Corporate Entrepreneurship in Complex Organisations: Towards a Holistic Decision Aid Tool Set to Analyse and Plan Innovative Design Projects

Karolin Gebhardt, Andreas Riel, Tom Maes

Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 00 (2019) 000–000

www.elsevier.com/locate/procedia

29th CIRP Design 2019 (CIRP Design 2019)

Corporate Entrepreneurship in Complex Organisations: Towards a Holistic Decision Aid Tool Set to Analyse and Plan Innovative Design Projects

Karolin GEBHARDT[a,b]*, Andreas RIEL[a], Tom MAES[b]

[a]G-SCOP Laboratory, Université Grenoble Alpes, 46 avenue Félix Viallet, Grenoble, 38031, France.

[b]Bayer AG, 51373 Leverkusen, Germany.

* Corresponding author. Tel.: +49 214 3031167. *E-mail address:* karolin.gebhardt@grenoble-inp.fr, karolin.gebhardt@gmail.com

Abstract

Corporate innovative design projects (IDP) in large and complex organizations are characterized by a high level of both uncertainty and dynamics of needs, insights, and solution approaches. This article proposes a holistic decision aid tool supporting IDP managers and teams in both the prospective planning and retrospective analysis of IDP's. This tool is essentially based on the classification of work packages according to their uncertainty levels with respect to the design problem and the design solution. Furthermore, the success of work packages can be assessed against pre-defined output criteria. This methodological support is complemented by the stakeholder dimension, which adds the involved stakeholders as well as their relationships and influences in the project. The analysis of an ongoing IDP at a leading global industrial player in the pharmaceutical and chemical industry serves as validation platform for the presented tool set.

Peer-review under responsibility of the scientific committee of the CIRP Design Conference 2019

Keywords: Innovative Design Projects; Corporate Entrepreneurship; Decision Aid Tool

1. Introduction

Leading innovative design projects (IDP) to success is difficult, most notably because of the high level of uncertainty that is typically associated with them. In order to cope with their uncertainty, IDPs require diverse project management methods over their life cycles. Although there is an increasing number of different project management approaches, there is currently "no conceptual model (…) that enables project managers to understand why different approaches exists, which one to choose, and when" [1-3]. There is a lack of practical decision aid tools which enable project managers within complex organizations to plan, analyze and control IDPs in a highly uncertain environment [4].

In this paper, we propose a novel decision aid tool set supporting managers of IDPs in large corporate organizations in managing, planning and understanding IDPs with respect to uncertainty reduction and effective network spread in the organization. The paper is organized as follows: section 2 introduces our research question and the methodology applied to address it. Section 3 investigates essential related work in corporate entrepreneurship, uncertainty management, and stakeholder network theory. Section 4 describes the naviProM model with regard to navigating in project management approaches. Section 5 proposes our decision aid tool built upon the hypothesis and the findings from state of the art analysis. Section 6 adds the network perspective in managing IDPs. Section 7 validates this model in the specific industry context based on one concrete IDP. Section 8 concludes with a discussion and a summary of the key contributions as well as an outlook on our future research.

2. Research question and methodology

In order to provide a decision aid tool that supports IDP managers to analyze, understand and model IDPs in uncertain environments, this paper addresses the question what are the requirements for such a tool and how to model it. Thus, the high level of uncertainty (Section 1) has to be reduced as effectively and efficiently as possible to push the project towards a value-adding execution mode characterized by low uncertainty.

Our methodology is based on an exhaustive literature analysis on the subjects of project management, uncertainty management, corporate entrepreneurship, innovation management, and stakeholder integration. This literature analysis is complemented by a field research on the basis of corporate innovation projects. We assume that project management approaches cannot be separated from the specific organizational context and culture, which is why our tool shall cover both the methodological an organizational dimension of IDPs.

3. Related works

Corporate Entrepreneurship aims at creating a supportive environment for internal IDPs. Although its relevance for organizational competitiveness is acknowledged in science and in the industry, very few holistic frameworks exist how to implement IDPs [5,6]. Thereby, IDPs are typically characterized by the involvement of a diverse set of network partners and a high level of uncertainty [7]. This level of uncertainty not only changes during IDP´s lifecycle but also in individual projects and project work packages. Thus, management science constitutes that different levels of uncertainty require different or tailored methodologies [8,9]. However, no model exists that guides which approach to use and when [1,2,3,4] or how to build, adapt and apply proven models in the more complex project management [10].

