiveness and efficiency, as well as a co-moderating effect of project methods and human resources. Focusing on radical innovation projects, O'Connor and Rice (2013) recommend project management focus on four more general key areas of uncertainty: technical, market, organizational and resource. Yeo and Ren (2008) develop a conceptual model and framework for risk management maturity. As part of their model, they postulate four categories of risk, relating to processes, organization, technology and the environment. These categories were developed based on the analysis of 51 published project cases. Based on a literature review, Park (2010) identified 24 risk factors in 5 categories: operational, technology, organizational, market and supplier risks. The following paper addresses risk in a particular application in the aerospace industry. Addressing the latest overheating batteries problem that grounded the Boeing Dreamliner 787 at the beginning of 2013, Denning (2013) identified several risks that plagued the project including coordination, innovation, outsourcing, partially implementing the Toyota model, off shoring, communication by computer, labor relations, and disengaged top management risks. The article concludes with some recommendations for Boeing. Another study looked at a particular risk, namely the risk of customer integration (also see Tang and Zimmerman, 2009). In their study, Song et al. (2013) focused on the risk evaluation of customer integration in NPD. Potential risks include loss of know-how, much dependence on customer, and limitations to incremental innovations. They proposed an evaluation approach for assessing customer integration risk and applied it in a project for mobile phone development

1.3. Existing empirical investigations of risk management in NPD

A number of prior studies have pointed out that risk management in general is an important contributor to new product development program success: For example, Mu et al. (2009) show that risk management strategies targeting technological, organizational and marketing risk factors improve NPD performance individually and interactively. The study by Jacob and Kwak (2003) highlights the positive contribution of risk management to improve project selection, review and resource allocation of NPD projects. In their investigation of over 100 technology-related projects, Raz et al. (2002) show that the use of risk management practices contribute to project success. In a recent large scale survey of 700 project managers on risk management in general project management, Zwikael and Ahn (2011) showed that even moderate risk management efforts increased project performance. Also, a recent study carried out by one of the authors indicates that a lack of proper risk management is one of the 10 major challenges that plague large-scale new product development programs, and that conversely the introduction of efficient risk management practices is a contributor to increased performance (Oehmen et al., 2012).

Wirthlin (2009) used empirical data to model the US defense acquisition system as three interdependent processes: budgeting (how much and when to buy), requirements development (why and what to buy), and acquisition (how to buy). He defined five key characteristics of the acquisition system: cost, schedule, quality, transparency, and flexibility. He concluded that flexibility, transparency, and quality are the most valued and are essentially non-negotiable, whereas cost and schedule are negotiable. He describes the behaviors and results that occur from valuing these three characteristics as follows: If flexibility is valued, e.g. being able to start programs at will, rush things through, jump ahead of other programs in development cycle, then the system must be able to deal with the funding instability that ensues. If transparency is valued, e.g. process checking, error-proofing, consensus-building, then the system must maintain process reviews and levels of approval and accept expensive use of calendar time. If quality is valued, e.g. not giving relief for technical requirements, capabilities and performance expectations, then expect program delays and cost increases to develop and mature the necessary technologies, or deliver the expected capabilities, etc.

Other studies have focused on investigating particular risk management methods and risks: Based on a review of the literature, Kwak and Stoddard (2004) synthesize both risks as well as “lessons learned” for effective risk management. Realizing the importance of control of risks to the sustained success of risk management, Zentis and Schmitt (2013) suggested an integrated model for assessment and control of technical risks. The model