To manage IDPs in dynamic and uncertain environments, project managers have to take diverse perspectives, like the task and organization perspective [11, 12]. There is a need to focus IDPs to the smallest possible scope to break down the work in digestible work packages [13]. Nevertheless, there is poor published research on how to transfer proven decision tools, like the Work Breakdown Structure (WBS), into the applied project management [10].

Furthermore, network management is needed, as entrepreneurs normally do not have the required competences to drive an idea from developing and testing to production and delivery of a final solution. They need to expand their network to get access to complementary assets [14,15] under a high level of uncertainty [16]. Against this background, scientific findings in role and network theory have identified major roles that have to be represented in IDPs [7,17].

4. Capturing IDP PM needs with naviProM

Based on the hypothesis expressed in section 2, we propose a two-dimensional model to capture the project management needs of IDP work packages. NaviProM (Navigation in Project Management), depicted in Fig. 1, is spanned on two axes representing the uncertainty regarding the needs respectively the uncertainty regarding the solution. Based on the two binary axes, the four innovation project management approaches *Experiment*, *Iterate*, *Plan* and *Execute* are assigned to the four spaces [18]. We will characterize each of these four spaces, along with their respective expected inputs, throughputs and outcomes in the following subsections.

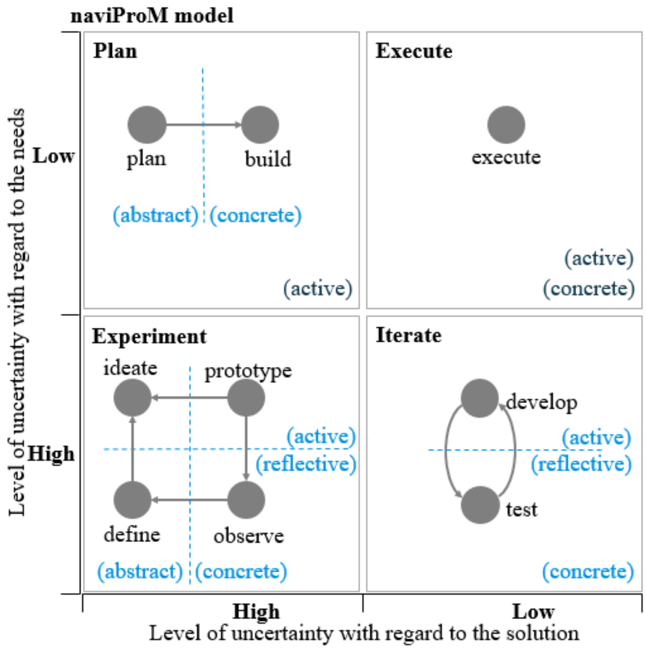

Figure 1: NaviProM decision aid tool

4.1 Experiment

When IDP teams are confronted with a high level of uncertainty with regard to both defining the problem and developing a solution, the naviProM model recommends experimentation to gain deeper insight. The experiential learning model of Kolb (1984) constitutes that project teams learn through “the process whereby knowledge is created through the transformation of experience”, which assumes to pass through the four steps of having an insight, synthesizing ideas, derive corresponding hypotheses, and test them based on prototypes [19].

Together these steps form one experiential learning circle, which means to fluidly move back and forth between the concrete and abstract perspectives as well as between the reflective and active mode. This circle can be repeated multiple times until the project team is able to eliminate uncertainty regarding the needs or the solution and feels comfortable to move to a more target-oriented approach. Order and time spent in each mode do not follow an established standard [20]. In case of a high level of uncertainty this methodical approach of experimentation allows creativity and rapid, unrestricted learning from the environment. Methods of experimentation are e.g. Design Thinking [21] or systematic invention tools like TRIZ [22]. The key players within experimentation are the project team and the users/ customers. Based on input, throughout and outcome evaluation after an experiment against expected items such as those suggested in Tab. 1, the project manager can assess the success of experimentation.

Table 1: Experiment: input, throughput, & outcome

Input	Throughput	Outcome
▪ High level of problem and solution uncertainty ▪ Broad, fuzzy, unstable vision ▪ Empirical, implicit specifications	▪ Human-centered, problem-oriented ▪ Fast and small learning circles ▪ Suitable experimentation design development and execution	▪ New insights related to the problem and/or the solution ▪ Fulfilled learning objective to get deeper understanding

4.2. Iterate

Iterations are recommended if there is a high level of uncertainty related to the needs, however low uncertainty related to the design solution. Iterations are solution-oriented as teams focus on understanding and defining the customer needs, and adapt the solution accordingly. Iteration-based methods are e.g. Scrum, Kanban or the Spiral Model. To proceed as effectively as possible, based on their given knowledge, teams build a solution (active mode) and test it e.g. through customer feedback (reflective mode). While iterating in this “express test cycle”, teams stay in the concrete mode to continuously validate the solution with regard to their increasing customer understanding. Thereby the learning is restricted by the roughly defined solution. Because of the growing understanding, project changes are inevitable, which makes adaptability to change a central characteristic of iteration [23,24,25]. Table 2 suggests relevant expected inputs, throughput and outcomes.

Table 2: Iterate: input, throughput, & outcome

Input	Throughput	Outcome
▪ Vague, incomplete specification ▪ High level of problem uncertainty ▪ Clear idea of the solution´s concept	▪ Prioritization of learning objective ▪ Target-oriented, iterative development, ▪ Incremental delivery, ongoing result validation.	▪ Validated working solution ▪ Development & scope progress

4.3. Plan

Planning is the recommended approach if the problem or project requirements are well understood but the solution or the way how to solve the problem is highly uncertain. As the required input information is given, project managers can develop an execution plan in terms of activities and resources which they can track. They can demand a specific degree of detail with respect to the project plan or give a clear budget restriction to provide guidance to the project team. The manager as well as the project team play key roles. Based on input evaluation the project manager is able to validate if the selected approach fits to the project conditions. Based on the outcome evaluation the manager is able to monitor if the execution takes place as planned and ends in a valuable solution (satisfying outcome) or if the team gets bogged down in details or waste time and effort in adjusting the plan (unsatisfying outcome), cf. Table 3.

Table 3: Plan: input, throughput, & outcome

Input	Throughput	Outcome
▪ Clear problem specification ▪ High level of uncertainty regarding the solution	▪ Structuring and prioritization of given information ▪ Abstraction of potential results	▪ Plan with milestones, activities, resources ▪ Measurable objectives

4.4. Execute

In case of a clear understanding of the problem as well as the related solution, direct execution is recommended, without further learning or planning. Measuring performance is simple as the defined solution is achieved or not (cf. Table 4). The key players are the operating experts/team members.

Table 4: Execute: input, throughput, & outcome

Input	Throughput	Outcome
▪ Clear problem specification ▪ Well-understood solution concept	▪ Follow the process ▪ Process-based control	▪ Result as agreed or/and defined

The key idea is to apply this classification to individual work packages and/or tasks of the IDP in order to support project managers in choosing the most appropriate management approach per task. In the following section, we will complement naviProM with a method of structuring IDPs in appropriate work packages and tasks.

5. IDP work breakdown

We will make use of the concept of the work breakdown structure (WBS) to help IDP managers break down the IDP to tasks whose input and outcome uncertainty levels can be clearly classified, and a management approach can be chosen and applied. The WBS offers a proven way to subdivide a project into subprojects based on individual work packages [26]. The WBS can include a cost and schedule plan of a work package as well as network plan to illustrate the dependencies of work packages [27].

In order to propose generic work packages with particular relevance to IDPs, we elaborate on Griffin´s hourglass model [28, 29]. Griffin developed 5 major objectives which function as generic reference points of IDPs from the initial starting point to the final implementation. These are complemented with objectives related to the corporate context [30]:

- Define the problem
- Understand the problem

- Define the target group
- Understand the early adopter
- Develop a specification
- Invent the solution
- Validate the solution
- Business alignment
- Develop the solution (content /technically)
- Create user acceptance for the solution

IDP managers can use these objectives both for analyzing ongoing projects, as well as planning new projects. They can analyze or plan work packages and tasks necessary to achieve these objectives, and classify each of them using naviProM.

6. Stakeholder integration

So far our tool does not include the organizational dimension which is nonetheless an indispensable part of IDP success. We therefore complement our tool with the integration of stakeholders involved in each IDP work package or task. Derived from the task perspective and based on scientific findings we define three central roles that determine task related progress of an IDP:

(1) Core team who is driving the project,

(2) Functional expert who complements the required set of expertise, and

(3) User who potentially uses or buys the IDP result.

From an organizational perspective, the IDP has to be formally integrated in the permanent organization and has to create a value related to its vision [11]. Newly developed solutions generally do not fit to the established system, require an adjustment of an organization's well-established practices or may eliminate established processes. Thus, IDP teams are frequently exposed to active and passive resistance, face resistance as well as political pressure. The level of resistance is particularly high in the period where IDP teams and results are integrated into an organization's institutionalized environment (e.g. organizational structure, restrictive mindset, lack of competences) [16]. Therefore, the focus is on relationship management between the temporary IDP and the permanent organization. To overcome these difficulties, two further roles are critical for IDPs in a corporate context:

(4) Sponsor who provides resources that are not formally implemented as well as project support and protection in demonstrating IDP feasibility [31].

(5) Gatekeeper who can provide access to the organizational level and the necessary resources.

Apart from the network roles, the relationships between these roles and the IDP are crucial. In particular, under conditions of high uncertainty, when there is no formal organizational acceptance of an idea, dedicated resources are limited. Therefore a team has to start building a network of supporters, of colleagues who are committed to the idea and willing to support the IDP team (e. g with their network, expertise, resources). In this case the people do not fulfill their formal function or role, but act on the basis of personal conviction, interest and motivation. They have a positive attitude towards the project. However, people with a negative attitude can have a negative influence on the IDP, e. g. through resistance, fear or conflict. To evaluate the influence of stakeholders we differentiate between positive, negative and neutral. In addition this influence can differ in its efficiency. Thus, a well-intentioned advice or support can be wrong or not supportive [32]. Therefore, we also rate the efficiency between efficient, neutral or inefficient.

7. Case Study

We applied the presented tool set to the analysis of four different IDP's at a leading Life science company. In this section, we present the key insights we gained from this activity for one selected project to demonstrate the power and potential of our decision tool set, whose quantitative evaluation is still ongoing. For confidentiality reasons, and because the project is a strategic one, we are not allowed to publish any project specifics.

The project belongs to a business area having direct access to external end customers. The IDP team consists of 5 internal employees, 3 of which have the required domain knowledge and are based in different departments in the same business area, whereas two of them come from IT. Their mission is to develop a mobile software application for global use. Supported by a corporate innovation initiative with funding and consultancy, the prototype reached TRL 4 [33] after a project period of 1 year. While being aligned with business priorities, customer acceptance was not satisfying. In order to help find this problem's root cause, we supported the project manager with our tools set. Figure 2 shows the main outcome.

We identified three main work streams, depicted as grey arrows: customer development (CDW), solution development (SDW), and business development (BDW). Time-wise, four phases (blue, overarching boxes) are significant: Phase 1 concentrated on understanding customer needs, phase 2 focused on solution invention as well as business development. During phase 3 the team developed and validated the solution, while the future phase 4 will concentrate on the creation of customer acceptance. Illustrated by the three overarching I-typed work packages, the team first defined the major objectives (green boxes "P") which were iteratively adjusted afterwards. Only phase 4 did not see any iteration so far. There, the dotted arrows show the aspired interconnection and consolidation of the work streams. The question marks next to the work packages indicate that the latter have not been completed and therefore did not generate any measurable outcome yet. At the beginning of phase 4 customer expectations towards the product are still unclear. In order to

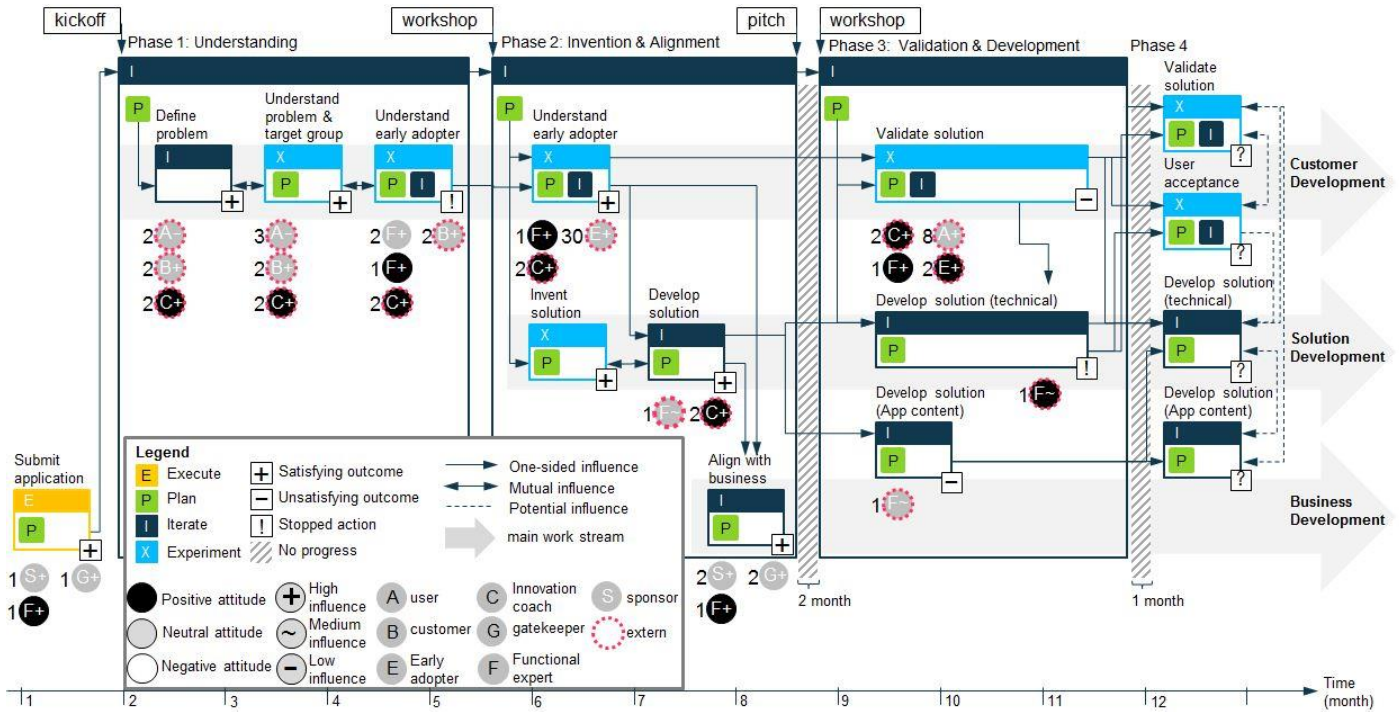

Figure 2: sample project analysis using naviProM

find the root cause we analyze the phases 1-3.

In phase 1, the team concentrated its activities on customer understanding through experimentation. Here, the adjustment of involved stakeholders is of peculiar interest. In the beginning, two different external target groups (A & B) were involved. With sharpened role and problem understanding the team only involved B and in later phases E as it turned out that B constituted the buying customer, E the early adopter, and A the end user. The end users had a negative feedback while selected customers had a positive attitude towards the IDP. This adjustment indicates that experimentation gave the team a better understanding of its customers and product. The experiment to understand the role of early adopters ("!") was stopped and was restarted in phase 2. The work packages in phase 1 interact well (double-headed arrows), aiming at understanding the problem and undertaking appropriate actions based on a presumably steeply rising learning curve. The major objectives (invention & alignment) of phase 2 were achieved by integrating supportive early adopters, as well as a coach and a functional expert to validate the experimental design. The team iteratively developed a first solution draft (with satisfying outcome "+") which served as basis of the later solution development. The results of both work packages flew into the BDW. The team structured the generated results and insights ("P") to later develop a pitch by iteration in front of two sponsors (S) and two gatekeepers (G). The "+" indicates that the team achieved the aspired alignment, generating the basis for the downstream work packages. In phase 3, the team started three separate work packages: (1) develop the technical solution, (2) generate the content, and (3) validate the solution. The team did address solution validation in an experiment ("X"-type work package), however with unsatisfying outcome, indicated by a "-"; as the experiment did not generate the data needed to validate the assumption. They planned the execution of the experiment in advance. A questionnaire was developed iteratively and validated by two external innovation coaches (C) and one functional expert (F). Both these stakeholders supported the IDP positively ("+") and effectively (black node). Early adopters (E) and end users (A) were involved early on for feedback, which indicates that the team experimented or iterated. Due to the lack of an appropriate prototype (solution development) the experiment did not generated the needed data.

In parallel, the iterative development of the technical solution and the content was started independently (few connecting arrows). An external functional expert (F) was involved in developing the content. The outcome of this work package was unsatisfying ("-"). The technical development was done in a continuous and efficient exchange with another external functional expert (F). The team regularly validated the results, however without involving the end customer ("B" stakeholder missing in all work packages). Because of the unsatisfying outcome of the content work package, the technical development work package had to be interrupted ("!"). Hence, we can assume that (1) failing to integrate the end customer in the development iterations, as well as (2) limited interaction between the 3 work packages constitute the main sources of problems generated in phase 3. To summarize, our tool creates an overview of the work packages, their stakeholders, as well as their relationships complemented with the rated outcomes on a macro-level. It provides the project manager and team with the insights to quickly capture the project's history, nail down the key problem sources (in this case the lack of customer involvement in phase 2 validation, as well as the lack of interaction between the work packages in phases 2 and 3).

8. Summary, Conclusion and Outlook

We proposed and applied a complementary decision aid tool for IDP managers to quickly capture the current IDP status and its history in order to understand root causes of problems and/or to plan future IDP activities and stakeholder involvement. To achieve this, our tool integrates work package classification according to their uncertainty levels (naviProM), relationships and flows among work packages, as well as stakeholders including their roles and influences. By proposing modular work package stereotypes that are characteristic for IDPs, our tool provides a sort of Lego® for IDP project managers, which can be applied to both the analysis and synthesis (i.e., strategic future planning) of IDP's. While we elaborated mainly on analysis in this paper, our future research focus clearly lies on proposing IDP patterns based on the elementary work package "bricks" of our toolset. Such patterns would provide a completely new support to IDP project managers to plan and constantly adjust their design projects with respect to activities to carry out and stakeholders to be involved.

References

[1] Pich MT, Loch CH, De Meyer A. On Uncertainty, Ambiguity, and Complexity in Project Management. Management Science 2002; 48(8): 1008-1023. Research Collection Lee Kong Chian School Of Business.

[2] Brown WJ, McCormick HW, Thomas SW. Anti Patterns in Project Management. New York: John Wiley; 2000.

[3] Shenhar A. One size does not fit all projects: exploring classical contingency domains. Manage Sci. 2001; 47 (3):394-414.

[4] Howell D, Windahl C, Seidel R. A project contingency framework based on uncertainty and its consequences, International Journal of Project Management 2010; 28:256-264.

[5] Crawford GC, Kreiser PM. Corporate entrepreneurship strategy: extending the integrative framework through the lens of complexity science. Small Bus. Econ. 2015; 45(2): 403-423.

[6] Ireland RD, Covin JG, Kuratko DF. Conceptualizing corporate entrepreneurship strategy. Entrepreneurship Theory Pract 2009; 33(1): 19-46.

[7] Dedehayir O, Mäkinen SJ, Ortt JR. Roles during innovation ecosystem genesis: A literature review. Technological Forecasting and Social Change 2018; 136:18-29.

[8] Ramasesh RV, Browning TR. A conceptual framework for tackling knowable unknown unknowns in project management. Journal of Operations Management 2014; 32(4):190-204.

[9] Ciric D, Lalic B, Gracanin D, Palcic I, Zivlak N. Agile Project Management in New Product Development and Innovation Processes: Challenges and Benefits Beyond Software Domain. IEEE International Symposium on Innovation and Entrepreneurship (TEMS-ISIE), Beijing 2018, pp. 1-9.

[10] Daniel PA, Daniel C. Complexity, uncertainty and mental models: From a paradigm of regulation to a paradigm of emergence in project management. International Journal of Project Management 2018, 36(1):184-197.

[11] Andersen ES. Do project managers have different perspectives on project management?. International Journal of Project Management 2016; 34(1), 58-65.

[12] Paluch S, Antons D, Brettel M, Hopp C, Salge TO, Piller F, Wentzel D. Stage-gate and agile development in the digital age: Promises, perils, and boundary conditions. Journal of Business Research 2019.

[13] Collyer S, Warren CM. Project management approaches for dynamic environments. International Journal of Project Management 2009; 27(4):355-364.

[14] Greve A, Salaff JW. Social networks and entrepreneurship. Entrepreneurship theory and practice 2003; 28(1):1-22.

[15] Teece DJ. Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy. In D.J. Teece (ed.), The Competitive Challenge: Cambridge, MA: Ballinger Publishing; 1987. pp. 185-219

[16] Kelley DJ, Peters L, O'Connor GC. Intra-organizational networking for innovation-based corporate entrepreneurship. Journal of Business Venturing 2009; 24(3):221-235.

[17] Markham SK, Ward SJ, Aiman-Smith L, Kingon AI. The valley of death as context for role theory in product innovation. Journal of Product Innovation Management 2010; 27(3):402-417.

[18] Gebhardt K, Maes T, Riel A. A Project Management Decision Support Tool for Keeping Pace with the Dynamics of Corporate Innovation Projects. European Conference on Software Process Improvement. Springer, Cham; 2018. pp. 619-630.

[19] Kolb DA. Experiential Learning: Experience as the Source of Learning and Development. New Jersey: Prentice-Hall; 1984.

[20] Beckman SL, Barry M. Innovation as a learning process: embedding design thinking. Calif. Manag. Rev. 2007; 50(1):25-56.

[21] Brown T. Design thinking. Harvard Business Review 2008; 86(5):84-92.

[22] Altshuller G, translated by Shulyak L. And Suddenly the Inventor Appeared-TRIZ, the Theory of Inventive Problem Solving, Technical Innovation Center, INC. Worcester, MA, 1996.

[23] Heck J, Rittiner F, Steinert M, Meboldt M. Iteration-based performance measurement in the fuzzy front end of PDPs. Procedia CIRP 50; 2016. p. 4-19.

[24] de Weck OL, Eckert CA classification of uncertainty for early product and system design. International Conference on Engineering Design, ICED 2007, 28-31 August 2007, Paris: Cite des Sciences et de l'industrie; 2007.

[25] McManus H, Hastings DA framework for understanding uncertainty and its mitigation and exploitation in complex systems. INCOSE International Symposium, Rochester, NY 2005; 15(1):484-503.

[26] PERT Cost Systems Design PERT Coordinating Group (Jun 1962) (DOD and NASA Guide)

[27] Tausworthe RC. The work breakdown structure in software project management. Journal of Systems and Software 1979; 1:181-186.

[28] Koen P, Ajamian G, Burkart R, Clamen A, Davidson J, D'Amore R, et al. Providing clarity and a common language to the 'fuzzy front end'. Research Technology Management 2001; 45:46-55.

[29] Griffin A, et al. Industrial Marketing Management 2014; 43:1362-1371.

[30] Ries E. The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. Crown Books, 2011.

[31] Tighe G. From experience: Securing sponsors and funding for new product development projects – the human side enterprise. J. Prod. Innov. Manag. 1998; 15:75-81.

[32] Hoang H, Yi A. Network-based research in entrepreneurship: A decade in review. Foundations and Trends in Entrepreneurship 2015; 11(1):1-54.

[33] Mankins JC. Technology readiness assessments: a retrospective. Acta Astronaut 2009; 65(9-10): 1216-1223.